STUDIES ON LIVER DYSFUNCTIONS IN GOATS WITH SPECIAL REFERENCE TO ITS THERAPY WITH CERTAIN HERBAL HEPATOTONICS

A Thesis
submitted to the
Bidhan Chandra Krishi Viswavidyalaya
in partial fulfilment of the requirements for the Degree of
Master of Veterinary Science
in
VETERINARY MEDICINE

BY

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BIDHAN CHANDRA KRISHI VISWAVIDYALAYA
1991

Dedicated

to

My beloved Parents

APPROVAL SHEET

APPROVAL OF EXAMINERS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (VETERINARY)

We, the undersigned, have been satisfied with the performance of Himansu Sekhar Patra, in the Viva-Voce Examination, conducted today the ..... 1991, recommended that the thesis be accepted for the award of the Degree.

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A C K N O W L E D G E M E N T

I express my deepest sense of gratitude and indebtedness to Dr. N.R.Pradhan, M.V.Sc., Reader, Department of Clinics, Faculty of Veterinary and Animal Sciences, Bidhan Chandra Krishi Viswavidyalaya, Nadia and formerly Lecturer, Department of Veterinary Medicine and Public Health, Faculty of Veterinary and Animal Sciences, Bidhan Chandra Krishi Viswavidyalaya, Nadia, for his excellent guidance, constant encouragement and taking constant interest offering constructive criticisms with advice and suggestions during the course of my experiment.

I record my sincere gratitude to Dr. B. N. Mukherjee, Ph.D., Head, Department of Veterinary Medicine and Public Health, Bidhan Chandra Krishi Viswavidyalaya for his valuable suggestions and help during the course of present investigation.

I gratefully express my deep sense of appreciation to Dr. A.K.Pramanik, Ph.D., Reader, Dr. A. Chakraborti, Ph.D., Reader, Dr. S.K.Mitra, M.V.P.H., Reader, Dr. S. Sarkar, Ph.D., Lecturer, Department of Veterinary Medicine and Public Health for their valuable suggestions and inspirations during the course of this investigations.

I am also highly grateful to Dr. D.K.Basak, Ph.D., Reader, Department of Veterinary Pathology, Bidhan Chandra Krishi Viswavidyalaya for his help in interpretation of the histopathological studies for this investigation.

The help and suggestions graciously extended by Dr. A. K. Chakraborty, Ph.D., Reader and Head, Department of Veterinary Pharmacology and Toxicology, in preparing the chemical materials of this study is gratefully acknowledged.

It is my pleasure to express my sincere thanks and gratitude to my colleagues Dr. S.K.Roy, Dr. K.C.Das, Dr. D.Basak, Dr. P. Majumder, for their inspirations during the course of this investigation.

The timely help and co-operation received from the non-teaching staffs of this department, is also highly appreciated.

Thanks are due to M/s. Vetmed Ltd. and M/s. Indian Herbs, for supplying the medicines for the trial.

I render my thanks to Sri P.K.Chakraborty and Sri T.K. Bhowmik for typing the thesis.

I render my thanks to 'Sun Beam' in taking Photographs for this investigation.

I also express my deepest sense of indebtedness to my parents for their constant inspiration during the course of this study.

Lastly, I express my sincere thanks to 'Soma', for her constant encouragement throughout the experimental period.

Himansu Sekhar Patra
(HIMANSU SEKHAR PATRA)

Dated : Mohanpur
The. 3rd Aug'. .1991.

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LIST OF ABBREVIATIONS USED

A/G ratio	=	Albumin globulin ratio
&	=	and
AP	=	Alkaline phosphatase
@	=	at the rate of
BU	=	Bodansky unit
CTC	=	Carbontetrachloride
CO	=	Company
OC	=	Centrigrade
DLC	=	Differential leucocyte count
^{O}F	=	Fahrenheit
Fig	=	Figure
g	=	gram
Gr	=	Group
GOT	=	Glutamic oxalacetic transaminase
GPT	=	Glutamic pyruvic transaminase
H & E	=	Haematoxylene and Eosin
Hb	=	Haemoglobin
hr	=	hour
I/M	=	Intramuscular
I/V	=	Intravenous
IU	=	International Unit
kg	=	Kilogram
l	=	litre
Ltd	=	Limited
$\angle$	=	Less than
MCH	=	Mean corpuscular haemoglobin

MCHC	=	Mean corpuscular haemoglobin concentration
MCV	=	Mean corpuscular volume
mg	=	milligram
min.	=	minute
ml.	=	millilitre
mm.	=	millimeterM
M/S	=	Messers
µg	=	microgram
No.	=	Number
%	=	Percentage
PER	=	Rough endoplasmic reticulum
Sec.	=	Second
S.E.	=	Standard error
TEC	=	Total erythrocyte count
TLC	=	Total leucocyte count
±	=	Plus minus
U	=	Unit

CHAPTER I

INTRODUCTION

1.0 INTRODUCTION

The goat is an important domestic animal, because it is one of the oldest domesticated ruminant and it has better ability to adapt in various local conditions (Devendra and Burns, 1970). This goat is considered as poorman's cow since its maintenance cost is very low and its meat is also acceptable to most of the communities of this country. Its growth rate and multiplicity is also very high. According to the FAO report of 1988, goat comprises about 20.78 percent amongst the total population of goat in the world. In India, the total population of goat is 108.493 million, against the world's population of 521.974 million. Goats contribute about 3 percent of the total milk and 35 percent of total meat produced in India (Chawla et al., 1981). In West Bengal, most of the poor farmers depend mostly on the goat production which plays an unique role in their agricultural economy,. But due to poor management, nutrition and disease conditions, the growth rate of these goats is very poor. Amongst the diseases of goats, liver dysfunction is the most important and common one in them.

The liver is one of the largest organ of the body and is probably one of the most important, having a complex

metabolism of its own and, in addition, being involved in most of the general metabolic processes of the body (Ford, 1965). The removal of liver cause death in animals within 12 months (Mullen, 1976). The liver is the largest organ of the body and it has numerous functions in respect of other glands. The functions of the liver may be discussed under five main headings, which are circulatory, excretory, metabolic, defensive and haemopoietic function (Mullen, 1976). Therefore any abnormality in the level of protein, glucose cholesterol and lipid indicate the extensive liver damage (Pearson and Craig, 1980) since it helps to maintain the level of them. The liver guards the internal environment and encounter first and identify the substances absorbed through the digestive tract. The portal vein carries the products of digestion from the G.I. tract. All the products of digestion passing through liver, some are stored in the liver and others are paseed to various tissues of the body, either in the same form of the products by which it is absorbed or after undergoing certain chemical reactions in the liver.

Liver dysfunctions occur due to damage of the hepatocytes by certain drugs, chemicals or some other agents (Captain and Syed, 1966). Dwivedi et al. (1987) opined that certain drugs which are used extensively in some diseases also causes liver dysfunction. Carbontetrachloride which is used extensively in parasitic intestations due to its low cost, causes severe hepatotoxicity in animals. Even at therapeutic dose,

it produces toxicity in debilitated and starved animals (Sethuraman et al., 1978). A single toxic dose produces centrilobular necrosis and diffuse fatty infiltration. These changes occur within 1 to 5 hours of CTC administration and maximum damage occur within 24 to 48 hours (Recknegal, 1967).

Sen et al. (1976) remarked that without assessing the status of the liver, indiscriminate use as of anthelmintics can cause death of the animals.

Toxic plants like Lantana camara, Ipomoea carnea, Senecio sps. etc. contain hepatotoxins which are not consumed by the animals normally, but sometimes the goats eats the leaves of these plants especially during the summer season when draught prevails in tropical and subtropical countries. Ingestion of these leaves causes moderate to marked hepatotoxicity in them. Certain toxic fungi like Aspergillus flavus, Fusarium spp. also causes hepatotoxicity, when ingested through feed. Nutritional deficiency of methionine, choline, riboflavin and vitamin E and intake of high fat diet also sometimes causes hepatotoxicity in animals. All the toxic materials absorbed from the gastrointestinal tract passes through the liver which maintains the health and production of the animal.

Following toxicity, considerable damages occur in the liver before clinical signs appear. The clinical silence of liver injury largely sterns from three important hepatic characteristics. They are, a high degree of reserve functional

capacity, a complex and multiple functional activity and an unusual ability to regenerate by the liver parenchyma (Mullen, 1976).

The incidence of hepatic damage has been reported from the field by Nair (1981) in Indian elephants, Boishya et al. (1981) in cattle, calves and goats, Prasad et al. (1982) in buffalo calves, cows and Mahanta et al. (1983) in buffalo calves.

The diagnosis of liver dysfunction is difficult one. The clinical signs and certain liver function tests may help to diagnose the liver diseases. In primary hepatic disease, the clinical signs are caused solely by the lesions of the liver but in secondary involvement the clinical signs are unrelated to the liver damage. Clinical signs of hepatic dysfunctions for all species are anorexia, alimentary tract stasis, discoloured faeces, pain on palpation on hepatic area, jaundice, discoloured urine, odema and emaciation, photosensitization, interference in blood clotting and certain nervous signs (Mullen, 1976).

For the veterinary clinician it is important to know the effects of partial loss of liver function so that he may be in a better position to detect the damage, assess its degree, and finally can estimate it's effect on the patient's future productivity (Ford, 1965). Although there are number of various liver function tests available for detection of

liver damage but no single test can confirm the functional status of the liver and its parenchymal damage (Kaneko, 1980).

The liver function tests which are based on the excretory function, metabolic activities, enzymatic activities and pathological alterations can only help to assess the liver disorder at a particular time (Mullen, 1976). Alemu et al. (1977) stated that, the extent of liver damage caused by the toxic agents can be monitored by measuring the serum enzyme activities. Though the various tests are available, but the estimation of the serum enzyme activities are the most sensitive and important liver function tests available for the diagnosis of hepatic dysfunction.

The treatment of liver disorder is costlier in animals. Therefore certain hepatotonics of herbal origin have been tried by various workers and were claimed to be effective (Mahanta et al. 1983; Sharma et al. 1986; Dange et al. 1986; Dhumal et al. 1989; Peer et al. 1990 and Pradhan, 1991). It is important to know the exact nature of the damage of the liver, its pathogenesis due to toxicity and the regeneration of the liver parenchyma with the herbal hepatotonics in India is still debatable in domesticated animals particularly in goats.

It is therefore proposed to take up the study of liver dysfunctions in goats both experimentally and clinically as follows :

I. To study the pathogenesis of liver damage in goats by causing experimental damage of liver with carbontetrachloride, and hepatotoxic chemical agent.

II. To correlate the extent of hepatic damage as diagnosed by clinical, haematological, biochemical and histopathological studies on the animals with liver dysfunctions during the period of experimental study.

III. To correlate a good number of liver function tests more specific for goats for diagnosis of liver dysfunction.

IV. To carry out the comparative therapeutic study to find out the efficacy of certain herbal liver tonics in comparison with the conventional therapy in cases of experimental hepatic damage in goats.

CHAPTER II

REVIEW OF LITERATURE

2.0 REVIEW OF LITERATURE

2.1 Experimental Hepatic Damage

Carbontetrachloride is a chlorinated hydrocarbon, chemically related to chloroform. CTC is one of the most extensively used hepatotoxic substance used for assessment of various liver function tests as well as some therapeutic trials.

Rose (1932) used carbontetrachloride as drench in sheep and cattle to induce hepatotoxicity. He opined that inclement weather enhances the toxicity.

Oxer (1933) produced hepatopathy in sheep with drenching of 2-3 ml of carbontetrachloride in liquid paraffin. Siliya Leitao (1945) concluded that lambs within 6 months of age could sustain the toxicity of 55 ml of carbontetrachloride given along with calcium borogluconate therapy.

Cornelius et al. (1959) administered carbontetrachloride to horses, cows, pigs and dogs to produce experimental hepatotoxicity.

Gallagher (1960) administered undiluted carbontetrachloride of 50 ml by stomach tube into the rumen of sheep and observed that the sheep died from respiratory embarrassment within 2 hours of CTC administration.

Setchell (1961) studied the liver and kidney functions by administering 40 ml of carbontetrachloride with 60 ml of liquid paraffin and 50 ml of carbontetrachloride with 100 ml of liquid paraffin in two experiments in sheep.

Ford and Boyd (1962) studied the various liver function tests by administering dimidium bromide in a single parenteral injection in cattle for inducing liver injury.

Toxic dose of carbontetrachloride ranges from 0.25 to 0.5 ml/kg body weight in different animals was reported by Cornelius et al. (1963).

Kondos et al. (1963) administered carbontetrachloride by intramuscular injection at the dose rates of 1, 2, 4 and 8 ml or by intraruminal injection at the dose rates of 1, 2 and 4 ml in sheep infected with Fasciola hepatica.

Ford and Lowrence (1965) reported that, a single oral dose of 1-2 ml of carbontetrachloride produced marked centrilobular necrosis of the liver with rapid rise of serum enzymes levels in sheep but repeatation of this dose showed less severe liver lesions and less increase in serum enzyme concentration.

Gee (1967) administered carbontetrachloride at the dose of 5 ml of a 20% solution in liquid paraffin and 5 ml of 40% solution in liquid paraffin through different routes but observed the same effect. He opined that intraabomasal route resulted more mortality than the intra-ruminal route.

Seawright McLean (1967) postulated that pretreatment with phenobarbitone, enhances the activity of carbontetrachloride intoxication, as the injections of phenobarbitone stimulates the activity of the microsomal drug-metabolizing enzymes in the liver cells.

Selenium has some effect on carbontetrachloride toxicity in animals was reported by Kondos and McClymount (1967). They observed that the toxicity of carbontetrachloride reduces following selenium administration.

Recknagal (1967) reported that a single toxic dose of carbontetrachloride produces centrilobular necrosis and diffuse fatty infiltration. Biochemical and ultrastructural studies have confirmed that the functional and morphological changes of cell organelles occur as early as 1 to 5 hours following CTC administration and maximum damage occurs within 24 to 48 hours after carbontetrachloride administration.

Gopinath and Ford (1970) studied the histochemical and histopathological changes of the liver by administering alpha-napthyl isothiocyanate (ANIT) @ 100 to 400 mg/kg orally in sheep and calves.

Goodman and Gilman (1971) reported carbontetrachloride having selective toxicological effects which involved kidney and liver.

Hunt (1971) administered 10 ml of a 40% solution of carbontetrachloride in liquid paraffin by intraruminal injection in sheep. He opined that the protein content in the diet could influence the hepatotoxicity due to carbontetrachloride.

Mottalib et al. (1976) could induce hepatopathy as well as nephrotoxicity in goats by administering 50-60 ml of carbontetrachloride with arachis oil through intramuscular injection.

Sen et al. (1976) administered carbontetrachloride @ 1 ml/kg body weight in goats to study some liver function tests.

Anderson et al. (1977) and (1982) studied the plasma enzyme activities and some other blood components in cattle by experimentally inducing hepatopathy with the infection of metacercaria of F. hepatica.

Alemu et al. (1977) produced hepatic disorders by administering carbontetrachloride in sunflower oil at the dose of 0.5 ml/kg body weight in sheep through stomach tube and observed the clinical signs.

Sethuraman and Verma (1979) studied the various liver function tests in buffaloes by administering carbontetrachloride intraruminally @ 0.5 ml/kg body weight.

Nooruddin et al. (1982) studied certain haematological and biochemical changes of Black Bengal goats which were naturally infected with Fasciola gigantica.

Mahanta et al. (1983) administered carbontetrachloride @ 0.3 ml/kg body weight by intraruminal route to induce hepatopathy in buffalo calves.

Mahanta (1984) administered carbontetrachloride in buffalo calves @ 0.5ml/kg body weight intraruminally to induce hepatic damage and studied different liver function tests.

Maru and Pachuri (1985) studied the nature of liver dysfunctions in buffalo calves with carbontetrachloride @ 0.5ml and 0.25ml/kg body weight at different intervals.

Sharma et al. (1986) administered carbontetrachloride @ 0.75ml/kg body weight with 20-50ml of liquid paraffin in a single dose to induce hepatotoxicity in goats.

Bhatta and Roychoudhury (1986) studied the biochemical changes of blood on the 34th day of post-infection of Fasciola infected calves.

Peer (1987) administered carbontetrachloride @ 0.5 ml/kg body weight orally as a single dose diluted with liquid paraffin (1:10) to induce hepatopathy.

Tirkey et al. (1987) studied the haematological and biochemical parameters in goats, by administering Ipomoea carnea orally to induce liver damage.

Dhumal et al. (1989) administered carbontetrachloride at the dose of 0.5ml/kg body weight intraperitoneally as a single dose in male rabbits and estimated the serum enzymes to detect the extent of hepatic damage.

Pradhan (1991) studied the biochemical changes of blood and the histopathological and electronmicroscopical changes of liver in goats by experimentally inducing hepatotoxicity with carbontetrachloride @ 1ml/kg body weight orally by stomach tube for 2 occassions at 48 hours interval.

2.2 Clinical Symptoms

Clinical signs of liver dysfunctions appear when 75% of the lobules of liver are affected. In primary liver dysfunctions, the clinical signs appear due to lesions of the liver and in secondary dysfunctions, the syndrome may include some clinical signs unrelated to the hepatic lesions.

Inappetance, dirrhoea, emaciation and death due to decubitus condition in cirrhosis of liver in cattle was reported by Gillain (1932).

Oxer (1933) observed, partial loss of appetite lethergy rather than depression in sheep. He also reported that, rumination was unaffected and the cases recovered after 4-9 days.

Blakemore (1946) noted depression, inability to stand and coma before death in suffolk ewes following carbontetrachloride intoxication.

Mangalik et al. (1957) opined ascites have a direct relation with the degree of hepatic cirrhosis/fibrosis in rats with carbontetrachloride intoxication.

Gallagher (1960) recorded mortality in sheep within 4 to 5 hours after 300ml of carbontetrachloride administration. Respiratory distress was the marked clinical feature which became more pronounced when the animals in recumbancy.

Setchell (1962) recorded dullness and observed scouring in CTC induced hepatic disorders in sheep. Convulsions of unspecified nature was also recorded by him.

Ford and Boyd (1962) noted signs of weakness, loss of appetite, icterus and fall of milk production in two cows, experimentally induced hepatopathy by parenteral administration of dimidium bromide.

Symptoms of photosensitization and icterus were noticed in cattle due to feeding of flood affected alfa-alfa (lucerns), hay by Glenn et al. (1965).

Poor appetite, letharginess and dullness were the symptoms, recorded by Captain and Syed (1966) in carbontetrachloride poisoning in horses.

Photosensitization and icterus due to Lantana camara poisoning in sheep along with the lesions of the skin like erosion, ulceration, sloughing of necrotic tissue and haemorrhages at the less pigmented areas were observed by Bwangamoi (1967) at Entebee.

Rosenberger (1979) recorded yellowish pigmentation of sclera of the visible mucous membrane as an indication of jaundice in cattle.

Loss of appetite was noted in carbontetrachloride poisoning in sheep by Caple and Heath (1971).

Severe abdominal pain and haemorrhages were recorded by Goodman and Gilman (1971) following oral administration of carbontetrachloride.

Finn and Tennant (1974) recorded aggressive behaviour, ataxia, terminal recumbancy with muscle tremors and involuntary jerking of the limbs, tenesmus and unusual bellowing in hepatic encephalopathy in cattle.

Hungerford (1975) recorded dullness as the only symptom of hepatic dysfunction in cattle. In some cases he noted scouring as a marked feature.

Anorexia and letharginess in sheep and calves following carbontetrachloride administration were observed by Anwar et al. (1976), but no such symptoms were visible in dogs with the same dose of carbontetrachloride by them.

Mullen (1976) recorded the clinical signs of hepatic dysfunction for all species of farm animals which were anorexia, alimentary tract stasis, discoloured faeces, pain on percussion of the hepatic area, enlargement of liver, displacement and rupture of the liver, jaundice, discoloured urine, oedema, emaciation, photosensitization, interference with blood clotting and some nervous signs.

Sethuraman and Verma (1978) recorded the clinical signs like dullness, salivation, anorexia, muscle asthenia, occular discharge, increased pulse and respiration, icterus loose motion in buffalo calves following carbontetrachloride intoxication.

Singh et al. (1978) observed the symptoms like stretching of head and neck, trembling, quivering of muscles around the nares, incoordination of movement , deep laboured respiration, excessive nasal discharge, dullness and depression, coma and recumbancy in sheep following carbontetrachloride administration @ 50ml per sheep through stomach tube.

Morrow et al. (1979) recorded the clinical signs of decreased hepatic functions, as anorexia, depression weakness, ketonuria, fever, marked fall in milk yield and progressive

debility in Holstein - Friesian herd due to excessive consumption of corn silage and brewer's grain during late lactating and non-lactating period.

Anderson et al. (1981) noted dullness, inappetance and icterus in calves following 24-48 hours of carbontetrachloride administration.

Blood et al. (1983) remarked the cardinal signs of hepatitis in ruminants to be anorexia, depression, muscle weakness, mild to moderate clonic convulsion, coma and recumbancy.

Mahanta et al. (1983) observed the signs of dullness, salivation, anorexia, muscular weakness, reluctance to move, occular discharge and loose motion following 48-72 hours of carbontetrachloride administration in buffalo calves.

Sharma et al. (1986) observed the signs of dullness, loss of appetite, dehydration, jaundice, incoordination, loss of body weight, dirrhoea, pyrexia, tachycardia and stretched neck following carbontetrachloride administration in goats.

Tirkey et al. (1987) noted the signs of dullness, ataxia, incoordination of gait and paralysis of hind quarter with dirrhoea, lacrimation, nasal discharge, roughness of hair coat, progressive weakness and emaciation following administration of Ipomoea carnea in goats.

Peer et al. (1988) recorded the clinical signs of dullness and depression from 2nd day of carbontetrachloride administration in goats. They also observed loss of appetite, rough hair coat, dirrhoea, pale mucous membrane, excessive nasal discharge, stretching of head and neck, chewing like movements of jaws, trembling of limbs and jerky movements, in co-ordination and quivering of muscles in the affected goats.

Peer et al. (1990) observed the clinical signs of emaciation, pale to yellow mucous membrane and enlarged liver, in goats following carbontetrachloride poisoning.

Pradhan (1991) produced experimentally hepatopathy in goats. He recorded the signs like dullness, depression, inappetance, diarrhoea, incordination, aimless movements, rough hair coat, pale or yellowish mucous membrane, trembling of limbs and coma etc. in them.

2.3 Haematological Examinations

Literatures on haematological values in goats are scanty. Some haematological findings have been reported in normal goats by some workers, but very little informations are available from the animals following carbontetrachloride intoxication. There are wide variation in blood constituents in male and female animals.

2.3.1 Haemoglobin (Hb)

Finn and Tennant (1974) observed significant decrease of haemoglobin concentration in hepatic encephalopathy in cattle.

Dessouky and Moustafa (1979) noted severe decrease of haemoglobin percentage in fasciola infected buffaloes.

Nooruddin et al. (1982) worked on the Fasciola gigantica infected Black Bengal goats and they observed significant depression of haemoglobin level in infected goats as compared to the healthy control animals.

Haroun et al. (1986) studied on the naturally occurring ovine fascioliasis in sudan. They observed that infected animals showed a clear decrease in haemoglobin concentration in comparison to the healthy control sheep.

Swarup et al. (1987) opined that Fasciola gigantica infection certainly reduces the haemoglobin concentration in buffaloes.

Tirkey et al. (1987) studied the haematological values in goats following feeding of Ipomoea carnea and they noticed decreased haemoglobin concentration in them.

Peer et al. (1988) studied the haemoglobin values in goats following oral administration of carbontetrachloride and observed a sharp decline in the haemoglobin level after oral administration of carbontetrachloride in those goats.

Chaudhuri et al. (1988) recorded decreased haemoglobin concentrations in buffaloes with natural infections of Fasciola gigantica.

The haemoglobin content of the blood of the buffaloes naturally infected with Fasciola hepatica was found to be significantly reduced by Chaudhuri et al., (1990).

Peer et al. (1990) noted significant declination in the haemoglobin content in goats following oral administration of carbontetrachloride for producing experimental hepatopathy.

2.3.2 Total erythrocyte count

Finn and Tennant (1974) recorded decreased erythrocyte count in hepatic encephalopathy in cattle.

Dessouky and Moustafa (1979) observed decreased erythrocyte count in buffaloes, which were severely infected with Fasciola gigantica.

Nooruddin et al. (1982) recorded significant depression of total RBC count in goats which were naturally infected with Fasciola gigantica.

Haroun et al. (1986) observed decreased erythrocyte counts in sheep with natural infection of Fasciola gigantica.

Tirkey et al. (1987) observed slight decrease in erythrocyte count following feeding of Ipomoea carnea in goats.

Chaudhri et al. (1988) recorded decreased erythrocyte count in buffaloes which were naturally infected with Fasciola gigantica.

Peer et al. (1990) noticed reduced total erythrocyte count following oral administration of carbontetrachloride in goats.

2.3.3 Packed cell volume

Packed cell volume is the percentage of total volume occupied by the packed erythrocytes when a given of whole blood in centrifuged at a given period with a constant speed with EDTA as anticoagulant.

Finn and Tennant (1974) observed a significant decrease of packed cell volume in hepatic encephalopathy in cattle.

Dessouky and Moustafa (1979) studied the haematological findings in fasciola infected buffaloes and observed decreased packed cell volume in the severely affected animals.

Nooruddin et al. (1982) reported decreased packed cell volume in naturally infected Fasciola gigantica in Black Bengal goats.

Haroun et al. (1986) recorded a prominent decrease in packed cell volume in naturally infected Fasciola gigantica infected sheep.

Tirkey et al. (1987) recorded slight decrease of packed cell volume in experimentally induced Ipomoea carnea toxicity in goats.

Peer et al. (1988) observed significant decrease of packed cell volume following oral administration of carbontetrachloride in goats.

Chaudhri et al. (1988) recorded decreased packed cell volume in buffaloes having natural infection of Fasciola gigantica.

Peer et al. (1990) recorded a significant decline of packed cell volume in goats following oral administration of carbontetrachloride.

2.3.4 Mean corpuscular volume, Mean corpuscular Haemoglobin and Mean Corpuscular Haemoglobin concentration.

These values depends on the Packed cell volume, Haemoglobin, and Total RBC count of blood of animals. However, there is no report available regarding the changes of these values in relation to hepatopathy.

2.3.5 Clotting time

Clotting defects may be seen in liver diseases. Synthesis of some clotting factors may be suppressed either as a result of the reduced absorption of vitamin K, generally observed in obstructive jaundice or due to the overall reduction in function of the hepatic cells which is observed in acute hepatitis.

The main reaction consists of the interaction of the fibrinogen and thrombin to produce fibrin. Fibrinogen is one of the normal plasma protein is synthesized in the liver. Thrombin, on the other hand, is derived from a precursor prothrombin, is also synthesized in the liver with the help of vitamin K.

Rowsell (1969) described that the liver is responsible for the synthesis of many proteins involved in the clotting process of blood.

Mullen (1976) opined that defections in blood clotting requires an assessment of liver function.

Pradhan et al. (1987) observed increased clotting time in goats suffering from anaemia due to haemonchosis.

2.3.6 Total leucocyte count

Finn and Tennant (1974) recorded significant increase of total leucocyte count in cattle with hepatic encephalopathy.

Dessouky and Moustafa (1979) observed leukocytosis in buffaloes which were naturally infected with Fasciola gigantica.

/Nooruddin et al. (1982) worked on the naturally infected Fasciola gigantica infections in goats and they observed significant leucocytosis, a relative neutrophilia and eosinophilia in them. He opined that the leucocytosis in infected goats was due to manifold increase of polymorphonuclear neutrophils and eosinophils.

Haroun et al. (1986) recorded leukocytosis and eosinophilia in sheep of Sudan which were naturally infected with Fasciola gigantica in an endemic area.

Swarup et al. (1987) recorded increased leucocyte count, total eosinophil count, eosinophil leukocyte ratio, percentage of eosinophil, percentage of monocyte in buffaloes which were naturally infected with Fasciola gigantica.

Peer et al. (1988) observed significant increase of leukocyte count with neutrophilia and eosinophilia in goats following oral administration of carbontetrachloride.

Peer et al. (1990) observed leukocytosis and neutrophilia with initial lymphopenia on day 2 post-carbontetrachloride administration in goats and there was a decrease in total leukocyte count from day 5. The neutrophil count however became normal on day 18 of post CTC administration.

Dessouky and Moustafa (1979) remarked that there were no difference between the total serum proteins in Fasciola infected buffaloes in comparison to the noninfected animals. However, the albumin content was found to decrease moderately while the gammaglobulin values were found to be elevated.

Kaneko (1980) reported that none of the alterations in the serum proteins were entirely specific for liver damage, the combination of an absolute low albumin and or a high gamma-globulin level was quite typical.

Barnouin et al. (1981) recorded significant decrease of serum albumin in cattle with liver lesions with Fasciola hepatica.

Kessabi and Lamnaquer (1981) recorded increase in total protein and globulin levels and decrease in albumin level in liver disorders.

Nooruddin et al. (1982) noticed a tendency towards increase value of total serum protein in Fasciola gigantica infected goats. However they observed significant increase of globulin level and significant decrease of albumin and albumin globulin ratio in them.

Holtenius (1982) reported that animals with liver abscesses had as a rule normal liver function tests but with high gamma-globulin and low albumin level in serum.

Poulatov (1984) noticed dysproteinaemia with sharp decrease in albumin and a rise in gamma-globulins in goats infected with Fasciola hepatica and Fasciola gigantica in USSR

Karsai and Schafer (1984) remarked that low levels of serum albumin and high levels of serum beta and gamma-globulins were good diagnostic profiles of liver diseases in dairy cows.

Mahanta (1984) reported nonsignificant change in serum total protein, albumin and A/G ratio in buffalo calves following carbontetrachloride poisoning.

Haroun et al. (1986) noticed a marked hypoalbuminaemia with a decrease in A/G ratio in sheep, naturally infected with Fasciola gigantica.

Bhatta and Roychoudhury (1986) reported decrease in total blood proteins in experimentally infected Fasciola hepatica in calves.

Dwivedi et al. (1986) could not find any significant change in serum protein levels in rabbits with carbontetrachloride induced hepatic damage.

Tirkey et al. (1987) reported that, the administration of aquous extract of Ipomoea carnea did not alter the total serum protein, albumin and globulin levels and the albumin/globulin ratio in goats.

Peer (1987) observed decreased total serum protein, albumin and A/G ratio and slight increase in serum globulin in goats following carbontetrachloride poisoning.

Chaudhri et al. (1988) reported hypoalbuminaemia in buffalo calves which were naturally infected with fasciola gigantica.

Pradhan (1991) recorded a significant decrease of total serum protein, albumin and A/G ratio in goats with experimental hepatopathy with carbontetrachloride. He however detected no significant alteration in the globulin level.

2.4.3 Serum bilirubin

Bilirubin is produced mainly from haemoglobin in the reticuloendothelial system as a result of the destruction of aged red cells. The hepatic parenchymal cells have the ability to absorb bilirubin from plasma. Hyperbilirubinaemia and jaundice are the result of a disturbance of balance between the rate of production of bilirubin and the rate of excretion and they have clinical importance in the diagnosis and evaluation of liver damage.

Varachin et al. (1960) reported the normal total bilirubin content and the elevation of direct values and declination of indirect values of bilirubin in sheep with fasciola and dicrocoelium infection.

Benedek (1961) reported the bilirubin levels between 0.2 and 2.5 mg/100 ml with no direct reacting bilirubin in 19 cattle with severe hepatic degeneration and 14 cattle following experimental carbontetrachloride poisoning.

Huhn (1961) recorded significant increase of serum bilirubin in acute reversible disturbances of liverfunction in cattle.

Ford and Boyd (1962) observed an increase in serum bilirubin level in cattle in later stages of experimental liver lesions which they attributed to be due to interference in biliary secretion.

Trifnov (1964) reported increased total bilirubin values after 6 hours of carbontetrachloride poisoning in sheep which increased further at 24 to 48 hours of toxicity.

Seawright and McLean (1967) reported significant increase in serum bilirubin levels in sheep after 24 hours of administration of carbontetrachloride.

Gopinath and Ford (1969) observed increased concentrations of serum bilirubin and phylloerythrin along with other biochemical changges in sheep while studying the effect of Lantana camara on the liver.

Gopinath and Ford (1970) also recorded increased serum bilirubin level within 24 hours of administration of alphanaphthyl

isothiocyanate (ANIT) in calves and sheep which returned to normal by 6th day.

Dwivedi et al. (1971) reported increased total serum bilirubin level in calves following Lantana poisoning in ruminants.

Sheep dosed with carbontetrachloride, showed no significant change in serum bilirubin concentration (Harvey and Hoe, 1971).

Hansen (1972) concluded that indirect reacting pigment might be useful in diagnosing biliary obstruction.

Gopinath and Ford (1973) reported no hyperbilirubinemia following halothane administration in calves.

Finn and Tennant (1974) observed significant hyperbilirubinemia in calves with liver lesions and they opined that, in each case, the elevation of plasma bilirubin concentration was due exclusively to vanden Bergh reacting pigment.

Harvey and Obeid (1974) observed hyperbilirubinemia in domesticated animals of Sudan in various liver disorders.

Amrousi et al. (1974) observed elevated serum bilirubin level in all the sheep especially in those with post necrotic cirrhosis and chronic nonsuppurative hepatitis.

Pradhan (1991) reported increased serum cholesterol level following oral administration of carbontetrachloride in goats.

2.4.5 Icteric index

The intensity of yellow pigmentation of serum is measured by icteric index. It is a simple method of measuring bilirubin content of the serum.

Gray (1960) opined the icteric index test as the simple, rapid and useful means for indicating the amount of bilirubin present in the serum.

Finn and Tennant (1974) recorded an increased level of icteric index in calves with hepatic encephalopathy.

Soliman and Elamrousi (1974) suggested it as a useful method for determination of the concentration of bilirubin content of the serum and it as also helpful in determining the presence of any latent or subclinical jaundice in animals.

Sethuraman and Verma (1979) and Mahanta et al. (1983) reported increased icteric index value in buffalo calves with experimental hepatic damage caused by carbontetrachloride.

Prasad et al. (1982) observed increased icteric index level in a female buffalo suffering from chronic hepatic jaundice, but Verma (1982) however could not found its diagnostic value for the diagnosis of chronic hepatitis in cattle.

Awasthy and Rao (1984) reported increased serum icteric index level in cows suffering from liver fluke infection.

Mahanta (1984) recorded significant increase of icteric index value in buffalo calves with carbontetrachloride toxicity. The highest average value of 39.0 ± 2.34 unit was recorded on 4th day, as compared to the 0 day value of 9.28 ± 0.58 unit.

Pandey et al. (1985) observed increased level of icteric index values in dogs by producing experimental hepatopathy with carbontetrachloride.

Pradhan (1991) recorded significant increase of the icteric index value from day 2 upto day 15 of the experimental hepatopathy with CTC in goats.

2.4.6 Van den Bergh test

The determination of total bilirubin and conjugated bilirubin in the serum is based on Van den Bergh reaction. So this Van den Bergh test is capable of detecting bilirubin in both the forms. The conjugated form of the bilirubin reacts with diazo reagent and form a red compound which is known as direct reaction. The formation of red colour after addition of alcohol is known as indirect reaction and the presence of unconjugated bilirubin in the serum is detected in this way.

Ford (1965) opined that the quantitative application of Van den Bergh test is capable to detect the type of lesion of the liver causing jaundice.

Kaneko (1980) suggested that the quantitative test which measures the unconjugated (indirect reacting) and conjugated (direct reacting) bilirubin may be determined by routine methods as a practical diagnostic procedure.

Prasad et al. (1982) recorded both direct and indirect positive reactions in Van den Bergh test in a buffalo cow showing chronic hepatic jaundice.

Verma et al. (1982) observed some positive and some negative reactions from 12 cows suffering from chronic hepatitis.

Mahanta (1988) observed the biphasic reactions from 1st to 6th day of CTC administration in buffalo calves.

Pradhan (1991) also recorded the biphasic reactions from day 2 upto day 11 in goats with CTC poisoning.

2.4.7 Serum enzymes

The liver is one of the main metabolic centres of the body. It would be expected, the cells contain a multiplicity of vital enzymes. When liver damage occurs, the cell membranes may become more permeable and the cells may rupture,

and increased levels of enzymes are found in the circulating blood as these enzymes are diffused into the blood stream. Thus the measurement of serum activities of these enzymes can reflect the integrity of the walls of the liver cells and can provide an important method of assessing liver damage.

2.4.7.1 Serum glutamic oxalacetic transaminase (SGOT)

The serum glutamic oxalacetic transaminase (SGOT) is found in many organs as well as in liver and increased serum level of SGOT suggest liver damage.

Grunder (1961) reported that the serum glutamic oxalacetic transaminase (SGOT) estimation had been useful for liver function test in cattle.

Huhn (1961) reported significant changes of serum glutamic oxalacetic transaminase in cattle with low doses of CTC.

Boyd (1962) recorded increased serum glutamic oxalacetic transaminase activity due to liver damage in sheep.

Ford and Boyd (1962) recorded the significantly increased SGOT level due to experimental liver damage in cattle. They observed, even a slight damage of liver can also cause increase of this enzyme level and hence they concluded this enzyme as a sensitive indicator of early and mild hepatocellular damage.

Trifnov (1964) observed increased serum GOT level after 6 hours of CTC administration, in a study on the effects

of CTC on enzyme profiles in sheep. He observed the serum GOT level to increase six fold from 24th to 48th hours of CTC administration.

Ford (1967) observed small and inconsistent changes of serum GOT in sheep and cattle subjected to CTC or spordesmin induced liver damage.

Mullen (1967) opined increased serum GOT level would confirm the liver dysfunctions in large animals. He further opined that in acute liver disease a large increase in activity is usually present.

Choudhuri (1968) opined that estimations of serum GOT along with serum bilirubin could be used for diagnostic and prognostic interpretation of liver disorders in different species of animals.

Gopinath and Ford (1969) reported that feeding of 10 gm of powdered leaf of Lantana camara to the sheep as a single oral dose or as a divided dose on two consecutive days could increase the activity of serum GOT in them.

Slight increase of GOT level in sheep with hepatic damage by alphanaphthyl isothiocynate (ANIT) was reported by Gopinath and Ford (1970).

Fowler (1971) reported increased activity of serum GOT level in goats following therapeutic doses of CTC, which reached maximum at 24 hours after administration.

Harvey and Hoe (1971) observed increased serum GOT level following oral administration of CTC in sheep and they suggested that estimation of serum GOT activity could be used as screening test for hepatic dysfunction in sheep.

Hunt (1971) reported high rise of serum GOT level at 12 hours with a peak at 36 hours in sheep with carbontetrachloride which were maintained at different dietary protein levels.

Nikov (1972) suggested that the SGOT, serum aldolase and SDH were more liver specific serum enzymes though none of these were reliable for the diagnosis of liver cirrhosis.

Hari et al. (1973) recorded increase of SGOT activity in buffalo calves with hepatopathy produced experimentally with lantana poisoning.

Adam et al. (1974) observed increased SGOT levels in goats with fatty changes of liver.

Amrousi et al. (1974) performed liver function tests in liver diseases in sheep and observed in all the cases SGOT showed variable results with a tendency to decrease.

Shaw (1974) reported elevated serum GOT level in liver diseases of ruminants (sheep and cattle).

Hoe and Wilkinson (1973) suggested that estimation of serum GOT level is a valuable index of liver damage and they observed increased GOT level in liver damage.

Grimoldi et al. (1976) could not record the significant changes in serum GOT level in sheep with CTC poisoning.

Mullen (1976) suggested serum GOT elevation confirm the diagnosis of acute hepatic cell damage in large animals.

Alemu et al. (1977) recorded elevated SGOT level with CTC poisoning in sheep.

Sethuraman and Verma (1979) opined SGOT as more sensitive and reliable then estimation of SGPT in acute and chronic hepatitis in buffalo calves.

Rosenberger (1979) reported serum GOT as one of the best indicators of liver health.

Pearson and Craig (1980) observed increased serum GOT in liver damage in ruminants.

Abdel Salam et al. (1982) noticed markedly increased SGOT level in goats with CTC induced hepatopathy.

Mahanta et al. (1983) observed marked increase in SGOT level with a little change in SGPT level at 3rd and 7th day following CTC administration in buffalo calves and suggested active liver damage.

Haroun *et al.* (1986) reported increased SGOT level in naturally infected *Fasciola gigantica* in sheep and indicated hepatic damage.

Tirkey *et al.* (1987) reported no significant increase in serum GOT level following oral administration of aqueous extract of *Ipomoea carnea* in goats.

Chaudhri *et al.* (1988) observed increased SGOT level with liver damage caused by liver fluke infection (*Fasciola gigantica*).

Peer (1987) reported significant increase of SGOT level in goats after CTC poisoning.

Hadkool and Sainapurkar (1989) observed no significant increase of SGOT levels in hepatobiliary diseases of cattle.

Pradhan (1991) noticed a marked significant increase of serum GOT level in goats with CTC poisoning for producing experimental hepatopathy.

2.3.7.2 Serum glutamic pyruvic transaminase (SGPT)

Grunder (1961) opined that, estimation of serum GPT could confirm 70-80% of acute and 40-50% of chronic liver diseases in cattle.

Huhn (1961) observed significant change of serum GPT level in cattle following administration of low doses of CTC.

Boyd (1962) observed significant increase of serum GPT level in experimental hepatic necrosis in cattle, sheep and rats.

Mullen and Bell (1967) reported increase in serum transaminase levels in calves reared on barley diet.

Dwivedi et al. (1971) reported that calves fed with dried Lantana leaves @ 6 gm/kg body weight showed no changes in SGPT activities.

Hari et al. (1973) could not detect any change in serum GPT activities in lantana poisoning in buffalo calves.

Hoe and Wilkinson (1973) opined SGPT may be considered as the enzyme of choice in the detection of liver damage in dog particularly in acute viral hepatitis.

Adam et al. (1974) observed no change in serum GPT level in goats with fatty changes of liver.

Amrousi et al. (1974) opined evaluation of serum GPT level is the good reflection of the liver status, since it was found to increase in all the cases of liver disorders in sheep.

Grimoldi et al. (1976) however could not record any change in serum GPT level in sheep before and after CTC administration.

Alemu et al. (1977) reported moderate increase in serum GPT activities following CTC poisoning, in sheep.

Grimoldi et al. (1976) observed no significant change in alkaline phosphatase values before and after CTC administration in sheep.

Alemu et al. (1977) observed slight increase in serum alkaline phosphatase activity in sheep following CTC administration and opined that serum levels of alkaline phosphatase is of less diagnostic value in them.

Pearson and Craig (1980) opined that alkaline phosphatase, a non-specific enzyme which had been present in liver, bone, intestine, placenta and kidney, was not a sensitive indicator of hepatic damage in equine and food animals.

Noonan (1981) observed slight increase in serum alkaline phosphatase activity for 6 days following administration of a non-lethal dose of CTC to induce liver damage in dogs and mares.

Kumar and Pachauri (1984) reported significant increase in serum alkaline phosphatase activity in buffaloes which were naturally infected with liver flukes.

Maru and Pachauri (1985) recorded alkaline phosphatase levels in buffaloes following oral administration of CTC @ 0.5 ml/kg body weight in one group and 0.25 ml/kg body weight in another at weekly intervals for five days. They observed the peak value at 9th and 27th day in 1st and 2nd groups respectively and concluded that, serum enzymes did not distinguish between acute and chronic liver damage.

Swarup et al. (1986) recorded increased serum alkaline phosphatase level in goats suffering from naturally occurring fascioliasis.

Tirkey et al. (1987) observed no significant change in serum alkaline phosphatase level following administration of aquous extract of Ipomoea carnea in goats.

Swarup and Pachauri (1988) reported reduced serum alkaline phosphatase activity in buffaloes affected with fascioliasis.

Maqbool and Jalnapurkar (1989) reported that serum alkaline phosphatase level was not significantly affected in hepatobiliary diseases in cattle.

Pradhan (1991) recorded a moderate increase of serum alkaline phosphatase activity in goats with repeated doses of carbontetrachloride in goats.

2.4 Gross and Histopathological Changes

Gillain (1932) reported that in hepatic cirrhosis of cattle, the most striking changes were early mononuclear infiltration at interlobular septa followed by increase in connective tissue. The intralobular spaces were invaded by fibroblasts and liver cell columns were broken up by fibrous tissue and there was regeneration of liver cells.

Winterhalter (1942) observed necrobiosis of hepatic parenchyma around central lobular vein after 24 hours of carbontetrachloride poisoning given at the dose rate of 2.1 ml orally, followed by necrosis and haemorrhagic inflammatory reaction by 48 hours. These inflammatory reactions subsided by the 3rd day showing regeneration and by the end of 8th day liver was found normal.

Blakemore and McDougall (1946) found fatty degeneration and necrosis of the liver with congestion of the abomasum in sheep treated with carbontetrachloride.

Setchell (1961) noted marked centrilobular necrosis in majority of the liver cells and marked tubular necrosis with some enlargement of Bowman's capsule of the kidney after 48 hours of oral dosing of 40 ml of CTC with 60 ml of liquid paraffin administered by stomach tube in sheep.

In an another experiment with 50 ml of CTC and 100 ml of liquid paraffin, Setchell (1961) observed one sheep died 24 hours after drenching. The liver of this sheep showed slight tubular degeneration. The another sheep which died 48 hours after drenching, the liver showed marked centrilobular necrosis with fatty degeneration of the remaining cells and the kidneys showed mild tubular degeneration with a few shrunken glomeruli.

Gallagher et al. (1962) reported severe liver damage following carbontetrachloride poisoning in sheep. Post mortem findings of this sheep revealed a moderate to severe degree of pulmonary oedema.

Boyd (1962) observed fatty infiltration and centrilobular necrosis with increased serum enzyme activity in sheep and cattle with hepatic necrosis following CTC administration.

Setchell (1962) reported the sheep which died soon after drenching with CTC along with liquid paraffin showed fatty liver. The kidneys were pale and enlarged. Congestion and petechial haemorrhages were also observed in some places. Haemorrhages around the coronary vessels were also reported. Lungs were comparatively normal.

Gallagher (1964) observed severe diffuse centrilobular necrosis of liver following intratracheal and intraruminal administration of carbontetrachloride in sheep.

Jones (1965) speculated that hepatotoxic effect of CTC poisoning in animals was a sort of delayed poisoning. He observed necrosis of liver cells around the central vein at 24 hours followed by inflammatory haemorrhagic and necrotic changes. The changes however, subsided on 3rd day followed by regeneration of hepatic cells and the liver became normal on 8th day.

Ross (1965) found cirrhosis of the liver especially the ventral lobe and less extensive fibrosis of the bile ducts in Fasciola hepatica infected calves.

Balu and Ganapathy (1966) studied the gross and histopathological changes in dogs poisoned with CTC at 0.5 ml/kg body weight orally. On postmortem examination the liver presented greyish yellow colour and mottled appearance with thickened edges. The organ was greasy to touch and hard to cut. The liver cells were found necrotic around the central vein and the necrotic areas were strawn with mass of pyknotic and karyorrhectic nuclei. The liver cells surrounding the necrotic areas showed fatty changes and in the portal triads, there was marked biliary hyperplasia with moderate lymphocytic infiltration.

Recknagal (1967) reported that a single toxic dose of CTC in sheep produces centrilobular necrosis and diffuse fatty infiltration.

Seawright and McLean (1967) observed minimal centrilobular necrosis to moderate to marked centrilobular necrosis involving almost all hepatocytes, with different doses of CTC poisoning with phenobarbitone in sheep. They also noticed accumulation of lipid in the tubular epithelium of the kidney and in the myocardial fibres.

Gopinath and Ford (1969) observed jaundice, photosensitization with swollen and vacuolated peripheral hepatic cells as pathological lesion in sheep with Lantana camara poisoning.

Caple and Heath (1971) observed necrosis and vacuolation of the hepatocytes around the central vein in sheep after oral dosing of 50% CTC with liquid paraffin administered by stomach tube.

Dwivedi et al. (1971) observed cloudy swelling, fatty degeneration and focal areas of necrosis in the liver and kidneys following oral administration of lantana leaves fed at 6 gm/kg body weight.

Gupta et al. (1972) observed degeneration, necrosis, autolysis, moderate to extensive fibrosis with mononuclear infiltration of liver in human babies suffering from infectious hepatitis.

Amrousi et al. (1974) observed post-necrotic cirrhosis and chronic non-suppurative hepatitis in sheep with increased level of serum bilirubin and SGPT.

Finn and Tennant (1974) reported fibrotic liver, focal hepatic hyperplasia and abomasal oedema on necrospy findings in hepatic encephalopathy in cattle. On histopathological examination they observed extensive terminal pulmonary oedema and

hyaline degeneration of renal epithelial cells. The hepatic changes of fibrosis, megalocytosis, bile duct hyperplasia and focal hepatocyte hyperplasia were also reported.

Mottelib et al. (1976) found cloudy swelling in the hepatocytes after injection of 50 to 60 ml of CTC in arachis oil to goats. Pyknotic nuclei around the centrilobular vein in liver and tubular degeneration in kidneys were also noticed.

Alemu et al. (1977) observed marked pathological changes in sheep following oral administration of CTC in sunflower oil. The livers grossly examined on the 2nd day of dosing showed dark and pale surfaces distributed uniformly throughout the entire liver. The histopathological sections revealed haemorrhagic necrosis of the hepatic centrilobular zones and the loss of architecture of liver cells. The haemorrhagic necrosis was more severe in sheep fed with low protein diet where more hepatocytes were completely destroyed and the periacinar hepatocytes in these areas showed pyknotic and karyorrhectic nuclei. The CTC dosed sheep sacrificed at the end of the experiment of 12 days showed less severe cellular damage indicating that they were undergoing hepatic regeneration.

Sethumurra and Verma (1973) observed necrotic foci and congestion of liver, haemorrhages and congestion of liver and serous membrane, intestinal mucosa, kidneys and the brain in buffalo calves with CTC poisoning. In microscopic observation

there were centrilobular necrosis, Fatty degeneration and cloudy swelling.

Sethuraman et al. (1978) observed necrotic focal, congestion and haemorrhages of liver, kidneys and lungs on gross examination in buffalocalves following oral administration of CTC @ 0.5 ml/kg body weight. Animals given CTC @ 0.25 ml/kg body weight showed mottling of liver due to necrosis and haemorrhages on epicardium and kidneys. On microscopic examination centrilobular necrotic areas were found replaced by blood and the remaining hepatocytes showed cloudy swelling, fatty degeneration and coagulative necrosis. Kidneys showed diffuse fatty changes and the fatty changes were also seen in the myocardial cells. Haemorrhages in the epicardium and interstitial oedema in the myocardium were also noticed. Severe congestion was noticed in lungs. Disorganisation of the liver cells accompanied by severe diffuse necrosis was observed in animals with low doses of CTC and these necrotic hepatic cells showed fatty changes.

Singh et al. (1978) noticed swollen liver with round edges and few greyish foci within 12-36 hours of CTC administration @ 50 ml/sheep through stomach tube. Petechial haemorrhages were seen in kidneys. Lungs were emphysematous with frothy exudate in trachea and bronchi but no changes were observed in the heart. Microscopically necrotic changes with marked liver necrosis masking centrilobular zone were seen. There were

pyknotic nuclei and vacuoles in peripheral areas of lobules. The central vein having uniform eosinophilic mass with few erythrocyteswere distended. In the portal tract, vessels were hyperaemic. The renal changes included increased glomerular size and vacuolation of glomerular cells. In the interstitium of the cortex and medula, focal haemorrhages were evidenced and interlobular blood vessels were hyperaemic. Atelectasis and emphysema were observed in lungs. In the area of emphysema, alveoli were distended and intercommunicated with each other. The lumen of the bronchi were dilated and contained eosinophilic materials.

Angus and Greig (1979) administered 19.9% V/V CTC in oil at 5 ml orally in lambs and observed severe pulmonary oedema and congestion of the lungs, multiple and petechial haemorrhages in the epicardium. Severe cortical necrosis of both kidneys with huge basophilic deposits in tubules and glomeruli were found. The arterial walls were also basophilic and homogenous which extended to many tubular and glomerular basement membrane. In liver, necrosis and fibrosis of the centrilobular areas was found. The lobule centres had numerous shrunken hepatocytes and multi-nucleated giant cells. The above changes were noticed within 7-10 days of CTC poisoning.

Pass et al. (1979) observed hepatic necrosis in sheep after injecting lantadene A, the toxic principle of Lantana camara intravenously.

Pearson and Craig (1980) remarked that in equine and other food animals biliary hyperplasia was reversible if insult is removed in time. Fat droplets in liver cells could be an early or less severe and often reversible change. Necrosis of hepatocytes indicated more recent damage.

Blood et al. (1983) described the lesions of hepatitis, as enlargement and swelling of the hepatic edges, with a variance in cross section with different etiological agents. Lobulation was more pronounced with pale and red colour of the parenchyma due to engorgement of the centrilobular vessels or with necrosis in toxic type of hepatitis. In infectious type, the lesions were pachy in distribution where as parasitic hepatitis was characterised by traumatic lesions with focal haemorrhage and necrosis.

Mahanta et al. (1983) studied the microscopical changes of liver with administration of CTC in buffalo calves. The liver showed fatty changes with areas of coagulative necrosis and complete loss of nuclei and focal infiltration of mononuclear cells in the liver parenchyma after 7 days of CTC administration. On 14th day post CTC administration, large foci of infiltration of mononuclear cells in the liver parenchyma were noticed. In the portal triad regions, regeneration of the liver parenchyma without fatty changes were also noted.

Pandey et al. (1983) observed fatty infiltration, parenchymatous degeneration and necrosis of the hepatic cells, after 48 hours in dogs with CTC at 1 ml/kg body weight. The outline of the hepatic cells was inconspicuous, the cytoplasm was eosinophilic and the nuclus was pyknotic and occasionally eccentric.

The fatty changes in the hepatic cells were marked after 120 hours of CTC poisoning, as indicated by nucleic hyperchromatosis. During this phase, proliferation of the fibrovascular tissue, presence of serofibrinous exudate and oedematous changes accompanying hydropic degeneration were noticed at the periphery of the hepatic lobules and in the adjoining area of portal triad. After 192 hours of CTC administration mild fibrosis was observed.

Mahanta (1984) observed diffuse necrosis with infiltration of the inflammatory cells and severe diffuse fatty changes in buffalo calves poisoned with carbontetrachloride. No significant change except regeneration was noticed after fourteen days of CTC administration. The kidneys showed interstitial nephritis with lymphocytic infiltration and vacuolar degeneration in the epithelial cells lining the tubules, along with atrophy of the glomeruli. Section of the heart showed haemorrhages in the myocardium.

Sharma et al. (1984) noticed centrilobular damage involving about ½th of the liver lobules in CTC poisoning in dogs given at 1 ml/kg body weight with ground nut oil. Endothelial cells and hepatic cells around the central veins were swollen and necrotic. Neutrophilic and macrophagic infiltration were observed in the centrilobular areas. Dogs with repeated doses for three occasions at 24 hours intervals showed extensive hepatic damage with centrilobular necrosis occupying the midzone of the lobules. In addition to massive cellular infiltration around the central vein, the proliferation of the connective tissue around the central vein was also observed.

Dwivedi et al. (1986) observed swollen, pale and mottled liver macroscopically and extensive diffuse, haemorrhagic parenchyma and obliteration of the normal architecture of the liver cells histopathologically in rabbits with experimental hepatopathy following administration of CTC @ 0.2 ml/kg body weight in paraffin for 4 consecutive days. Centrilobular degeneration and pyknotic nuclei were also noticed.

Dange et al. (1986) produced experimental hepatopathy in albino rats using carbontetrachloride @ 1.25 ml/kg body weight in liquid paraffin for 2 consecutive days. Histopathologically they observed degeneration and fibrosis of the liver.

Haroun et al. (1986) studied the liver damage in sheep in naturally occurring fascioliasis. The histopathological

changes comprised of degenerative and necrotic changes of the hepatocytes associated with haemorrhage, fibrosis and increased lobulation of the liver along with mononuclear cell infiltration were observed.

Nooruddin et al. (1987) studied the pathology of Fasciola gigantica infection in the livers of goat. In acute cases, the livers were enlarged and had numerous patchy haemorrhagic spots on the surface along with the deposition of fibrin were noticed. Histopathologically, there was extensive damage to the liver parenchyma along with numerous haemorrhagic tracts which were filled with desquamated cells, blood and inflammatory cells. In chronic cases the livers were invariably cirrhotic.

On histological examination, dilatation and thickening of the bile ducts were common with hyperplastic ductular epithelium. The haemorrhagic tracts were replaced by the proliferation of the fibrous tissue. The sinusoids were dilated but empty. At some places mononuclear fibrosis and micro-abscesses were demonstrated.

Peer (1987) studied hepatopathy in goats with CTC poisoning. On gross examination, the liver was enlarged, pale yellow in colour and slightly hard with rounded edges. The gall bladder was distended with bile, kidneys were mottled in appearance with a few foci of petechial congestion. Lungs were

oedomatous with areas of consolidation, emphysema and congestion. The heart was slightly pale in colour.

Histopathologically, the normal architecture of the liver altered moderate to marked in most cases. Most of the lobules exhibited centrilobular degeneration/necrosis, while other showed periportal degeneration/necrosis. Mononuclear infiltration was also observed.

Kidneys also exhibited moderate to marked degrees of degeneration/necrotic changes which were more prominent in the tubules and glomeruli. The tubular lining epithelium desquamated and the detritus were lying in the tubular lumina. The glomerular changes were atrophy/shrinkage of capillary tubes leaving enlarged Bowman's space and in some cases there was empty Bowman's space containing varying amount of protineous materials. Mild degree of intertubular and glomerular congestion were also seen.

In lungs, congestion, odema, collapse and compensatory emphysema were seen. The alveoli were either packed with erythrocytes or inflammatory exudates. Bronchi/bronchioles exhibited partial desquamation and/or focal hyperplasia of lining epithelial cells and the lumina were partially packed with these desquamated epithelial cells and inflammatory cells.

Heart showed moderate to severe degrees of granular/ vacuolar degeneration, loss of cross striation of myofibrilar segments and absence of nucleus.

Swarup et al. (1987) studied the pathology of naturally occurring fascioliasis and biliary amphistomiasis in buffaloes. In fascioliasis, hepatic cells were swollen with distinct vacuolation and degeneration. The hepatic cords were distorted and the bile ducts showed hyperplasia. In amphistomiasis, there was bile duct hyperplasia with a zone of fibrocellular reaction and connective tissue proliferation around the site of fluke attachment. Liver cells showed vacuolar degeneration.

Tirkey et al. (1987) studied the effect of feeding of Ipomoea carnea leaves on goats. The goats were sacrificed.

Histopathologically, the liver showed mild degenerative changes. The hepatocytes around the central vein showed vacuolar degeneration. In some hepatocytes the vacuoles were large and the nucleus was pushed to one side of the cell. The von kupffer cells were hypertrophied. The bile ducts were proliferated. A good number of fibroblastswere extended into the liver parenchyma from the portal tract.

The goats which died on 56th day showed diffuse fatty changes of liver. There was proliferation of fibrous connective tissue in the portal tract. In some of the portal tracts,

proliferation of the connective tissue was pronounced and the fibroblasts were extended towards the centre of the liver lobule. Congestion of the blood vessels and proliferation of the bile ducts at some places were also seen.

In kidneys, epithelial cells lining the tubules showed vacuoles. Many epithelial cells were desquamated. In some tubules, albuminous casts were also seen, but no changes were observed in the glomerulus of the goat which died on the 27th day. Nephrosis was observed in the convoluted tubules of the goats which died on 56th day. Albuminous casts were seen in the proximal and distal convoluted tubules, and in the collecting tubules. The Bowman's space showed varying amounts of albuminous casts. In some of the convoluted tubules, desquamation of the epithelial cells was pronounced.

In heart, the histological alteration of the myocardium was of mild in nature. There was focal disintegration and fragmentation of myofibrils. There was focal disintegration and fragmentation of myofibrils. A few mononuclear cells were seen in between the muscle fibres. Some of the cardiac muscle fibres showed degenerative changes and fatty changes.

Swarup and Pachauri (1988) studied the histopathological changes in liver of buffaloes affected with fascioliasis. They observed disruption of hepatic cells, loss of parenchymal structure, cellular infiltration and fibrotic and hyperplastic changes in the bile ducts.

Aganusi et al. (1989) studied the pathological changes due to Fasciola gigantica infection in sheep. Gross and histological changes of the liver attributable to the presence of the parasites at different times after infection includes the petechial haemorrhages and tortuous migrating tracts at different areas, hepatomegaly, friability of the liver parenchyma, massive eosinophilic infiltration and biliary cirrhosis.

Bradfold (1990) studied on the CTC induced hepatopathy in large animals. Necrospy findings showed congestion, degeneration and necrosis of liver and kidneys.

Histopathologically, centrilobular necrosis of the liver, cloudy swelling and necrosis of the tubular epithelium of the kidney were seen. Chronic exposure to CTC cause hepatic fibrosis.

/Peer et al. (1990) studied in experimental CTC induced hepatopathy in goats. On gross examination, the liver was enlarged and slightly firm with rounded edges. Call bladder was engorged with thick inspisatated bile. Kidneys were mottled with petechial haemorrhages. Lungs were odematous with areas of congestion. Heart showed mild hydropericardium.

Histopathologically, hepatocytes showed varying degrees of degenerative and necrotic changes. Most of the lobules exhibited centrilobular degeneration while a few showed periportal degeneration and necrosis. There were aggregates of mononuclear cells.

The kidneys exhibited moderate to marked degenerative and necrotic changes. These changes were more prominent in the tubules than in the glomeruli. Lungs revealed different degrees of congestion, oedema, collapse and compensatory emphysema. The heart showed moderate to severe degree of degenerative and necrotic changes in the myofibrils. These were characterised by granular/vacuolar degeneration, loss of cross striation of myofibrillar segments and absence of nucleus.

Pradhan (1991) produced experimental hepatopathy with CTC in goats. On gross examination, the liver was severely enlarged and was slightly hard. There were presence of few white to greyish necrotic foci and haemorrhagic spots on the surfaces. Kidneys showed few foci of petechial haemorrhages and congestion. Lungs were congested, oedematous and were consolidated.

On histopathological examination, the liver showed varying degrees of degenerative/necrotic changes of the hepatocytes. Most of the lobules exhibited centrilobular coagulative necrosis. Fatty changes were encountered in some lobules. Moderate to massive haemorrhages were evident around the central vein and hepatic lobules. Other changes included proliferation of the reticuloendothelial cells and infiltration of few mononuclear cells around the central veins.

Kidneys showed moderate to marked degenerative/necrotic changes, which were comparatively more prominent in tubules than glomeruli. In some tubules, epthelial casts were present. The glomerular changes were characterized by hypertrophy of the glomerular tuft leading to obliteration of the Bowman's space.

Lungs revealed varying degrees of congestion and oedema due to presence of severe serous exudation. The alveoli were packed with either erythrocytes or inflammatory exudates, Bronchi/bronchioles exhibited partial desquamation and/or focal hyperplasia of lining epithelial cells.

Section of the heart showed epicardial and myocardial haemorrhages along with congestion of the blood vessels.

2.5 Therapy

A number of indigenous herbs and proprietory preparations have been claimed to be effective in liver disorders in man and animals which includes Liv.52, Livol, Tefroli vet granules, Hygrophilia spinosa, Andrographis paniculata etc.

Kirtikar and Basu (1933) studied the action of Solanum nigrum, a constituent of Livol and Liv. 5 2 and found root bark of this plant being used as laxative, reduced the inflammation of the liver. The juice of this root in doses of

6-8 ounces was given in the treatment of chronic hepatic enlargement, was found a valuable alternative.

Gyrogy (1944) advocated methionine 2-4 gm, cystine or choline 2-4 gm, balanced B complex, protein rich and fat restricted diet for the treatment of experimental hepatopathy in animals.

Popper et al. (1949) studied the effects of Vit. B_{12} given at 15 ug/100 gm body weight subcutaneously before and after CTC poisoning in rats alongwith high protein diet at 72, 48 and 24 hours interval. They noticed that, injection of vit. B_{12} restricted the pathological changes of liver.

Solanum nigrum and Terminalia arjuna have not curative and prophylactic action against varied liver diseases. Extract of S. nigrum cured chronic inflammation of liver and dysentery whereas bark of T. arjuna was used as a tonic and antidote for poisons. The fruit was used as general tonic (Chopra et al., 1956).

Murkibhavi and Seth (1957) found Liv.52 as an useful for treatment of jaundice in dog and domestic animals.

Gallagher (1960) reported a course of three daily intraperitonial injection of 2 gm nicotinic acid, given at 46, 28 and 0 hours before the administration of carbontetrachloride @ 50 ml/sheep, was found to afford considerable protection against specific liver damage.

Judah (1960) reported that in the experimental animals, choline and antihistaminics lessen damage to mitochondria caused by CTC poisoning and may be useful in therapy.

Lal and Kalra (1960) advocated liberal administration of glucose saline to restore the function of liver in lantana poisoning in domesticated animals.

Captain and Syed (1966) tried Liv.52 in race horses as a protective against CTC poisoning and concluded their studies with the comments that, Liv. 52 protected the liver effectively against this hepatotoxic drug. They also opined that Liv. 52 improved appetite, increased weight gain and brightened the body coat in weak mares and orphan foals.

Harrison (1966) opined that parenteral injection of vit. K facilitate coagulation of blood in the treatment of liver diseases.

Kadvekar and Murkibhavi (1971) reported that vit. B complex and liver extract were found helpful in the treatment of anorexia associated with liver dysfunction.

Gupta et al. (1972) noted that prolonged use of Liv.52 help the hepatic parenchyma to revert to normal architecture in human beings. They also suggested that Liv. 52 tablet for a prolonged time help the regeneration of hepatic structure and improvement of hepatic function.

Hari et al. (1973) reported that the mild to moderate cases of lantana poisoning could be successfully cured with 20% glucose saline, phenergan, liver extract, Liv. 52 and saline purgative than 5% glucose saline and phenergan only in buffalo calves.

Prasad (1974) opined that probably Liv. 52 stimulate the mitotic activity of liver cells and so stimulate the mitotic acitvity of liver cells and so stimulate the liver cells to regenerate.

Sinha et al. (1975) reported Liv. 52 given at dose rates of 25 drops daily yielded significant weight gain in body weight in calves.

Alikutty (1981) used vitamin B complex and liver extract in the form of Beekom-L and recorded the desired effect of tonning up of liver functions in experimentally induced alkalosis in calves.

Roychoudhury (1981) reported that the functional status of the liver of buffalo calves in acidosis could be improved with treatment of livogen, berin and calcium.

Boishya et al. (1982) reported Livol as one of the effective drug for treatment of hepatic disorders in domestic animals.

Verma (1982) studied the efficacy of some drugs in chronic hepatitis of cattle. One group was treated with Vitamin B complex (Glaxo), Livogen 5 ml on alternate days, Phthalylsulphathiazole @ 30 gm daily and intestinal astringent containing heavy kaolin, calcium carbonate etc. and the other groups were treated with Livogen, Liver extract 5 ml each given on alternate days, Halquinochlorhydroxyquinolin and intestinal astringent for 1 to 2 months and both the treatments were found effective in correcting chronic hepatic disorders in cattle.

Mahanta et al. (1983) opined Livol has a protective effect on liver and it can promote the recovery of liver damage caused by CTC in buffalo calves.

Pandey et al. (1983) reported Livol as one of the effective drug for the treatment of CTC induced hepatic disorders in dog.

Blood et al. (1983) reported that parenteral administration of calcium, glucose and amino acid mixture containing methionine and choline were useful in the treatment of toxic hepatitis in animals. They further remarked that oral administration of broad spectrum antibiotics were essential to control protein digestion and putrification.

Arora and Madhumohini (1984) fed Livol to kids @ 0.8 gm/kg and observed significant weight gain. They remarked that

livol was equally effective for growth both during pre-ruminant and post-ruminant ages.

Brahmanandam and Ravikumar (1984) opined Tefroli as a very safe and effective drug in the management of viral hepatitis of children, since it could remarkably helped to shorten the whole course of illness in them.

Narendranath et al. (1985) induced hepatotoxicity in albino rats with CTC and D-galactosamine hydrochloride and treated these rats with Tefroli tablets and syrup. With biochemical and histopathological studies, they concluded that, Tefroli was a very effective drug in correcting hepatic disorders.

Pandey et al. (1985) studied the efficacy of Livol given @ 500 mg/kg orally to dogs with carbontetrachloride induced hepatopathy and concluded that it has better protective action.

Dange et al. (1986) studied the effect of 'Arogyavardhini' against the carbontetrachloride induced hepatic damage in albino rats. From that study, they concluded that pretreatment with 'Arogyavardhini' was effective to protect the liver against carbontetrachloride induced acute hepatic damage.

Dwivedi et al. (1986) studied the efficacy of Andographis paniculata in the treatment of CTC induced liver damage in rabbits and suggested it as a effective herbal hepatotonic.

Mahanta et al. (1986) experimentally induced hepatitis in buffalo calves with carbontetrachloride and tried with two indigenous drugs, Liv. 52, Livol and one proprietory preparation along with some supportive therapy, in three different groups for treatment. The 1st group was treated with Liv.52 @ 3 gm/animal twice daily for 5 days, the 2nd group was treated with Livol @ 30 gm/animal twice daily for 5 days and the 3rd group was treated with Beekom -L @ 5 ml. I/M daily for 5 days, Rintose 200 ml I/V twice daily for 5 days, Thiacal 50 ml I/V twice daily for 5 days, Anthisan 5 ml I/M daily for 3 days, Betnesol 2 ml I/M daily for 3 days, Celin 1 gm orally daily for 5 days, Tetracycline tablets 500 mg orally daily for 3 days along with the healthy rumen liquor with 25 gm of cobalt salt daily from 4th day of induction of hepatitis. On the basis of the blood biochemical profiles and histopathological observations these treatments were found to be more or less effective in correcting liver dysfunctions in buffalo calves.

Dhumal et al. (1989) studied the effect of Liv. 52 on carbontetrachloride induced hepatotoxicity in male rabbits. On the basis of biochemical estimations, they concluded that Liv. 52 had a hepatoprotective action against carbontetrachloride.

/Peer et al. (1990) studied the efficacy of Liv. 52 and Tinospora cardiofolia in experimental CTC induced hepatopathy in goats. From the biochemical and histopathological observations, they concluded that in liver dysfunctions, Liv. 52 had better therapeutic efficacy than T. cardiofolia.

/Pradhan (1991) studied the efficacy of Liv. 52 and Tefrolivet granules in experimentally induced hepatotoxicity in goats. From the biochemical, histopathological and electronmicroscopical observations, he concluded that both the drugs had better protective action against the carbontetrachloride induced hepatotoxicity.

CHAPTER III

MATERIALS AND METHODS

3.0 M A T E R I A L S A N D M E T H O D S

3.1 Experimental Animals

Twenty five healthy, Black Bengal goats of either sex aged 10-18 months with a body weight ranging from 9-13 kg., were selected for this experiment. These animals were subjected to extensive clinical examination of blood, faeces and urine to rule out the presence of any disease. These animals were kept in animal shed, fed on wheat bran, gram, rice and molasses and were allowed to graze on pasture for 6 hours in day. These goats were dewormed with Fenbendazole @ 5 mg/kg body weight orally, 4 weeks prior to the experimental study. When all the goats were found clinically healthy, these goats were divided randomly into five groups, comprising five in each group.

3.2 Induction of Experimental Carbontetrachloride (CTC) Toxicity

Carbontetrachloride was used for induction of liver damage in this experiment. Prior to the administration of carbontetrachloride, the body weights of each goat were recorded and CTC was

administered @ 0.75 ml/kg body weight for 2 occasions at 48 hours interval, orally through stomach tube. The animals were kept on the same feeding and management scheudule after the administration of carbontetrachloride.

3.3 Experimental Design

Group - I. The animals of this group acted as healthy control.

Group - II. Animals of this group received CTC orally and were kept as untreated control group.

Group -III. IV & V. Experimental hepatic damage was induced in groups III, IV & V as in group II and different therapeutic trials were carried out in the animals of these groups.

3.4 Clinical Symptoms

The experimental animals were observed daily for general condition, posture, appetite, feeding and grazing, and for other clinical signs, if any. Rectal temperature was recorded by means of a thermometer. The respiratory rate, rhythm and depth were recorded by means of a stethoscope. The rate, rhythm and character of pulse were also recorded as per standard procedure. The ruminal motility was recorded for 5 minutes. Body weights were also recorded. The conjunctival mucous membranes and oral mucous membranes were also examined for any change of colour. The heart and lungs were examined by auscultation,

periodically. The liver and kidneys were also examined periodically by palpation. Overt clinical signs, if any, were also recorded.

3.5 Collection of Samples for Analysis

3.5.1 Blood

Blood was collected 0 day (prior to the experiment), 2nd day, 3rd day and thereafter at 2 days intervals upto 21st day of the experiment.

Fifteen millilitres of blood was collected from the jugular vein by means of a sterilized syringe and needles and then kept in three different vials and one test tube. Three millilitres of blood was poured in the first vial containing 3 mg of disodium salt of EDTA as an anticoagulant for haematological studies. In the 2nd vial about 1 ml of blood was collected for determination of clotting time. In the third vial containing 2 mg of sodium fluride, about 2 ml of blood was collected, for the determination of glucose.

For biochemical estimations about 9 ml of blood was collected in a sterilized test tube without any anticoagulant. These tubes were kept on slanting position and were kept for 4-6 hours at room temperature for seperation of serum. Then the serum was harvested by a sterilized pasture pipette, kept in the sterilized vials and were stored in the deep freeze for further processing.

3.5.2 Specimen for histopathological studies

All the surviving/dead animals were sacrificed and gross changes in liver, heart, kidneys and lungs were recorded. Representating samples were collected (about 1 ccm) from each organ described before in 10% formal saline for histopathological examinations.

3.6 Analysis of Blood Samples

3.6.1 Analysis of blood for haemotological observations

The Packed cell volume (PCV), Total erythrocyte count (TEC), Haemoglobin (Hb), Total leucocyte count (TLC) and Differential leucocytic count (DLC) were estimated by the methods recommended by Schalm et al. (1986).

The Mean corpuscular volume (MCV), Mean corpuscular Haemoglobin (MCH), and Mean corpuscular Haemoglobin concentration (MCHC) were also determined by the methods as stated in Schalm et al. (1986).

The results of these haemotological parameters were expressed as follows:

i) Packed cell volume (PCV) - percentage (%)

ii) Total erythrocyte count(TEC) - million/cubic mm

iii) Haemoglobin (Hb) - g/dl

iv) Total leucocyte court - thousand/cubic mm

v) Differential count - percentage (%)

vi) Mean corpuscular volume(MCV) -

$$= \frac{\text{Packed cell volume}}{\text{RBCS in millions}} \times 10 \text{ cubic microns}$$

vii) Mean corpuscular Haemoglobin (MCHC) $= \frac{\text{Hb in gms/100 ml}}{\text{RBCS in millions}} \times 10$ micromicrograms

viii) Mean corpuscular Haemoglobin concentrations (MCHC) $= \frac{\text{Hb in g/100 ml}}{\text{PCV}} \times 100$ percent

3.6.2 Clotting time

The clotting time was done as per the method recommended by Schalm et al., (1986). The results were expressed in minutes and seconds.

3.6.3 Blood glucose

Blood glucose was estimated by Nelson - Somogyi method as described by Oser (1979). The results were expressed in mg/100 ml.

3.6.4 Serum protein

3.6.4.1 Total serum protein

Total serum protein was estimated as per Biuret method as described by Wootton (1974). The results were expressed in gm/100 ml.

3.6.4.2 Serum albumin

Serum albumin was also estimated as per Biuret method as described by Wootton (1974). The results were expressed in gm/100 ml.

3.6.4.3 Serum globulin

Serum globulin was determined by subtracting albumin from the total serum protein values and expressed in gm/100ml.

3.6.4.4 Serum albumin and globulin ratio (A/G ratio)

The A/G ratio was determined by dividing the percent albumin with the percent of globulin in the serum.

$$A/G \text{ ratio} = \frac{\text{Serum albumin percent}}{\text{Serum globulin percent}}$$

3.6.5 Serum bilirubin

Total serum bilirubin was estimated by Malloy and Evelyn (1937) cited by Oser (1979). The results were expressed in mg/100 ml.

3.6.6 Serum cholesterol

Serum cholesterol was estimated as per Anderson and Keys (1956) method as described by Wooton (1974). The results were expressed in mg/100 ml.

3.6.7 Serum icteric index

Serum icteric index was determined as per the method of Oser (1979). The results were expressed in units.

3.6.8 Van den Bergh Test

Van den Bergh Test was done as cited by Sastry (1979).

3.6.9 Serum enzymes

Serum enzymes were estimated within 24 hours of collection of serum samples.

3.6.9.1 Serum glutamic oxalacetic transaminase (SGOT)

SGOT activities were measured by Yatzidis (1960) and expressed in /ug pyruvic acid/ml, incubated at 37°C for one hour.

3.6.9.2 Serum glutamic pyruvic transaminase (SGPT)

SGPT activities were measured by Yatzidis (1960) and expressed in /ug pyruvic acid/ml, incubated at 37°C for one hour.

3.6.9.3 Serum alkaline phosphatase (AP)

Serum alkaline phosphatase was measured as per the method of Fiske and Subba Row as cited by Sastry (1979) and the results were expressed in Bodansky units per 100 ml of serum.

3.7 Pathomorphological Studies

3.7.1 Gross examination

Post mortem examination was done on both sacrificed and dead animals of the experiment. The gross pathological changes were recorded immediately of various organs like liver, lungs, heart and kidneys.

3.7.2 Histopathological study

The autopsy materials collected were preserved and fixed in 10% formal saline. The materials were trimmed and washed with running tap water for 24 hours and then tissues were dehydrated with 50% alcohol, 70% alcohol, 90% alcohol and absolute I and absolute II alcohols, each for 2 hours. Then the materials were immersed in Denial ceder wood oil upto transparency and finally embedded in paraffin for 3 occassions for 2 hours each. The sections were cut at 5-6 /um in thickness in microtome and stained with routine haematoxylene and cosin (Mayer's haematoxylene) stain.

3.8 Therapeutic Trials in Experimental Hepatic Disorders with Indigenous Drugs (Group III and IV)

Two indigenous drugs viz, Livol* powder, composed of Andrographis paniculata, Boerhaavia diffusa, Terminalia arjuna, Citrullus colocynthis, Eclipta alba, Trachyspermum ammi, Terminalia Chebula, Solanum nigrum, Aphanamixis rohituka,

Ichnocarpus frutescens, Nigella sativa, Picrorrhiza kurroa, Phyllanthus niruri, Fumaria parviflora, Achyranthes aspera, along with Black salt which contain Sodium chloride, Terminalia chebula, Terminalia bellerica, Phyllanthus embilica and Vetliv** powder, Composed of Andrographis paniculata, Berberis aristata, Trachyspermum ammi, Asteracantha longifolia, Phyllanthus embilica, Luffa amara and Oldenlandia corymbosa, were selected for the present study for therapeutic trials.

The treatments were started after 24 hours (3rd day) of 2nd dose of CTC administration when the severity of liver damage were marked.

The treatments carried out as follows:

I. Group III : Livol powder @ 8 gm/animal twice daily for 8 days.

II. Group IV : Vetliv powder @ 10 gm/animal twice daily for 8 days.

The efficacy of these treatments were judged on the basis of clinical improvements and restoration of haematological, biochemical and pathomorphological changes to normal.

3.9 Therapeutic Trials in Experimental Hepatic Disorders with Proprietory Preparations (Group V)

The animals of Group V were treated with proprietory

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* Livol - Indian Herbs Research and Supply Co.

** Vetliv - Vetmed

preparations which also started after 24 hours of 2nd dose of CTC administration and all the observations like clinical, haematological biochemical and pathomorphological changes were conducted as adopted in Group III and Group IV. The therapeutic measures were carried out as follows:

I. Beekom-L[1] - (Thiamine Hcl - 25mg Riboflavine, sodium phosphate 1.5 mg, Vitamin B_6 - 5 mg Niacinamide - 50 gm, cyanocobalamin - 50 mcg, choline chloride - 25 mg, and crude liver extract having B_{12} activity equivalent to not less than 2 mcg of cyanocobalamin), 1.5 ml I/M daily for 5 days.

II. Dextrose[2] (Dextrose 20 gm per 100 ml) - 40 ml I/V twice daily for 5 days.

III. Calborol[3] (Calcium Borogluconate containing calcium gluconate 83 parts and boric acid 17 parts) - 15 ml I/V daily for 5 days.

IV. Chloril Vet[4] (Chlorpheniramine maleate I.P 10 mg/ml) - 1 ml I/M daily for 5 days.

V. Vetalog [5] (Triamcinolone acetonide 6 mg/ml) - 0.5 ml I/M daily for 3 days.

VI. Woktrin powder[6] (Sulphadiazine IP 10%, Trimethoprim IP 2%)- 0.5 gm twice daily orally, for 3 days.

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1 & 6 Wockhardt Veterinary Pvt. Ltd., Bombay - 18

2 Asian Laboratories, Calcutta - 1

3 May and Baker Ltd., Bombay - 13

VII. Kapilin[7] (Menaphthone Sodium Bisulphite I.P 10 mg/ml) - 1 ml daily for 3 days.

VIII. Redoxon[8] (L-ascorbic acid - 200 mg tabs.) - 2 tabs. orally daily for 5 days.

IX. Healthy rumen liquor with 10 mg cobalt sulphate orally daily for 3 days from 3rd day of 1st dose of CTC administration.

3.9 Statistical Analysis

The data were analysed statistically as per the method described by Snedecor and Cocharan (1968).

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4 TTK Pharma Pvt. Ltd., Madras - 4

5 Sarabhai Chemicals, Bombay - 1

7 Allenburys Pharmaceutical Division, Bombay - 25

8 Roche Products Ltd., Bombay - 34

CHAPTER IV

RESULTS AND DISCUSSION

4.0 RESULTS AND DISCUSSION

4.1 Observations on Control Animals (Group I)

4.1.1 Clinical symptoms

Animals of this group were active, alert, healthy and had good appetite. Body coats were glossy in appearance. Posture and gait were normal. The conjunctival mucous membranes were pink to roseate in colour in all the animals, which simulates the observations of Kelly (1979) in cattle and goats and of Pradhan (1991) in goats.

The mean values of normal body temperature, pulse rate and respiratory rates were 102.16 ± 0.27°F, 77.60 ± 1.30 per min. and 25.80 ± 1.23 per min. respectively (Table 1). These findings are in conformity with that of Kelly (1979), Lloyd (1982) and Pradhan (1991) in goats. The average ruminal motility in healthy goats was 7.00 ± 0.32 per 5 min. which was similar to the observation of Vihan *et al.* (1979) but little

Table 1. Clinical symptoms of healthy Black Bengal goats (Group I)

Parameters	Mean ± S.E.
No. of animals	5
General condition	Animals were active, alert, healthy and had a good appetite. Body coats were glossy. Conjunctival mucous membranes were pink to rosy in colour. Posture and gait were normal.
Body temperature (^{o}F)	102.16 ± 0.27
Pulse rate/min.	77.60 ± 1.80
Respiration/min.	25.80 ± 1.28
Ruminal motility/min.	7.00 ± 0.32
Body weight (kg)	11.20 ± 0.66

higher than the findings of Peer (1987) in goats. The average body weight of these goats were 11.20 ± 0.66 kg.

4.1.2 Haematological observations

The results of analysis of blood for haematological observations have been presented in Table 2 and 3.

The average haemoglobin concentration was 9.36 ± 0.38 g/dl in the present study, agrees with the findings of Milson et al. (1960), Krishnan and Visvanathan (1965), Bhargava (1980) and Kundu et al. (1991) but little lower than the findings of Nooruddin (1982), Schalm (1986) and Pradhan and Misra (1987). This difference of haemoglobin level might be due to age and sex of the animals.

The mean values of total erythrocyte count of the present study was 10.98 ± 0.59 millions/cubic mm which simulates the findings of Vaidya et al. (1970), Bhargava (1980) and Kundu et al. (1991) and little lower than the findings of Krishnan and Visvanathan (1965), Nooruddin et al. (1982), Schalm et al. (1986), Pradhan and Misra (1987) and Peer (1988). This difference in total erythrocyte count might also be due to age and sex of the animal as well as the environmental changes.

The average packed cell volume observed in the present study was 32.20 ± 2.08%. This findings is similar to the findings of Bhargava (1980), Schalm et al. (1986) and Kundu et al. (1991) but slightly higher than the values reported by

Table 2. Haematological studies of healthy Black Bengal goats (Group I)

Parameters	Mean ± S.E.
Haemoglobin (g/dl)	9.36 ± 0.38
Total erythrocyte count TEC (millions/cubic mm)	10.99 ± 0.59
Packed cell volume PCV (%)	32.20 ± 2.08
Mean corpuscular volume MCV (cubic microns)	29.42 ± 1.70
Mean corpuscular Haemoglobin MCH (micro micrograms)	8.55 ± 0.18
Mean corpuscular Haemoglobin concentration MCHC (%)	29.36 ± 1.45
No. of animals	5

Table 3. Haematological studies of healthy Black Bengal goats (Group I)

Parameters	Mean ± S.E.
Clotting time (min. sec.)	2 min. 40 sec.
Total leucocyte count TLC (thousands/cubic mm)	11.68 ± 0.17
Differential leucocyte count DLC (%)	
Lympocytes (%)	57.20 ± 1.98
Neutrophils (%)	35.40 ± 1.75
Eosinophils (%)	3.20 ± 0.58
Monocytes (%)	1.40 ± 0.24
Basophils (%)	0.80 ± 0.24
No. of animals	5

Krishnan and Visvanathan (1965), Nooruddin et al. (1982) and slightly lower than the value of Peer et al. (1988). This difference might be due to the differences in age and nutritional status of the animals.

In the present study the mean corpuscular volume on an average was found to be 29.42 ± 1.70 cubic microns in healthy goats, which agrees with the findings of Bhargava (1980), Schalm et al. (1986) and Kundu et al. (1991) and little higher than the value reported by Krishnan and Visvanathan (1965).

The average values of mean corpuscular volume in the present study was 8.55 ± 0.18 micro micrograms which simulates the findings of Bhargava (1980) and Kundu et al. (1991) but is much higher than the values recorded by Krishnan and Visvanathan (1965) and Schalm et al. (1986).

The average value of mean corpuscular haemoglobin concentration in the present study was 29.36 ± 1.45 percent, agrees with the finding of Kundu et al. (1991) but is slightly higher than the value reported by Bhargava (1980) and little lower than the values reported by Krishnan and Visvanathan (1965) and Schalm et al. (1986).

The mean value of clotting time observed in the present study was 2 mins. and 40 secs. which corroborates the reports of Schalm et al. (1986), Pradhan and Misra (1987) and Kundu et al. (1991).

The mean total leucocyte count was 11.68 ± 0.17 thousands/ cubic mm. in the present study, is almost similar to the values recorded by Vaidya et al. (1970), Peer et al. (1988) and Kundu et al. (1991), but slightly higher than the values as reported by Krishnan and Visvanathan (1965), Bhargava (1980), Noorudin et al. (1982) and Schalm et al. (1986). The mean differential leucocyte count values observed in this study were as follows-Lymphocyte 57.20 ± 1.98 percent, Neutrophil 35.40 ± 1.75 percent, Eosinophil 3.20 ± 0.58 percent, Monocyte 1.40 ± 0.24 percent and Basophil 0.80 ± 0.37 percent, which corroborates the findings of Krishnan and Visvanathan (1965), Vaidya et al. (1970), Bhargava (1980), Schalm et al. (1986) and Kundu et al. (1991). However, a lower lymphocyte percentage and a higher neutrophil percentage than the present value was reported by Peer et al. (1988) which might be due to the differences in age and sex of the animals.

4.1.3 Liver function tests

The results of the blood biochemical analysis have been presented in Table 4 and 5.

The average blood glucose concentration observed in the present study was 59.38 ± 2.28 mg%, simulates the findings of Swenson (1977), Swarup et al. (1986), Peer et al. (1990) and Pradhan (1991), but was lower than the value recorded by Vihan et al. (1982) and higher than the value recorded by Tirkey et al. (1987). The difference may be due to age, sex and food habitant of the animals.

Table 4. Blood biochemical profiles of healthy Black Bengal goats (Group I)

Parameters	Mean ± S.E.
Blood glucose (mg%)	59.38 ± 2.28
Total serum protein (g%)	6.51 ± 0.27
Serum albumin (g%)	3.93 ± 0.22
Serum globulin (g%)	2.63 ± 0.13
A/G ratio	1.48 ± 0.11
Icteric index (units)	4.90 ± 0.45
Van den Bergh test	Negative
No. of animals	5

Table 5. Blood biochemical and serum enzyme activities in healthy Black Bengal goats (Group I)

Parameters	Mean ± S.E.
Total serum bilirubin (mg%)	0.31 ± 0.06
Serum cholesterol (mg%)	108.06 ± 6.33
Glutamic oxalacetic transaminase (µg of pyruvic acid formed in 1 ml of serum at 37°C in 60 mins).	92.40 ± 5.34
Glutamic pyruvic transaminase (µg of pyruvic acid formed in 1 ml of serum at 37°C in 60 mins)	72.20 ± 1.85
Alkaline Phosphatase (Bodansky Units/100ml.)	3.97 ± 1.16
No. of animals	5

In the present study, the average total serum protein level was found to be 6.51 ± 0.27 g% in healthy animals, which similates the findings of Swenson (1977), Vihan and Rai (1983) and Peer (1987) but slightly lower than the findirgs of Vihan et al. (1982), Bhattacharyya and Duttagupta (1987) and higher than the findings of Nooruddin et al. (1982), Swarup et al. (1986) and Pradhan (1991).

The mean albumin concentration was 3.93 ± 0.22 g%, agrees with the findings of Gorczyca et al. (1960), Swenson et al. (1977), Nooruddin et al. (1982), Peer (1987) and Pradhan (1991) but lower than the observation of Vihan et al. (1982) and higher than Swarup et al. (1986). The average serum globulin level was 2.63 ± 0.13 g% which corroborates the findirgs of Nooruddin et al. (1982), Peer (1987) and Pradhan (1991) but higher than the findings of Vihan and Rai (1983) and Swarup et al. (1986) and slightly lower from that of Vihan et al. (1982). The mean serum albumin, globulin ratio was found to be 1.48 ± 0.11 which simulates the findings of Nooruddin et al. (1982), Swarup et al. (1986), Peer (1987) and Pradhan (1991). These differences might be due to the differences in age and nutritional status of the animals (Adaval and Gangwar, 1971).

The level of total serum bilirubin in the present study was 0.31 ± 0.06 mg% which similates the findirgs of Harvey and Cheid (1974), Peer et al. (1990) and Pradhan (1991) but higher

than the values obtained by Berger (1956), Kelly (1979) and Nooruddin (1982) in goats. However Seawright and McLean (1967) and Blood et al. (1983) mentioned bilirubin level ranging from 0.08 - 0.23 mg% and 0 - 0.40 mg% respectively in healthy sheep. The differences might be attributed to the age of the animals (Amrousi et al., 1965 and Coles, 1980).

In the present study, the average total serum cholesterol level was 108.06 ± 6.33 mg% which varied between 91.26 - 127.25 mg%, was comparable with the values mentioned by Kritchevsky (1958), Swenson (1977), Peer et al. (1990) and Pradhan (1991) but was much lower than the value of 258.50 ± 1.18 mg% as reported by Tirkey et al. (1987). A great variation in the cholesterol content of blood in animals within the same species under different physiological conditions has been noted (Murtaza et al., 1978).

The average value of serum icteric index obtained in this present study was 4.90 ± 0.45 units, agrees with the findings of Schalm et al. (1986) and Pradhan (1991). However Soliman and Elamrousi (1974) recorded 7.32 ± 0.34 and 9.40 ± 0.42 units in healthy male and female sheep of 1-2 year of age respectively.

Serum Van den Bergh test was negative in all the healthy animals of Group I, which simulates the observations of Coles (1980) in cattle and Pradhan (1991) in goats.

The mean values of serum GOT and GPT were 92.40 ± 5.34 and 27.20 ± 1.85 /ug of pyruvic acid per ml respectively in the present study, similates the observations of Bhattacharyya and Chakraborty (1979) and Pradhan (1991) in goats. However Peer (1987) recorded serum GOT and GPT level as 76.22 ± 7.822 and 20.34 ± 3.646 RF units/ml respectively ir healthy goats. Tirkey et al. (1987) recorded GOT and GPT level as 99.50 ± 6.02 and 34.50 ± 1.93 RF units/ml respectively in healthy goats while Alemu et al. (1977) recorded 60 I.U./l and 11.7 ± 4.6 I.U./l of GOT and GPT respectively in healthy sheep.

The mean values of serum alkaline phosphatase activity obtained in this present study was 3.97 ± 1.16 Bodansky units/ 100 ml. Adaval et al. (1969) reported 2.733 ± 0.712 and 3.587 ± 2.102 B.U./100 ml of serum of alkaline phosphatase in indigenous male and female goats respectively. Bhattacharyya and Duttagupta (1987) recorded 11.20 ± 1.20 B.U./100 ml in growing Black Bengal kids of 15 to 213 days of age. Tirkey et al. (1987) also recorded 2.42 - 3.27 B.U./100 ml of alkaline phosphatase in Black Bengal goats. The differences might be due to the differentces in age, sex and geographical habitate of the animals (Blood et al., 1983).

4.2 Observations on Experimentally Induced Hepatic Damage in Untreated Black Bengal goats (Group II)

4.2.1 Clinical symptoms

The clinical signs of group II after administration of carbontetrachloride are presented in Tables 6a and 6b. Dullness and depression were observed in all the animals from 2nd day and were noticed in all the animals till the end of the experimental period. There was marked detoriation of health in all the animals.

Dullness and depression have been reported after administration of CTC in sheep (Cxer, 1933; Blakemore, 1946; Setchell, 1961; Anwar et al., 1976 and Singh et al., 1978), calves (Hurgerford, 1975; Anwar et al., 1976; Anderson et al., 1981 and Blood et al., 1983), horses (Captain and Syed, 1966), buffalo calves (Sethuraman and Verma, 1978; Mahanta et al., 1983 and Mahanta et al., 1986), goats (Sharma et al., 1986; Peer et al., 1988 and Pradhan, 1991). In the present study, dullness and depression were observed in all the animals were attributed due to CTC toxicity of the central nervous system (Jones et al., 1977 and Blood et al., 1983).

Loss of appetite due to CTC toxicity was observed in all the animals throughout the experimental period of Group II, was also recorded in different species of animals by Gillain (1932), Cxer (1933), Captain and Syed (1966), Caple and Heath

Table 6a. Clinical observations in experimentally induced hepatitis in goats (Group II)

Parameters	Days								
	0	2	3	6	9	12	15	18	21
Dullness/depression	0/5	5/5	5/5	4/4	3/3	3/3	3/3	3/3	1/3
Loss of appetite	0/5	5/5	5/5	4/4	3/3	3/3	3/3	3/3	2/3
Dirrhoea	0/5	3/5	4/5	3/4	2/3	1/3	1/3	0/3	0/3
Incoordination	0/5	5/5	5/5	4/4	3/3	1/3	0/3	0/3	0/3
Aimless movements	0/5	2/5	4/5	3/4	2/3	1/3	1/3	0/3	0/3
Rough hair coat	0/5	5/5	5/5	4/4	3/3	3/3	1/3	1/3	0/3
Pale to yellowish mucous membrane	0/5	3/5	4/5	4/4	3/3	3/3	3/3	2/3	2/3
Nasal discharge	0/5	4/5	4/5	4/4	2/3	2/3	2/3	0/3	0/3
Chewing like movements	0/5	4/5	5/5	4/4	2/3	0/3	0/3	0/3	0/3
Trembling of limbs	0/5	3/5	4/5	3/4	1/3	1/3	0/3	0/3	0/3
Quivering of muscles	0/5	2/5	3/5	3/4	1/3	1/3	0/3	0/3	0/3
Coma	0/5	1/5	2/5	2/4	0/3	0/3	0/3	0/3	0/3
Palling/lying on ground	0/5	4/5	4/5	3/4	1/3	0/3	0/3	0/3	0/3
Death	0/5	0/5	0/5	2/5	0/4	0/3	0/3	0/3	0/3

(1971), Sethuraman and Verma (1978), Morrow et al. (1979), Anderson et al. (1981), Mahanta et al. (1983), Sharma et al. (1986), Peer et al. (1988) and Pradhan (1991). Partial or complete absence of bile salts coupled with distended liver in acute hepatitis produced anorexia (Blood et al., 1983).

Dirrhoea was recorded in almost all the animals of Group II, was also noticed by Gillain (1932), Setchell (1961), Sethuraman and Verma (1978), Mahanta et al. (1983), Sharma et al. (1986), Peer et al. (1988) and Pradhan (1991) in different species of animals. The loose motion was due to inflammation of both the abomasum and duodenum in addition to hepatitis (Blood et al., 1983).

Incoordination and aimless movements were noticed in most of the animals following carbontetrachloride administration, were also reported by Singh et al. (1978) in sheep and Sharma et al. (1986), Peer et al. (1978) and Pradhan (1991) in goats. These signs were due to the toxic effect of CTC on the central nervous system (Singh et al., 1978 and Blood et al., 1983).

Rough body coat was observed in all the animals of Group II similated the findings of Sharma et al. (1986), Peer et al. (1988) and Pradhan (1991) in goats. This symptom might have developed due to less feed intake by the animals resulting

Chewing like movements of jaws and lips recorded in some goats during the experimental period similates the findings of Peer et al. (1988) and Pradhan (1991) in goats.

Trembling of limbs with or without jerky movements were also observed in some of the animals during the experimental period. Similar symptoms were also noticed by Singh et al.(1978) in sheep and Peer et al. (1988) and Pradhan (1991) in goats. This might be attributed due to the hypoglycemia, resulting from CTC toxicity which had affected the central nervous system (Blood et al., 1983).

Quivering of muscles noticed in these experimental animals during the experimental period similates the findings of Singh et al. (1978) in sheep and Peer et al. (1988) and Pradhan (1991) in goats. Coma and recumbancy or falling/lying on the ground observed in some of the animals during the early stage of the experiment also corroborates the findings of Blakemore (1946), Singh et al. (1978), Peer et al. (1988) and Pradhan (1991) in different species of animals. The above nervous manifestations were due to hypoglycaemia and failure of normal hepatic detoxification mechanism leading to the accumulation of excess amino acids and ammonia or of acetylcholine and the libaration of toxic breakdown products of liver parenchyma (Blood et al., 1983). However, Singh et al. (1978) opined that decrease in calcium level due to CTC intoxication is the cause of nervous symptoms in animals.

Two animals died, one on 5th day and the other on 6th day of the experimental period. Death due to CTC poisoning was also recorded by Blakemore (1946), Gallagher (1960) within 30-36 hours and Pradhan (1991) on the 4th and 6th days of CTC dosing. Death of some animals following CTC administration were also recorded by Mahanta (1984) in buffalo calves and Peer (1987) in goats. The cause of death with CTC toxicosis was explained due to pulmonary oedema by Gallaghar(1960), cardiovascular collapse and respiratory failure by Jones (1965) and failure of regeneration of necrosed liver by Sethuraman and Verma (1978).

The gradual disappearance of some abnormal signs in the rest 3 animals was due to the regeneration of damaged hepatic cells (Jubl and Kennedy, 1970).

The mean values of temperature, pulse rate, respiration, ruminal motility and body weights recorded during the experimental period following CTC induced hepatotoxicity are presented in the Table 6b.

The average body temperature which was 102.30 $\pm$ 0.33^{o}F at 0 day increased significantly ($P < 0.05$) on 3rd day and then decreased and reached to 102.40 $\pm$ 0.35^{o}F on 21st day of experimental period. However, Gillain (1932) reported subnormal temperature in CTC poisoning in dogs, where as elevated body temperature was recorded by Sharma *et al.* (1986), Peer *et al.*(1988)

and Pradhan (1991) in goats. Trembling of limbs and quivering of the muscles may be the contributing factors for increased body temperature.

The mean pulse rate recorded on 0 day was 75.80 ± 1.85 per min., increased significantly ($P<0.01$) from 2nd day and reached maximum to 105.40 ± 1.82 per min. on 3rd day. Thereafter the values decreased and reached to 79.33 ± 1.20 per min. on 21st day (Table 6b). Similar changes were also recorded by Sethuraman and Verma (1978) in buffalo calves and Sharma et al. (1986), Peer et al. (1988) and Pradhan (1991) in goats. Significant increase in pulse rate may be due to compersatory increase in anaemic conditions for meeting the requirement of oxygen to the body tissues for normal metabolic activities (Kelly, 1979).

The mean respiratory rate recorded on 0 day was 27.60 ± 1.03 per min. increased significantly ($P<0.01$) on 2nd day (33.80 ± 1.56 min.) and reached maximum on 3rd day (36.60 ± 1.03) per min. Then the values of respiratory rate decreased gradually and reached to 28.33 ± 0.88 per min. on 21st day (Table 6b).

Similar observations following CTC toxicity were also recorded by Mangalik et al. (1957) in rats, Singh et al.(1978) in sheep, Mahanta (1984) in buffalo calves and Peer et al. (1988) and Pradhan (1991) in goats. Anaemia is associated with

low oxygen carrying capacity of the erythrocytes which increases the respiratory rate for more frequent exchange of air (Blood et al., 1983; Schalm et al., 1986).

The mean values of ruminal motility recorded on 0 day was 6.30 ± 0.37 per 5 min., decreased significantly (P/0.01) from 2nd day onwards and reached minimum on 6th day (2.25 ± 0.43). There after the values increased gradually and reached to 4.66 per 5 min. on 21st day but all these values were statistically significant (P/0.01) from the 0 day value (Table 6b).

These observations corroborated with the observations of Mullen (1976) in farm animals, Peer (1987) and Pradhan(1991) in goats. Sharma (1985) suggested that, decreased contractile activity of the rumen might be due to weakness which further causes increased retention of ingesta and higher accumulation of fermentation products and volatile fatty acids in rumen. He also opined that various degrees of acidosis may be responsible for decreased ruminal motility.

The average body weights recorded on 0 day was 10.30 ± 0.73 kg reduced gradually and reached minimum to 8.23 ± 0.37 kg at the end of the experiment, but the differences were not statistically significant. This nonsignificant difference also similates the observations recorded by Mullen (1976), Sharma et al. (1986) Peer et al. (1988), Pradhan (1991) in different species of animals. The reduction in body weight may be due

to disturbances in absorption of nutrients, reduction in their metabolism due to acute hepatic dysfunction (Peer, 1987) and also due to decreased feed intake.

4.2.2 Haematological examination

Results of haematological changes of goats of Group II are presented in Table 7 and 8.

4.2.2.1 Haemoglobin

The mean values of haemoglobin level recorded on 0 day were 9.48 ± 0.39 g/dl, decreased significantly (P/0.01) from day 2 and reached to the minimum level (6.35 ± 0.25 g/dl) or day 6. Thereafter the values increased gradually (Table 7), though the values remained statistically significant (P/0.01) from the 0 day value.

Similar observations of decreased haemoglobin level with liver lesions have also been reported by Peer et al. (1988) and Peer et al. (1990) in goats and Finn and Tennant (1974), Dessouky and Moustafa (1979), Nooruddin et al. (1982), Haroun et al. (1986), Swarup et al. (1987), Tirkey et al. (1987), Chaudhri et al. (1988) and Chaudhri et al. (1990) from other species of animals.

Haemoglobin is the only source of bilirubin (Mullen, 1976). In carbontetrachloride toxicity there is more production of bilirubin which comes from the destruction of haemoglobin

Table 7. Haematological changes in experimentally induced hepatitis of Black Bengal goats of Group - II (Mean ± S.E.)

Days	Haemoglobin	TEC (millions/ cubic mm)	PCV (%)	MCV (cubic microns)	MCH (micro micrograms)	MCHC (%)	No. of animals
0	9.48 ± 0.39	11.06 ± 0.54	31.60 ± 1.75	28.55 ± 0.73	8.73 ± 0.26	29.83 ± 1.66	5
2	7.52** ± 0.22	9.20 ± 0.61	23.40** ± 2.54	27.06 ± 2.19	8.27 ± 0.43	33.62* ± 3.59	5
3	6.40** ± 0.14	7.38 ± 0.56	19.60** ± 2.54	26.18 ± 4.33	8.88 ± 0.74	37.98 ± 4.39	5
6	6.35** ± 0.25	8.01 ± 0.57	22.75** ± 2.29	28.82 ± 3.94	8.02 ± 0.54	28.93 ± 3.11	4
9	6.93** ± 0.44	8.78* ± 0.81	24.33** ± 1.45	28.26 ± 3.23	7.96 ± 0.49	28.85 ± 3.36	3
12	6.67** ± 0.37	9.54 ± 0.71	26.33** ± 2.03	27.93 ± 2.95	7.09 ± 0.39	26.07 ± 3.56	3
15	6.53** ± 0.47	9.62 ± 0.73	27.00* ± 2.31	27.45 ± 3.22	6.81 ± 0.28	24.77 ± 3.71	3
18	6.67** ± 0.52	9.67 ± 0.74	27.66* ± 2.60	29.04 ± 3.73	6.94 ± 0.19	24.79 ± 4.12	3
21	6.73** ± 0.63	9.68 ± 0.75	26.67* ± 2.33	27.89 ± 3.12	6.94 ± 0.22	25.79 ± 4.06	3

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$)

Table 8. Haematological changes in experimentally induced hepatitis of Black Bengal goats of Group II (Mean ± S.E.)

Days	Clotting time (min. sec.)	TLC (thousand/ cubic mm)	DLC (%)					No. of animals
			Lymphocy -tes	Neutro -phils	Eosino -phils	Monocy -tes	Baso- phils	
0	2 min. 42 sec.	9.89 ± 0.43	55.40 ± 1.80	39.40 ± 1.57	3.40 ± 0.68	1.75 ± 0.43	0.20 ± 0.20	5
2	3 min. 11 sec.	11.09* ± 0.39	48.00** ± 1.30	45.80** ± 1.16	4.80 ± 0.37	1.00 ± 0.45	0.40 ± 0.24	5
3	3 min. 33 sec.	11.58** ± 0.45	41.20** ± 1.77	53.20** ± 0.73	5.40* ± 0.51	1.40 ± 0.24	0.80 ± 0.37	5
6	3 min. 33 sec.	12.21** ± 0.51	43.25** ± 1.55	50.75** ± 1.25	4.25 ± 0.63	1.25 ± 0.48	0.50 ± 0.50	4
9	3 min. 34 sec.	12.41** ± 0.35	47.00** ± 0.58	47.67** ± 0.33	3.67 ± 0.33	1.33 ± 0.33	00.33 ± 0.33	3
12	3 min. 44 sec.	11.10 ± 0.63	49.67* ± 0.67	45.00* ± 0.58	3.33 ± 0.33	1.33 ± 0.33	0.67 ± 0.33	3
15	3 min. 35 sec.	10.68 ± 0.65	50.67* ± 0.67	44.67* ± 0.89	3.67 ± 0.67	1.00 ± 0.58	0.00 ± 0.00	3
18	3 min. 25 sec.	10.75 ± 0.64	51.33 ± 1.45	44.33* ± 0.67	3.33 ± 0.67	0.67 ± 0.33	0.33 ± 0.33	3
21	3 min. 32 sec.	10.78 ± 0.64	53.60 ± 1.53	42.33 ± 0.67	3.00 ± 0.58	1.33 ± 0.33	0.33 ± 0.33	3

* Statistically significant at 5% level (P < 0.05)

** Statistically significant at 1% level (P < 0.01)

and therefore the haemoglobin concentration of blood decreases. Peer et al. (1990) also opined that the decreased haemoglobin concentration in CTC poisoning is due to increased cell destruction and inadequate cell production.

4.2.2.2 Total erythrocyte count

The mean value of total erythrocyte count recorded on 0 day was 11.06 ± 0.54 millions/cubic mm. of blood, which decreased significantly ($P < 0.01$) from day 2 and reached to a minimum level of 8.01 ± 0.57 millions/cubic mm. on day 6 and then increased gradually and reached to 9.68 ± 0.75 millions/cubic mm. on 21st day though the values except the 9th day value were not significant.

These observations simulated the findings of Peer et al. (1990) in goats with carbontetrachloride poisoning. Similar findings of decreased total erythrocyte count with liver dysfunctions have also been reported by Finn and Tennant (1974), Dessouky and Moustafa (1979), Nooruddin et al. (1982), Haroun et al. (1986), Sgarup et al. (1987), Tirkey et al. (1987) and Chaudhri et al. (1988) from other different species of animals.

However, the significant reduction of total erythrocyte count might be due to increased cell destruction and inadequate cell production due to liver dysfunctions caused by CTC poisoning.

4.2.2.3 Packed cell volume

There was significant ($P < 0.01$) decrease of Packed cell volume from its 0 day value of 31.60 ± 1.75% to 19.60 ± 2.54% on 3rd day but thereafter the values gradually increased (Table 7), upto the end of the experimental period, though the values remained statistically significant ($P < 0.01$).

Similar observations have also been recorded by Peer et al. (1990) in goats, poisoned with CTC and by Finn and Tennant (1974), Dessouky and Moustafa (1979), Nooruddin et al. (1982), Haroun et al. (1986), Tirkey et al. (1987) and Chaudhri et al. (1990) in other different species of animals with hepatic dysfunctions.

Peer et al. (1990) opined that decreased level of packed cell volume could be due to increased cell destruction and inadequate cell production due to liver dysfunction.

4.2.2.4 Mean corpuscular volume

The mean value of mean corpuscular volume recorded on 0 day was 28.55 ± 0.73 cubic microns, decreased gradually and reached to 26.17 ± 4.33 cubic microns on 3rd day, though the values were not statistically significant but thereafter the values showed increasing trend (Table 7).

The non-significant decrease of mean corpuscular volume was also recorded by Tirkey et al. (1987) in goats and Chaudhri

et al. (1988) in buffaloes with hepatic dysfunction. The value of mean corpuscular volume depends on the level of total erythrocyte count and packed cell volume. Therefore, decrease of both these values in this experiment also decreased the MCV level.

4.2.2.5 Mean corpuscular haemoglobin

The average value of mean corpuscular haemoglobin recorded on 0 day was 8.73 ± 0.26 micro micrograms, decreased gradually and reached to the minimum level (6.31 ± 0.28 micro micrograms) on day 15 but increased gradually thereafter (Table 7), though the values were not statistically significant from the 0 day value.

However, increased MCH value was recorded by Tirkey et al. (1987) in goats with liver lesions.

4.2.2.6 Mean corpuscular haemoglobin concentration

The average value of mean corpuscular haemoglobin concentration recorded on 0 day was 29.83 ± 1.66%, increased significantly ($P < 0.05$) on day 2 (33.62 ± 3.59%) and reached to the maximum level of 37.99 ± 4.39 % on day 3 but thereafter declined gradually (Table 7), though the values were not statistically significant.

Similar observations have also been recorded by Tirkey et al. (1987) in goats with Ipomoea carnea induced hepatopathy.

The values of mean corpuscular haemoglobin concentration depends on the levels of haemoglobin and packed cell volume of blood.

4.2.2.7 Clotting time

The mean value of clotting time recorded on 0 day was 2 min. and 42 sec. which increased gradually and reached to the maximum value of 3 min. and 44 sec. on day 12 and then decreased gradually (Table 8).

Rowaell (1969) opined that the liver is responsible for the synthesis of many proteins involved in the clotting process of blood. Therefore, in liver dysfunction, liver is unable to synthesize those proteins required for the clotting mechanism. Hoe and Wilkinson (1973) suggested that synthesis of clotting factors may be suppressed as a result of the reduction of absorption of vitamin K or due to overall reduction in function of hepatic cells in liver diseases, resulting in increased clotting time of blood. Loos of plasma proteins, impaired digestion and absorption of protein, calcium and vit. K have been attributed to be the main causes for reduction of prothrombin and fibrinogen level of blood and the increased clotting time (Pradhan et al., 1987).

4.2.2.8 Total leucocyte count

The total leucocyte count of the animals of Group II increased significantly ($P < 0.01$) from its 0 day value of 9.39 $\pm$ 0.43 thousands/cubic mm. to 12.41 $\pm$ 0.35 thousands/cubic mm.

on day 9 and thereafter decreased gradually and reached to 10.78 ± 0.84 thousands/cubic mm. at the end of the experiment (Table 8), though the values were not statistically significant from the 0 day value. Similar observations were also recorded by Peer et al. (1990) in goats with CTC poisoning. Significant increase of total leucocyte count were also recorded by Finn and Tennant (1974), Dessouky and Moustafa (1979), Nooruddin et al. (1982), Haroun et al. (1986) and Swarup et al. (1987) from other different species of animals with liver lesions.

This increased total leucocyte count might be due to the acute inflammatory changes of the liver with CTC.

However, Tirkey et al. (1987) could not observe any significant change in total leucocyte count in Ipomoea carnea induced hepatopathy in goats.

4.2.2.9 Differential leucocyte count

The mean value of lymphocyte recorded on 0 day was 55.40 ± 1.80 %, which decreased significantly ($P < 0.01$) and reached to 41.20 ± 1.77 % on day 3, increased gradually thereafter and reached to 53.00 ± 1.53 % at the end of the experiment, though the values were statistically significant ($P < 0.05$) till day 15 of the experiment.

The mean neutrophil percent increased significantly ($P < 0.01$) from its 0 day value of 39.40 ± 1.57 % to 53.20 ± 0.73%, on day 3 but thereafter decreased significantly ($P < 0.05$)

and reached to 42.33 ± 0.67 % on day 21 of the experiment. Similarly, the mean value of eosinphil recorded on 0 day (3.40 ± 0.68 %) also increased significantly ($P<0.05$) on day 3 (5.40 ± 0.73%) and decreased gradually to 3.00 ± 0.58% at the end of the experiment. However, these later values were not statistically significant.

The mean values of Monocyte and Basophil were not however significantly changed in this experiment (Table 8).

These findings simulated the findings of Peer et al. (1990) in goats with hepatic dysfunction. Nooruddin et al. (1982), Harour et al. (1986) and Swarup et al. (1987) also recorded the similar observations with hepatic dysfunctions in other species of animals.

Nooruddin et al. (1982) opined that the leucocytosis is infected goats (Fasciola gigantica) was due to manifold increase of polymorphonuclear neutrophils and eosinophils as a result of hepatic dysfunction. According to Duncan and Prasse (1977) the changes in the differential leucocytic picture may be due to the inflammatory changes caused by carbontetrachloride.

4.2.3 Liver function tests

The results of blood biochemical changes of goats of Group II are presented in Table 9 and 10.

Table 9. Blood biochemical changes in experimentally induced hepatitis in goats of Group II (Mean ± S.E.)

Days	Blood glucose (mg%)	Serum protein (g%)	Albumin (g%)	Globulin (g%)	A/G ratio	Icteric index (units)	Van den Bergh test	No. of animals
0	59.38 ± 2.28	6.49 ± 0.27	3.85 ± 0.24	2.64 ± 0.15	1.48 ± 0.13	4.91 ± 0.45	-ve	5
2	37.87** ± 3.49	6.23 ± 0.27	3.41 ± 0.23	2.81 ± 0.17	1.23 ± 0.12	10.35* ± 0.57	+ve	5
3	29.48** ± 3.56	5.57 ± 0.41	2.76** ± 0.20	2.80 ± 0.33	1.05* ± 0.15	18.77 ± 0.65	+ve	5
6	28.75** ± 3.90	5.48* ± 0.34	2.64** ± 0.32	2.85 ± 0.38	0.99* ± 0.20	19.33** ± 0.83	+ve	4
9	30.57** ± 4.94	5.25* ± 0.32	2.79** ± 0.39	2.42 ± 0.09	1.16 ± 0.18	14.95** ± 1.36	+ve	3
12	34.37** ± 4.78	5.46* ± 0.29	2.81** ± 0.34	2.51 ± 0.10	1.07* ± 0.13	11.38* ± 1.04	-ve	3
15	41.88** ± 3.83	5.64* ± 0.28	3.01* ± 0.05	2.45 ± 0.31	1.21 ± 0.12	8.61* ± 1.33	-ve	3
18	46.51** ± 4.29	5.70 ± 0.24	3.12* ± 0.05	2.58 ± 0.21	1.22 ± 0.08	6.62 ± 0.73	-ve	3
21	48.80** ± 3.49	5.83 ± 0.27	3.29* ± 0.09	2.54 ± 0.33	1.34 ± 0.20	5.87 ± 0.67	-ve	3

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$)

Table 10. Blood biochemical changes and serum enzyme activity in experimentally induced hepatitis in goats of Group II (Mean ± S.E.)

Days	Total bilirubin (mg%)	Serum cholesterol (mg%)	SGOT (µg pyruvic acid/ml)	SGPT (µg pyruvic acid/ml)	AP (Bodansky units/100 ml)	No. of animals
0	0.31 ±0.06	108.53 ± 6.58	95.80 ± 4.38	27.20 ± 2.63	3.99 ± 1.14	5
2	0.95** ± 0.19	152.43** ± 6.93	315.20** ± 4.80	66.80** ± 5.57	8.91* ± 1.09	5
3	1.19** ± 0.20	190.81** ±11.51	479.60** ±19.08	93.60** ± 6.79	11.33** ± 1.08	5
6	1.33** ± 0.24	223.80** ± 9.29	443.25** ±23.11	84.75** ± 6.75	7.56* ± 1.23	4
9	1.19** ± 0.32	218.35** ± 9.01	341.33** ±17.29	69.67** ± 8.84	5.51 ± 0.73	3
12	1.08** ± 0.33	209.28** ± 8.85	241.33** ±10.41	61.67** ± 6.01	5.38 ± 0.72	3
15	0.95** ± 0.31	196.82** ± 7.55	174.67** ± 6.77	50.33** ± 3.71	4.94 ± 0.46	3
18	0.87** ± 0.30	179.71** ± 7.00	152.67** ± 7.05	47.33** ± 4.41	4.57 ± 0.43	3
21	0.71** ± 0.28	165.74** ± 6.56	139.67** ± 9.21	42.33 ± 4.70	4.27 ± 0.64	3

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$)

4.2.3.1 Blood glucose

The mean value of blood glucose level recorded on 0 day was 59.38 ± 2.23 mg%, decreased significantly ($P < 0.01$) and reached to 28.75 ± 3.90 mg% on 6th day of the experiment. Thereafter the values increased gradually (Table 9) and reached to 48.80 ± 3.49 mg% at the end of the experiment though the values were statistically significant ($P < 0.01$) from the 0 day value.

Similar observations have also been reported by Frunder et al. (1956), Sethuraman and Verma (1978), Mahanta (1984), Dwivedi et al. (1986), Peer et al. (1990) and Pradhan (1991) in different species of animals. However, Amrousi et al. (1974), Mullen (1976) and Roychoudhury (1981) reported hyperglycaemia in animals with liver lesions, while Tirkey et al. (1987) remarked that hepatotoxicity due to administration of Ipomoea carnea, has no effect on blood sugar levels in goats.

Mullen (1976) reported that the liver with its hormonal control mechanism, is undoubtedly the most important organ for carbohydrate metabolism and is the principal agent in the maintenance of normal blood sugar level. He further opined that, blood glucose levels of animals are maintained within normal limits by glycogenesis and glycolysis. The CTC poisoning depletes the liver glycogen and results in marked reduction of free glucose level in the blood. Rosenberger (1979) opined that, severe excretion, starvation, hypothyroidism, adreno-cortical

insufficiency and hypopituitarism are responsible for the causes of hypoglycemia in cattle while Dwivedi et al. (1986) and Sharma et al. (1986) remarked that in CTC toxicity, the liver cells become unable to convert glycogen into glucose and hence impaire gluconeogenesis and hamper glucogenesis of fatty acids.

4.2.3.2 Serum protein

The mean value of total serum protein recorded on 0 day was 6.49 ± 0.27g%, decreased significantly (P < 0.05) to 5.25 ± 0.33 g% on 9th day and then the values increased gradually (Table 9).

Similarly, the mean albumin value also decreased significantly (P < 0.01) from its 0 day mean value of 3.85 ± 0.24 g% to 2.64 ± 0.32 g% on 6th day. The values increased gradually thereafter (Table 9) and reached to 3.29 ± 0.09 g% at the end of the experiment, though the values were statistically significant from its 0 day value. However, no significant changes were observed in mean globulin values during the experimental period (Table 9).

The A/G ratio decreased significantly (P < 0.05) from its 0 day value of 1.48 ± 0.13 to 0.99 ± 0.20 on 6th day of the experiment. Thereafter the mean values increased gradually and reached to 1.34 ± 0.20 at the end of the experiment (Table 9).

The present findings of decreased total serum protein agrees with the findings of Barryman and Bellman (1943), Jonson and Liberg (1974), Mullen (1976), Sethuraman and Verma (1979), Peer (1987), Chaudhri et al. (1990) and Pradhan (1991) in different species of animals. Non-significant variation of the total serum protein levels were also reported by Amrousi et al. (1974), Prasad and Joshi (1975), Sen et al. (1976), Kaneko (1980), Poultov (1984), Mahanta (1984) and Dwivedi et al. (1986) in different species of animals with liver disorders. However, little increase in total serum protein with hepatic insufficiency were reported by Dwivedi et al. (1971) in calves, Alemu et al. (1977) and Kessabi and Lamnaquer (1981) in sheep and Nooruddin et al. (1982) in goats.

Decreased albumin level agrees with the findings of Dwivedi et al. (1971), Prasad and Joshi (1971), Finn and Tennant (1974), Mullen (1976), Dessouky and Moustafa (1979), Kaneko (1980), Barnouni et al. (1981), Kessabi and Lamnaquer (1981), Nooruddin et al. (1982), Holtenius (1982), Karsai and Schafer (1984), Poultav (1984), Peer (1987) and Pradhan (1991) in different species of animals, while non-significant change of serum albumin with hepatopathy was also reported by Harvey and Hoe (1971), Sen et al. (1976), Alemu et al. (1977) and Mahanta (1984).

Non-significant change of serum globulin observed in this study has been supported by Harvey and Hoe (1971),

Sen et al. (1976). Alemu et al. (1977), Jonson and Liberg (1974) and Mahanta (1984), while observed lower globulin level and Trifnov (1964), Dwivedi et al. (1971), Finn and Tennant (1974), Sethuraman and Verma (1979), Dessouky and Moustafa (1979), Keneko (1980), Kessabi and Lamnaquer (1981), Nooruddin et al. (1982), Holtenius (1982), Poultov (1984), Karsai and Schafer (1984), Peer (1987) and Pradhan (1991) observed higher globulin levels in different species of animals with hepatic dysfunctions. Gopinath and Ford (1970), Dwivedi et al. (1971), Finn and Tennant (1974) and Jonson and Liberg (1974) in calves, Mullen (1976) in horses and farm animals, Haroun et al. (1986) in sheep and Nooruddin et al. (1982), Peer (1987) and Pradhan (1991) in goats observed decreased A/G ratio with liver disorders which similates with the findings of the present study. However, Sen et al. (1976), Alemu et al. (1977) and Tirkey et al. (1987) in goats and Mahanta (1984) in buffalo calves observed no significant change in A/G ratio with liver disorders.

Berryman and Pollman (1943) opined that plasma proteins diminished only as the whole dietary intake was diminished by CTC poisoning. Mullen (1976) remarked that albumin, with the exception of certain gamma-globulins are all synthesized in the liver. In severe hepatic disturbances, the formation of plasma proteins is retarted. Any process which affects albumin synthesis, also hampers the A/G ratio. So hepatic necrosis causes hypoalbuminaemia. Since all the fractions of the globulins are not synthesized in the liver, globulin level didnot change significantly.

4.2.3.3 Icteric index

The average serum icteric index level recorded on 0 day was 4.91 ± 0.45 units, was found to increase significantly ($P < 0.01$) from 2nd day (10.35 ± 0.57 units) onwards and reached to the maximum level of 19.33 ± 0.83 units on day 3. Thereafter the value decreased gradually and reached to 5.37 ± 0.67 units at the end of the experiment (Table 9).

A significant increase in serum icteric index level was also recorded in CTC induced hepatotoxicity by Sethuraman and Verma (1979), Maharta et al. (1983) and Mahanta (1984) in buffalo calves, Awasthy and Rao (1984) in cows, Pandey et al. (1985) in dogs and Pradhan (1991) in goats. The significant increase in serum icteric index value following CTC administration indicates functional inefficiency of damaged liver. Impaired excretion of bile pigments leads to its accumulation causing high icteric index level in the serum. However, Blood et al. (1983) opined that measurement of icteric index value of the serum cannot be considered as a liver function test but can be used to measure the degree of jaundice present.

4.2.3.4 Van den Bergh test

The qualitative Van den Bergh test in useful for the clinician to differentiate the types of icterus present, although it is not extensively used as a practical diagnostic procedure

(Kaneko, 1980). In the present study, Van den Bergh test showed biphasic reaction from the 2nd day to 9th day post CTC administration, which indicated the presence of both congugated and unconjugated serum bilirubin. Similar observations have been recorded by Prasad et al. (1982) and Verma et al. (1982) in clinical cases of chronic hepatitis in buffaloes and cows respectively and by Mahanta (1984) in buffalo calves and Pradhan (1991) in goats with acute hepatic dysfunction caused by CTC poisoning. Ford (1965) opined that the quantitative application of Van den Bergh test enable to detect the type of liver lesions. He also remarked that the presence of both congugated and uncongugated form of bilirubin in the serum reflects impaired conjugation as well as its excretion into the bile canaliculi by the inflammed hepatic cells.

4.2.3.5 Serum bilirubin

The mean serum bilirubin level recorded on 0 day was 0.31 ± 0.06 mg%, increased significantly ($P < 0.01$) from 2nd day (0.95 ± 0.19 mg%) onwards and reached to its highest level on 6th day (1.33 ± 0.24 mg%). The values then declined gradually and reached to 0.71 ± 0.28 mg% at the end of the experiment (Table 10) though the values remained statistically significant ($P < 0.01$).

Similar observations have also been recorded by Trifnov (1964), Segwright and McLean (1967), Gopinath and Ford (1969, 1970), Dwivedi et al. (1971), Finn and Tennant (1974), Harvey and Obeid (1974), Amrousi et al. (1974), Mullen (1976), Pearson and Craig (1980), Anderson et al. (1981), Nooruddin et al. (1982), Wood and Powel (1983), Mahanta (1984), Sharma et al. (1986), Peer et al. (1990) and Pradhan (1991) in different species of animals. However, Beattie et al. (1944) in cattle, Harvey and Hoe (1971) and Grimoldi et al. (1976) in sheep reported no change while Sharma et al. (1986) observed decreased bilirubin level in goats with CTC toxicity.

Harvey and obeid (1974) and Kaneko (1980) opined that estimation of total serum bilirubin is not sensitive indicator of liver damage, while Amrousi et al. (1974) and Mottelib et al. (1976) remarked the Same as a sensitive index of liver disorders in sheep and goat respectively. Mullen (1976) remarked that erythrocytes have a definite life span and are continually exposed to mechanical stresses, as a result, they eventually disintegrate and liberate haemoglobin. Haemoglobin is the only source of bilirubin and under normal conditions, the rate of bilirobin production in the reticuloendothelial cells parallels the rate of erythrocyte destruction and is fairly constant. Bilirubin is a waste product and the hepatic parenchymal cells have the ability to absorb bilirubin from plasma and to conjugate it with glucoronic acid and excrete it into the bile canaliculi.

Hyperbilirubinaemia is the result of a disturbance of balance between the rate of production of bilirubin and the rate of excretion. Chemical toxins may cause erythrocytic destruction and results in haemolytic jaundice with overproduction of bilirubin. Diminished excretion of bilirubin occurs due to obstruction of the biliary tract, failure of the liver parenchymal cells to excrete bilirubin and a combination of both obstruction and cell damage.

Hoe and Wilkinson (1973) opined that interference with the orderly flow of bilirubin from the red blood cells to the alimentary canal is associated with increased bilirubin in the serum and thereby develop jaundice.

Pearson and Craig (1980) opined that increase of serum bilirubin indicates failure of the excretory function of liver. Failure of liver uptake of bilirubin leads to increased indirect reacting bilirubin, while failure of secretion leads mainly to an increase in conjugated bilirubin. Blockage of bile flow can also cause an increase in both conjugated and unconjugated bilirubin.

4.2.3.6 Serum cholesterol

The serum cholesterol level increased significantly ($P < 0.01$) and reached a maximum level of 223.80 ± 9.29 mg% on 6th day from its initial 0 day value of 108.53 ± 6.58 mg%. The value then gradually decreased and reached to 165.75 ± 6.56 mg%

on 21st day, but still remained statistically elevated ($P<0.01$) (Table 10).

Similar observations were also recorded by Harvey and Hoe (1971) and Alemu *et al.* (1977) in sheep, Mahanta (1984) in buffalo calves, Dwivedi *et al.* (1986) in rabbits and Sharma *et al.* (1986), Peer *et al.* (1990) and Pradhan (1991) in goats with hepatic dysfunctions. However, Gupta *et al.* (1976) and Mottelib *et al.* (1976) observed decreased cholesterol level with hepatic disorders in calves and goats respectively. Mullen (1976) remarked that the estimation of cholesterol is an useful diagnostic tool for the diagnosis of liver dysfunction in farm animals. He reported that, as there are no specific tests designated for fat metabolism and as the metabolism of cholesterol is closely associated with that of fat, serum cholesterol concentration has been used successfully to determine liver dysfunction. Hoe and Wilkinson (1973) opined that increased level of total cholesterol with hepatic dysfunction could be due to decreased excretion and probably due to over production of cholesterol by the liver. Harvey and Hoe (1971) suggested that this test was of useful in the detection of liver damage in sheep dosed with carbontetrachloride and hexachlorophene, while Rosenberger (1979) stated that total cholesterol level in serum was of limited use in detecting liver diseases because of its wide variability and susceptibility to various internal and external factors. However, in view of the present findings, it is suggested that the estimation of total cholesterol can be used for the diagnosis of acute toxic hepatic damage.

4.2.3.7 Serum enzymes

Increased serum enzyme activity is often the first change observed in liver diseases. Estimation of liver specific enzymes is the most sensitive and reliable test to detect hepatic damage as well as for making a prognosis and evaluation of therapy (Kanako, 1980).

4.2.3.7.1 Serum glutamic oxalacetic transaminase

The average value of serum GOT level recorded on 0 day was 95.80 ± 4.38 /ug pyruvic acid/ml, increased significantly ($P < 0.01$) and reached to the maximum level of 479.60 ± 19.80 /ug pyruvic acid/ml on 3rd day. The values thereafter decreased gradually, though they remained significantly ($P < 0.01$) higher than the 0 day value till the end of the experiment (Table 10).

The significant increase of serum GOT level observed in this study, corroborates the finding of Gopinath and Ford (1970), Shaw (1974), Mullen (1976) Rosenberger (1979) and Pearson and Graig (1980) in cattle, Hari et al. (1973), Sethuraman and Verma (1979) and Mahanta et al. (1983) in buffalo calves, Trifnov (1964), Gopinath and Ford (1969), Harvey and Hoe(1971), Hunt (1971), Grimoldi et al. (1976), Alemu et al. (1977), and Haroun et al. (1987) in sheep and Fowler (1971), Adam et al. (1974), Abdel Salam et al. (1982), Peer (1987) and Pradhan (1991) in goats with hepatic dysfunctions.

SGOT is widely distributed in tissues of all species of animals especially in muscles and liver and is located in the cell cytoplasm. Increased serum GOT activities confirm the liver disfunction and acute liver disorders in large animals (Mullen 1976). Harvey and Hoe (1971) suggested that estimations of serum G OT activities could be used as a screening test for hepatic dysfunction in sheep. Pearson and Craig (1980) opined that serum GOT commonly indicate the hepatocellular damage in ruminants and they do not agree with the opinion of Alemu et al. (1977). Stogdale (1978) noticed that the activity of serum GOT rises extensively due to muscle degeneration and liver necrosis.

4.2.3.7.2 Serum glutamic pyruvic transaminase

The mean value of serum GPT recorded on 0 day was 27.20 ± 2.63 /ug pyruvic acid/ml, also increased significantly (P < 0.01) and reached to 93.60 ± 6.79 /ug pyruvic acid/ml on 3rd day. Thereafter the mean values declined gradually and reached to 42.33 ± 4.70 /ug pyruvic acid/ml on 21st day, but still remained significantly (P < 0.01) elevated (Table 10).

Increased serum GPT activity observed in this study confirms the finings of Huhn (1961) in cattle, Boyd (1962) in cattle, sheep and rats, Amrousi et al. (1974), Alemu et al. (1977) in sheep, Sethuraman and Verma (1979) in buffalo calves and Teer (1987) and Pradhan (1991) in goats. However, no alteration of serum GPT activity was also reported by Gopinath and

Ford (1969), Adam et al. (1974), Grimoldi et al. (1976), Pearson and craig (1980) and Mahanta (1984) in different species of animals with hepatopathy.

Stogdale (1978) reported that in animals SGPT is released when liver cell membrane is disrupted due to pathological destruction of the hepatocytes. Though increased SGPT level was observed in the present study, yet the increasing trend was comparatively lower than SGOT, since the ruminants liver contain low level of this enzyme (Ford and Boyd, 1960; Pearson and Craig, 1980).

4.2.3.7.3 Alkaline phosphatase

The mean alkaline phosphatase activity prior to induction of hepatitis was 3.99 ± 1.14 BU/100 ml, increased significantly ($P < 0.05$) from 2nd day (8.91 ± 1.09 BU/100 ml) and reached maximum on 3rd day (11.33 ± 1.08 BU/100 ml). Thereafter, the level declined gradually (Table 10).

Increased serum alkaline phosphatase activities were also recorded by Boyd (1962), Hari et al. (1973), Finn and Tennant (1974), Grimoldi et al. (1976), Kumar and Pachauri (1984), Maru and Pachuri (1985), Swarup et al. (1986) and Pradhan (1991) in different species of animals with liver dysfunctions.

Harvey and Obeid (1974) opined that due to wide normal range of alkaline phosphatase, the estimation of serum alkaline phosphatase activity has limited its use as a diagnostic aid in animals. Pearson and Craig (1980) opined that alkaline phosphatase, being a non-specific enzyme which is present in the liver, bone, intestine, placenta and kidney is not a sensitive indicator of hepatic damage in equine and food animals. Mullen (1976) opined that the alkaline phosphatase is present in the cytoplasm of all the epithelial cells and bone. Alkaline phosphatase activity decreases as age advances in animals. In cattle, sheep, pigs and horses, the alkaline phosphatase activities show great individual variation and the estimation alone is not a reliable means for the diagnosis of liver damage. Only severe hepatic damage will raise the activities above normal.

4.2.4 Gross and histopathological changes

4.2.4.1 Gross changes

All the Carcasses which died during the experimental study, sacrificed at the end of the above period, were found markedly emaciated. Visible mucous membranes were pale to icteric.

Significant pathological changes were observed in the vital organs like, liver, kidneys, heart and lungs. Most severe charges were found to occur in liver followed by kidneys, lungs and heart.

Gross pathological changes of liver showed severe enlargement (Fig 1) change of colour, slightly hard on palpation and rounded edges. There were presence of few white to greyish necrotic foci and haemorrhagic spots on the surfaces. (Fig 1). The gall bladder was distended with thick inspissated greenish bile (Fig 1).

The above findings of liver were comparable with the findings of Sethuraman and Verma (1978) and Sethuraman et al. (1978) in buffalo calves, Singh et al. (1978) in sheep and Peer et al. (1990) and Pradhan (1991) in goats with CTC induced hepatotoxicity.

Kidneys showed presence of few foci of Petechial haemarrhages and congestion which similates with the observations of Sethuraman and Verma (1978) add Sethuraman et al. (1978) in buffalo calves, Singh et al. (1978) in sheep and Peer et al. (1990) and Pradhan (1991) in goats with CTC induced hepatotoxicity. Cut surfaces which revealed severe congestion at the corticomedullary junction (Fig 2), simiates with the observation of Pradhan (1991) in goats. However, Peer et al. (1990) also reported mottled appearance of the kidneys, which was not observed in this study.

Lungs were red in colour, congested and odematous with areas of consolidation and were surrounded by mild emphysematous areas in the lobes (Fig 3), which similates with the observations of Sethuraman et al. (1978) in buffalo calves,

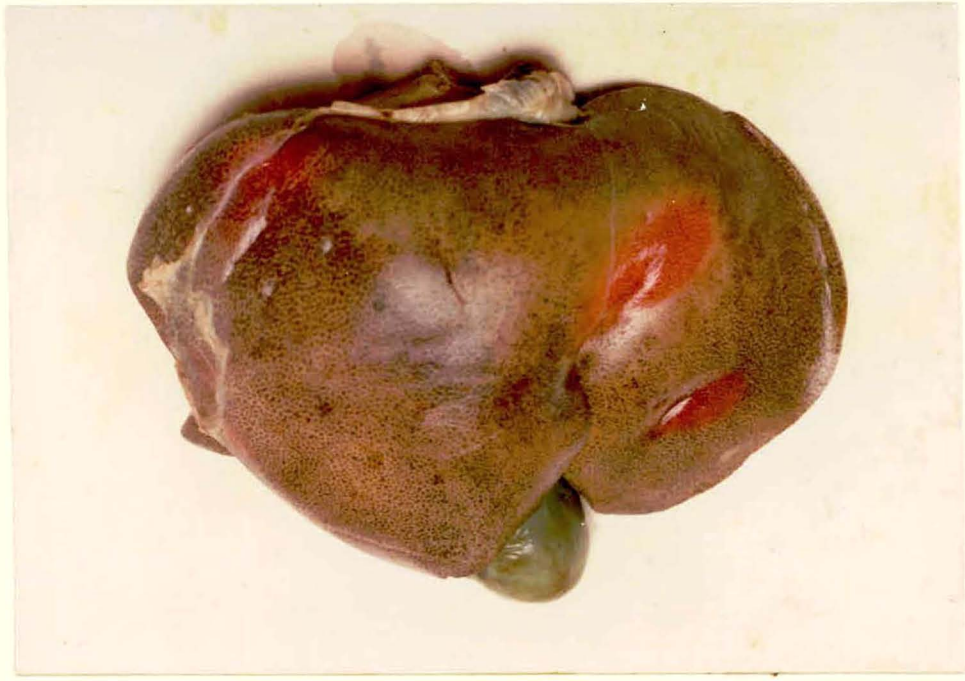

Fig. 1 Enlarged liver with distended gall bladder and congestion and haemorrhagic spots on the surfaces.

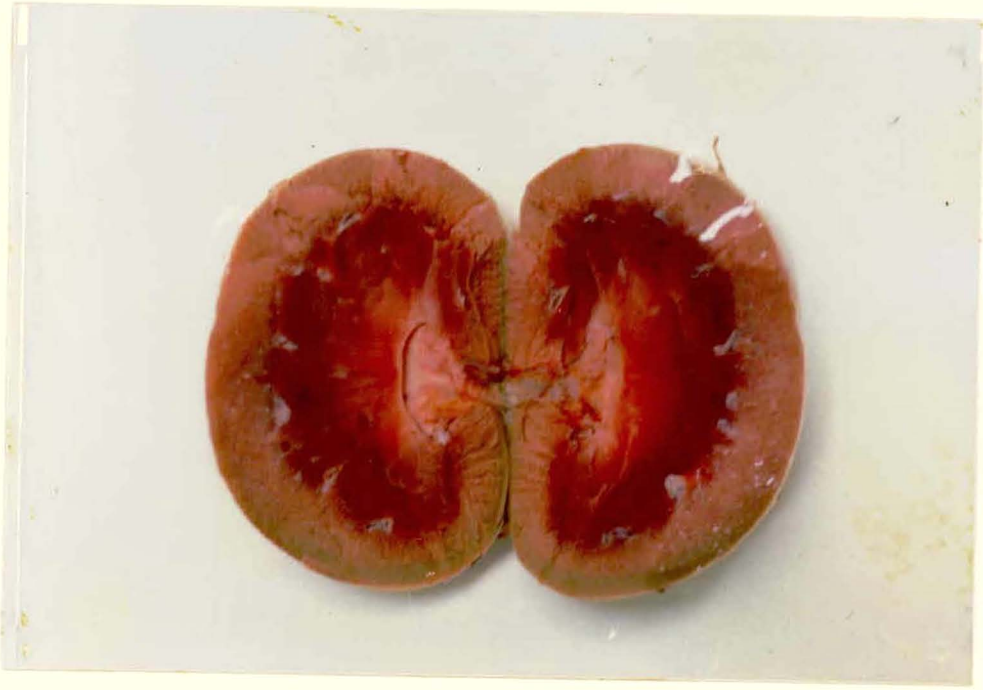

Fig. 2 Severe congestion at the corticomedullary junction of the kidney.

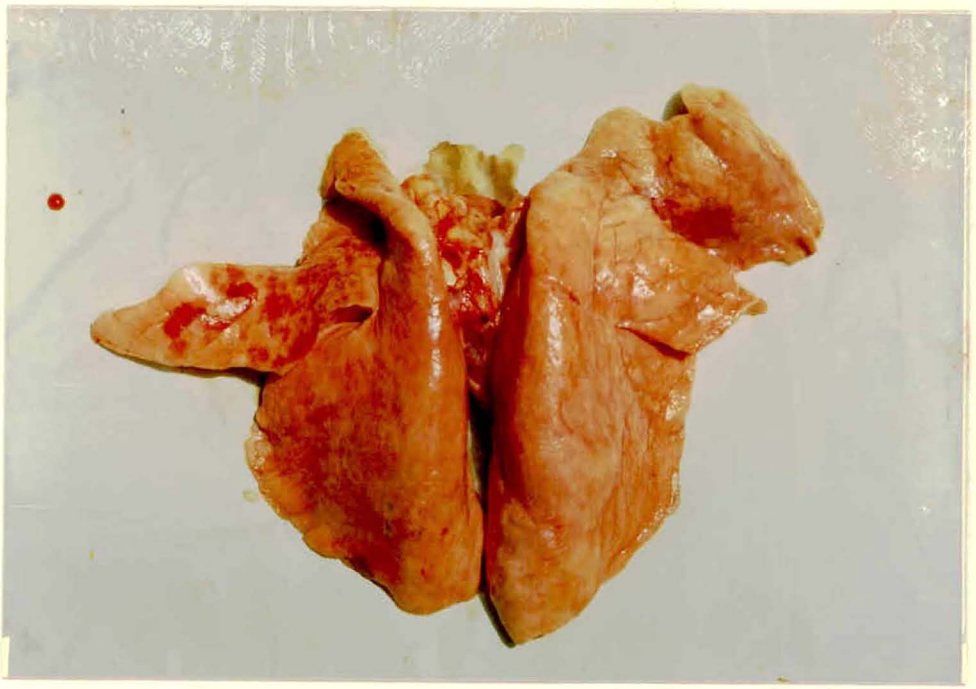

Fig. 3 Congested and odematous lung with areas of consolidation.

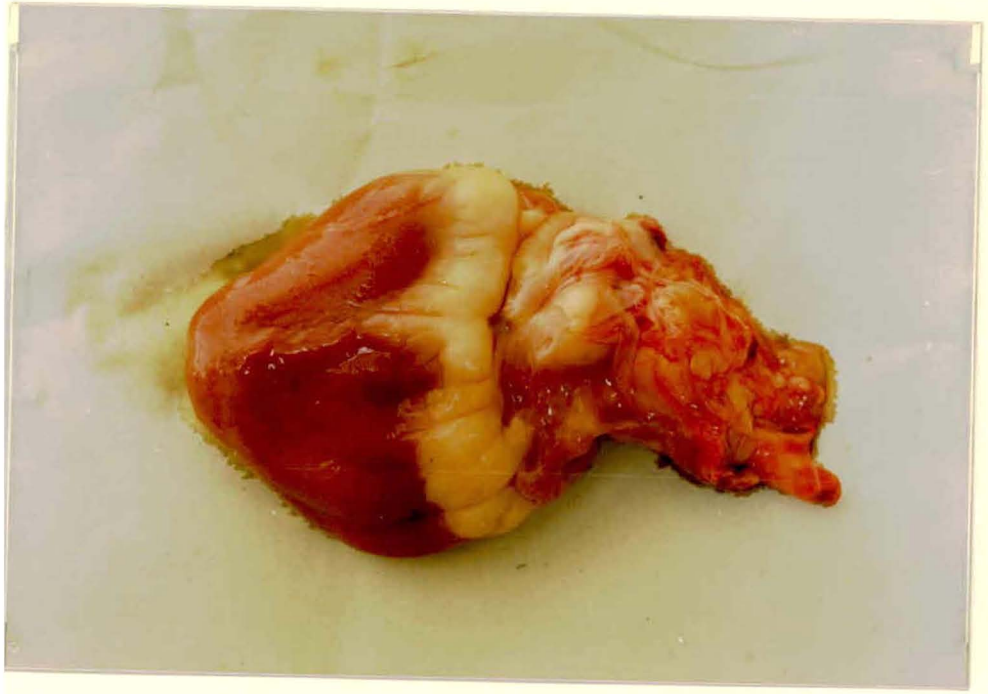

Fig. 4 Pale discoloured heart.

Singh et al. (1978) and Angus and Greig (1978) in Sheep and Peer et al. (1990) and Pradhan (1991) in goats with CTC induced hepatotoxicity.

The heart showed pale discolouration (Fig 4) without any other changes which similates with the observation of Pradhan (1991) in goats. No gross changes of the heart of sheep with CTC poisoning was reported by Singh et al. (1978), but, Sethuraman et al. (1978) in buffalo calves and Angus and Greig (1979) in lambs observed haemorrhagic epicardium and Peer et al. (1990) in goats observed pale discolouration with mild degree of hydropericardium in goats with CTC poisoning.

4.2.4.2 Histopathological changes

Liver - The normal architecture of the hepatic parenchyma was found altered moderate to markedly in most of the cases. Most of the liver lobules exhibited centrilobular degeneration and coagulative necrosis (Fig 5). Moderate fatty changes were encountered in the hepatic cells. There were moderate to massive haemorrhages around the central veins and sinusoids of the hepatic chords. Degeneration and necrotic changes were also observed away from the central vein. (Fig 6). The above changes in liver were comparable with the findings of Winterhalter (1942), Gallagher (1960), Boyd (1962), Gallagher (1964), Balu and Ganapathy (1966), Seawreght and Mclean(1967), Caple and Heath (1971), Alemu et al. (1977), Sethuraman and

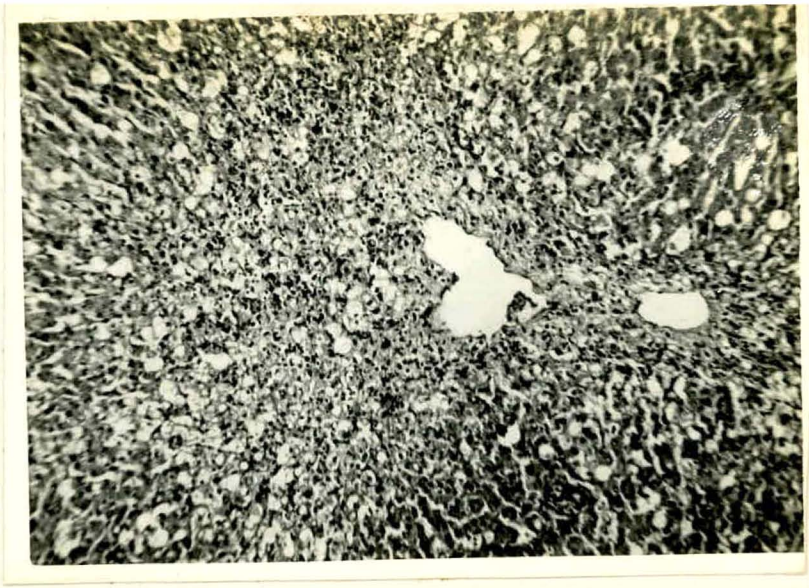

Fig. 5 Section of the liver showing centrilobular degeneration and coagulative necrosis after CTC administration. H & E X 100.

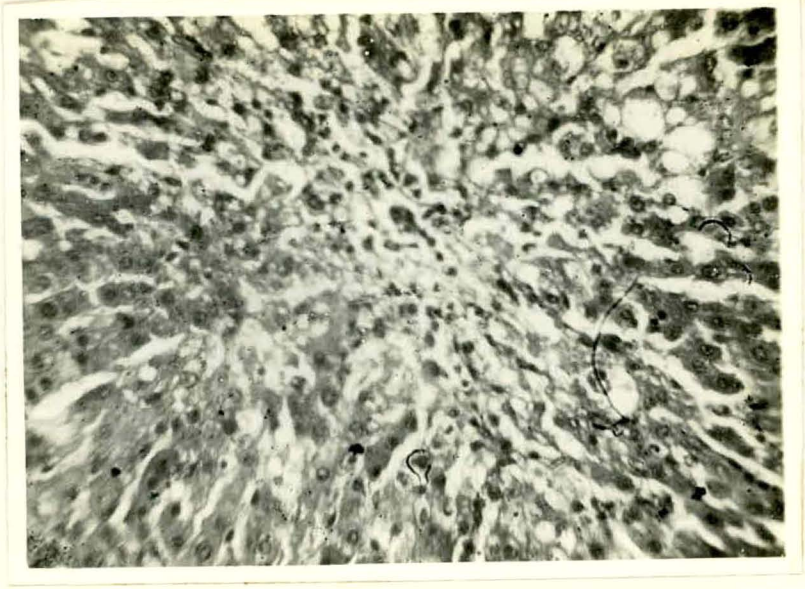

Fig. 6 Section of the liver showing haemorrhages and necrotic changes around the central vein after CTC administration. H & E X 450.

Verma (1978), Singh et al. (1978), Pandey et al. (1983), Sharma et al. (1984) Dwivedi et al. (1986), Dange et al. (1986), Peer (1987), Bradfold (1990) and Pradhan (1991) in different species of animals in CTC induced hepatotoxicity.

Except centrilobular necrosis, some places showed peripheral degeneration and necrosis. The hepatic cords were distorted and there were complete absence of hepatic cells in some places. There were sinusoidal dilation and congestion and proliferation of reticuloendothelial cells. There were aggregation of mononuclear cells towards the central vein. The proliferation of bile duct was also noticed.

Other changes included infiltration of mononuclear calls in the periportal areas and around the central veins, similates the observations of Mahanta (1984) in buffalo calves, Sharma et al. (1984) in dogs and Peer et al. (1990) and Pradhan (1991) in goats. The degenerative and necrotic changes of the liver away from the central veins were also observed (Fig 6).

Kidneys - Kidneys also showed moderate to marked degenerative and necrotic changes which were seen more in the tubules than in the glomeruli. Both the proximal and distal convoluted tubules showed different degrees of degeneration which corroborates with the findings of Setchell (1961) in sheep and Mottelib et al. (1976), Peer (1987) and Pradhan (1991) in goats with CTC poisoning.

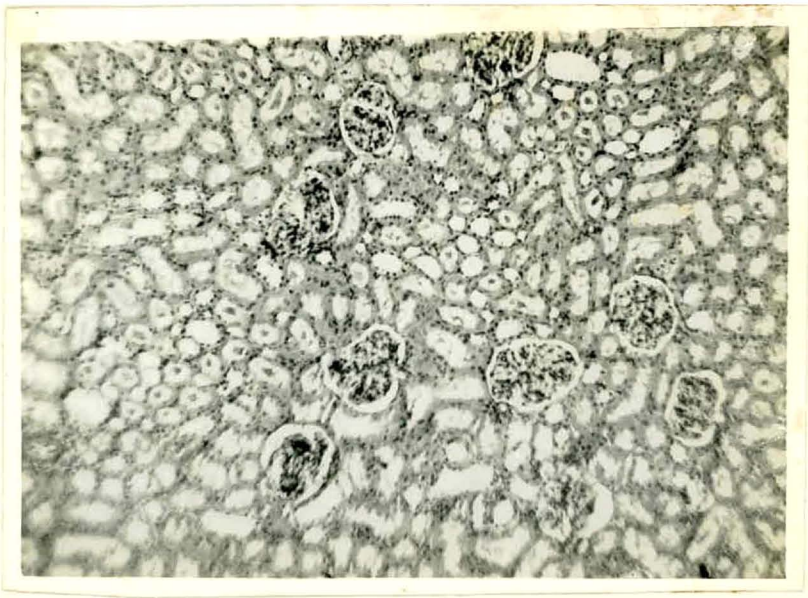

Fig. 7 Section of the kidney (glomerulus) showing hypertrophy and obliteration of Bowman's space after CTC administration. H & E X 450.

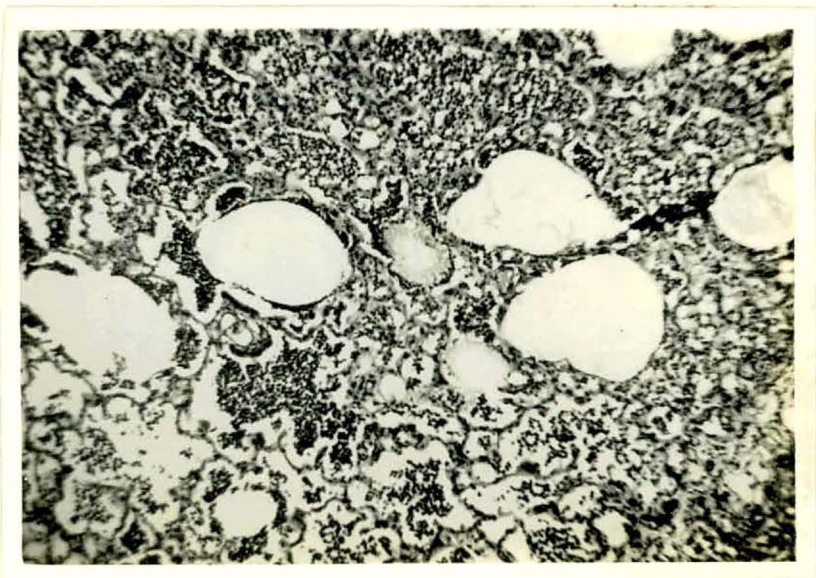

Fig. 8 Section of the lung showing emphysema following CTC administration, H & E X 100.

In some tubules, epithelial casts were present and the entire lumina of the tubules were filled with casts. Detachment of the epithelial cells from the basement membrane was also evident in many tubules and the lesions were found in both the descending and ascending tubules. These changes were due to nephrotoxic effects of the carbontetrachloride. However, in some places casts were formed by the erythrocytes.

The glomerular changes were characterised by hypertrophy of the glomerular tuft leading to obliteration of Bowman's space (Fig 7). In some places capillary tufts were disintegrated. Hypertrophy of the glomerular tuft was also reported by Setchell (1961), and Singh et al. (1978) in sheep and Bradfold (1990) in large animal and Pradhan (1991) in goats with CTC poisoning. Congestion of the capillaries in the glomerular tufts were also noticed which similates with the observation of Pradhan (1991) in goats. In addition to the above findings, intertubular spaces showed haemorrhagic changes and coagulation of erythrocytes in some places.

However, Seawright and McLean (1967) in sheep and Sethuraman et al. (1978) in buffalo calves noticed fatty changes in the tubular epithelium of the kidney. Singh et al. (1978) noticed eosinophilic proliferation of the tubular epithelium and there were areas of focal haemorrhages in the interstitium of both cortex and medulla of the kidneys. Mahanta (1984) reported lymphocytic infiltration and vacuolar degeneration of epithelial

cells of buffalo calves, while, Peer (1987) noticed varying amounts of proteinous materials in empty Bowman's spaces in goats.

Lungs -

Histopathologically, the lungs showed varying degrees of congestion, intraalveolar exudation of mononuclear cells, alveolar collapse and compensatory emphysema (Fig. 8).

Some of the changes corroborated with the findings of Gallagher (1960), Singh et al. (1978) and Angus and Greig (1979) in sheep, Sethuraman et al.(1978) in buffalo calves and Peer (1987) and Pradhan (1991) in goats with CTC poisoning. Alveolar emphysema was probably due to outcome of the strenous respiratory effects to exhale the absorbed CTC from the lumen (Clarke and Clarke, 1975).

The alveoli were either packed with erythrocytes and inflammatory exudates. The alveolar vessels were dilated and were packed with erythrocytes and inflammatory cells (Fig. 9). The damage were more seen towards the peribronchial areas. The bronchial epithelium showed severe necrotic and inflammatory changes and infiltrated with mononuclear cells.

Thickening of the bronchial walls in many places was observed. Formation of thrombus withir the vessels of the peribronchial areas (Fig. 10) noticed. Proliferation of lymphoid cells were also seen in peribronchea' areas. These findings

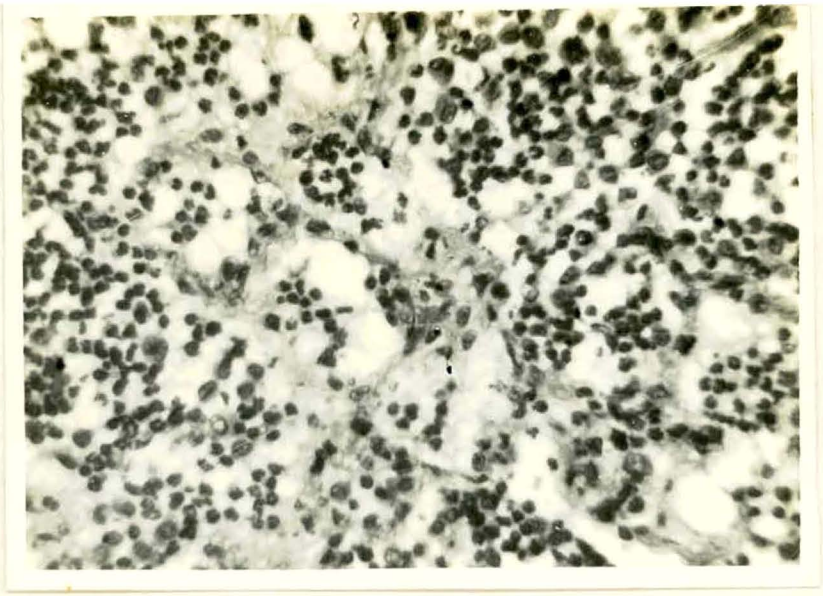

Fig. 9 Section of the lung alveoli are packed up with inflammatory cells of mononuclear variety after CTC administration. H & E X 450.

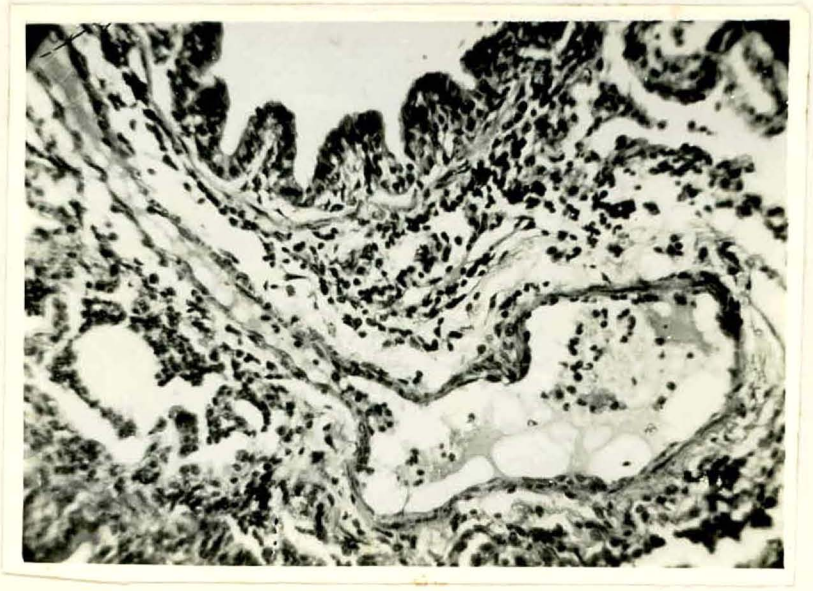

Fig. 10 Section of the lung showing formation of thrombus within the vessel of the peribronchial area and hyperplasia of the peribronchial lymphoid cells along with thickening of the bronchial wall after CTC administration. H & E X 270.

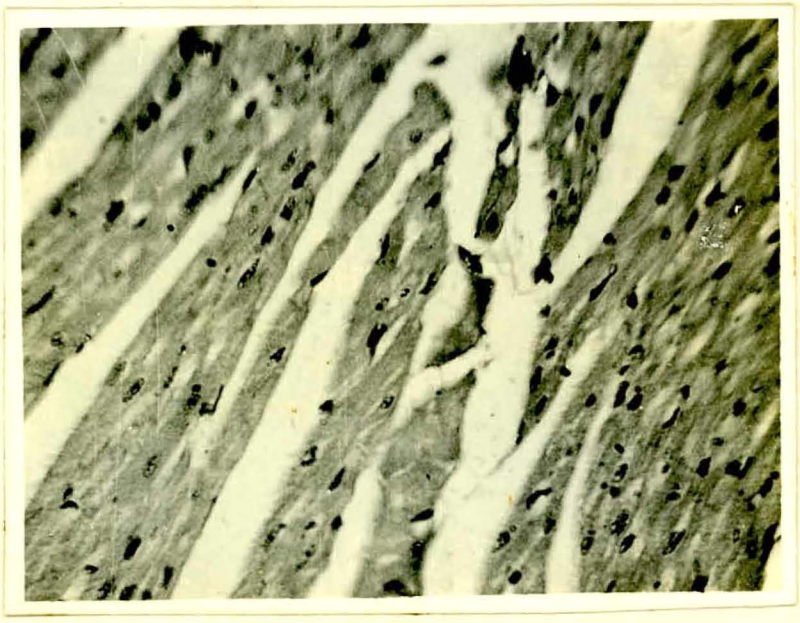

Fig. 11 Section of the heart showing loss of striation of myofibrils after CTC administration. H & E X 450.

similated with the observation of Pradhan (1991) in goats. In addition to the above changes, bronchial lumina partially filled with degenerative necrotic cells were also noticed. These changes might be due to the toxic effect of the carbontetrachloride.

Heart -

The section of the heart showed epicardial and myocardial haemorrhages along with congestion of blood vessels. This finding corroborates with the observations of Sethuraman et al. (1978) in sheep, Mahanta (1984) in buffalo calves and Pradhan (1991) in goats. Haemorrhagic pericarditis were also observed. Coagulative necrosis of the cardiac muscles and fatty changes in the myocardium were also noticed. There were loss of striation (Fig. 11) and infiltration of mononuclear cells in between the myofibrils. The granular and vacuolar degeneration was observed in the myofibrils which are in conformity with the findings of Peer (1987) and Pradhan (1991) in goats. In addition to it, thrombus formation towards the pericardium was also observed. However, accumulation of lipid in the myocardial fibres reported by Seawright and McLean (1967) was not observed in the present study.

4.3 Observations on Experimentally Induced Hepatitis in Goats treated with Vetliv (Group III)

The therapeutic measures were carried out in 5 goats of Group III with Vetliv, from 24 hours after 2nd dose (3rd day)

of CTC administration, sioce the severity of the disease was marked clinically in all the animals by this time.

There is no report available regarding the protective and curative effects of Vetliv against liver damage in animals but some of its ingredients have been reported to stimulate the hepatic functions by different workers.

One important herbal ingredient, Andrographis paniculata has been reported to act effectively against loss of appetite and general debility by Kirtikar and Basu (1975) and is an useful antipyretic, febrifuge and cholagogue and also shows satisfactory results in sluggish liver (Nadkarni, 1976) which increases the biliary flow and liver weight (Choudhury, 1971) and is effective in protecting liver damage (Dwivedi et al., 1986).

Kirtikar and Basu (1975) opined that Oldenlandia corymbosa, the other ingredient of Vetliv, is useful in the treatment of fever, jaundice and other diseases of liver.

Asteracantha longifolia was reported to be an useful against the inflammation of liver, ascites, anaemias and constipation by Kirtikar and Basu (1975).

Kirtikar and Basu (1975) also remarked that Luffa acutangula var amara, the other ingredient of Vetliv is an useful antipyritic and is also effective against the jaundice, which occurs due to liver disorders.

Table 11a. Clinical observations in experimentally induced hepatitis in goats and its therapy with Vetliv of Group III

Parameters	Pre-treatment (days)					Post-treatment (days)			
	0	2	3	6	9	12	15	18	21
Dullness/depression	0/5	5/5	5/5	5/5	2/5	2/5	0/5	0/5	0/5
Loss of appetite	0/5	5/5	5/5	4/5	2/5	2/5	0/5	0/5	0/5
Dirrhoea	0/5	2/5	3/5	3/5	1/5	0/5	0/5	0/5	0/5
Incoordination	0/5	2/5	4/5	3/5	1/5	1/5	0/5	0/5	0/5
Aimless movements	0/5	3/5	4/5	2/5	1/5	0/5	0/5	0/5	0/5
Rough hair coat	0/5	5/5	5/5	3/5	3/5	1/5	0/5	0/5	0/5
Pale to yellowish mucous membrane	0/5	5/5	5/5	5/5	2/5	1/5	0/5	0/5	0/5
Nasal discharge	0/5	3/5	4/5	3/5	0/5	0/5	0/5	0/5	0/5
Chewing like movements	0/5	1/5	3/5	2/5	0/5	1/5	0/5	0/5	0/5
Trembling of limbs	0/5	2/5	4/5	2/5	1/5	1/5	0/5	0/5	0/5
Quivering of muscles	0/5	2/5	4/5	2/5	1/5	0/5	0/5	0/5	0/5
Coma	0/5	0/5	2/5	0/5	0/5	0/5	0/5	0/5	0/5
Falling/lying on ground	0/5	0/5	2/5	0/5	0/5	0/5	0/5	0/5	0/5
Death	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5

Table 11b. Clinical observations in experimentally induced hepatitis in goats and its therapy with vetliv of Group III (Mean ± S.E.)

Day	Temperature (^{o}F)	Pulse rate (per min.)	Respiration (per min.)	Ruminal motility (per 5 min.)	Body weight (in kg)	No. of animals
0	102.28 ± 0.26	76.20 ± 1.93	26.20 ± 1.77	6.60 ± 0.24	11.20 ± 0.73	5
2	103.46* ± 0.47	93.60** ± 2.48	32.60* ± 2.33	2.60** ± 0.51	10.72 ± 0.68	5
3	103.96* ± 0.57	106.20** ± 3.14	35.60** ± 2.54	2.40** ± 0.24	10.40 ± 0.64	5
6	103.32 ± 0.40	92.20** ± 2.71	30.00 ± 2.07	3.60** ± 0.31	10.28 ± 0.65	5
9	102.54 ± 0.17	80.20 ± 3.21	27.60 ± 2.08	5.80 ± 0.37	10.54 ± 0.68	5
12	102.34 ± 0.21	77.80 ± 2.87	26.60 ± 2.15	6.60 ± 0.24	10.76 ± 0.65	5
15	102.44 ± 0.23	76.20* ± 2.13	26.40 ± 1.69	6.80 ± 0.37	10.85 ± 0.66	5
18	102.40 ± 0.20	77.40 ± 2.65	26.80 ± 2.03	6.40 ± 0.40	10.98 ± 0.71	5
21	102.36 ± 0.13	76.60 ± 2.50	27.60 ± 1.57	7.00 ± 0.40	11.03 ± 0.72	5

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$).

Rough and dry hair coat, observed in all the animals, disappeared completely on 15th day of the experiment.

Pale to yellowish mucous membranes, observed in all the animals also disappeared completely from 15th day of the experiment. The ingredients of Vetliv, Oldenlandia corymbosa, Luffa accuntangula Var amara and Berbaris aristata are effective in corrective jaundice while Phyllanthus embilica and Asteracantha longifolia are useful in correcting anaemia (Kirtikar and Basu, 1975). Vetliv powder, might be due to its curative effect on the regeneration of liver cells, helped in the synthesis of plasma proteins, corrected anaemia and thus helped in correcting the pale discolouration of the mucous membranes. Similarly, its cholagogue action helped to increase the biliary flow to correct jaundice.

Nasal discharge observed in 80% of the animals on 3rd day of the experiment, disappeared completely on 9th day, following treatment with Vetliv. Other symptoms like chewing like movements, trembling of limbs and quivering of muscles observed in some animals also disappeared on 9th day. Vetliv, being a hepatic stimulant drug, helpled in correcting hypoglycemia and thus helped in correcting nervous manifestations.

Coma and lying/falling on the ground recorded in 2 animals on 3rd day of the experiment, disappeared on or before 6th day following treatment. The recovery was probably due to faster regeneration of hepatic parenchyma with Vetliv.

However, in this present study, no death was recorded which supports the mechanism of regeneration of hepatic parenchyma with Vetliv powder.

The mean values of temperature, pulse rate, respiratory rate, ruminal motility and body weights of group III animals have been presented in Table 11b.

The body temperature increased significantly ($P < 0.05$) on 3rd day (103.96 $\pm$ 0.57°F) from its 0 day value of 102.23 $\pm$ 0.26°F but declined rapidly thereafter following treatment. Andrographis paniculata and Luffa acutangula var amara and Oldenlandia corymbosa, the ingredients of Vetliv have been reported as effective antipyretics by Nadkarni (1976) and Kirtikar and Basu (1975) respectively. Therefore Vetliv was useful in correcting the fever of these animals of group III.

The pulse rate which increased significantly ($P < 0.01$) from the base value of 76.20 $\pm$ 1.93 per min. to 106.20 $\pm$ 3.14 per min. on 3rd day of the experiment, remained significantly ($P < 0.01$) elevated upto 6th day and reached to normal level on 12th day (76.20 $\pm$ 2.13 per min.).

The mean respiratory rate recorded on 0 day was 26.20 $\pm$ 1.77 per min., increased significantly ($P < 0.01$) from 3rd day (35.60 $\pm$ 2.54 per min.) but declined promptly thereafter and returned to its normal level on 9th day. Since Vetliv

stimulates the hepatic function, therefore corrects anaemia and thus helps in reducing pulse and respiratory rates.

The ruminal motility of healthy goats (0 day) was 6.60 ± 0.24 per 5 min., declined significantly ($P < 0.01$) from 3rd day (2.40 ± 0.24 per 5 min.) but increased gradually and returned to normal rate on 12th day (6.60 ± 0.24 per 5 min.). The values on the 6th and 9th days were statistically significant as evident is Table 11b. Vetliv might have corrected the general debility and inappetance in animals and thus indirectly may be responsible for increased contractile activities of the rumen.

The mean value of the body weight observed on 0 day was 11.20 ± 0.73 kg, decreased to 10.28 ± 0.65 kg on 6th day and then increased gradually and reached to 11.03 ± 0.72 kg on 21st day of the experiment, following treatment with Vetliv.

Dwivedi et al. (1986) reported that, Andrographis paniculata (an ingredient of Vetliv) helps to increase the weight gain in rabbits with CTC induced hepatopathy. It is therefore postulated that, Vetliv stimulates the hepatic function, induces metabolic process and thus help in increasing body weight gain.

4.3.2 Haematological study

The changes of the haematological observations of Group III animals have been represented on table 12 and 13

Table 12. Haematological observations in experimentally induced hepatitis in goats and its therapy with Vetliv of Group III (Mean ± S.E.)

Days	Haemoglobin (g/dl)	TEC (millions/ cubic mm)	PCV (%)	MCV (cubic microns)	MCH (micro micrograms)	MCHC (%)	No.of animals
0	9.34 ± 0.37	10.87 ± 0.58	31.40 ± 1.57	28.97 ± 0.58	8.62 ± 0.18	29.83 ± 0.61	5
2	7.80* ± 0.31	8.53* ± 0.55	24.60* ± 2.01	28.21 ± 1.08	9.22 ± 0.38	32.21 ± 1.74	5
3	6.56** ± 0.28	6.72** ± 0.55	19.60** ± 1.43	29.21 ± 1.34	9.90* ± 0.49	33.89* ± 1.89	5
6	7.18** ± 0.17	8.01** ± 0.41	22.80** ± 1.46	27.88 ± 2.61	9.01 ± 0.30	31.98 ± 2.01	5
9	7.88* ± 0.20	8.15** ± 0.41	26.80 ± 1.85	33.43 ± 3.66	9.74 ± 0.42	29.89 ± 1.82	5
12	8.70 ± 0.31	9.27* ± 0.49	28.60 ± 2.09	30.64 ± 2.19	9.73 ± 0.30	30.99 ± 2.13	5
15	8.88 ± 0.23	10.23 ± 0.35	30.00 ± 2.07	28.67 ± 2.45	8.69 ± 0.19	30.17 ± 2.14	5
18	9.16 ± 0.24	10.84 ± 0.43	29.80 ± 2.08	27.60 ± 2.17	8.47 ± 0.16	31.58 ± 1.76	5
21	9.54 ± 0.27	10.98 ± 0.46	31.20 ± 1.77	28.59 ± 2.09	8.71 ± 0.19	30.89 ± 1.57	5

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$)

Table 13. Haematological observations in experimentally induced hepatitis in goats and its therapy with Vetliv of Group III (Mean ± S.E.)

Days	Clotting time (min.sec.)	TLC (thousands/ cubic mm)	DLC(%)					No. of animals
			Lymphocytes	Neutrophils	Eosino phils	Baso- phils	Monocy- tes	
0	2 min. 43 sec.	10.29 ± 1.07	56.60 ± 1.36	38.60 ± 1.50	3.20 ± 0.20	0.40 ± 0.24	1.20 ± 0.49	5
2	3 min. 21 sec.	10.94 ± 0.94	48.80** ± 0.86	46.40** ± 1.03	3.60 ± 0.40	0.20 ± 0.20	1.00 ± 0.32	5
3	3 min. 35 sec.	11.92 ± 0.71	42.60** ± 1.36	52.40** ± 1.43	4.20 ± 0.66	0.20 ± 0.18	0.60 ± 0.40	5
6	3 min. 15 sec.	11.29 ± 0.88	47.20** ± 1.59	48.40** ± 1.91	3.20 ± 0.37	0.40 ± 0.24	0.80 ± 0.20	5
9	3 min. 8 sec.	10.71 ± 0.99	53.20 ± 1.88	42.40 ± 1.72	3.00 ± 0.32	0.60 ± 0.40	0.80 ± 0.37	5
12	2 min. 38 sec.	10.35 ± 0.92	55.40 ± 1.86	39.60 ± 2.06	3.20 ± 0.20	0.20 ± 0.20	1.20 ± 0.37	5
15	2 min. 42 sec.	10.21 ± 0.97	56.80 ± 1.65	38.40 ± 1.91	3.00 ± 0.32	0.20 ± 0.20	1.60 ± 0.24	5
18	2 min. 52 sec.	10.24 ± 0.99	57.00 ± 1.52	38.20 ± 1.85	3.00 ± 0.32	0.60 ± 0.24	1.20 ± 0.37	5
21	2 min. 45 sec.	10.12 ± 0.97	57.40 ± 1.33	38.00 ± 1.92	3.20 ± 0.20	0.40 ± 0.24	0.80 ± 0.37	5

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$).

4.3.2.1 Haemoglobin

The mean value of haemoglobin level recorded on 0 day was 9.34 ± 0.37 g/dl, decreased significantly on 2nd day (7.80 ± 0.31 g/dl) and 3rd day (6.56 ± 0.28 g/dl). Thereafter the values increased gradually and reached to 9.16 ± 0.24 g/dl on 18th day of the experiment, though the mean values of day 6 and 9 were found to be statistically significant. Phyllanthus embilica and Asteracantha longifolia., the ingredients of Vetliv are reported to be useful in correcting anaemia by Kirtikar and Basu (1975). Therefore Vetliv, being a herbal hepatotonic stimulated the hepatic functions, and thus helped to decrease the cell destruction and to increase the adequate cell production, which ultimately helped to increase the haemoglobin concentration.

4.3.2.2 Total erythrocyte count

The average total erythrocyte count recorded on 0 day was 10.87 ± 0.58 millions/cubic mm., decreased significantly ($P < 0.05$) from 2nd day (8.53 ± 0.55) onwards, reached minimum to 6.72 ± 0.55 millions/cubic mm. on 3rd day (significant at $P < 0.01$). Thereafter, the values increased gradually following treatment with Vetliv and become normal on 18th day. However the values upto day 12 were found statistically significant (Table 12). Vetliv, the hepatotonic, helped to decrease the cell destruction and to increase the cell production and thus helped to increase the total erythrocyte count.

4.3.2.3 Packed cell volume

The mean value of packed cell volume recorded on 0 day was 31.40 ± 1.57 %, decreased significantly (P < 0.05) from 2nd day (24.60 ± 2.01%) onwards and reached minimum to 19.60 ± 1.43% on 3rd day (significant at P< 0.01). Thereafter, the values increased gradually and returned to its normal level on 21st day (31.20 ± 1.77%) following treatment with Vetliv (Table 12). Vetliv, the herbal hepatotonic stimulated the liver function, helped to increase the cell production and decreased cell destruction and thus helped in increasing packed cell volume level.

4.3.2.4 Mean corpuscular volume

The initial average value of mean corpuscular volume recorded on 0 day was 28.97 ± 0.58 cubic microns, did not show any significant variation either following CTC toxicity or with treatment of Vetliv and reached to 28.59 ± 2.09 cubic microns at the end of the experiment.

4.3.2.5 Mean corpuscular haemoglobin

The average value of mean corpuscular haemoglobin recorded on 0 day was 3.62 ± 0.18 micro micrograms, increased significantly (P < 0.05) and reached maximum to 9.90 ± 0.49 micro micrograms on day 3 but thereafter declined gradually and returned to its normal level on 3.69 ± 0.19 micro micrograms on 15th day of the experiment following treatment with Vetliv.

4.3.2.6 Mean corpuscular haemoglobin concentration

The initial average value of mean corpuscular haemoglobin concentration (29.83 ± 0.61%) also increased statistically ($P < 0.05$) to 33.89 ± 1.89 % on 3rd day (Table 12) but decreased gradually and returned to its normal level (29.89 ± 1.82 %) on 9th day following treatment with Vetliv.

The above three values, i.e. MCV, MCH and MCHC depends on the values of haemoglobin % TEC concentration and PCV%. Therefore rapid correction of these three later values following treatment with Vetliv, helped to bring their normal levels promptly in this experiment in comparison to Group II.

4.3.2.7 Clotting time

The mean value of clotting time recorded on 0 day was 2 min. and 43 sec., increased gradually to 3 min. and 35 sec. on 3rd day. Thereafter the values declined gradually and returned to normal on 12th day (2 min. 48 sec.) following treatment with Vetliv (Table 13). Vetliv, being an herbal hepatotonic stimulated the liver function, promoted the synthesis of plasma proteins including prothrombin and fibrinogen, also helped in absorption of vitamin K and thus ultimately helped to reduce the clotting time.

4.3.2.8 Total leucocyte count

The initial mean total leucocyte count recorded on 0 day was 10.29 ± 1.07 thousands/cubic mm., increased gradually

and reached maximum to 11.92 ± 0.83 thousands/cubic mm on 3rd day. Thereafter the values decreased gradually and reached to its normal level on 12th day (10.35 ± 0.92 thousands/cubic mm.) following treatment with Vetliv (Table 13). Some herbal ingredients of Vetliv mentioned earlier, help to reduce the inflammation of liver and thus might have helped to decrease the level of total leucocyte count.

4.3.2.9 Differential leucocyte count

The differential leucocyte count of the present study of the animals of Group III have been presented on table 13.

The mean lymphocyte percentage recorded on 0-day was 56.60 ± 1.36% decreased significantly ($P < 0.01$) and reached minimum to 42.60 ± 1.36% on 3rd day. The values then increased gradually and reached to normal level of 56.80 ± 1.65% on 15th day following treatment with Vetliv.

On the other hand, the mean neutrophil percentage was 38.60 ± 1.50% on 0 day, increased significantly ($P < 0.01$) and reached maximum to 52.40 ± 1.43% on 3rd day. But followirg treatment with Vetliv, the values decreased gradually, and returned to normal level (38.40 ± 1.91%) on 15th day, though the value on day 6 (48.40 ± 1.91%) was found statistically significant ($P < 0.01$).

The eosinophil percentage prior to treatment with Vetliv was higher but following treatment, became normal.

The variation of the monocyte and basophil percentage are not marked (as evident in Table 13) before and after treatment with Vetliv.

Vetliv reduces the inflammation and thus helps to normalise the lymphocyte and neutrophil percentage rapidly.

The changes in the differential leucocyte count in the early stage of the experiment suggest the inflammatory changes of the liver, but following treatment with Vetliv, increase in the lymphocyte% and decrease in the neutrophil % indicates the reduction of the hepatic inflammatory changes.

4.3.3 Liver function tests

The changes in blood biochemical profiles of the animals of Group III have been depicted in Tables 14 and 15.

4.3.3.1 Blood glucose

The average blood glucose level decreased significantly ($P < 0.01$) from its 0-day value of 57.29 $\pm$ 2.35 mg%, to 35.09 $\pm$ 3.93 mg% on 2nd day and 28.00 $\pm$ 4.11 mg% on 3rd day. The level thereafter gradually increased, and reached almost to normal level of 59.47 $\pm$ 3.09 mg% on 15th day of the experiment following treatment with Vetliv, though the values on day 6 and 9 were statistically significant ($P < 0.01$) (Table 14). Vetliv, being a hepatic stimulant drug might have stimulated the carbohydrate metabolism including increased glycolytic activity and

Table 14. Blood biochemical changes in experimentally induced hepatitis in goats and its therapy with Vetliv of Group III (Mean ± S.E.)

Days	Blood glucose (mg%)	Serum protein (g%)	Albumin (g%)	Globulin (g%)	A/G ratio	Icteric index	Van den Bergh test	No. of animals
0	57.29 ± 2.35	6.63 ± 0.27	3.39 ± 0.23	2.74 ± 0.15	1.42 ± 0.10	5.09 ± 0.43	-ve	5
2	35.09** ± 3.93	5.90 ± 0.28	3.19 ± 0.24	2.71 ± 0.17	1.18 ± 0.12	11.67** ±0.56	+ve	5
3	28.00** ± 4.11	5.77 ± 0.31	2.97* ± 0.30	2.80 ± 0.30	1.06* ± 0.11	19.78** ± 0.65	+ve	5
6	36.17** ± 3.65	5.74 ± 0.34	2.99* ± 0.28	2.75 ± 0.09	1.09* ± 0.09	11.87** ± 0.83	+ve	5
9	43.48** ± 3.28	6.09 ± 0.34	3.36 ± 0.21	2.73 ± 0.24	1.23 ± 0.08	8.97** ± 0.98	-ve	5
12	51.78 ± 3.16	6.40 ±0.65	3.72 ± 0.18	2.68 ± 0.31	1.39 ± 0.09	6.46 ±1.04	-ve	5
15	59.47 ± 3.09	6.59 ± 0.33	3.89 ± 0.19	2.70 ± 0.23	1.44 ± 0.04	5.13 ±0.63	-ve	5
18	58.65 ± 3.13	6.77 ± 0.24	4.05 ± 0.23	2.72 ± 0.19	1.49 ± 0.06	5.23 ± 0.58	-ve	5
21	59.27 ± 3.14	6.60 ± 0.27	3.89 ± 0.24	2.71 ± 0.33	1.43 ± 0.07	5.12 ± 0.46	-ve	5

* Statistically significant at 5% level ($P < 0.05$)
** Statistically significant at 1% level ($P < 0.01$)

Table 15. Blood biochemical changes and serum enzyme activity in experimentally induced hepatitis in goats and its therapy with Vetliv of Group III (Mean ± S.E.)

Days	Total bilirubin (mg%)	Serum Cholesterol (mg%)	SGOT (µg pyruvic acid/ml	SGPT (µg pyruvic acid/ml	AP (Bodansky units/100 ml)	No. of animals
0	0.31 ± 0.04	110.93 ± 6.93	98.21 ± 4.37	28.03 ± 2.23	3.93 ± 1.13	5
2	0.93** ± 0.09	158.79** ± 8.93	333.13** ± 4.83	65.21** ± 5.47	9.23** ± 1.02	5
3	1.12** ± 0.16	190.16** ±11.51	484.21** ±15.07	78.93** ± 6.58	11.16** ± 1.23	5
6	0.96** ± 0.12	184.72** ± 9.29	368.23** ±12.07	68.83** ± 8.83	7.28** ± 0.73	5
9	0.69* ± 0.14	162.62** ± 8.27	184.26** ±10.23	50.17** ± 6.41	4.09 ± 0.74	5
12	0.46 ± 0.09	140.06* ± 6.88	129.46** ± 8.42	39.12 ± 5.21	4.12 ± 0.56	5
15	0.40 ± 0.08	118.16 ± 7.55	96.26 ± 7.06	29.21 ± 3.01	3.99 ± 0.47	5
18	0.33 ± 0.05	115.49 ± 7.21	101.37 ± 6.51	31.23 ± 2.19	4.26 ± 0.48	5
21	0.32 ± 0.05	112.76 ± 6.47	96.93 ± 9.23	30.17 ± 2.43	3.97 ± 0.33	5

* Statistically significant at 5% level ($P < 0.05$)

** Statistically significant at 1% level ($P < 0.01$)

gluconeogenesis of the liver cells and thus helped to increase the blood glucose level.

4.3.3.2 Serum protein

The mean total serum protein level did not change significantly at any stage of these animals of Group III. The values however varied in between 6.63 ± 0.27 g% to 5.74 ± 0.34 g% during this study. However, the albumin level significantly ($P < 0.05$) declined from its 0 day value of 3.89 ± 0.23 g% to 2.97 ± 0.33 g% on 3rd day of the experiment but increased gradually and reached to normal level on 15th day of the experiment in these animals of Group III while there was no significant variation of serum globulin level throughout the experimental study. The A/G ratio however decreased gradually from its 0 day value of 1.42 ± 0.10 g% to 1.06 ± 0.11 g% on 3rd day and thereafter increased gradually and reached to normal level on 15th day (Table 14) following treatment with Vetliv. Vetliv, being a herbal hepatotonic might have helped in regeneration of hepatic parenchyma cells and thus helped in the synthesis of plasma proteins especially the albumin, since all the fractions of globulin are not synthesised in the liver (Mullen, 1976). Decrease in the total serum protein and A/G ratio was due to decrease in albumin concentration due to hepatotoxicity in the early part of the experiment. Following therapy with Vetliv, the improved albumin concentration helped to increase both the total protein level and A/G ratio.

4.3.3.3 Icteric index

The mean serum icteric index level increased rapidly ($P < 0.01$) from its 0 day value of 5.09 ± 0.43 units to 19.73 ± 0.65 units on 3rd day and the values thereafter declined gradually, though remained significantly elevated ($P < 0.01$) upto 9th day (8.97 ± 0.98 units) from its 0 day value and reached to normal level or 15th day (5.13 ± 0.63 units) (Table 14). Vetliv probably helped in toning up of the liver which might have helped in rapid normalisation of the icteric index level in these animals of Group III.

4.3.3.4 Van den Bergh test

The Van den Bergh test showed positive reactions from day 2 to day 6 only in these animals (Table 14). This indicated improvement of hepatic functions following treatment with Vetliv, showing normal conjugation and excretion of bilirubin into the bile canaliculi.

4.3.3.5 Serum bilirubin

The serum total bilirubin on 0 day revealed 0.31 ± 0.04 mg% which increased significantly ($P < 0.01$) to 1.12 ± 0.06 mg% on 3rd day and thereafter the level decreased gradually and became normal (0.33 ± 0.05 mg%) on 18th day of the experiment (Table 15), following therapy with Vetliv though the values of day 6 to day 9 were significant ($P < 0.05$).

Pearson and Craig (1980) reported that increase in serum bilirubin level indicates failure of excretory function of the liver. The ingredients of Vetliv which were useful in correcting jaundice and liver dysfunctions as mentioned earlier might have helped to correct the hepatic function and thus helped in reducing serum bilirubin content.

4.3.3.6 Serum cholesterol

The mean serum cholesterol level increased significantly ($P < 0.01$) to a maximum level of 190.16 ± 11.51 mg% on 3rd day from its 0 day value of 110.93 ± 6.93 mg%, but reached thereafter to normal level (115.49 ± 7.21 mg%) on 18th day of the experiment following treatment with Vetliv (Table 15). However, the values from day 6 to 12 were significant from the 0 day value. Vetliv, being a hepatic stimulant helped effectively in normal synthesis and excretion of cholesterol and thus helped to reduce the cholesterol level following therapy.

4.3.3.7 Serum enzymes

4.3.3.7.1 Serum glutamic oxalacetic transaminase

The serum GOT level observed on 0 day was 98.21 ± 4.37 µg pyruvic acid/ml, increased highly significantly ($P < 0.01$) and reached maximum on 3rd day (484.21 ± 15.07 µg pyruvic acid/ml). Thereafter the level gradually decreased to the normal level of 96.26 ± 7.03 µg pyruvic acid/ml on 15th day of the

experiment, though the values revealed significantly ($P < 0.01$) elevated upto 12th day of the experiment (Table 15). This decreasing trend of the serum enzyme activities might be due to the gradual repairative process of the damaged liver with Vetliv, towards the end of the experiment, which was also supported by the histopathological examination of the liver.

4.3.3.7.2 Serum glutamic pyruvic transaminase

A significant increase in serum GPT level was also observed from its 0 day value of 23.03 ± 2.23 µg pyruvic acid/ml to 78.93 ± 6.58 µg pyruvic acid/ml on 3rd day. Thereafter the values gradually declined and reached to its normal level on 29.21 ± 3.01 µg pyruvic acid/ml on 15th day of the experiment, though the mean values remained significantly ($P < 0.01$) elevated upto 9th day (Table 15). Vetliv, being a hepatic stimulant herbal hepatotonic, helped to reduce the cellular damage and leakage of the enzymes and thus helped to reduce the serum GPT level.

4.3.3.7.3 Serum alkaline phosphatase

The average alkaline phosphatase activity was also found to increase significantly ($P < 0.01$) from its 0 day value of 3.93 ± 1.13 BU/100ml to the maximum level of 11.16 ± 1.23 BU/100 ml on 3rd day, but the values decreased gradually thereafter and reached almost to normal level on 15th day (3.99 ± 0.47 BU/100 ml)

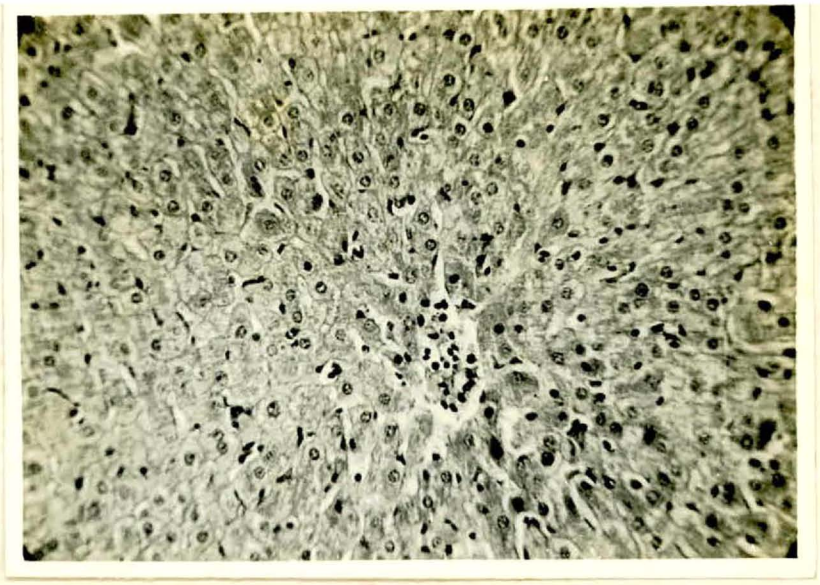

Fig. 12 Section of the liver showing regenerated hepatocytes with few mononuclear cells and dead erythrocytes in the central vein following therapy with Vetliv. H & E X 270.

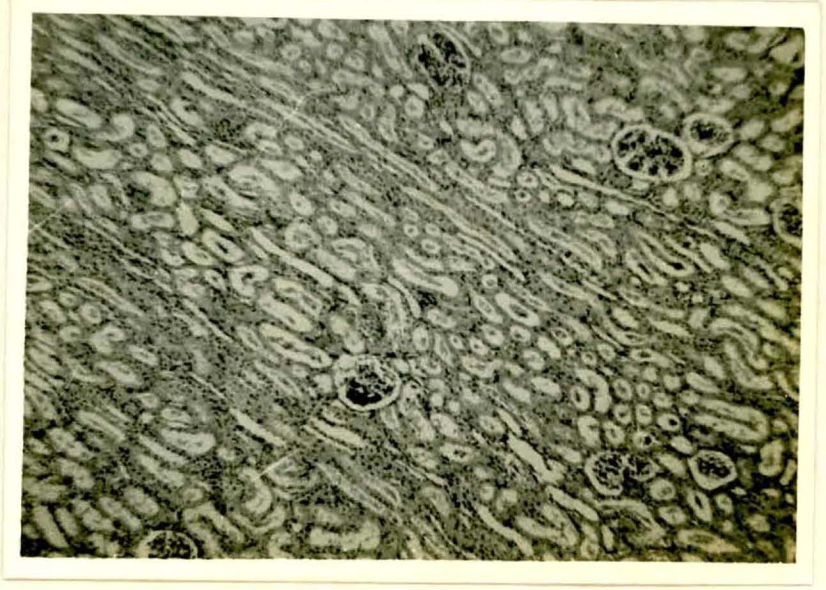

Fig. 13 Section of the kidney showing more or less normal picture but casts are present following therapy with Vetliv. H & E X 100.

goats with CTC induced hepatitis treated with Tetrolivet granules on herbal hepatotonic containing Andrographis paniculata, which is also a constituent of Vetliv.

From this remarkable improvement with Vetliv it is postulated that along with the protective effect on the hepatocytes it has also the mitotic acitivity in the hepatocytes which could escape degenerative changes in the course of CTC poisoning.

Kidneys - The interstitial blood vessels were found congested. There was mild congestion of the glomerular tuft. Some tubular lumina were found to contain epithelial detritus and proteinous materials. Kidney showed more or less normal in appearance but mild tubular degeneration and occasional casts in the tubules were also seen (Fig 13). These findings correlates the firdings of Pradhan (1991) in goats with the therapy of Tefrolivet granules, an other herbal hepatotonic.

Lungs- Lung alveoli showed inflammatory prepneumonic changes occasionally and peribronchial lymphatic nodes showed hyperplastic changes. The bronchial epethelium showed quite normal in appearance (Fig 14). There were accumulation of coagulated blood materials within the peribronchial blood vessels.

Heart - Section of the heart showed normal myocardium but mild degenerative changes were also observed in some places. Hydropic degeneration, loss of striation and focal areas of myofibrilar necrosis were observed. These finding corroborated with

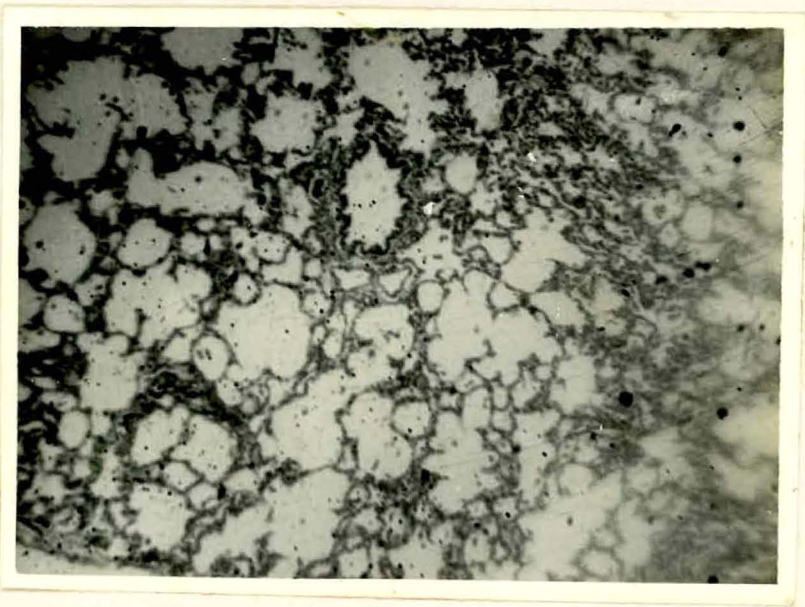

Fig. 14 Section of the lung showing emphysema following therapy with Vetliv.
H & E X 100.

Table 16a. Clinical observations in experimentally induced hepatitis and its therapy with Livol of Group IV

Parameters	Pre-treatment (days)				Post-treatment (days)				
	0	2	3	6	9	12	15	18	21
Dullness/depression	0/5	5/5	5/5	4/5	2/5	2/5	0/5	0/5	0/5
Loss of appetite	0/5	5/5	5/5	5/5	3/5	0/5	0/5	0/5	0/5
Dirrhoea	0/5	2/5	3/5	2/5	1/5	0/5	0/5	0/5	0/5
Incoordination	0/5	3/5	4/5	2/5	1/5	0/5	0/5	0/5	0/5
Aimless movements	0/5	2/5	3/5	2/5	0/5	0/5	0/5	0/5	0/5
Rough hair coat	0/5	5/5	5/5	4/5	3/5	1/5	0/5	0/5	0/5
Pale to yellowish mucous membrane	0/5	5/5	5/5	4/5	3/5	2/5	0/5	0/5	0/5
Nasal discharge	0/5	3/5	4/5	3/5	1/5	0/5	0/5	0/5	0/5
Chewing like movements	0/5	3/5	4/5	2/5	1/5	0/5	0/5	0/5	0/5
Trembling of limbs	0/5	2/5	3/5	2/5	1/5	0/5	0/5	0/5	0/5
Quivering of muscles	0/5	1/5	3/5	1/5	0/5	0/5	0/5	0/5	0/5
Coma	0/5	1/5	2/5	0/5	0/5	0/5	0/5	0/5	0/5
Falling/lying on ground	0/5	0/5	2/5	0/5	0/5	0/5	0/5	0/5	0/5
Death	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5

Table 16b Clinical observations in experimentally induced hepatitis in goats and its therapy with Livol of group IV (Mean ± S.E.)

Days	Temperature (°F)	Pulse rate (per min.)	Respiration (per min.)	Ruminal motility (per 5 min.)	Body weight (in kg.)	No. of animals
0	102.28 ± 0.31	76.40 ± 1.93	25.80 ± 1.43	6.80 ± 0.20	11.20 ± 0.66	5
2	103.46 ± 0.56	93.00** ± 2.38	32.40** ± 1.63	2.60** ± 0.51	10.82 ± 0.66	5
3	104.04* ± 0.56	102.67** ± 3.54	39.20** ± 1.65	2.33** ± 0.37	10.48 ± 0.69	5
6	103.70* ± 0.55	93.20** ± 3.15	29.20 ± 1.24	3.40** ± 0.24	10.04 ± 0.63	5
9	102.92 ± 0.52	82.80 ± 2.92	26.20 ± 0.86	5.80 ± 0.24	10.26 ± 0.60	5
12	102.68 ± 0.44	78.80 ± 2.71	27.40 ± 0.93	6.80 ± 0.37	10.62 ± 0.67	5
15	102.52 ± 0.32	76.80 ± 1.85	26.20 ± 1.39	7.00 ± 0.45	10.76 ± 0.66	5
18	102.40 ± 0.26	77.20 ± 1.16	27.40 ± 1.36	6.80 ± 0.24	10.81 ± 0.68	5
21	102.30 ± 0.30	76.60 ± 1.12	25.40 ± 1.32	6.60 ± 0.40	11.17 ± 0.68	5

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$)

aimless movements observed in 3 goats of Group IV from 3rd day also disappeared completely from 9th day.

Rough and dry hair coat observed in all the animals, disappeared by 15th day following treatment. Similar improvements with therapy of livol have also been reported by Mahanta et al. (1983), in buffalo calves.

Pale to yellowish mucous membrane observed in all the animals were found to be corrected by 15th day of the experiment. The Livol was due to its curative effect on regeneration of liver cells which helped in the synthesis of plasma proteins and thus helped in correcting anaemias. It also helped to improve the excretory function of the liver and thus helped also to release of excess bilirubin to correct the icteric condition.

Nasal discharge observed in 60% of the animals on 3rd day, also disappeared completely by 12th day following treatment. Other symptoms like chewing like movements, trembling of limbs observed in some of the animals disappeared completely on 12th day, while quivering of muscles observed in some animals disappeared by 9th day following treatment. Similar observations were also recorded by Mahanta et al. (1983) in buffalo calves. Livol, being a hepatic stimulant drug helped in correcting hypoglycemia and thus helped in prompt corrections of these nervous manifestations.

Coma and lying on the ground noticed in 2 animals on 3rd day, disappeared from 6th day. The recovery is probably due to faster restoration of hepatic parenchyma with Livol which helped in prompt hepatic detoxification.

However, in this experimental study, no death was recorded which supports the mechanism of regeneration of hepatic parenchyma with Livol.

The mean values of temperatue, pulse rate, respiration, ruminal motility and body weights have been presented in Table 16b.

The body temperature increased significantly ($P < 0.05$) on 3rd day from 0 day, decreased gradually and became normal thereafter following therapy with Livol. Kirtikar and Basu (1975) opined Soymida febrifuga, Terminalia beleria, Ichnocarpus frutescens, Nigella sativa, Fumari parviflora and Andrographis paniculata, the ingredients of Livol are the effective antipyretics, which helped to reduce the fever.

The pulse rate increased significantly ($P < 0.01$) from the 0 day value of 76.40 $\pm$ 1.93 per min. to the maximum of 102.67 $\pm$ 3.54 per min. on 3rd day and thereafter the values decreased gradually and became normal on 15th day (76.80 $\pm$ 1.85) following therapy with Livol (Table 16b), though the value of 6th day was also significant ($P < 0.01$).

The mean respiratory rate recorded on 0 day was 25.30 ± 1.43 per min., increased significantly ($P < 0.01$) on 3rd day (39.20 ± 1.65 per min.) and then the values decreased gradually and became almost normal on 9th day (26.20 ± 1.39 per min.) (Table 16b). Livol, being a hepatic stimulant drug, corrected anaemia and so helped in reducing pulse and respiratory rates.

The ruminal motility decreased significantly ($P<0.01$) from its 0 day value of 6.80 ± 0.20 per 5 min. to 2.33 ± 0.24 per 5 min. on 3rd day. Thereafter the values increased gradually and became normal on 12th day (5.80 ± 0.24 per 5 min.) following therapy with Livol (Table 16b). Livol, as a hepatic stimulant, increased appetite and corrected weakness in animals which helped to increase the contractile activities of the rumen.

The average body weight of the animals of Group IV decreased gradually from its 0 day value of 11.20 ± 0.66 kg to minimum of 10.04 ± 0.63 kg on day 6 but thereafter increased gradually and reached to 11.17 ± 0.68 kg on 21st day (Table 16b).

This findings similated the findings of Arora and Madhumohini (1984) who fed Livol to kids and observed significant weight gain. However, it is postulated that Livol, being a hepatotonic stimulated the hepatic functions, induced metabolic processes and thus helped in increasing body weight. Increase in body weight gain following feeding of Livol was also reported by Rao and Subba Reddy (1986) and Pradhan et al. (1987) in broiler birds.

4.4.2 Haematological study

The changes of the haematological observations of Group IV animals have been represented on tables 17 and 18.

4.4.2.1 Haemoglobin

The mean value of haemoglobin level observed on 0 day was 9.56 ± 0.29 g/dl decreased significantly (P < 0.01) on 3rd day to 6.96 ± 0.41 g/dl, but thereafter the values increased gradually and became almost normal (9.40 ± 0.39 g/dl) on 18th day, following treatment with Livol (Table 17) though the 6th day value was also significant (P < 0.01). Livol, being a hepatic stimulant, helped to decrease the celldestruction and to increase the cell production and thus helped in increasing haemoglobin concentration.

4.4.2.2. Total erythrocyte count

The average value of total erythrocyte count recorded on 0 day was 10.59 ± 0.34 millions/cubic mm., decreased significantly (P < 0.01) from 2nd day onwards and reached minimum to 6.78 ± 0.26 millions/cubic mm. on 3rd day. Thereafter the values increased gradually following therapy with Livol and became normal on 18th day (10.55 ± 0.29 millions/cubic mm.) (Table 17). However, the 6th and 9th day values were also significant (P < 0.01). Livol, being a hepatic stimulant, helped to decrease the cell destruction and also to increase the cell production and thus helped to increase the total erythrocyte count.

Table 17. Haematological observations in experimentally induced hepatitis in goats and its therapy with Livol of Group IV (Mean ± S.E.)

Days	Haemoglobin (g/dl)	TEC (millions/ cubic mm)	PCV (%)	MCV (cubic microns)	MCH (micro micro-grams)	MCHC (%)	No. of animals
0	9.56 ± 0.29	10.59 ± 0.34	31.40 ± 1.50	29.14 ± 1.43	9.04 ± 0.22	30.57 ± 0.82	5
2	8.08* ± 0.42	8.84** ± 0.33	24.60** ± 1.21	28.05 ± 1.85	9.21 ± 0.64	32.83* ± 0.41	5
3	6.96** ± 0.41	6.78** ± 0.26	20.38** ± 1.26	30.43 ± 2.83	10.39 ± 0.92	34.18** ± 0.47	5
6	7.12** ± 0.38	8.19** ± 0.35	21.63** ± 1.07	26.66 ± 1.85	8.78 ± 0.66	32.90* ± 0.32	5
9	7.60 ± 0.34	8.58** ± 0.48	25.15** ± 1.07	29.77 ± 2.25	8.89 ± 0.65	30.21 ± 0.21	5
12	8.46 ± 0.43	10.06 ± 0.44	26.83* ± 1.24	26.38 ± 1.72	8.50 ± 0.65	31.66 ± 1.62	5
15	9.12 ± 0.44	10.46 ± 0.41	29.03 ± 0.92	27.95 ± 1.55	8.78 ± 0.58	31.40 ± 1.09	5
18	9.40 ± 0.39	10.55 ± 0.29	31.23 ± 0.86	29.65 ± 0.79	8.92 ± 0.35	30.07 ± 0.60	5
21	9.78 ± 0.28	10.79 ± 0.37	31.65 ± 1.20	29.43 ± 1.33	9.10 ± 0.37	30.96 ± 0.56	5

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$)

Table 18. Haematological observations in experimentally induced hepatitis in goats and its therapy with Livol of Group IV (Mean ± S.E.)

Days	Clotting time	TLC (thousands/ cubic mm)	DLC %					No. of animals
			Lymphocytes	Neutrophils	Eosinophils	Basophils	Monocytes	
0	2 min. 56 sec.	11.10 ± 0.49	57.80 ± 0.97	37.40 ± 1.50	3.20 ± 0.58	0.40 ± 0.18	1.00 ± 0.45	5
2	3 min. 21 sec.	11.85 ± 0.58	48.80** ± 0.99	45.40** ± 1.80	3.80 ± 0.66	0.60 ± 0.24	1.40 ± 0.33	5
3	3 min. 41 sec.	12.13 ± 0.44	42.00** ± 1.36	50.80** ± 1.72	4.80* ± 0.33	0.80 ± 0.20	1.60 ± 0.43	5
6	3 min. 19 sec.	11.38 ± 0.36	47.40** ± 1.28	46.80* ± 1.91	4.00 ± 0.37	1.00 ± 0.27	0.80 ± 0.37	5
9	3 min 14 sec.	11.06 ± 0.35	51.00** ± 1.53	42.80* ± 1.82	4.20 ± 0.20	1.20 ± 0.30	1.00 ± 0.37	5
12	2 min. 58 sec.	11.13 ± 0.42	53.60* ± 1.72	40.00 ± 1.03	3.60 ± 0.32	1.20 ± 0.20	1.60 ± 0.24	5
15	2 min. 45 sec.	11.10 ± 0.49	55.60 ± 1.36	38.20 ± 1.43	3.40 ± 0.24	1.00 ± 0.24	1.80 ± 0.80	5
18	2 min. 49 sec.	10.86 ± 0.45	55.60 ± 1.33	38.20 ± 1.92	3.80 ± 0.28	0.80 ± 0.18	1.60 ± 0.37	5
21	2 min. 59 sec.	10.81 ± 0.49	56.40 ± 1.63	38.00 ± 0.85	3.40 ± 0.37	0.80 ± 0.21	1.40 ± 0.24	5

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$)

4.4.2.3 Packed cell volume

The mean value of packed cell volume recorded on 0 day was 31.40 ± 1.50%, also declined significantly (P < 0.01) to 20.38 ± 1.26% on 3rd day but increased gradually thereafter and became almost normal on 18th day (31.23 ± 0.86%) following treatment with Livol (Table 17) though the values of 6th and 9th days were significant (P < 0.01). This might be due to decreased cell destruction and increased cell production after therapy with Livol.

4.4.2.4 Mean Corpuscular volume

There was a slight decrease in mean value of mean corpuscular volume following CTC toxicity which promptly became normal with therapy of Livol (Table 17).

4.4.2.5 Mean corpuscular haemoglobin

The average value of mean corpuscular haemoglobin recorded on 0 day was 9.04 ± 0.22 micro micrograms, increased slightly to 10.39 ± 0.92 micro micrograms on 3rd day and became normal at the end of the experiment (Table 17).

4.4.2.6 Mean corpuscular haemoglobin concentration

The average value of mean corpuscular haemoglobin concentration recorded on 0 day was 30.57 ± 0.82%, increased significantly (P < 0.01) on 3rd day (34.18 ± 0.47%) and thereafter the values decreased gradually and became almost normal on 9th day (30.21 ± 0.21%) following therapy with Livol.

The above three values i.e. MCV, MCH and MCHC depends upon the changes of haemoglobin, total erythrocyte count and PCV percentage. Therefore rapid correction of these values with therapy of Livol in this experimentals helped to correct these later values also.

4.4.2.7 Clotting time

The mean value of clotting time recorded on 0 day was 2 min. and 56 sec., increased gradually and reached maximum to 3 min. and 41 sec. on 3rd day which thereafter decreased gradually following treatment with Livol and became normal on 12th day (2 min. and 58 sec.) (Table 18). Livol, being a hepatic stimulant, promoted the synthesis of plasma proteins including prothrombin and fibrinogen (Pandey et al., 1985), also helped to increase the absorption of vitamin K and thus helped to reduce the clotting time.

4.4.2.8 Total leucocyte count

The mean value of total leucocyte count recorded on 0 day was 11.10 ± 0.49 thousands/cubic mm., increased gradually to 12.13 ± 0.44 thousands/cubic mm. on 3rd day. Thereafter the values decreased gradually and became almost normal (11.10 ± 0.49 thousands cubic mm.) on 15th day following treatment with Livol (Table 18). It is postulated that, Livol helps to reduce the inflammation of the liver and thus results in decreasing

level of total leucocyte count, since Solanum nigrum and Phyllanthus embilica, the ingredients of livol, have been reported by Kirtikar and Basu (1975) to reduce effectively the inflammatory changes of the liver.

4.4.2.9 Differential leucocyte count

The differential leucocyte count of the present study of the animals of Group IV, have been presented on table 18.

The mean value of lymphocyte percentage recorded on 0 day was 57.80 ± 0.97%, decreased significantly ($P < 0.01$) and reached minimum to 42.00 ± 1.36% on 3rd day. Thereafter the mean values increased gradually following therapy with Livol and became normal (56.40 ± 1.63%) at the end of the experiment. The mean values on 6th and 9th days were however found statistically significant ($P < 0.01$).

The mean value of neutrophil percentage recorded on 0 day was 37.40 ± 1.50%, increased significantly ($P < 0.01$) and reached maximum to 50.80 ± 1.72% on 3rd day. Thereafter the values decreased gradually and became normal (38.20 ± 1.43%) on 15th day following therapy with Livol. The values on 6th and 9th days were however significant.

The eosinophil level also increased significantly ($P < 0.05$) on 3rd day (4.80 ± 0.33%) from its 0 day mean value of 3.20 ± 0.58% but decreased gradually and became almost normal on 18th day (3.40 ± 0.32%) following treatment with Livol.

There was however no difference in basophil percentage before and after therapy with Livol.

The mean monocyte level slightly increased to 1.60 ± 0.43% on 3rd day from its 0 day value of 1.00 ± 0.45% but became promptly normal on 9th day (1.00 ± 0.37%) following treatment with Livol.

This rapid normalisation of the differential leucocyte count picture might be due to the Solanum nigrum and Phyllanthus embilica, the herbal ingredients of Livol, who had helped to reduce the acute inflammatory changes of the liver.

4.4.3 Liver function tests

The changes in blood biochemical profiles of the animals of Group IV have been presented in Table 19 and 20.

4.4.3.1 Blood glucose

The mean value of blood glucose level recorded on 0 day was 58.97 ± 2.47 mg%, decreased significantly ($P < 0.01$) to 36.23 ± 3.85 mg% on 2nd day and 28.19 ± 4.13 mg% on 3rd day. The level gradually improved thereafter and became normal (57.69 ± 3.16 mg%) on 18th day of the experiment (Table 19). This findings corroborates the observations of Mahanta et al. (1986) who noticed increased blood glucose level following treatment with Livol in buffalo calves in experimentally CTC induced hepatopathy. It is postulated that, Livol induces the hepatic function, stimulates

Table 19. Blood biochemical changes in experimentally induced hepatitis in goats and its therapy with Livol of Group IV (Mean ± S.E.)

Days	Blood glucose (mg %)	Serum protein (g%)	Albumin (g%)	Globulin (g%)	A/G ratio	Icteric index (units)	Van den Bergh test	No. of animals
0	58.97 ± 2.47	6.75 ± 0.27	3.97 ± 0.24	2.78 ± 0.17	1.43 ± 0.10	4.99 ± 0.43	- ve	5
2	36.23** ± 3.85	6.22 ± 0.31	3.48 ± 0.18	2.74 ± 0.17	1.27 ± 0.08	11.96** ± 0.56	+ ve	5
3	28.19** ± 4.13	5.91 ± 0.28	3.04* ± 0.29	2.87 ± 0.30	1.06** ± 0.05	17.23** ± 0.83	+ ve	5
6	37.21** ± 3.65	6.03 ± 0.68	3.16* ± 0.24	2.87 ± 0.12	1.10* ± 0.06	12.09** ± 0.76	+ ve	5
9	44.96* ± 3.69	6.50 ± 0.33	3.66 ± 0.33	2.84 ± 0.31	1.29 ± 0.08	9.43** ± 0.65	-ve	5
12	52.86 ± 3.16	6.71 ± 0.37	3.90 ± 0.18	2.81 ± 0.24	1.38 ± 0.07	6.93* ± 0.58	-ve	5
15	57.69 ± 3.17	6.77 ± 0.38	3.95 ± 0.19	2.82 ± 0.18	1.40 ± 0.04	5.19 ± 0.46	-ve	5
18	59.17 ± 3.13	6.87 ± 0.24	4.04 ± 0.24	2.83 ± 0.24	1.42 ± 0.12	5.13 ± 0.43	-ve	5
21	59.48 ± 2.97	6.77 ± 0.18	3.96 ± 0.24	2.81 ± 0.20	1.41 ± 0.11	5.01 ± 0.37	-ve	5

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$)

Table 20. Blood biochemical changes and serum enzyme activity in experimentally induced hepatitis in goats and its therapy with Livol of Group IV (Mean ± S.E.)

Days	Total bilirubin (mg%)	Serum cholesterol (mg%)	GOT (µg pyruvic acid/ml)	GPT (µg pyruvic acid/ml)	AP (Bodansky Units/ 100 ml)	No. of animals
0	0.29 ± 0.05	109.27 ± 6.87	96.23 ± 4.48	27.29 ± 2.48	4.27 ± 1.14	5
2	1.02** ± 0.10	146.13** ± 8.47	329.13** ± 5.13	62.98** ± 5.01	7.23 ± 1.03	5
3	1.18** ± 0.08	193.73** ±11.23	481.17** ±16.01	83.94** ± 8.93	10.10** ± 0.83	5
6	1.01** ± 0.10	182.46** ± 9.29	383.46** ±12.03	62.49** ± 6.43	7.69* ± 0.74	5
9	0.71** ± 0.12	168.26** ± 6.88	192.27** ± 8.43	49.17** ± 5.21	4.62 ± 0.56	5
12	0.49* ± 0.06	139.23* ± 7.37	136.16** ± 7.05	42.21* ± 4.03	4.21 ± 0.37	5
15	0.36 ± 0.07	115.72 ± 7.43	99.86 ± 6.53	29.77 ± 3.18	4.36 ± 0.45	5
18	0.30 ± 0.08	111.79 ± 5.43	96.39 ± 7.73	30.98 ± 2.47	4.06 ± 0.51	5
21	0.31 ± 0.07	116.89 ± 5.17	98.31 ± 9.13	31.27 ± 2.33	4.31 ± 0.37	5

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$).

the carbohydrate metabolism and thus helps in increasing blood glucose level.

4.4.3.2 Serum protein

The total serum protein level did not however differ significantly from its pretreatment value of 6.75 ± 0.27 g% throughout the experimental period, while the mean albumin value significantly ($P < 0.05$) decreased from its 0 day value of 3.97 ± 0.24 g% to 3.04 ± 0.29 g% on 3rd day of the experiment and thereafter increased gradually to the normal level on 15th day of the experiment (Table 19). However, there was no significant variation of serum globulin levels throughout the experimental period, but the A/G ratio declined significantly ($P < 0.01$) from its 0 day value of 1.43 ± 0.10 to 1.06 ± 0.05 on 3rd day and thereafter increased gradually and reached to its pretreatment value on 15th day (Table 19). Increased A/G ratio following treatment with Livol was also recorded by Mahanta et al. (1983) in buffalo calves. Improvement of protein synthesis in liver was also observed by Pandey et al. (1985) in dogs after treatment with Livol. According to them, Livol, being a powerful herbal hepatotonic, helps in quicker regeneration of the hepatic parenchyma and thus helps in proper metabolism of protein.

4.4.3.3 Icteric index

The mean value of serum icteric index level recorded on 0 day was 4.99 ± 0.43 units, increased significantly ($P<0.01$) and reached maximum to 17.23 ± 0.83 units on 3rd day but

thereafter the mean values increased gradually following treatment with Livol and became normal on 15th day though the values upto 12th day were significant (Table 19). Similar observations were also recorded by Mahanta et al. (1983) in buffalo calves and Pandey et al. (1985) in dogs following treatment with Livol. Livol helps to reduce the bilirubin concentration and thus the icteric index level.

4.4.3.4 Van den Bergh test

Serum Van den Bergh test showed positive reactions from 2nd to 6th days of the experiment and became negative from 9th day onwards (Table 19). This indicates improvement of hepatic functions following treatment with Livol, showing normal conjugation and excretion of bilirubin into the bile.

4.4.3.5 Serum bilirubin

The serum total bilirubin level increased significantly ($P < 0.01$) from its 0 day value of 0.29 ± 0.05 mg% to 1.18 ± 0.08 mg% on 3rd day and thereafter decreased gradually and reached to 0.30 ± 0.08 mg% on 18th day of the experiment, although the mean values remained significantly elevated upto 12th day of the experiment as evident in Table 20.

Mahanta et al. (1983) and Pandey et al. (1985) also observed the similar changes of bilirubin level with treatment of Livol in CTC induced hepatopathy in buffalo calves and dogs respectively. Livol, probably due to its anti-inflammatory

action reduces the intrahepatic congestion, which relieves cholastasis and helps to increase the biliary flow in restoring the normal serum bilirubin.

4.4.3.6 Serum cholesterol

The mean serum cholesterol level increased significantly ($P < 0.01$) to the highest level of 193.73 ± 11.23 mg% on 3rd day from its 0 day value of 109.27 ± 6.87 mg%. Thereafter the values decreasedg radually and reached to its normal level of 111.79 ± 5.43 mg% on 18th day of the experiment (Table 20). Improvement of the excretory function of the damaged liver following treatment with Livol was reported by Pandey et al. (1985) in dogs. Livol, being a hepatic stimulant, induces the excretory function of the liver and thus helps in decreasing serum cholesterol level, since some of the cholesterol synthesized in the liver is excreted through the bile.

4.4.3.7 Serum enzymes

4.4.3.7.1 Serum glutamic oxalacetic transaminase

The serum GOT level increased highly significantly ($P < 0.01$) to the maximum level of 481.17 ± 16.01 µg pyruvic acid/ml on 3rd day from its pretreatment value of 96.23 ± 14.48 µg pyruvic acid/ml. Thereafter the values decreased gradually and became normal on 18th day following treatment with Livol (Table 20) though the values upto 12th day were significant

($P < 0.01$). Similar observations of declination of SGOT level, following treatment with Livol in CTC induced hepatopathy have been reported by Mahanta et al. (1983) and Mahanta et al. (1986) in buffalo calves. It is postulated that, Livol being a powerful hepatotonic rapidly repairs the damaged hepatic parenchymatous cells and thus helps to reduce the leakage of this enzyme from the cells.

4.4.3.7.2 Serum glutamic pyruvic transaminase

The serum GPT level also increased significantly ($P < 0.01$) to the maximum level of 83.94 ± 8.93 /ug pyruvic acid/ml 3rd day from the 0 day value of 27.29 ± 2.48 /ug puruvic acid/ml which thereafter decreased gradually and became normal on 15th day (29.77 ± 3.18 /ug pyruvic acid/ml) of the experiment (Table 20) following treatment with Livol, though the values upto 12th day were significantly high. The gradual declination of serum GPT values with therapy of Livol in liver disorders was also reported by Mahanta et al. (1983) in buffalo calves. Livol, being a hepatic stimulant, helps to reduce the cellular damage and leakages of the enzymes and thus reduces serum GPT level.

4.4.3.7.3 Alkaline phosphatase

The serum alkaline phosphatase activity increased significantly ($P < 0.01$) to 10.10 ± 0.83 BU/100ml on 3rd day from the 0 day value of 4.27 ± 1.14 BU/100 ml, decreased rapidly

thereafter and reached to the normal level of 4.21 ± 0.37 BU/100 ml on 12th day of the experiment (Table 20). Livol, as a hepatic stimulant, restores the functions of the liver and helps to reduce the serum alkaline phosphatase activity.

4.4.4 Gross and histopathological changes

4.4.4.1 Gross changes

The carcasses in general were good. The liver, kidneys, lungs and heart appeared almost normal in appearance.

4.4.4.2 Histopathological changes

Liver : Local aggregation of mononuclear cells in the liver parenchyma and throughout the liver parenchyma proliferation of kuffer cells were noticed. Necrosis was absent but centrilobular congestion, mild degeneration were observed in some of the lobules. Regeneration of liver parenchyma without fatty changes were also noted (Fig 15). These findings similates with the observations of Mahanta et al. (1983) in buffalo calves. Based on the above observations it is concluded that Livol has a protective effect on Liver which can promotethe recovery of liver parenchyma damaged by carbontetrachloride.

Kidneys: Kidneys showed more or less normal picture. Only some degenerative changes (Fig 16).were noticed. Interstitial blood vessels were found congested. Mild congestion of the glomerular

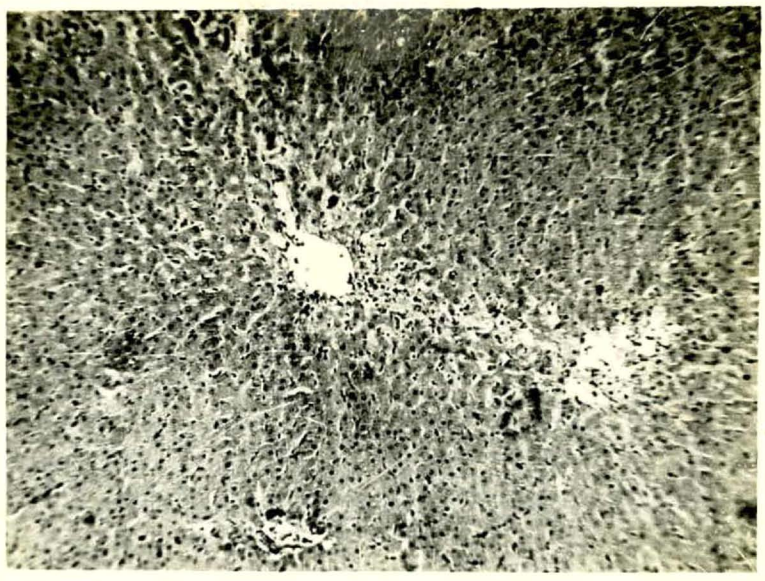

Fig. 15 Section of the liver showing regeneration of liver parenchyma without fatty changes but persistence of focal fatty degeneration following therapy with Livol. H & E X 100.

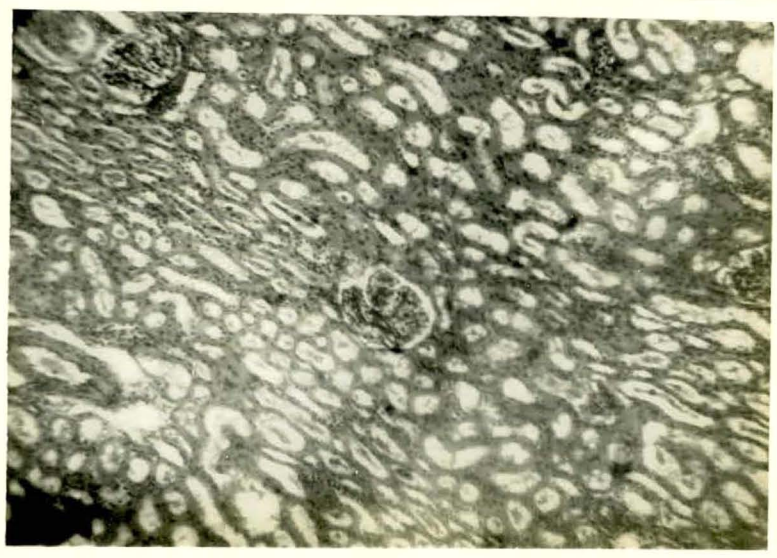

Fig. 16 Section of the kidney showing more or less normal picture except some degenerative changes after treatment with Livol. H & E X 450.

Fig. 17 Section of the lung parenchyma showing more or less normal appearance after treatment with Livol. H & E X 100.

Gallagher (1960) reported that, nicotinic acid, a precursor of pyridine nucleotide can afford considerable protection against specific liver damage and liver dysfunctions in sheep. Roychoudhury (1981) opined that the functional status of the liver in acidosis of buffalo calves can be improved by administration of Berin (Vit. B_1).

Blood et al. (1983) reported that parenteral administration of calcium, glucose and amino acid mixture containing methionine and choline are useful in the treatment of toxic hepatitis in animals.

Lal and Kalra (1960) advocated liberal administration of glucose saline to restore the effective function of liver in domesticated animals in poisonings. Calcium therapy prevent guanidine toxicity and combat hypoglycemia in liver diseases (Minot, 1931 and Blood et al., 1983) and also found to be beneficial in relieving the symptoms probably by fortifying the liver (Jones et al., 1977). Further, it has been reported that there was decrease in the ionised calcium level (Sethuraman and Verma, 1978) during hepatic damage. In the present study, calcium (Calborol), choline (Beekom-L) and antihistamine (chloril) have been used. Judah (1960) reported that choline and antihistamine lessen the damage tomitochondria of hepatic cells caused by CTC poisoning. 'Vetalog' was used parenterally for promoting gluconeogenesis and to relieve the animals from the stress of toxicity.

Since the damaged liver was unable to detoxify the ammonia and other nitrogenous substances, administration of sulpher drugs have been found to be effective in controlling protein putrification. Injection of Vit.K (Kapilin) was done to prevent the clotting defects in liver diseases, since synthesis of clotting factors in the liver are suppressed (Hoe and Wilkinson, 1973). Vit. C (Redoxon) was also incorporated in the above therapy as it helps in the formation of collagen which is necessary for proper healing (Sastry, 1979). Fresh rumen liquor and cobalt salts were administered to establish the normal microbial activity of rumen and to bring back the normal microbial digestion and to improve the appetite.

4.5.1 Clinical symptoms

The clinical signs of the animals of Group V during the experimental study are presented in Table 21a.

Dullness and depression observed in all the animals on 2nd day disappeared completely from 9th day onwards. Similar findings of clinical improvements with treatment of Beekom-L (containing vit. B complex and liver extract), calcium, glucose and others in CTC induced hepatotoxicity have been reported by Mahanta et al. (1986) in buffalo calves, with Belamyl (containing Vit. B complex and liver extract), calborol/Mifex, and Sodibicarb in hexachloroethane toxicity by Vihan (1987) in goats and with Livogen (containing vit. B complex and liver extract),

Table 21a. Clinical observations in experimentally induced hepatitis in goats treated with proprietory preparations (Group V)

Parameters	Pre-treatment (days)			Post-treatment (days)					
	0	2	3	6	9	12	15	18	21
Dullness/depression	0/5	5/5	5/5	4/5	2/5	0/5	0/5	0/5	0/5
Loss of appetite	0/5	5/5	5/5	4/5	2/5	0/5	0/5	0/5	0/5
Dirrhoea	0/5	2/5	3/5	1/5	0/5	0/5	0/5	0/5	0/5
In co-ordination	0/5	3/5	4/5	1/5	0/5	0/5	0/5	0/5	0/5
Aimless movements	0/5	2/5	3/5	1/5	0/5	0/5	0/5	0/5	0/5
Rough hair coat	0/5	4/5	4/5	3/5	1/5	0/5	0/5	0/5	0/5
Pale to yellowish mucous membrane	0/5	5/5	5/5	4/5	2/5	0/5	0/5	0/5	0/5
Nasal discharge	0/5	3/5	4/5	2/5	0/5	0/5	0/5	0/5	0/5
Chewing like movements	0/5	2/5	3/5	2/5	0/5	0/5	0/5	0/5	0/5
Trembling of limbs	0/5	3/5	3/5	2/5	0/5	0/5	0/5	0/5	0/5
Quivering of muscles	0/5	1/5	2/5	1/5	0/5	0/5	0/5	0/5	0/5
Coma	0/5	1/5	2/5	1/5	0/5	0/5	0/5	0/5	0/5
Falling/lying on ground	0/5	1/5	2/5	2/5	0/5	0/5	0/5	0/5	0/5
Death	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5

calborol, dextrose, Vit. C, Vit. K antihistamine and others in CTC induced hepatotoxicity by Pradhan (1991) in goats.

Loss of appetite which was also observed on 2nd day, disappeared from 6th day onwards. Similar findings was also observed by Verma (1982), Mahanta et al. (1986) in buffalo calves Vihan (1987) and Pradhan (1991) in goats with hepatopathy. The beneficial effects of Vit. B complex and liver extract therapy in anorexia have been reported previously by Kadvekar and Murkibhavi (1971), Misra and Singh (1974) and Verma (1982) in cattle, Mahanta et al. (1986) in buffalo calves Vihan (1987) and Pradhan (1991) in goats, and Vit. B complex alone in anorexia by Naga et al. (1975) in sheep.

Dirrhoea recorded in 3 goats disappeared completely on 9th day in this experimental study which corroborates the findings recorded by Verma (1982) in cattle, Mahanta et al. (1986) in buffalo calves, Vihan (1987) and Pradhan (1991) in goats. Blood et al. (1983) remarked that administration of antibiotic is essential to control protein digestion and putrification which helps to check dirrhoea. Gut acting sulpher preparations are also useful for this purpose.

Incoordination and aimless movements observed in some of the animals, disappeared completely from 9th day onwards which similates with the findings of Vihan (1987) in hexachloroethane toxicity and Pradhan (1991) in CTC toxicity in goats. It has been postulated that the above mentioned drugs which

were used in this group of animals helped to protect the central nervous system from the toxic effect of carbontetrachloride.

Rough and dry hair coat observed in 80% of the animals on 2nd day, disappeared completely from 12th day of this experimental study which corroborates with the findings of Pradhan (1991) in goats. Liver extract, Vit. B complex which were used for the treatment of these animals might have helped to increase the appetite and thus corrected rough and dry condition of the body coat.

Pale and yellowish mucous membrane observed in all the animals on 2nd day, disappeared completely from 12th day onwards from all the animals which corroborated with the findings of Mahanta et al. (1986) in buffalo calves and Pradhan (1991) in goats. The vit. B complex, liver extract, calcium and others which were used to stimulate the hepatic functions might have corrected anaemia and also have helped to excrete the circulating bilirubin.

Nasal discharge noticed in 80% of the goats on 3rd day, disappeared completely on 9th day also corroborates the findings of Pradhan (1991) in goats, who treated the CTC induced hepatopathy in goats with Livogen, calcium, antihistamine, Dextrose etc.

Some nervous signs like chewing like movements, trembling of limbs, quivering of muscles recorded in some of the goats, disappeared completely from 9th day onwards also

similates with the findings of Pradhan (1991) in goats. Hypoglycaemia and hypocalcaemia developed in these animals due to CTC toxicity might have been effectively corrected with these proprietory preparations which has helped to correct the nervous manifestations.

Other signs like coma and lying on the ground, observed in some animals, disappeared completely from all the animals from 9th day following treatment with the above drugs and due to withdrawl of the toxic effect of the CTC on the central nervous system. Similar findings were also confirmed the findings of Pradhan (1991) in goats.

However, no death was recorded during this experimental study which supports prompt regeneration of the hepatic parenchymatous cells by the treatment of the above drugs.

The mean values of temperature, pulse rate, respiration, ruminal motility and body weights have been presented in Table 21b.

The body temperature increased moderately on 3rd day but decreased promptly and became normal on 12th day (Table 21b). This observation corroborates with the findings of Vihan (1987) and Pradhan (1991) in goats.

The pulse rate recorded on 0 day was 76.00 $\pm$ 1.91 per min., increased significantly ($P < 0.01$) and reached maximum to 101.80 $\pm$ 3.48 per min. on 3rd day. Thereafter the mean

Table 21b. Clinical observations in experimentally induced hepatitis in goats and its therapy with proprietory preparations of Group V (Mean ± S.E.)

Days	Temperature (°F)	Pulse rate (per min.)	Respiration (per min.)	Ruminal motility (per 5 min.)	Body weight (in kg)	No. of animals
0	102.28 ± 0.29	76.60 ± 1.91	26.40 ± 1.46	6.80 ± 0.20	11.20 ± 0.73	5
2	103.40 ± 0.56	94.20** ± 3.28	33.60** ± 1.56	2.40** ± 0.51	10.70 ± 0.77	5
3	103.98* ± 0.57	101.80** ± 3.48	39.00 ± 2.68	1.80** ± 0.37	10.36 ± 0.78	5
6	103.46 ± 0.51	94.80** ± 3.71	30.20 ± 1.59	3.80** ± 0.24	10.14 ± 0.76	5
9	103.10 ± 0.47	81.80 ± 3.07	27.20 ± 1.83	5.60 ± 0.37	10.26 ± 0.75	5
12	102.90 ± 0.48	76.00 ± 2.02	26.40 ± 1.63	6.60 ± 0.37	10.46 ± 0.74	5
15	102.62 ± 0.46	77.80 ± 1.88	25.80 ± 1.24	6.80 ± 0.49	10.66 ± 0.74	5
18	102.46 ± 0.36	77.60 ± 2.31	27.60 ± 1.66	7.00 ± 0.55	11.10 ± 0.73	5
21	102.30 ± 0.36	76.80 ± 2.13	26.80 ± 1.49	6.80 ± 0.20	11.18 ± 0.72	5

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$)

values decreased gradually and became normal to 76.00 ± 2.02 per min. on 12th day following treatment with the above drugs (Table 21b), though the 6th value was significant (P < 0.01).

The respiratory rate was also found to increase significantly (P < 0.01) and reached to the maximum level of 39.00 ± 2.68 per min. on 3rd day from its 0 day value of 26.40 ± 1.46 per min. but thereafter the same values decreased gradually and became normal (26.40 ± 1.63 per min.) on 12th day following treatment with the above drugs (Table 21b). Mahanta (1984) and Pradhan (1991) also observed the similar findings of decreased pulse and respiratory rates with treatment of liver extract, vit. B complex, glucose, calcium and others in CTC induced hepatopathy in buffalo calves and goats respectively. They opined, these drugs might have helped to correct anaemia and also helped to increase the oxygen carrying capacity of the blood and thus helped to reduce both the pulse and respiratory rates to the normal level.

The average ruminal motility recorded on 0 day was 6.80 ± 0.20 per 5 min., decreased highly significantly (P < 0.01) and reached minimum to 1.80 ± 0.37 per 5 min. on 3rd day and thereafter the mean values increased gradually and became normal (6.60 ± 0.37 per 5 min.) on 12th day of the experiment with the help of the above drugs (Table 21b), though the 6th day value was also significantly (P < 0.01) high. The treatment adopted in this group of animals effectively corrected the

weakness as well as appetite and indirectly helped to increase the ruminal motility of the animals. Pradhan (1991) also observed the same and also remarked the same in his study.

The mean body weight recorded on 0 day was 11.20 ± 0.73 kg, decreased non-significantly to 10.14 ± 0.76 kg., on 6th day and thereafter increased gradually and reached almost to its earlier weight on 18th day of the experiment following treatment with the above drugs, which corroborates with the findings of Pradhan (1991) in goats. The improved body weights might be due to improvement of appetite and metabolism of feed stuffs which thus helped in increasing the body weight gain in these animals.

4.5.2 Haematological study

The changes of haematological observations of Group V animals have been presented on table 22 and 23.

4.5.2.1 Haemoglobin

The mean haemoglobin concentration recorded on 0 day was 9.88 ± 0.24 g/dl, decreased significantly ($P < 0.01$) and reached minimum to 6.32 ± 0.34 g/dl on 3rd day. Thereafter the values increased gradually and became almost normal on 12th day (9.93 ± 0.23 g/dl) following treatment with the above drugs (Table 22). Vitamin B complex, vit. C, liver extract, cobalt salts etc. used in this group of animals helped in the synthesis of haemoglobin and thus helped to increase the haemoglobin level.

Table 22. Haematological observations in experimentally induced hepatitis in goats and its therapy with proprietory preparations of Group V (Mean ± S.E.)

Days	Haemoglobin (g/dl)	TEC (millions/ cubic mm)	PCV (%)	MCV (cubic microns)	MCH (micro micrograms)	MCHC (%)	No. of animals
0	9.88 ± 0.24	10.72 ± 0.59	29.40 ± 1.47	27.64 ± 1.48	9.02 ± 0.23	32.71 ± 0.72	5
2	8.08** ± 0.37	8.92* ± 0.44	25.20* ± 1.37	28.48 ± 1.93	9.12 ± 0.59	32.19 ± 0.42	5
3	6.32** ± 0.34	6.63** ± 0.37	20.36** ± 1.53	30.93 ± 2.25	9.59 ± 0.93	31.17 ± 0.37	5
6	7.93** ± 0.24	8.76* ± 0.42	23.20* ± 1.85	26.81 ± 1.89	9.11 ± 0.65	34.31 ± 0.32	5
9	8.96 ± 0.37	9.60 ± 0.35	27.79 ± 2.08	29.17 ± 2.25	9.29 ± 0.58	31.98 ± 0.21	5
12	9.93 ± 0.23	10.59 ± 0.49	29.12 ± 2.13	27.72 ± 1.55	9.44 ± 0.38	34.23 ± 1.43	5
15	9.46 ± 0.24	10.76 ± 0.37	29.86 ± 1.77	27.98 ± 0.81	8.87 ± 0.37	31.81 ± 1.08	5
18	10.04 ± 0.30	10.79 ± 0.43	31.02 ± 1.85	28.97 ± 1.33	9.37 ± 0.34	32.49 ± 0.56	5
21	10.13 ± 0.18	10.82 ± 0.42	30.80 ± 1.48	28.69 ± 1.55	9.43 ± 0.53	33.01 ± 0.67	5

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$)

Table 23. Haematological observations in experimentally induced hepatitis in goats and its therapy with proprietory preparations of Group V (Mean ± S.E.)

Days	Clotting time	TLC (thousands/cubic mm)	DLC %					No.of animals
			Lymphocytes	Neutrophils	Eosinophils	Basophils	Monocytes	
0	2 min. 57 sec.	9.45 ± 0.48	57.40 ± 0.98	37.60 ± 1.80	3.40 ± 0.53	0.40 ± 0.20	1.20 ± 0.43	5
2	3 min. 23 sec.	10.69 ± 0.53	49.20** ± 1.36	45.20** ± 1.30	3.80 ± 0.37	0.40 ± 0.18	1.40 ± 0.48	5
3	3 min. 47 sec.	12.37** ± 0.45	44.00** ± 1.45	49.80** ± 1.83	4.40 ± 0.33	0.80 ± 0.24	1.00 ± 0.37	5
6	3 min. 12 sec.	10.25 ± 0.37	51.20* ± 1.73	44.40* ± 1.91	4.20 ± 0.20	0.40 ± 0.30	0.80 ± 0.24	5
9	2 min. 59 sec.	10.02 ± 0.49	54.20 ± 1.81	40.40 ± 1.95	3.20 ± 0.24	1.00 ± 0.33	1.20 ± 0.33	5
12	2 min. 54 sec.	9.82 ± 0.42	55.80 ± 1.91	38.20 ± 1.65	4.00 ± 0.28	0.40 ± 0.37	1.60 ± 0.43	5
15	2 min. 51 sec.	9.96 ± 0.37	56.40 ± 1.34	37.40 ± 1.43	4.00 ± 0.37	0.80 ± 0.24	1.40 ± 0.80	5
18	2 min. 57 sec.	9.67 ± 0.49	58.20 ± 1.32	36.60 ± 1.28	3.40 ± 0.86	0.60 ± 0.18	1.20 ± 0.23	5
21	2 min. 55 sec.	9.47 ± 0.45	57.40 ± 0.95	37.20 ± 1.57	3.40 ± 0.93	0.60 ± 0.20	1.40 ± 0.37	5

* = Statistical significant at 5% level ($P < 0.05$)

** = Statistical significant at 1% level ($P < 0.01$)

4.5.2.2 Total erythrocyte count

The mean value of total erythrocyte count recorded on 0 day was 10.72 ± 0.59 millions/cubic mm., decreased significantly (P < 0.05) to 8.92 ± 0.44 millions/cubic mm. on 2nd day and 6.63 ± 0.37 millions/cubic mm. (significant P <0.01) on 3rd day, but thereafter the values increased gradually and became normal (10.59 ± 0.49 millions/cubic mm.) on 12th day of this experiment (Table 22) following treatment with the above mentioned drugs. Increased total erythrocyte count with therapy vit. B complex and liver extract was also reported by Pradhan et al. (1987) in goats suffering from anaemia due to haemonchus infection. This might be due to increased cell production with the help of liver extract, vitamins and other used in these animals.

4.5.2.3 Packed cell volume

The packed cell volume decreased significantly (P<0.01) from its 0 day value of 29.40 ± 1.47%, to 20.36 ± 1.53% on 3rd day which thereafter increased gradually and became almost normal (29.12 ± 2.09%) on 12th day following improved therapy. This improvement of PCV level was due to increased production of erythrocytes and decreased cell destruction with liver extract, vit. B complex and others used for treating the goats of this Group V.

4.5.2.4 Mean corpuscular volume

The average pretreatment mean corpuscular volume noticed on 0 day was 27.64 ± 1.48 cubic microns, though varied in between 26.71 ± 1.89 and 30.93 ± 2.25 cubic microns throughout the experiment but the changes were not significant. However rapid correction of total erythrocyte count and PCV level with the improved therapy helped to correct the MCV level also.

4.5.2.5 Mean corpuscular haemoglobin

There was also no significant variation of the average value of mean corpuscular haemoglobin throughout this experiment which varied in between 8.87 ± 0.37 to 9.59 ± 0.65 micro micrograms in animals of Group V. This might be due to rapid improvement of the total erythrocyte count and haemoglobin level with the improved therapy.

4.5.2.6 Mean corpuscular haemoglobin concentration

The average value of mean corpuscular haemoglobin concentration prior to hepatopathy was 32.71 ± 0.72 % also did not changed significantly following CTC induced hepatopathy or with treatment with the improved therapy in these animals.

4.5.2.7 Clotting time

The average value of clotting time recorded on 0 day was 2 min. and 57 sec., increased gradually and reached maximum to 3 min. and 47 sec. on 3rd day, but thereafter the values

decreased gradually and became almost normal on 9th day (2min. and 59 sec.) as evident in Table 23. This observation similates the findings of Pradhan et al. (1987) in goats who treated the anaemic goats with Hepaplex, a liver tonic containing vit. B complex and crude liverextract. They opined, the crude liver extract along with vit. B complex promoted the synthesis of plasma proteins including prothrombin and fibrinogen and thus helped to reduce the clotting time. Besides calcium (calborol) used in this group of animals also helped to correct the clotting time.

4.5.2.8 Total leucocyte count

The average value of total leucocyte count recorded on 0 day was 9.45 ± 0.48 thousands/cubic mm., increased significantly ($P < 0.01$) on 3rd day (12.37 ± 0.45 thousands/cubic mm.) and then declined gradually and became almost normal (9.82 ± 0.42 millions/cubic mm.) from 12th day onwards (Table 23).

The co-trimoxazole given along with the antihistamine and corticosteroid used in this group might have helped to reduce the inflammation and thereby helped to decrease the total leucocyte count to normal.

4.5.2.9 Differential leucocyte count

The differential leucocyte count observed in this present study have been presented in table 23.

Table 24. Blood biochemical changes in experimentally induced hepatitis in goats and its therapy with proprietory pretarations of Group V (Mean ± S.E.)

Days	Blood glucose (mg%)	Serum protein (g%)	Albumin (g%)	Globulin	A/G ratio	Icteric index (units)	Van den Bergh test	No. of animals
0	57.93 ± 2.47	6.75 ± 0.27	3.96 ± 0.24	2.79 ± 0.23	1.42 ± 0.08	4.28 ± 0.47	-ve	5
2	38.91** ± 4.31	6.29 ± 0.37	3.51 ± 0.23	2.78 ± 0.24	1.26 ± 0.09	11.15** ± 0.65	+ve	5
3	27.43** ± 3.68	5.85 ± 0.35	2.94* ± 0.37	2.91 ± 0.20	1.01** ± 0.10	16.29** ± 0.68	+ve	5
6	42.17** ± 3.93	6.09 ± 0.24	3.31 ± 0.32	2.78 ± 0.18	1.19 ± 0.14	10.87** ± 0.98	+ve	5
9	51.23 ± 3.67	6.44 ± 0.65	3.72 ± 0.19	2.71 ± 0.27	1.38 ± 0.08	7.23** ± 0.65	-ve	5
12	55.67 ± 3.16	6.67 ± 0.58	3.88 ± 0.24	2.79 ± 0.24	1.39 ± 0.07	5.46 ± 0.83	-ve	5
15	58.23 ± 3.18	6,74 ± 0.43	3.93 ± 0.20	2.81 ± 0.18	1.40 ± 0.10	4.69 ± 0.68	-ve	5
18	58.97 ± 3.10	6.63 ±0.28	3.88 ± 0.33	2.75 ± 0.16	1.41 ± 0.11	4.89 ± 0.53	-ve	5
21	58.95 ± 2.75	6.90 ± 0.33	4.05 ± 0.27	2.85 ± 0.31	1.42 ± 0.09	4.42 ± 0.47	-ve	5

* = Statistically significant at 5% level ($P < 0.05$)

** = Statistically significant at 1% level ($P < 0.01$)

Table 25. Blood biochemical changes and serum enzyme activity in experimentally induced hepatitis in goats and its therapy with proprietory preparation of Group V

(Mean ± S.E.)

Days	Total bilirubin (mg%)	Serum cholesterol (mg%)	GOT (µg pyruvic acid/ml)	GPT (µg pyruvic acid/ml)	AP (Bodansky units/100 ml)	No. of animals
0	0.32 ± 0.04	115.27 ± 6.63	90.13 ± 4.47	27.46 ± 2.37	3.49 ± 1.16	5
2	1.04** ± 0.06	156.29** ± 8.93	318.26** ± 5.16	56.17** ± 5.12	7.97* ± 1.05	5
3	1.27** ± 0.08	186.29** ±11.33	476.27** ±16.02	81.23** ± 8.87	11.13** ± 0.93	5
6	0.87** ± 0.10	176.11** ± 9.27	281.13** ±12.12	62.29** ± 6.43	7.23* ± 0.68	5
9	0.58 ± 0.14	152.63** ± 6.83	171.21** ± 8.47	41.16* ± 4.04	4.01 ± 0.56	5
12	0.35 ± 0.09	129.27 ± 7.43	96.21 ± 7.08	32.23 ± 2.48	4.06 ± 0.48	5
15	0.34 ± 0.06	118.29 ± 7.28	95.16 ± 6.43	29.17 ± 2.23	3.83 ± 0.51	5
18	0.30 ± 0.08	117.16 ± 8.43	94.97 ± 7.21	28.93 ± 2.17	3.66 ± 0.37	5
21	0.29 ± 0.06	120.19 ± 9.21	92.15 ± 9.10	30.48 ± 2.33	3.38 ± 0.48	5

* = Statistically significant at 5% level (P ≤ 0.05)

** = Statistically significant at 1% level (P < 0.01)

4.5.3.1 Blood glucose

The average value of blood glucose recorded on 0 day was 57.93 ± 2.47 mg%, decreased significantly ($P < 0.01$) to 27.43 ± 3.68 mg% on 3rd day (minimum) but following treatment, the values thereafter increased gradually and became almost normal on 12th day (55.67 ± 3.16 mg%), though the 6th day value was also significant ($P < 0.01$) from the base value (Table 24).

Similar observations were also recorded by Mahanta *et al.* (1986) in buffalo calves and Pradhan (1991) in goats with improved therapy in CTC induced hepatopathy. The improvement in blood glucose level following improved therapy in all the animals of this group indicated normal glucogenesis in the liver. The rate of improvement of blood glucose level was faster as compared to groups III and IV treated with Vetliv and Livol respectively. This was due to supplementation of glucose through intravenous route. Besides, injection of 'Vetalog' probably helped to correct the hypoglycemia in animals of group V resulting in early improvement of glucose level. Liver extract and vit. B complex also helped to improve the hepatic function as well as to improve the blood glucose level.

4.5.3.2 Serum protein

The serum total protein level was also found to decline gradually and reached to 5.85 ± 0.28 g% on 3rd day from its 0 day value of 6.75 ± 0.27 g% but following treatment the

4.5.3.3 Icteric index

The average value of icteric index recorded on 0 day was 4.28 ± 0.47 units, increased significantly ($P < 0.01$) on 2nd day (11.15 ± 0.65 units) and reached maximum to 16.29 ± 0.68 units on 3rd day. Following improved therapy, the values thereafter dropped gradually and reached to 5.46 ± 0.83 units on 12th day of this experiment, though the values till 9th day, were also significant ($P < 0.01$) (Table 24).

Pradhan (1991) also observed the similar declination of icteric index value with treatment of Livogen and Dextrose in CTC induced hepathopathy in goats. It is postulated that, the improved therapy effectively helped to regenerate the liver cells and thus reduced the icteric index level.

4.5.3.4 Van den Bergh test

The serum Van den Bergh test showed positive reactions upto 6th day and negative thereafter (Table 24) also similates the findings of Pradhan (1991) in goats. This finding indicated normal conjugation and excretion of bilirubin into bile canaliculi due to normal functioning of the liver with the improved therapy.

4.5.3.5 Total serum bilirubin

The pre-treatment serum bilirubin level recorded on an average on 0 day was 0.32 ± 0.04 mg%, increased significantly ($P < 0.01$) and reached maximum to 1.27 ± 0.08 mg% on 3rd day

after induction of hepatitis. Thereafter following treatment, the values decreased gradually and reached to 0.35 ± 0.09 mg% on 12th day of the experimental study, though the value of 6th day was also significant ($P < 0.01$) (Table 25). This observation corroborates with the findings of Mahanta et al. (1986) in buffalo calves and Pradhan (1991) in goats and indicates the restoration of biliary clearence to normal due to repair of hepatic damage.

4.5.3.6 Serum cholesterol

The mean serum cholesterol level also showed a increasing trend ($P < 0.01$) and reached maximum to 136.29 ± 11.33 mg% on 3rd day. The values thereafter decreased gradually and became nonsignificant from 12th day onwards following improved therapy (Table 25). Similar observations were recorded by Mahanta et al. (1986) in buffalo calves and Pradhan (1991) in goats. This decrease in serum cholesterol indicates normalisation of the functional status of the liver with the help of these supportive therapy.

4.5.3.7 Serum enzymes

4.5.3.7.1 Serum glutamic oxalacetic transaminase

The serum GOT level increased marked significantly ($P<0.01$) and reached maximum to 476.27 ± 16.02 µg pyruvic acid/ml on 3rd day from its 0 day value of 90.13 ± 4.47 µg pyruvic acid/ml.

Following treatment, the values decreased gradually and became nonsignificant from 12th day onwards (Table 25). This observation corroborates with the findings of Mahanta et al. (1986) in buffalo calves and Pradhan (1991) in goats with identical improved therapy in CTC induced hepatotoxicity. In comparison to the Groups III and IV, where indigenous therapy were given, rapid declination of this serum enzyme activity was noticed which might be due to the combined effects of various therapetic agents, which helped in rapid regeneration of the hepatic cells.

4.5.3.7.2 Serum glutamic pyruvic transaminase

The serum GPT level also increased significantly ($P < 0.01$) and reached to the maximum level of 81.23 ± 3.87 µg pyruvic acid/ml on 3rd day from its 0 day value of 27.46 ± 2.37 µg pyruvic acid/ml. Thereafter the values decreased gradually to 62.29 ± 6.43 µg pyruvic acid/ml on 6th day ($P < 0.01$) and 41.16 ± 4.01 µg pyruvic acid/ml on 9th day ($P < 0.05$) and 32.23 ± 2.48 µg pyruvic acid/ml on 12th day of the experiment (Table 25), which similates with the observations recorded by Pradhan (1991) in goats. Rapid declination of this serum enzyme activity also indicates the effectiveness of the combined therapy used in this group.

4.5.3.7.3 Alkaline phosphatase

The average serum alkaline phosphatase activity recorded on 0 day was 3.49 ± 1.16 BU/100 ml, increased significantly ($P < 0.01$) to 11.13 ± 0.93 BU/100 ml on 3rd day but became non significant from 9th day onwards following improved therapy (Table 25) which simulates the findings recorded by Pradhan (1991) in goats. This findings indicated that, the improved by therapy used in these animals of Group V, were helpful in reducing the cellular damage of liver and thus in reducing the serum alkaline phosphatase activity.

4.5.4 Gross and histopathological changes

4.5.4.1 Gross changes

The appearance of carcass, as well as liver, kidneys, lungs and heart were normal, indicating effectiveness of the improved treatment adopted in this group of animals.

4.5.4.2 Histopathological changes

Liver: Around the central vein, the healthy and regenerated hepatocytes were evident (Fig 18) which supports the findings of Mahanta (1984) and Pradhan (1991) in buffalo calves and goats respectively. Persistence of hyperactive kuffer cells and mild fatty changes were also encountered in some places. However chatterjee (1985) remarked that, choline prevents the deposition of fats and accelerates the rate of removal of fat from the liver.

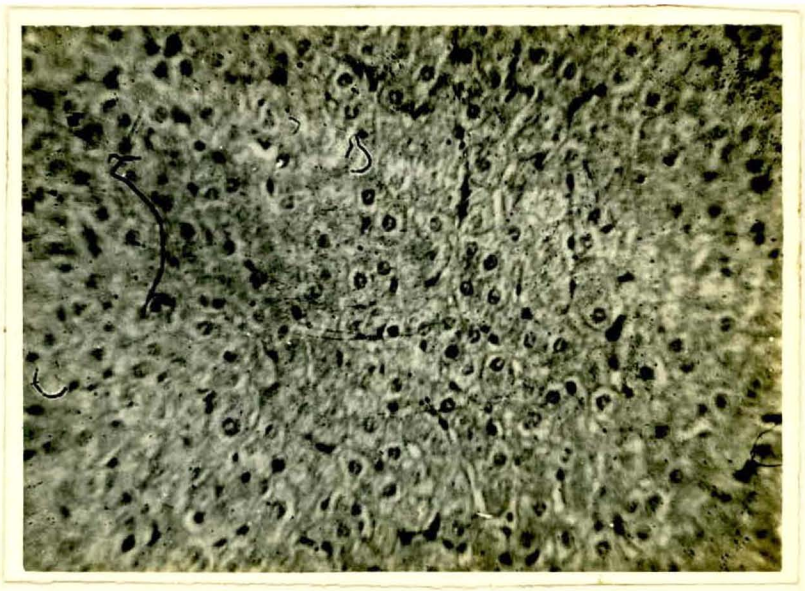

Fig. 18 Section of the liver showing complete regeneration of hepatic parenchyma after treatment with proprietory preparations. H & E X 450.

Kidney: Regeneration of the components of kidney parenchyma, with presence of epithelial detritus were clearly evident. Besides, mild degree of congestion and degeneration were also seen which corroborated the findings of Pradhan (1991) in goats. Vit. B complex, Vit. C, calcium and others used in this group of animals helped in the regenerative process of the kidney parenchyma.

Lungs: Healthy lung parenchyma and bronchioles were observed. However, cellular infiltration especially mononuclear cells were observed in some places. Vit. B complex, Vit. C and others helped in regeneration of the lung parenchyma.

Heart: Section of the heart was seen normal.

CHAPTER V

SUMMARY
AND
CONCLUSION

5.0 SUMMARY AND CONCLUSION

Liver dysfunctions occur due to good number of causes in animals. Clinical manifestations like inappetance, dullness and depression, rough hair and body coat, loose stool and progressive emaciation which are generally observed in clinical cases of hepatopathy are less helpful in diagnosis of liver dysfunctions in goats. Therefore in the present study, some common and some specific liver function tests were selected for the diagnosis of some experimental cases of hepatopathy and to formulate a suitable therapy for the condition, which might be helpful to diagnose and to treat the clinical cases of hepatic disorders in animals.

For this study, twenty five clinically healthy Black Bengal goats of either sex aged 10 to 18 months with a body weight ranging from 9-13 kg were selected. They were randomly divided into five equal groups. Group I animals were considered as healthy control. In Groups II, III, IV, V, carbontetrachloride was administered orally through stomach tube @ 0.75ml/kg body weight for 2 occasions at 48 hours interval, for producing experimental hepatic damage. The animals of Group II

were used as untreated control throughout the experimental period. The animals of Group III and IV were treated with two herbal liver tonics namely Vetliv and Livol respectively, while the animals of Group V were treated with some proprietory preparations containing liver extract, Vit. B complex, Vit. K, glucose, calcium, antihistamine and steroid given parenterally and Vit. C, cotrimoxasole, healthy rumen liquor and cobalt salts given orally.

In the healthy control group, clinical observations including temperature, pulse rate, respiratory rate and ruminal motility were observed and body weights were recorded. Haematological observations like haemoglobin, total erythrocyte count, packed cell volume, clotting time, total leucocyte count, differential leucocyte count, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, were estimated. Some blood biochemical profiles like glucose, total protein, albumin, globulin, A/G ratio, total bilirubin cholesterol and icteric index values were estimated. Van den Bergh test was also done. Serum enzymes like GOT, GPT and AP activities were also estimated.

In the animals of Group II, III, IV and V, clinical examinations, haematological studies and blood biochemical studies were done as in Group I, prior to induction of hepatitis (0 day), on 2nd day, 3rd day and thereafter every two days intervals upto 21st day of the experimental study.

In the animals of Group II, the characteristic signs like, dullness and depression, inappetance, dirrhoea, inco-ordination, aimless movements, rough hair coat, pale to yellowish mucous membrane, nasal discharge, chewing like movements, trembling of limbs, quivering of muscles, coma, falling lying on the ground were recorded 24 hours after the administration of CTC and most of these signs persisted till the end of the experiment. The body temperature, pulse rate and respiratory rates increased while the ruminal motility decreased significantly following CTC administration. The body weights were also found to decrease gradually. The haemoglobin, total erythrocyte count, packed cell volume decreased significantly following CTC administration but the total leucocyte count increased significantly. The clotting time also increased gradually. In differential leucocytic picture, the lymphocyte percentage decreased significantly ($P < 0.01$), while the neutrophil percentage increased significantly ($P < 0.01$) following CTC administration. The eosinophil percentage was also found to increase significantly ($P < 0.05$) on 3rd day following CTC administration. Marked changes in respect of the serum glucose, A/G ratio, icteric index, total serum bilirubin, serum cholesterol and serum enzymes like GOT and GPT activities were observed. The blood glucose level decreased significantly ($P < 0.01$) following CTC administration upto the end of the experiment. The serum total protein level decreased significantly ($P < 0.05$) from day 6 upto 15th day of the experiment.

The albumin level decreased significantly ($P < 0.01$) from day 3 but there was no significant change of serum globulin level. The A/G ratio decreased significantly ($P < 0.05$) from day 3 upto 12th day of the experiment. The serum icteric index level increased significantly ($P < 0.01$) from day 3 and remained elevated upto 15th day of the experiment. The Van den Bergh test was found to be positive from 2nd to 9th day of the experiment. The total serum bilirubin and cholesterol level increased significantly ($P < 0.01$) and remained elevated till the end of the experiment. The serum enzyme activities of GOT and GPT increased significantly ($P < 0.01$) from 2nd day onwards and remained significantly elevated upto 18th day of the experiment when the serum alkaline phosphatase showed a moderate increase only.

Out of 5 animals, 2 animals died on 5th and 6th days of the experimentation while the rest 3 animals recovered by 21st day. Gross and histopathological changes were marked in liver and kidneys, moderate in lungs but mild in heart. Histopathologically, severe centrilobular coagulative necrosis and moderate haemorrhages around the central veins and fatty changes in the hepatic cells of some lobules were noticed. The kidneys showed moderate to marked degenerative and necrotic changes which were more marked in the tubules than in the glomeruli. The lungs showed varying degrees of congestion, perivascular exudation of mononuclear cells, alveolar collapse and

compensatory emphysema. The section of the heart showed epicardial and myocardial haemorrhages along with congestion of the blood vessels.

The present findings revealed that, a combination of haematological examinations like clotting time, haemoglobin, total erythrocyte count, and some blood biochemical tests consisting of bilirubin, glucose, cholesterol, some serum enzymes like GOT and GPT were found applicable in early detection of the acute hepatic damage in goats. However Van den Bergh test and icteric index values may be used for the field test.

In Group III, IV and V, the clinical signs and the changes in haematological findings, blood biochemical findings and serum enzymatic activities were identical upto 3rd day of the experiment in animals of Group II and the therapy were given in all the groups from that day when the severity of the disease was more marked. The animals of Group III and IV received two indigenous hepatotonics, namely Vetliv and Livol respectively and showed gradual recovery following therapy. Most of the haematological and biochemical observations came to normal on 15th day of the experiment, indicating their effectiveness in restoring the functions of the experimentally induced hepatic damage.

On the basis of the haematological changes and blood biochemical changes in Group II, the animals of Group V, were

treated with a proprietory preparation of liver tonic, Beekom-L with certain supportive drugs like Dextrose, calborol, Kapilin given parenterally and Redoxon, Woktrin bolus (a cotrimoxasole preparation) given orally along with healthy rumen liquor and cobalt salts. After the initiation of this therapy, the animals of Group V showed early recovery in comparison to the animals of Group III and IV which were treated with Vetliv and Livol respectively. Most of the haematological and blood biochemical observations revealed that the functions of the liver of this group of animals returned to normal within 6-9 days after initiation of therapy.

The results of this experimental study suggested that the animals with early stages of liver disorders could be corrected effectively with liver extract, Vit. B complex. Dextrose 20%, calcium, antihistaminics, cortisone, Vit. K parenterally and Vit. C along with cotrimoxasole preparation, fresh rumen liquor and cobalt salt given orally. Alternatively, indigenous drugs like Vetliv and Livol can also be used in the treatment of liver dysfunctions in goats which works out to be cheaper and satisfactory.

CHAPTER VI

FUTURE SCOPE OF RESEARCH

6.0 FUTURE SCOPE OF RESEARCH

Future scope of research on liver dysfunctions in goats may be indicated on the following aspects.

1. During the course of this research works on liver dysfunctions in goats, it has been noticed that there has been some side effects leading to disturbances of kidney function. It is therefore necessary to assess in details, the extent of damage in the kidneys by suitable kidney function tests and to diagnose the extent of kidney damage for evolving suitable therapy.

2. Similarly, some disturbances on the respiratory functions like rate and depth of respiration have also been observed in this study. It would therefore be proper to further investigate the changes in the lungs relating to disturbances in the exchange of gases etc.

3. It has also been observed during the course of this study that there has been some changes on the heart secondary to experimental liver damage in goats. It is also suggested to conduct further studies on the extent of damage of the heart for evolving suitable therapy.

4. During the course of study, it is observed that liver biopsy is required to assess the changes in the liver. For this purpose, suitable biopsy needle for goats has to be designed.

5. On the basis of the above results, improvement of existing therapeutic measures has to be worked out, if necessary.

CHAPTER VII

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