THE ROLE OF SELECTED MINERALS IN RUMINAL INDIGESTION IN CROSS-BRED CATTLE

By

GEORGE THOMAS

THESIS

Submitted in partial fulfilment of

the requirement for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences

Kerala Agricultural University

Department of Clinical Medicine

COLLEGE OF VETERINARY AND ANIMAL SCIENCES

Mannuthy - Trichur

1983

DECLARATION

I hereby declare that this thesis entitled "THE ROLE OF SELECTED MINERALS IN RUMINAL INDIGESTION IN CROSS-BRED CATTLE" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Mannuthy,
24-11-1983.

GEORGE THOMAS

CERTIFICATE

Certified that this thesis, entitled "THE ROLE OF SELECTED MINERALS IN RUMINAL INDIGESTION IN CROSS-BRED CATTLE" is a record of research work done independently by Sri. George Thomas under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.

Dr. K.M. ALIKUTTY
(Chairman, Advisory Board).
Professor and Head,
Department of Clinical Medicine,
College of Veterinary and Animal Sciences, Mannuthy.

Mannuthy,
24-11-1983.

Dedicated to

My

Beloved Parents

ACKNOWLEDGEMENTS

I wish to place on record my deep sense of gratitude to Dr. K.M.Alikutty, Professor and Head, Department of Clinical Medicine and Chairman of the Advisory Committee for the valuable guidance, helpful suggestions and constant encouragement throughout this work.

I am greatly indebted to Dr. N.M.Aleyas, Associate Professor, Department of Clinical Medicine; Dr.N.Kunjikutty, Associate Professor, Department of Animal Nutrition; Dr. K.P. Sadanandan, Associate Professor and Sri.P.K.Ismail, Assistant Professor, Department of Physiology and Biochemistry, for their advice, constructive criticisms and valuable suggestions as Members of the Advisory Committee.

I am grateful to Dr. K.M.Jayakumar, Dr. P.C.Baby and Dr. P.C.Alex and other staff members of the Department of Clinical Medicine for their help and co-operation.

I am thankful to Dr. M.Krishnan Nair, Dean, College of Veterinary and Animal Sciences for the facilities provided for the research work.

Grateful acknowledgement is made to Sri. Samuel Mathew, Assistant Professor, College of Horticulture and Dr. C.S. Manomohan, Assistant Professor, Department of Pathology for their sincere help.

I sincerely thank Sri. V.K.Gopinathan Unnithan, Associate Professor, Department of Agricultural Statistics, Sri. B.Venkajakshan Nair and Sri. T.V.Sathianandan, M.Sc (Ag. Stat) scholars for the help and assistance rendered in the statistical analysis of the data.

The valuable help and co-operation rendered by my colleagues throughout the work are gratefully acknowledged.

My thanks are due to Sri. Skandakumar for typing the manuscript neatly.

I wish to express my gratitude to the Indian Council of Agricultural Research, New Delhi, for awarding the junior fellowship.

GEORGE THOMAS

TABLE OF CONTENTS

—oOo—

LIST OF TABLES

---oOo---

LIST OF ILLUSTRATIONS

---oOo---

Introduction

INTRODUCTION

Digestive disorders constitute one of the most common clinical problems which seriously affect the health and production in cattle. Incidence of digestive dysfunctions in cattle has been reported in great details from other parts of the country and from abroad (Nichols, 1963; Udall, 1964; Roflund, 1967; Joshi, 1970; Chakrabarthy et al. 1974; Joshi and Misra, 1974 and Prasad and Rekib, 1979a). Among these conditions the incidence of indigestion as a whole and simple indigestion in particular, associated with dietary variations is rated high (Joshi and Misra, 1974 and Prasad and Rekib, 1979a). Simple indigestion arises mainly from dietetic irregularities and the cross-bred cattle with greater production potentials and feed requirements are more prone to suffer from it. This is of particular importance in Kerala where cross-bred animals form majority of the cattle population and there is wide gap between production and demand for good quality feeds and fodder.

Microbial population in the rumen has a significant role to play in the digestive functions in ruminants. The types of diet greatly influence the composition and functions of the rumen microbes and as such the characteristics of the rumen contents are established with reference to feeding and managemental practices in a particular

area (Alonso, 1979). Normal rumen functions being dependant upon the survival and activity of rumen microbiota, optimum internal environment is to be maintained for maximal production. Digestive dysfunctions greatly alter the internal environment of the rumen and hence they are of great importance to dairy cattle production, warranting closer studies with particular reference to the above factors.

With advancing knowledge in rumen physiology the attention of research workers has now been focussed on the clinico-biochemical aspects of rumen dysfunctions. Minerals play vital role in the digestive and metabolic functions in the rumen. Many of them are required to maintain normal motor, secretory, digestive and absorptive functions of the alimentary system (Blood et al. 1979). In many digestive disorders, it is postulated that an exogenous or endogenous deficiency of minerals and vitamins exist which may be responsible for the clinical manifestations of these diseases (Hoflund and Nedstorm, 1948; Hoflund, 1967; Prasad et al. 1972 and Gupta et al. 1976). Further detailed information on the biochemical aspects of rumen disorders shall provide sound basis for their rational therapeutic management. However, under the feeding and managemental conditions prevailing in Kerala authentic informations are meagrely available for want of any systematic studies being undertaken on these aspects.

Hence an attempt has been made under the present investigations,

1. to study the incidence and seasonal dynamics of digestive disorders in cattle in the field by sample surveying,

2. to evaluate the changes in the physical characters and microbial activity of the rumen liquor,

3. to evaluate the status of some selected minerals in rumen liquor and blood; and,

4. based on the above observations to modify and compare the line of therapy with the conventional therapy for simple indigestion in cross-bred cattle.

Review of Literature

REVIEW OF LITERATURE

2.1. Incidence

Nichols (1963) reported that indigestion in cattle constituted 40.0 per cent of all illness treated every year at Wisconsin. Udall (1964) reported that nearly all cases of indigestion in cattle at Cornell, were from October to April with highest frequency observed during the months of October and November and the seasonal incidence of the disease was mainly attributed to the changes in their feed. On an average 80.02 per cent of cases of digestive disorders presented at Madras Veterinary College Hospital during 1961 and 1962 were indigestion (Balasubramanian and Ganapathy, 1965). In tropical areas of India rumen dysfunctions in bovines were common in hot and summer season when roughage was most dry and scarce. But during rainy and winter seasons no apparent influence of season or type of roughage on the incidence of indigestion was evident (Joshi, 1970). Verma and Ganapathy (1973) observed that incidence of indigestion was 75.70 to 81.57 per cent of the total cases admitted for various diseases of gastro-intestinal tract in cattle. Chakraborthy et al. (1974) reported that rumen dysfunctions in general and indigestions in particular were significantly high during south-west monsoon season (July to September) in Assam and the incidence of indigestion was highest in

comparison with other rumen dysfunctions. Joshi and Misra (1974) recorded high incidence of ruminal impaction during summer when the roughage fed was dry and coarse. According to them alkaline indigestion was more common in buffaloes due to intensive feeding and the influence of climatic variations on the incidence of ruminal dysfunctions was less pronounced in buffaloes than in cattle. Bindumadhav and Krishnamurthy (1979) observed that digestive disorders had the highest incidence among the total cases (36.60 per cent) as well among the medical category of cases (67.90 per cent) treated at Madras Veterinary College clinic during 1971 to 1973. Prasad and Rekib (1979a) reported that rumen dysfunctions in general were more prevalent (43.10 per cent) during summer. Among these the incidence of simple indigestion and ruminal tympany were comparatively high and rumen impaction noticed only during summer.

2.2. Classification

Nichols (1963) classified digestive disorders into those which primarily affected the digestive functions and those secondary to other disorders. Hoflund (1967) made clinical classification of digestive disturbances in ruminants into three types namely acid indigestion (pH 4.0 to 5.5), alkaline indigestion (pH 7.5 to 8.5), and simple indigestion (pH 6.0 to 7.0). Joshi (1970) categorised rumen dysfunctions

into indigestion, impaction and tympany. Kadvekar and Murkibhevi (1971) grouped bovine anorexia into primary and secondary. Primary anorexia comprised of traumatic and atraumatic types with organic and functional types under the latter and the functional type further classified into nutritional, microbial and biochemical types. Prasad et al. (1973) adopted the classification by Roflund (1967) with slight modifications under Indian conditions as simple, acid and alkaline indigestions, impaction and bloat. Joshi and Misra (1977) clinically classified rumen dysfunctions into simple indigestion, indigestion with impaction, indigestion with tympany and toxic indigestion (acid and alkaline indigestion) based on the physio-pathological examination of reticulo-rumen and pH of rumen liquor. Dirksen (1979) classified forestomachs disorders of cattle based on biochemical changes in rumen into those accompanied by high pH, low pH and those with normal pH.

2.3. Etiology

2.3.1. Simple indigestion.

Nichols (1963) suggested that indigestions in cattle were caused by ingestion of inadequate quantities of feed, improper ratio of nutrients, infrequent and irregular feeding and watering, too much of feed, feeds lacking physical

consistency and indigestible substances, poor environmental and managemental conditions and many non-specific disorders. Hoflund (1967) observed that in majority of cases of simple indigestion in cattle accompanied by normal pH (6.0 to 7.0) were caused by feeding damaged feed materials and formation of toxic breakdown products or by abrupt change in feeds, especially if they were inferior in quality. He also observed that deficiency of roughage resulted in disturbances in motor functions of the rumen and lack of rumination which resulted in depression of salivary secretions. Desh and Misra (1972) reported that sudden change of feed by replacing rice bran with decorticated soiseed in the rations produced primary indigestion in large number of dairy cattle. Gupta et al. (1976) suggested that defective synthesis or destruction of thiamine in the rumen could be a possible cause for rumen dysfunctions in zebu cattle and buffaloes. Prasad (1977) reported cases of hypocalcaemia characterised by hypomotile or atonic rumen with normal pH simulating simple indigestion in cattle. Blood et al. (1979) observed that prolonged or heavy oral sulphonamide or antibiotic dosing suppressed the normal flora and finally resulted in simple indigestion in cattle. Bueno et al. (1980) demonstrated gastro-intestinal hypomotility in magnesium deficient sheep.

2.3.2. Acid indigestion.

Hoflund (1967) observed acid indigestion in cattle characterised by pH of rumen ranging from 4.0 to 5.5 resulting from excessive feeding of easily fermentable carbohydrates, overeating and overfeeding with fodder beet, feeding on concentrates rich in starch and sugar and feeding with germinated grains. According to Dunlop (1972) the etiological factors for acid indigestion in ruminants include: excessive ingestion of feeds rich in non-fibrous carbohydrates like wheat, rice, barley, oats, carbohydrate precursors of lactic acid, toxic doses of feeds and constituents, psychological and environmental factors, starch quality and amylase activity, accumulation of lactic acid in gastro-intestinal tract, microbial metabolism of lactic acid, changes in pH in fore-stomachs, absorption and fate of lactic acid and lactate, changes in rumen osmolarity and other toxic factors in the ingesta. Experimental rumen acidosis was induced by feeding excess quantity of grains (Svendsen, 1974), molasses (Nauriyal and Baxi, 1973; Choudhari et al. 1980 and Sodhi et al. 1981), crushed barley grain (Nauriyal and Baxi, 1981) and crushed wheat grain (Randhawa et al. 1981). Aleyas and Vijayan (1981) reported that the etiological factors of acute indigestion included excess ingestion of paddy, raw rice, sudden change over to excess feeding of boiled rice,

payasam (a sweet preparation containing sugar and rice as main ingredients) and ingestion of jack fruit.

2.3.3. Alkaline indigestion.

Annison and Lewis (1959) observed alkaline indigestion with abnormally high rumen ammonia concentration in cattle due to overfeeding protein rich concentrates especially when such change over was abrupt. Alkaline indigestion due to exclusive feeding on paddy straw for four weeks in cattle was reported by Misra and Tripathy (1963). Hoflund (1967) stated that one of the commonest causes of alkaline indigestion in cattle could be intake of spoiled silage and rumen putrefaction occurred on intake of poor fodder and water or under poor stable hygiene. Nagarajan and Rajamani (1973) reported that alkaline indigestion in cattle resulted from drinking contaminated and sewage water. Davidovich et al. (1977) observed alkaline indigestion in cattle when the urea level in their rations were excessive. Prasad et al. (1973) produced experimental alkaline indigestion in cattle by intraruminal administration of 0.2 N sodium hydroxide. Sethuraman and Rathor (1979b) induced experimental alkaline indigestion in cattle and buffaloes by feeding guar soaked overnight. Alikutty (1981) produced experimental rumen alkalosis in cross-bred cattle in 12 hours by feeding three repeated doses of technical grade urea, intraruminally.

2.4. Clinical findings

2.4.1. Simple indigestion.

Simple indigestion, the mildest form of rumen dysfunction was characterised by anorexia, ruminal atony, dullness and drop in milk production (Joshi and Misra, 1977). Blood et al. (1979) described the clinical signs of simple indigestion as loss of appetite which might be partial or complete, drop in milk yield, depressed movements or complete atony of the rumen, cessation of rumination, constipation with scanty firm dung in most cases while mild diarrhoea was not uncommon especially on damaged feeds, firm and doughy rumen on palpation or slight to moderate distension of rumen especially with spoiled feeds, normal temperature, pulse and respiration and mild pain in those animals which developed distended rumen. Prasad (1979) represented that reticulo-ruminal motility was adversely affected in all types of indigestion irrespective of disturbances in pH of the rumen.

2.4.2. Acid indigestion.

Acid indigestion characterised by low pH of rumen contents might occur in peracute, acute, sub-acute and mild forms. Hoflund (1967) observed dehydration, hide-bound condition, sunken eyeball and oliguria in cases of acute indigestion in cattle. Juhasz and Szegedi (1968a and 1968b) reported decreased ruminal movements, increased heart and

respiratory rates in some cases culminating in respiratory failure and death from asphyxia in experimental rumen acidosis in sheep. Nash et al. (1972) and Misra and Singh (1974) observed subnormal temperature, rapid pulse and respiration, cold extremities, dry muzzle, dullness, dehydration, ataxia, dilated pupil, absence of rumen contraction, restlessness, water bellooned rumen, abdominal pain, anxious look, salivation, mild to acute tympany, recumbency and dyspnoea as important clinical signs of acute indigestion in cattle. The nature of feed influenced the speed and degree of onset of the illness; ground feed produced a faster clinical situation than whole grains. Diarrhoea was commonly observed; the faeces light coloured with sweet sour odour. In grain overload palpation of rumen contents revealed a firm and doughy consistency. In severe cases absence of rumen motility was noticed, but a gurgling sound due to gas arising through the fluid accumulated in the rumen could be appreciated on auscultation. Finally animal becoms recumbent and prognosis varied with the severity of the condition (Block et al. 1979). According to Sethuraman and Rathor (1979b) clinical symptoms in experimental acid indigestion in bovines were anorexia, dullness, suspended rumen motility, accelerated pulse and respiration, arched back, discharge from eyes and nostrils,

diarrhoea, dehydration, muscle tremors, shifting lameness, jugular pulse, recumbency, coma, concentrated urine and finally anuria. Suber and Hentger (1979) observed laminitis after 12 to 14 hours of induction of rumen engorgement in 50 per cent of affected steers. Sodhi et al. (1981) recorded tachycardia and increase in T-wave potentials and ventricular fibrillation just before death in ruminal acidosis induced by feeding molasses to cross-bred calves.

2.4.3. Alkaline indigestion.

Alkaline indigestion with high rumen pH 7.5 to 8.5 was characterised by putrid, fishy, smell to breath, anxious painful look, regurgitation, depressed pulse and respiration and reduced rumen motility (Nash et al. 1972 and Misra and Singh, 1974). Nagarajan and Rajamani (1973) observed symptoms like dryness of muzzle, congested mucous membranes, malodourous and putrid rumen contents, slight tympany, anorexia and atony of rumen. In experimentally induced rumen alkalosis, the sequential development of symptoms were anorexia, tympanitis, lacrimation, salivation, passage of semisolid dung, congestion of visible mucous membranes, alteration in pulse and respiratory rates, purulent discharge from eyes and nostrils, severe bloat, grinding of teeth, groaning, arched back, constipation, offensive odour from mouth, straddling gait, rough coat, restlessness, dyspnoea,

dilated pupil, muscle tremors, convulsions and polyuria (Sethuraman and Rathor, 1979b). Alikutty (1981) observed clinical signs of hyperammonaemia characterised by muscular tremors, ataxia and progressive tetany merging to convulsive episodes before death in alkaline indigestion in cattle. Choudhuri et al. (1981) observed reduced milk production, cessation of rumen motility, passage of scanty pasty dung, rough body coat and dryness of muzzle in chronic alkaline indigestion in cattle.

2.5. Biochemical changes

2.5.1. Blood.

2.5.1.1. Normal.

The normal serum calcium level in cattle ranged between 8.0 and 12.0 mg/dl, existing in two forms - a diffusible ionised form which accounts for 3.6 to 7.7 mg/dl and a non-diffusible protein bound form (Maodie, 1960). Normal values for serum calcium, inorganic phosphorus, magnesium, sodium and potassium in cattle were reported as 5.4 mEq/L (4.7 to 6.1), 5.6 to 6.5 mg per cent, 2.3 mEq/L (1.0 to 2.9), 142 mEq/L (132 to 152) and 4.8 mEq/L (3.9 to 9.5) respectively (Benjamin, 1961). According to Cornelius and Kaneko (1963) the normal serum calcium, inorganic phosphorus, magnesium, sodium and potassium levels in cattle were 9.4 to 12.2 mg per cent, 4.3 mg per cent, 2.05 ± 0.25 mg per cent,

132.0 to 152.0 mEq/L and 3.9 to 9.5 mEq/L respectively. Blood et al. (1979) reported the normal serum levels of calcium, inorganic phosphorus, magnesium, sodium and potassium as 8.0 to 11.0 mg/dl, 4.0 to 7.0 mg/dl, 1.0 to 2.7 mg/dl, 132.0 to 152.0 mEq/L and 3.9 to 5.8 mEq/L, respectively.

2.5.1.2. Diseased.

Meyer and Rustige (1958) reported that increased ammonia concentration in the rumen in alkaline indigestion caused a slight fall in blood calcium and magnesium, but higher levels of ammonia production did not enhance this effect. Hoflund (1965) reported low serum inorganic phosphorus levels in calves suffering from indigestion. Slanina (1969) found lowering of blood calcium level after 34 hours and between second to fifth day following experimental induction of acid and alkaline indigestion in cattle respectively. Huber (1971) observed that in acute indigestion the water loss was shared by intracellular and extracellular compartments and serum sodium, potassium and chloride concentrations were decreased in approximately isotonic proportions. Prasad et al. (1972) observed hypocalcaemia in some cases of simple and acid indigestions and impaction of rumen with normal serum inorganic phosphorus level and higher albumin - globulin ratio in cattle. According to him

the mean serum calcium and inorganic phosphorus levels in simple indigestion in cattle were 9.24 ± 0.35 mg/dl and 4.24 ± 0.33 mg/dl respectively and their values in acid indigestion were 10.4 ± 0.54 mg/dl and 4.25 ± 0.59 mg/dl. Prasad et al. (1973) reported that in experimental cases of acid and alkaline indigestions the serum calcium and inorganic phosphorus levels were not affected, but slight changes in serum protein and albumin levels were detected. Prasad and Joshi (1975) found that in impaction of the rumen serum calcium and inorganic phosphorus levels were in normal physiological ranges except in few borderline cases; but alterations in total serum protein and albumin - globulin ratio were apparent.

Cekale and Albrycht (1976) observed that deprivation of feed and water in cattle decreased the serum calcium and magnesium and increased the phosphorus levels which were detectable at 48 hours. Biochemical profile of rumen acidosis induced by intraruminal administration of molasses did not reveal any change in blood calcium, inorganic phosphorus and magnesium levels (Nauriyal and Baxi, 1978). Hentger (1979) observed decreased blood pH and plasma L-lactic acid and increased serum sodium and potassium in carbohydrate foundered cattle. Choudhuri et al. (1980) reported increased serum values for inorganic phosphorus and sodium and decreased values for calcium, magnesium and

potassium in buffalo calves with rumen acidosis. Joshi (1930) found no significant changes in calcium, phosphorus, magnesium and protein levels in blood in impaction of rumen and bloat in cattle. Huber et al. (1931) obtained significant correlation between serum diffusible calcium level and decrease in contractile strength of the rumen and suggested that rumen dysfunctions might occur considerably before onset of clinical signs of hypocalcaemia. In experimental rumen acidosis in crossbred cattle and buffaloes induced by feeding crushed barley, the blood inorganic phosphorus concentration was elevated while no change detected in serum calcium and magnesium (Mouriyal and Baxi, 1981).

2.5.2. Rumen liquor.

Watson (1933) observed that bacterial proliferation in the rumen was favourably influenced by higher rumen levels of phosphorus. In vitro studies by Hubert et al. (1959) showed that sodium, potassium, calcium and magnesium should be present in optimum concentration in the rumen for maximum cellulose digestion. Hungate (1966) reported that the rumen contents of sheep on chopped meadow hay contained magnesium 7.0 to 11.0 mg per 100 ml and calcium 11.0 to 21.0 mg per 100 ml and the abomasal values were 11.0 to 16.0 mg of magnesium and 39.0 to 56.0 mg of calcium per 100 ml. He also suggested that the need of phosphorus for rumen micro-organism

was fairly high; the cells contain 3.0 to 6.0 per cent phosphorus on dry matter basis and on occasion this element could be limiting.

The total volatile fatty acid and ammonia nitrogen influenced the rumen pH. In acid indigestion increased volatile fatty acid and decreased ammonia nitrogen levels were noticed whereas in alkaline indigestion the reverse of the condition was observed (Hoflund, 1967; Prasad et al. 1972 and 1973; Sethuraman and Rathor, 1979a, Alikutty, 1981 and Randhawa et al. 1981). Erickson et al. (1970) reported that the calcium and phosphorus concentrations in rumen fluid varied significantly among rations and between collection timings. Partial defaunation of rumen in cattle resulted in significant decline of rumen pH, buffering capcity, total volatile fatty acids and ammonia nitrogen (Kahlon et al. 1970).

Huber (1971) observed reduction in the osmolar concentration of ruminal sodium, potassium and chlorides and a great increase in osmolar concentration of ruminal lactic acid in acute indigestion induced with oral feeding of glucose in sheep. Prasad and Raghavan (1973) observed significant species difference between cattle and buffaloes in ruminal sodium, potassium and calcium concentrations and the level of feed intake and sampling time had a marked

effect on ruminal sodium and potassium. In vitro studies showed that sodium was an obligate growth requirement for most of the predominant rumen bacteria and it influenced the growth of rumen bacteria independent of potassium, but the latter ions were also required in the media containing sodium and potassium as major cations (Caldwell and Hudson, 1974).

Cekalo and Albrycht (1976) detected decrease in calcium, magnesium and potassium levels and increase in the values of phosphorus, sodium and pH of rumen fluid after 12 to 24 hours of deprivation of feed and water in cattle. Drueukink and Ruyter (1977) observed differences in sodium, potassium and chloride concentrations and pH of rumen fluid between rations and before and after feeding. Phillipson (1977) reported that sodium level was less in the rumen than in plasma whereas potassium concentration in the rumen was always greater than that in the plasma in normally fed sheep. Phosphate was absorbed only in traces from the rumen eventhough its concentration was many times greater than that in plasma. He also stated that the concentration of calcium and magnesium in an ultrafilterable form in rumen fluid was small and was not sufficient to overcome the potential difference across the rumen epithelium. In vitro studies showed that calcium absorption from the rumen was most rapid at pH 7.4 (Dimet et al. 1970).

Treseol and Lamand (1979) observed sharp fall in vitamin B_{12} values in rumen contents of sheep fed low cobalt hay diet. Yano et al. (1979) stated that in comparison with the concentration of calcium, magnesium and potassium, the concentration of phosphorus and sodium in the digesta and supernatant were higher in rumen and calcium solubilities tended to become lower with the elevation of dietary calcium. Choudhuri et al. (1980) reported that in rumen acidosis in buffaloes a decrease in pH of rumen fluid was accompanied by a decrease in sodium and potassium and increase in calcium, magnesium and inorganic phosphorus levels in rumen fluid. Supplementation of cobalt and copper either alone or in combination to basal ration were made in different experimental groups and higher concentration of total volatile fatty acids, total nitrogen and ammonia nitrogen were observed in all supplemented groups with highest value in copper plus cobalt group (Saxena and Ranjhan, 1980). Saxena and Srivastava (1980) conducted similar supplementation trials and recorded higher concentration of acetic acid in all supplemented groups with highest values in copper plus cobalt supplemented group, but these supplementatio had no significant effect on propionic acid concentration. They also found higher counts of protozoa and bacteria in all supplemented groups with highest values in copper plus cobalt supplemented group.

Alikutty (1981) reported that decrease in rumen magnesium content was not significant in experimental alkaline indigestion in cattle. *In vitro* studies showed that calcium absorption from different compartments of bovine stomach increased with increasing concentration of sodium in the rumen (Tinet *et al.* 1981a). However, the presence of phosphate reduced the absorption of calcium from all three compartments of bovine stomach (Tinet *et al.* 1981b).

2.5.3. *Urine.*

Hoflund (1967) observed that in acid indigestion the volume of urine diminished and anuria resulted in terminal stages. A linear relationship between pH of rumen liquor and urine in cattle suffering from either acid or alkaline indigestions was reported (Misra and Singh, 1974). Jagos *et al.*(1977) observed a decrease in pH of urine with an increase in inorganic phosphorus level of urine in chronic acidosis in dairy cows. Sethuraman and Rathor (1979a) reported increased specific gravity of urine in experimental acid indigestion in cattle and buffaloes. Choudhuri *et al.* (1980) reported decrease in pH of urine with an increase in inorganic phosphorus level in experimental rumen acidosis in buffaloes.

2.6. Diagnosis

2.6.1. History and feeding habits.

Indigestions were related mainly to dietetic irregularities and dietetic history may be useful diagnostic adjunct to guide specific therapy (Prasad and Rakib, 1979a). The nature, quality, quantity, consistency and composition of ration and proportion of dietary components should be given attention and were valuable guidance for the diagnosis of digestive disorders (Dirksen, 1979).

2.6.2. Physical examination.

Physical methods of diagnosis especially examination of the rumen and the reticulum were best made use for the diagnosis of digestive disorders in ruminents (Boddie, 1962; Misra et al. 1972a and Dirksen, 1979). Abdominal ballotment and rectal palpation were suggested to study the physical characters of the ingesta of the rumen (Nichols, 1963).

2.6.3. Rumen motility.

Rumen motility was considered as a valuable clinical index for diagnosis of digestive disorders (Boddie, 1962). Misra and Singh (1974) observed absence of motility of rumen in acid indigestion while in alkaline indigestion rumen contractions varied from one to five per five minutes. In healthy cattle, rumen motility rated two movements per minute

or three movements per two minutes and in clinical cases of bovine indigestion hypomotility (one movement per one to two minutes) or atony of rumen was evident (Prasad, 1979). According to Dirksen (1979) the rate of rumen movements varied from seven to twelve per five minutes and hypomotility or atony of rumen occured in all forestomachs disorders and when a ration poor in fibrous structure was fed.

2.6.4. Analysis of rumen liquor.

2.6.4.1. Odour.

Odour of rumen liquor was related to the nature of rumen contents and normally it was aromatic (Misra et al. 1972a and 1972b; Misra and Singh, 1974; Alonso, 1979 and Dirksen, 1979). Abnormal odours of rumen liquor were faint sour to putrid fishy in subacute primary indigestion, pungent in excess carbohydrate intake (Misra et al. 1972b) and putrid fishy in alkaline indigestion (Misra and Singh, 1974 and Sethuraman and Rathor, 1979a).

2.6.4.2. Colour.

Normal colour of rumen liquor could be yellowish brown (Misra et al. 1972a and 1972b and Misra and Singh, 1974), grey and olive to brownish green and pure green in grazing cattle (Dirksen, 1979). The colour of rumen liquor varied with nature of ingested feed, time of feeding and stage of digestion (Alonso, 1979).

The colour of rumen liquor in cattle was yellowish brown in simple indigestion (Nash and Misra, 1972), golden yellow to grey in acid indigestion (Nash et al. 1972), yellowish green to brown in subacute primary indigestion, golden yellow to greenish ash in acid indigestion (Misra et al. 1972b), yellowish in acid indigestion and dark brown in alkaline indigestion (Misra and Singh, 1974). According to Sethuraman and Nathor (1979a) the colour of rumen fluid in experimentally induced acid indigestion was brown at 24 hours, creamy at 48 hours and greenish white to white at 96 hours while in acute alkalosis rumen contents were frothy initially which became brownish creamy to brownish later.

2.6.4.3. Consistency.

The normal consistency of rumen fluid was viscous or slightly viscous whereas extremely viscous samples were those contaminated with saliva (Misra et al. 1972a and Dickson 1970). Liquid consistency was noticed in animals fed mostly on roughage diet (Misra et al. 1972a).

In alkaline indigestion the consistency of rumen fluid was watery (Hoflund, 1967; Misra and Singh, 1974 and Alikutty, 1981). In subacute primary indigestion the rumen liquor was thin liquid in consistency while in acute indigestion thin watery consistency was found (Nash et al.1972a and Misra et al. 1972b and Misra and Singh, 1974).

2.6.4.4. pH.

pH of rumen liquor varied partly with diet and Wilson (1967) found it lower in animals fed concentrate diet. Prasad et al. (1972) stated that pH of rumen liquor influenced rumen functions. Normal values of pH of rumen fluid in cattle varied from 6.7 to 6.9 (Misra et al. 1972a), 6.4 to 6.8 (Alonso, 1979), 6.5 to 7.0 (Blood et al. 1979) and 5.5 to 7.0 (Dirksen, 1979).

Simple indigestion in cattle was characterised by rumen pH of 6.0 to 7.0 (Hoflund, 1967), 6.7 to 6.9 (Misra et al. 1972b), 5.6 to 7.4 (Prasad et al. 1972) and 7.0 ± 0.07 (Vihan et al. 1973b).

pH of rumen contents in acid indigestion in cattle varied from 4.0 to 5.5 (Hoflund, 1967), 3.8 to 4.5 (Nash et al. 1972), 5.3 ± 0.017 (Vihan et al. 1973b) and 4.0 to 4.5 (Misra and Singh, 1974).

Alkaline indigestion in cattle was characterised by rumen pH of 7.5 to 8.5 (Hoflund, 1967), 8.0 (Nagarajan and Rajamani, 1973), 8.0 ± 0.08 (Vihan et al. 1973b), 7.2 to 9.5 (Misra and Singh, 1974), 8.0 to 8.9 (Choudhuri et al. 1981) and 8.26 ± 0.06 (Alikutty, 1981). pH value of 6.1 to 7.3 was observed in impaction of rumen (Prasad and Joshi, 1975). In secondary rumen dysfunctions in cattle the pH of rumen

fluid did not show much variation from normal (Prasad, 1977). However, Joshi (1980) reported pH ranging from 7.3 to 8.5 in cases of rumen impaction and bloat in cattle.

2.6.4.5. Rumen protozoa.

Hungate (1966) stated that the rumen protozoal count could be helpful in the primary diagnosis of alimentary dysfunction. Misra et al. (1972) observed that the gross rumen protozoal concentration in normal cattle varied from moderate (++) to high (+++) having 10 to 30 protozoa per microscopical field, the average protozoal motility ranging from moderate (++) to vigorous (+++) and the average protozoal number to be 3.58×10^5 per ml of rumen fluid. According to Dirksen (1979) the number of protozoa in the rumen fluid normally varied according to composition of ration, feeding time and level of the rumen from where the samples were collected and the protozoal count was about 10^5 per ml in cattle fed mixed ration, increasing to 10^6 per ml in those fed larger amounts of concentrates.

Increase or decrease in pH of rumen contents was detrimental to rumen protozoal population (Hoflund, 1967). Dash et al. (1972) observed no living protozoa in rumen fluid below pH 5.5, with some Entodinium population surviving at pH 5.5 and some Diplodinium group in alkaline range. Sudden change of feed from normal to salseed supplementation

resulted in simple indigestion in which lowering of protozoal concentration was evident and gross protozoal concentration varied from less (+) to moderate (++) with slow motility (Dash and Misra, 1972). A marked decrease in total protozoal count with slow (+) motility and concentration of protozoa varying from low (+) to moderate (++) with an average of 15 protozoa per microscopical field were observed in subacute primary indigestion(Misra et al. 1972b). Infusoria was either scanty or dead in tympany and impaction of rumen (Prasad et al. 1972 and Prasad and Joshi, 1975) and they were found dead and disintegrated in distinct acid (pH 5.5) and alkaline (pH 8.5) ranges (Prasad et al. 1973). Prasad (1975) reported that in simple indigestion all the three types of infusoria, large, medium and small were found viable in rumen contents, though in a few cases the large sized infusoria was inactive. He also found that in acid indigestion almost all the infusoria were absent and in alkaline indigestion the infusoria were scanty or feebly motile. According to Joshi and Misra (1977) in simple indigestion the rumen infusoria maintained more or less normal activity and number in cattle. Joshi (1980) reported that in bloat and impaction of rumen large forms of infusoria were less in number and poorly idiophilic. Choudhuri et al. (1981) observed that in alkaline indigestion in cattle at pH above 8.0 all rumen protozoa were dead.

Nauriyal and Baxi (1981) reported that during the first four days in experimentally induced acid indigestion no protozoa could be traced in rumen liquor.

2.6.4.6. Rumen bacteria.

Blancou (1979) reported that the activity of both rumen protozoa and bacteria decreased during summer season, but their number remained unchanged. Alonso (1979) observed that the number of rumen bacteria were influenced by the diet, presence of bacteriophages, protozoa, autolysis and action of digestive enzymes. Dirksen (1979) reported that the dominant bacteria in rumen liquor were gram negative type and the concentration of rumen bacteria varied from 10^7 to 10^{12} per ml of rumen fluid or per gram of solid rumen contents. Singh et al. (1980) observed that roughage - concentrate ration supported a much higher bacterial population than all roughage ration. Verma and Singh (1980) suggested that in normal buffalo calves bacterial growth in rumen was influenced by the quantity of ration consumed by them.

Vazquez (1975) observed proliferation of gram positive bacteria in lactic acidosis in cattle. Complete disappearance of rumen protozoa and a fall in total bacterial count from 6.8×10^{10} per ml to 9.0 to 4.5×10^8 per ml of rumen fluid were observed in experimentally induced acid indigestion (Nauriyal and Baxi, 1978 and 1981). Dirksen (1979) observed

that in acid indigestion gram positive bacteria were dominant and gram negative bacteria were predominant in both alkaline indigestion and rumen putrefaction.

2.6.4.7. Sedimentation activity time (SAT).

Nichols and Penn (1958) suggested sedimentation activity test and cellulose digestion test as two simple laboratory tests to assess the microbial activity of rumen and found that sedimentation activity time varied between animals and in same animal from time to time. In normal Indian cattle SAT varied from 8.0 to 18.0 minutes with an average of 12.9 minutes (Misra et al. 1972a and 1972b), while the values were found to vary from 3.0 to 9.0 minutes (Blood et al. 1979) and 4.0 to 8.0 minutes (Dirksen, 1979) in exotic animals and 20.33 ± 2.77 minutes in cross-bred cattle (Alikutty, 1981).

Poor cellulose digestion activity in rumen dysfunctions were reported by many workers (Nichols and Penn, 1958 and Blood et al. 1979). Hoflund (1967) found rapid sedimentation of fodder particles in alkaline indigestion. Misra et al. (1972b) reported that in subacute primary indigestion the SAT increased significantly with an average of 39.9 minutes. Prasad et al. (1973) observed quick sedimentation of particles and absence of cellulose digestion in 30 hours in rumen fluid in cases of acid and alkaline indigestions. Vihan et al.(1973a)

reported that the rate of cellulose digestion decreased in both acid and alkaline indigestions in buffaloes. Alikutty (1981) observed prolongation of SAT (51.29 ± 4.23 minutes) in experimental cases of alkaline indigestion in cross-bred cattle.

2.7. Treatment

2.7.1. Simple indigestion.

For restoration of motility of rumen, rumenatoric agents like potassium-antimony tartrate or tartar emetic has been recommended (Stevens et al. 1958). Kadvekar and Murkibhavi (1971) claimed satisfactory curative response to parenteral use of vitamin B-complex and liver extract at the dose rate of 1.0 ml per 50 kg body weight for three to five days in cases of bovine anorexia. In indigestion due to change of feed from normal to saiceed supplemented ration in cattle satisfactory response was obtained when treated with Himalayan Ratisu with treacle (Dash and Misra, 1972). According to Prasad et al. (1976a) treatment of simple indigestion in sheep and goat with stomachic powder alone was of limited clinical response and have suggested the use of rumenatoric drugs and agents which enhance the microbial activity in the rumen. Prasad et al. (1976b) found that 'Anorexon' (Pfizer) was effective in the treatment of simple indigestion and also as a supportive therapy for clinical management of

rumen acidosis and tympany in ruminants. Blood et al.(1979). reported that ruminal atony which responded to parenteral calcium administration was common in cattle. They suggested the use of parasympathetic stimulants in atony of gastro-intestinal tract, but their effects were transitory and were accompanied by undesirable side effects. They also recommended the reconstitution of rumen flora by use of cud transfer in long standing cases of anorexia. Prasad and Nakib (1979b) found that for the clinical management of simple indigestion in cattle parenteral administration of liver extract with vitamin B-complex (2 to 10 ml intramuscularly) or 'Tonophosphan' (2 to 5 ml intravenously)once daily for one to two days) was excellent and dependable and these were found superior to oral administration of 'Liv 52' (2 to 10 tablets or 1 to 4 teaspoonful syrup thrice daily) or stomachic powder alone.

2.7.2. Acid indigestion.

Hoflund (1967) reported that oral administration of one litre of brewer's yeast or 0.5 kg of baker's yeast orally found beneficial in grain engorgement in cattle. He also recommended parenteral use of B-vitamins, antihistaminics and normal saline (3.0 to 5.0 litres intravenously) as adjunctive therapy. Huber (1971) suggested that in sheep fluid replacement in acid indigestion should be directed to expand fluid compartments with isotonic electrolyte solutions which contains

limited quantities of colloids. Vihan et al. (1973a) observed reduced cellulose digestion in both acid and alkaline indigestions in buffaloes and recommended the use of rations low in cellulose content and the incorporation of substances which stimulate cellulose digestion in their rations.

Misra and Singh (1974) suggested the use of half pound of magnesium carbonate or sodium bicarbonate initially followed by an ounce daily for two days in acid indigestion and 200 ml of five per cent lactic acid in alkaline indigestion for correcting the pH or rumen. Subsequent to correction of rumen pH, use of 'Himalayan Satisa' orally and 'Livogen' intramuscularly cured 92.0 per cent of cases in five days while 'Himalayan Satisa' alone cured only 76.0 per cent of cases in seven days. Prasad et al. (1976a) administered sodium bicarbonate orally to neutralise local acidity in rumen and sodium bicarbonate intravenously to restore the alkali reserve in rumen acidosis of sheep and goat. Rumenatoric drugs and substances required for increased microbial activity in rumen were followed orally, which worked better than the use of rumenatorics alone as assessed by the revival of appetite.

Sethuraman and Rather (1979b) have tried line of therapy comprising of sodium bicarbonate orally and Ringer's

sodium lactate and 'Phenergan' parenterally in one group and magnesium carbonate orally and sodium bicarbonate and 'Vallergan' parenterally in another group of animals with experimental rumen acidosis. Complete recovery at 192nd hour was claimed for all the animals when they were further given appropriate doses of penicillin, rumenatoric drugs and cud transfer from healthy animals orally and thiamine hydrochloride and liver extract parenterally.

Aleyas and Vijayan (1981) suggested the use of antacids (magnesium hydroxide 25 g, pulvis zingiberis 20 g and pulvis nuxvomica 10 g) twice daily for three to four days with antihistaminics, 5.0 per cent dextrose saline, tender coconut water and fresh rumen liquor for three days as supportive therapy in clinical cases of acute indigestion in cattle. Nauriyal and Baxi (1981) suggested evacuation of rumen contents through fistula, parenteral use of chloramphenicol (700 mg), sodium bicarbonate 7.5 per cent solution (200 to 300 ml), antihistaminics and orally two per cent ammonia solution (300 ml) and ammonium carbonate (35 g) to bring down the residual rumen acidity for treatment of experimentally induced rumen acidosis in buffaloes. Supportive therapy included fresh cud inoculation, normal saline, liver extract and rumenatoric drugs for a period of four to five days.

2.7.3. Alkaline indigestion.

Hoflund (1967) suggested therapeutic regimen comprising of 60 to 80 g lactic acid dissolved in six to eight litres of water given by a stomach tube one to two times, supplementation of molasses or beet fodder to increase rumen's own lactic acid production and 6.0 to 9.0 g of streptomycin daily for three to five days in cases of alkaline indigestion in cattle due to ingestion of spoiled silage. Nagarajan and Rajamani (1973) had suggested the clinical management of alkaline indigestion in cattle comprising of intravenous administration of 500 ml of 30 per cent glucose solution, 10.0 ml antihistaminic and 10.0 ml of vitamin B-complex intramuscularly along with antibiotics and six ounces of six per cent acetic acid orally. Evacuation of rumen contents and drenching with four pints of fresh rumen fluid were also done. The whole schedule of treatments were repeated for three days. Prasad et al. (1976a) resorted to oral administration of lactic acid to lower the pH of rumen in alkaline indigestion in sheep and goat following which rumenatoric drugs and substances required for increased microbial activity in rumen were administered orally which proved better than the use of rumenatorics alone. Sethuraman and Rathor (1979b) treated experimentally induced alkaline indigestion in cattle with administration of acetic acid

orally, Ringer's sodium lactate intravenously and 'Vallergan' intramuscularly. Supportive therapy included streptomycin, rumenatoric drugs and cud from healthy animals orally and liver extract parenterally. Signs of recovery were noticed 144th hour onwards. Alikutty (1981) reported clinical recovery in 67.75 per cent of experimental cases of alkaline indigestion in cattle treated with a therapeutic regimen consisting of partial evacuation of rumen contents followed by intraruminal administration of lactic acid and 'Betnesol', 'Thiocal' and 'Beekon-L' parenterally, 'Policyclin', cobalt sulphate, fresh rumen liquor, molasses and rice gruel intraruminally as supportive therapy. Choudhuri et al. (1981) reported successful treatment of alkaline indigestion in cows by oral administration of two per cent lactic acid (500 ml) followed by two litres of fresh rumen liquor daily for two days. The above treatment was supported with intramuscular injection of vitamin B-complex and iron dextran for five alternate days and orally 200 yeast tablets daily for five days and liver tonics for ten days.

Materials and Methods

MATERIALS AND METHODS

3.1. Incidence

Data on the incidence of digestive disorders were collected from field veterinary hospitals at Pattikkad, Olur and Anthicadu and College veterinary hospitals, Kokkalai and Mannuthy for the period of five years from 1977 to 1981. The percentage of incidence of disease was calculated. The incidence of the disease during summer (February to May), rainy (June to October) and winter (November to January) seasons according to the agroclimatic conditions was studied by subjecting the data to one way classification.

3.2. Experimental studies

Eight apparently healthy adult cross-bred cattle selected at random from the University Livestock farm, Mannuthy, maintained under identical feeding and managemental conditions of the farm served as the control animals (Group I) for the present study. The animals were fed pelleted compounded livestock feed and green fodder at recommended standard levels. Clean drinking water was provided ad libitum. Rumen liquor and blood samples were collected from these animals at six hourly intervals for analysis. Evaluation of rumen liquor for pH, colour, odour,

consistency, protozoal motility and sedimentation activity time was made. The mean normal values for selected minerals viz., calcium, inorganic phosphorus, magnesium, sodium and potassium both in rumen liquor and blood were estimated.

Twelve selected clinical cases of simple indigestion in cross-bred cattle were utilized for clinical studies under the present investigation. Detailed clinical examination of all adult cross-bred cattle presented at the college veterinary hospital, Mannuthy, with the complaint of loss of appetite were carried out and diagnosis of cases of indigestion was made based on the history of feeding and management and the findings on clinical and laboratory investigations. The above animals were normally fed a ration comprising either compounded livestock feeds or locally mixed grains like black gram, cotton seed, paddy and wheat bran and oil cakes, in addition to the roughages (paddy straw, greens etc.). The animals were usually given water from domestic/local sources. The history of feeding revealed that the affected animals under the present study had dietary abnormalities like abrupt change in feeds and feeding schedule including intake of unconventional feeds and variations in the intake of water. Six each of such clinical cases of simple indigestion (Group II and III) were utilized at random for therapeutic studies. Clinical

observations and collection of rumen liquor and blood samples were made from all the animals of these groups on the first day they were presented at the clinic.

Animals of the group II were treated with the selected line of therapy comprising of bitter stomachics viz., Ammonium carbonate (15 G), pulvis nuxvomica (8 G), pulvis chiretta (30 G), pulvis gentian (30 G) and pulvis zingiberis (30 G) in two divided doses for two days and Livogen* 6 ml intramuscularly for four consecutive days. Clinical observations were made regularly and samples of rumen liquor and blood were collected on fourth day and seventh day of treatment. The samples were analysed for all parameters mentioned for the control group.

---

* LIVOGEN (Glaxo Laboratories (India) Ltd., Bombay.
Injection of liver extract with vitamin B-complex.
Each ml contains:

vitamin B1 BP (Vet)	25 mg
Riboflavin phosphate (sodium salt) JP	1.37 mg
Nicotinamide BP (Vet)	100 mg
d-panthenol IP	5 mg
vitamin B6 IP	5 mg
vitamin B 12 IP	30 mcg
Choline chloride	15 mg
Lignocaine hydrochloride	1% w/v

Liver injection crude derived from 8 g of fresh liver (proteolysed) containing vitamin B12 activity equivalent to not less than 2 mcg of cyanocobalamin.

Based on the observations from the animals of group II, modified line of therapy was adopted in the animals of group III. The modified line of treatment comprised of bitter stomachics as in group II, intravenous administration of Calborol** (335 ml given daily for two consecutive days) and orally two Anorexon*** tablets daily for three days. Clinical observations and course of the disease was recorded and collection and analyses of rumen liquor and blood samples were carried out as in the case of animals of group II.

3.3. Sampling and analysis of materials

Collection of rumen liquor was carried out anaerobically using a suction pump following the methods of Alonso (1979). Immediately after collection, pH of rumen liquor was determined using photovolt single electrode pH meter.

** CALBOROL (May and Baker Ltd., Bombay).
Calcium borogluconate B.Vet.C. injection (calcium gluconate with boric acid in the proportion of 83 parts to 17 parts)containing calcium equivalent to 1.36 per cent weight/volume.

*** ANOREXON (Pfizer Ltd., Bombay).
Each tablet contains:

Cobalt sulphate	: 50 mg
Ferrous sulphate Exis	: 100 mg
Thiamine monotartrate	: 25 mg
Vitamin B 12	: 30 mcg
Choline Bitartrate	: 9.1 mg

Physical characters of rumen liquor and protozoal motility were assessed as per method of Misra and Tripathy (1963). Sedimentation activity time was determined using suitable aliquots of fresh strained rumen liquor following the method of Nichols and Penn (1958). Estimations of the selected minerals viz., calcium, phosphorus, magnesium, sodium and potassium in rumen fluid were carried out using protein free filtrate of it obtained by precipitation with 10.0 per cent trichloroacetic acid.

For estimations of blood calcium and inorganic phosphorus, samples of blood plasma were obtained by collecting 10 ml of blood from the jugular vein in heparinised vials and for magnesium, sodium and potassium serum samples were obtained by collecting 10 ml of blood in suitable glass containers.

Estimations of calcium, inorganic phosphorus and magnesium in blood samples and rumen liquor were done by method of Roe and Kahn (1929) as described by Oser (1971), Fiske and Subbarow (1925) and Titan yellow method (Neill and Neilly, 1956) as cited by Oser (1971) respectively. Sodium and potassium determinations in serum and rumen liquor were carried out by flame photometric methods as described by Oser (1971). The data were analysed by applying student's 't' test (Snedecor and Cochran, 1967).

Results

RESULTS

4.1. Incidence

Data collected by sample survey on the incidence of digestive disorders in cross-bred cattle from field veterinary hospitals at Pattikkad, Ollur, Anthicadu and University veterinary hospitals at Kokkalai and Mannuthy for the period from 1977 to 1981 are presented in tables 1 to 3. Among cross-bred cattle admitted for treatment incidence of digestive disorders was 33.10 per cent (Table 1 and Fig. 1). Among these, the incidence of indigestion as a whole was 70.07 per cent with simple indigestion 48.90 per cent (Table 2 and Fig.2). Seasonal variations in the incidence of these conditions were significant being highest during summer followed by winter and rainy seasons (Table 3 and Fig. 3). The average monthly attendance of cases of digestive disorders per institution under study during summer, rainy and winter seasons were 190.0, 110.0 and 141.0 respectively while that of indigestion were 134.0, 79.0 and 96.0 respectively. The corresponding figures in case of simple indigestion were 97.0, 51.0 and 67.0 (Table 3).

4.2.Clinical observations

Onset of the condition was observed with loss of appetite which was partial (42.0 per cent) or complete

(58.0 per cent) in clinical cases taken up for the present study. Rumen motility was absent in 33.0 per cent of the cases while in 67.0 per cent of cases it was sluggish and reduced in number varying from one per minute to one per two or three minutes and rumination was suspended. Dung was normal in consistency in six of the cases, constipated with scanty, pasty dung in two cases and mildly diarrhoeic in the remaining four cases. Grinding of teeth as well as bad odour from mouth were observed in three animals. Systemic signs were not apparent as the rate of respiration and pulse and body temperature remained within normal ranges. Slight general depression and dullness were observed. In lactating animals there was reduction in the milk yield. Clinical signs in animals of group II and III with simple indigestion were identical and clinical recovery was achieved in all the animals treated as evidenced by revival of appetite and return of strong and regular rumen contractions. On termination of treatment all the animals started consuming normal quantities of feed and water and the milk yield started improving. Revival of appetite in animals of group II treated with conventional therapy took three to four days while in animals of group III treated with modified therapy it took two to three days.

4.3. Rumen liquor analysis

4.3.1. Physical characters.

Rumen fluid collected from animals of healthy group (Group I) had aromatic odour, greenish yellow colour and thick consistency with heavy concentration of disintegrated food particles (Table 4).

Changes in the physical characters, pH, protozoal motility and sedimentation activity time of rumen fluid collected from diseased animals of group II and III are presented in table 5 and 6 respectively.

Rumen fluid collected from diseased animals was brownish yellow/brownish in colour with faintly aromatic/ faint sour odour and thin/thick consistency. On the fourth day of admission the rumen liquor was brownish yellow/straw coloured/greenish yellow in colour with faintly aromatic/aromatic odour and thin/thick consistency. The physical characters of rumen liquor became normal by fourth day of admission in nine animals out of 12 (75 per cent) whereas in the remaining cases further time was taken upto seven days. On the seventh day of treatment the rumen fluid was straw coloured/brownish green/greenish yellow with aromatic odour and thick consistency (Tables 5 and 6).

4.3.2. pH.

pH of rumen fluid collected from healthy group ranged from 6.7 to 7.0 with an average of 6.8 (Table 4).

Ruminal pH in group II animals suffering from simple indigestion ranged from 6.7 to 7.1 (mean 6.92 ± 0.06) on the day of admission, 6.8 to 7.1 (mean 6.93 ± 0.049) on the fourth day of admission and 6.8 to 7.2 (mean 6.95 ± 0.061) on the seventh day of admission (Table 5). In group III animals the pH of rumen fluid varied from 6.7 to 7.1 (mean 6.90 ± 0.058) on the day of admission, between 6.0 and 7.0 (mean 6.88 ± 0.031) on the fourth day and between 6.9 and 7.1 (mean 6.96 ± 0.033) on the seventh day of admission (Table 6).

4.3.3. Protozoal motility.

On microscopic examination the protozoal motility in the rumen liquor collected from healthy animals ranged from moderate (++) to vigorous (+++) (Table 4).

In clinical cases of simple indigestion (group II and III) protozoal motility varied from slow (+) to moderate (++). Following treatment rumen protozoa became active in both the groups. In four of the cases in group II animals the protozoal motility was moderate (++) and vigorous (+++) in two cases on the fourth day of admission and on the seventh day of admission it became vigorous (+++) in all cases except one where it was moderate. On the fourth day of admission in group III animals protozoal motility was vigorous (+++) in all cases except in one which also

became vigorous (+++) on the seventh day of admission (Tables 5 and 6).

4.3.4. Sedimentation activity time (SAT).

Sedimentation activity time in healthy animals (Group I) varied from 12.0 minutes to 18.0 minutes with an average of 14.62 minutes (Table 4).

Sedimentation activity time ranged from 21.0 minutes to 40.0 minutes with an average of 25.6 minutes in all the animals with simple indigestion and the increase in SAT in diseased animals was found statistically significant ($P<0.01$) (Table 7). In group II animals suffering from simple indigestion prolonged SAT values of 21.0 to 40.0 minutes with an average of 27.0 minutes on the date of admission which improved upon to 15.0 minutes to 30.0 minutes with an average of 19.66 minutes on the fourth day and 12.0 to 18.0 minutes with an average of 14.66 minutes on the seventh day of admission were obtained (Table 5). The SAT values in animals of group III were found to be 21.0 to 30.0 minutes (mean 25.33 minutes), 16 to 25.0 minutes (mean 19.33 minutes) and 12.0 to 17.0 minutes (mean 14.50 minutes) on the first, fourth and seventh day of admission, respectively (Table 6). As the condition of the animal improved SAT values showed a progressive decrease reaching normal range between fourth and seventh day of admission.

The decrease in SAT between first and fourth day, first and seventh day and fourth and seventh days in both groups were statistically significant ($P<0.01$) (Table 8 and 9).

4.3.5. Mineral status.

The mean concentration of calcium, phosphorus, magnesium, sodium and potassium in rumen liquor of healthy cattle (Group I) were 17.75 ± 0.24 mg/dl, 10.90 ± 0.15 mg/dl, 11.15 ± 0.36 mg/dl, 133.14 ± 3.54 mEq/L and 22.82 ± 0.77 mEq/L, respectively (Table 7).

The mean comentration of calcium, phosphorus, magnesium, sodium and potassium in rumen liquor samples from clinical cases of simple indigestion (Group II and III) were 10.20 ± 0.37 mg/dl, 7.76 ± 0.23 mg/dl, 5.85 ± 0.20 mg/dl, 132.33 ± 1.17 mEq/L and 23.93 ± 1.74 mEq/L respectively. The concentrations of calcium, phosphorus and magnesium in rumen liquor of diseased animals were significantly low ($P<0.01$) when compared to the animals of the healthy control group whereas the sodium and potassium concentrations did not show any significant alterations (Table 7).

In animals of group II treated with conventional therapy the mean values of calcium, phosphorus, magnesium, sodium and potassium in rumen liquor were 10.003 ± 0.030 mg/dl, 7.65 ± 0.35 mg/dl, 5.84 ± 0.37 mg/dl, 136.25±4.85mEq/L

and 24.27 ± 2.39 mEq/L respectively on the date of admission, 11.18 ± 0.25 mg/dl, 8.66 ± 0.17 mg/dl, 6.97 ± 0.11 mg/dl, 139.96 ± 4.33 mEq/L and 25.13 ± 2.49 mEq/L on the fourth day of admission and 11.99 ± 0.44 mg/dl, 9.71 ± 0.21 mg/dl, 8.75 ± 0.71 mg/dl, 137.03 ± 2.47 mEq/L and 27.34 ± 1.31 mEq/L on the seventh day of admission. The increment in the concentration of calcium and phosphorus in the rumen liquor from first to fourth day, first to seventh day and fourth to seventh day were statistically significant ($P<0.01$). Ruminal magnesium level increased significantly ($P<0.05$) from first to fourth day and fourth to seventh day. The increase in the level of magnesium in rumen liquor from first to seventh day was highly significant ($P<0.01$). Ruminal sodium and potassium concentrations did not show any significant variations before, during or after treatment (Table 8).

The mean values of rumen calcium, phosphorus, magnesium, sodium and potassium in group III animals were 10.35 ± 0.61 mg/dl, 7.89 ± 0.38 mg/dl, 5.86 ± 0.12 mg/dl, 137.4 ± 6.09 mEq/L and 23.6 ± 2.54 mEq/L respectively on the first day of admission, 11.99 ± 0.36 mg/dl, 9.11 ± 0.36 mg/dl, 6.80 ± 0.44 mg/dl, 145.50 ± 5.86 mEq/L and 33.93 ± 1.42 mEq/L respectively on the fourth day of admission and 13.19 ± 0.29 mg/dl, 10.29 ± 0.20 mg/dl, 7.95 ± 0.39 mg/dl, 144.64 ± 3.90 mEq/L

and 23.58 ± 1.21 mEq/L respectively on the seventh day of admission. The increase in the concentration of ruminal calcium and phosphorus from first to fourth day, first to seventh day and fourth to seventh day were statistically significant ($P<0.01$). The higher value of ruminal magnesium on the fourth day was statistically significant ($P<0.05$) compared to the level on the first day of admission and the increase of ruminal magnesium from first to seventh day and fourth to seventh day were also significant ($P<0.01$). However, the levels of sodium and potassium in rumen liquor remained without significant alterations in this group also (Table 9).

Improvements in the levels of calcium, phosphorus and magnesium of rumen liquor over different days following therapy in animals of group II (conventional therapy) and group III (modified therapy) are shown in Fig. 4. The mean difference in the mineral status of rumen liquor over different days in the two treatment groups though different, were statistically not significant (Table 10).

4.4. Blood analysis

In the apparently healthy animals (Group I) the mean concentration of blood calcium, inorganic phosphorus, magnesium, sodium and potassium were 10.95 ± 0.06 mg/dl,

5.97 ± 0.05 mg/dl, 2.33 ± 0.024 mg/dl, 148.81 ± 1.41 mEq/L and 5.37 ± 0.18 mEq/L, respectively.

In clinical cases of simple indigestion the mean levels of plasma calcium, inorganic phosphorus, serum magnesium, sodium and potassium were 10.17 ± 0.096 mg/dl, 5.17 ± 0.093 mg/dl, 2.12 ± 0.028 mg/dl, 150.35 ± 1.30 mEq/L and 4.61 ± 0.13 mEq/L respectively. Significant difference ($P < 0.01$) was observed in the concentration of blood calcium, inorganic phosphorus and magnesium between healthy and diseased animals. However, the concentration of serum, sodium and potassium did not show any significant alteration in the diseased animals (Table 11).

In animals of group II treated with conventional therapy the mean concentration of calcium, inorganic phosphorus, magnesium, sodium and potassium in the blood before treatment were 10.30 ± 0.18 mg/dl, 5.25 ± 0.15 mg/dl, 2.13 ± 0.05 mg/dl, 151.79 ± 1.52 mEq/L and 4.92 ± 0.18 mEq/L, respectively. The respective mean values were 10.37 ± 0.24 mg/dl, 5.27 ± 0.17 mg/dl, 2.21 ± 0.053 mg/dl, 153.25 ± 2.30 mEq/L and 4.86 ± 0.26 mEq/L on the fourth day of admission and 10.70 ± 0.24 mg/dl, 5.42 ± 0.14 mg/dl, 2.33 ± 0.07 mg/dl, 150.36 ± 2.82 mEq/L and 4.75 ± 0.08 mEq/L on the seventh day of admission. The increase in the levels of blood calcium, inorganic phosphorus and magnesium

from first to fourth day of admission observed in this group was not statistically significant. The concentrations of blood calcium, inorganic phosphorus and magnesium were found to be higher on the seventh day and the increase in the levels of these minerals from first to seventh day and fourth to seventh day were statistically significant ($P<0.01$). But the concentrations of sodium and potassium in the serum did not show any significant change before, during or after treatment (Table 12).

The mean blood calcium, inorganic phosphorus, magnesium, sodium and potassium levels in group III animals were 10.15 ± 0.11 mg/dl, 5.10 ± 0.13 mg/dl, 2.10 ± 0.024 mg/dl, 148.91 ± 2.08 mEq/L and 4.29 ± 0.07 mEq/L, respectively on the day of admission, 10.64 ± 0.15 mg/dl, 5.43 ± 0.14 mg/dl, 2.32 ± 0.032 mg/dl, 148.54 ± 2.99 mEq/L and 4.34 ± 0.13 mEq/L on the fourth day of admission and 10.93 ± 0.19 mg/dl, 5.60 ± 0.16 mg/dl, 2.45 ± 0.053 mg/dl, 148.5 ± 1.65 mEq/L and 4.59 ± 0.11 mEq/L respectively on the seventh day of admission. The increases in the levels of blood calcium and inorganic phosphorus from first to fourth day, first to seventh day and fourth to seventh day were significant ($P<0.01$). The increase in the concentration of serum magnesium from first to fourth day and first to seventh day were significant ($P<0.01$) and the increase of serum magnesium concentration

from fourth to seventh day was also significant ($P<0.05$). However, the concentration of serum sodium and calcium before, during and after therapy did not show any significant change (Table 13).

Improvement in the levels of blood calcium, inorganic phosphorus and magnesium over different days following therapy in animals of group II (conventional therapy) and group III (modified therapy) are shown in Fig. 5. The improvement in the concentration of blood calcium, inorganic phosphorus and magnesium from first day to fourth day in group III animals treated with modified therapy was found significantly higher ($P<0.05$) than the improvement in the concentration of above minerals in group II animals treated with conventional therapy. Similarly the improvement in the concentration of plasma inorganic phosphorus from first to seventh day was statistically significant in the cases of animals treated with modified therapy compared to the animals treated with conventional therapy (Table 14).

Tables

Table 1. Overall incidence of digestive disorders in cattle in Kerala for the period from 1977 to 1981.

Year	Total cases	Digestive disorders	Indigestion	Simple Indigestion
1977	27,153	9023 (33.86)	6298 (23.20)	4378 (16.12)
1978	26,071	8750 (33.56)	6218 (23.58)	4477 (17.17)
1979	25,854	8316 (32.17)	5724 (22.14)	4045 (15.65)
1980	27,271	9072 (33.26)	6503 (23.85)	4393 (16.11)
1981	24,661	8288 (33.60)	5630 (22.83)	3905 (15.83)
Grand Total	1,31,010	43,349 (33.10)	30,373 (23.18)	21,197 (16.18)

(Figures in parenthesis denote percentage).

Table 2. Category-wise incidence of digestive disorders in cattle in Kerala for the period from 1977 to 1981.

Year	Digestive disorders	Indigestion	Simple Indigestion
1977	8293	6298 (70.58)	4378 (49.06)
1978	8750	6218 (71.06)	4477 (51.17)
1979	8316	5724 (68.83)	4045 (48.64)
1980	9072	6503 (71.69)	4393 (48.41)
1981	8288	5630 (67.93)	3905 (47.13)
Grand Total	43,349	30,373 (70.07)	21,197 (48.90)

(Figures in parenthesis denote percentage).

Table 3. Season-wise incidence of different categories of digestive dysfunctions.

Season	Monthly Average		
	Digestive disorders	Indigestion	Simple Indigestion
Summer (Feb-May)	190.0	134.0	97.0
Rainy (June-Oct)	110.0	79.0	51.0
Winter (Nov-Dec)	141.0	96.0	67.0
Critical Difference (P = 0.05)	14.33	12.29	7.53

ANOVA

Source of variation	Degrees of freedom	Mean sum of squares		
		Digestive disorders	Indigestion	Simple Indigestion
Due to season	2	8134.11**	3901.32**	2606.53**
Within season	12	108.12	79.55	29.83

** Significant at P = 0.01.

Table 4. Evaluation of rumen liquor in healthy control animals (Group I).

Sl No	Animal No.	Age (years)	pH	Colour	Odour	Consistency	Protozoal motility	Sedimentation activity time (minutes)
1	453	8	6.7	Greenish yellow	aromatic	thick	(+++)	15
2	044	5	6.8	Greenish yellow	aromatic	thick	(+++)	16
3	520	7	6.8	Greenish yellow	aromatic	thick	(+++)	12
4	639	7	6.7	Greenish yellow	aromatic	thick	(+++)	18
5	657	6	7.0	Greenish yellow	aromatic	thick	(+++)	14
6	597	8	6.8	Greenish yellow	aromatic	thick	(+++)	15
7	540	7	6.7	Greenish yellow	aromatic	thick	(+++)	14
8	009	4	7.0	Greenish yellow	aromatic	thick	(+++)	13
Mean ± SE	-	-	6.81± 0.044	-	-	-	(+++)	14.625 ± 0.55

Table 5. Evaluation of rumen liquor in cross-bred cattle with simple indigestion given conventional therapy (Group II).

Day	Sl No	pH	Colour	Odour	Consistency	Protozoal motility	Sedimentation activity time (minutes)
First day	1	7.0	brownish	faint sour	thick	(+)	430
	2	7.0	brownish yellow	faintly aromatic	thick	(+)	34
	3	6.8	brownish yellow	faintly aromatic	thick	(++)	32
	4	6.9	brownish yellow	faint sour	thick	(+)	21
	5	6.7	brownish yellow	faint sour	thin	(++)	32
	6	7.1	brownish yellow	faintly aromatic	thin	(++)	23
Mean ± SE	-	6.92 ± 0.06	-	-	-	-	27.0 ± 3.27
Fourth day	1	6.9	brownish yellow	faintly aromatic	thick	(++)	30
	2	6.8	straw coloured	faintly aromatic	thick	(++)	26
	3	7.0	brownish yellow	aromatic	thick	(++)	19
	4	7.0	brownish green	aromatic	thick	(+++)	17
	5	6.9	greenish yellow	aromatic	thick	(+++)	13
	6	7.1	greenish yellow	aromatic	thick	(++)	15
Mean ± SE	-	6.93 ± 0.049	-	-	-	-	19.66 ± 2.654
Seventh day	1	7.0	straw coloured	aromatic	thick	(+++)	18
	2	6.9	brownish green	aromatic	thick	(++)	16
	3	6.8	greenish yellow	aromatic	thick	(+++)	15
	4	7.0	brownish green	aromatic	thick	(+++)	14
	5	7.2	brownish green	aromatic	thick	(+++)	12
	6	6.8	greenish yellow	aromatic	thick	(+++)	13
Mean ± SE	-	6.95 ± 0.061	-	-	-	-	14.66 ± 0.881

Table 6. Evaluation of rumen liquor in cross-bred cattle with simple indigestion given modified therapy (Group III).

Day	Sl No	pH	Colour	Odour	Consis-tency	Protozoel motility	Sedimentation activity time (minutes)
First day	1	7.0	brownish yellow	faintly aromatic	thick	(++)	25
	2	6.9	brownish yellow	faint sour	thick	(++)	30
	3	6.7	brownish yellow	faintly aromatic	thin	(++)	25
	4	7.1	brownish yellow	faintly aromatic	thin	(+)	21
	5	6.9	brownish yellow	faint sour	thin	(+)	28
	6	6.8	brownish yellow	faint sour	thick	(++)	23
Mean ± SE	-	6.9 ± 0.057	-	-	-	-	25.33 ± 1.33
Fourth day	1	6.9	straw coloured	faintly aromatic	thick	(+++)	20
	2	7.0	brownish yellow	aromatic	thick	(+++)	25
	3	6.9	straw coloured	aromatic	thin	(++)	20
	4	6.8	brownish yellow	aromatic	thin	(+++)	16
	5	6.9	brownish green	aromatic	thick	(+++)	19
	6	6.8	greenish yellow	aromatic	thick	(+++)	16
Mean ± SE	-	6.98 ± 0.030	-	-	-	-	19.33 ± 1.34
Seventh day	1	7.0	straw coloured	aromatic	thick	(+++)	17
	2	7.1	brownish yellow	aromatic	thick	(+++)	16
	3	6.9	straw coloured	aromatic	thick	(+++)	15
	4	6.9	greenish yellow	aromatic	thick	(+++)	13
	5	7.0	greenish yellow	aromatic	thick	(+++)	14
	6	6.9	greenish yellow	aromatic	thick	(+++)	12
Mean ± SE	-	6.96 ± 0.033	-	-	-	-	14.50 ± 0.76

Table 7. Comparison of mineral status and sedimentation activity time (SAT) of rumen liquor in simple indigestion in cross-bred cattle.

Parameter	Healthy cattle (Mean ± SE)	Simple indigestion (Mean ± SE)	't' value
Calcium (mg%)	17.95 ± 0.24	10.20 ± 0.37	16.35**
Phosphorus (mg %)	10.80 ± 0.15	7.76 ± 0.23	10.38**
Magnesium (mg %)	11.15 ± 0.36	5.85 ± 0.20	14.32**
Sodium (mEq/L)	133.47 ± 3.54	132.33 ± 1.17	NS
Potassium (mEq/L)	22.02 ± 0.77	23.93 ± 1.74	NS
$ SAT (minutes)	14.63 ± 0.65	36.16 ± 1.70	6.98**

** Significant at P = 0.01. * Significant at P = 0.05

NS - Not Significant.

$ Mean values of SAT were compared after logarithmic transformation.

Table 8. Changes in mineral status and sedimentation activity time (SAT) of rumen liquor before, during and after treatment in group II animals (conventional therapy).

Parameter	First day (Mean ± SE)	Fourth day (Mean ± SE)	Seventh day (Mean ± SE)	't' value
Calcium (mg %)	10.003±0.38	11.18±0.25	11.99±0.44	4.18^{a**} 5.18^{b**} 3.36^{c**}
Phosphorus (mg %)	7.65±0.25	8.66±0.17	9.71±0.21	7.62 ** 18.90 ** 9.06 **
Magnesium (mg %)	5.84±0.37	6.97±0.11	6.75±0.71	3.08 * 4.41 ** 2.62 *
Sodium (mEq/L)	126.25±4.85	138.86±4.33	137.03±2.47	NS NS NS
Potassium (mEq/L)	24.27±2.39	25.13±2.49	27.34±1.31	NS NS NS
‡ SAT (minutes)	27.00±3.26	19.66±2.65	14.60±0.83	6.3 ** 8.4 ** 3.62 **

*Significant at P = 0.05. ** Significant at P = 0.01.

NS = Not Significant.

a = 't' value for comparing first and fourth day values.

b = 't' value for comparing first and seventh day values.

c = 't' value for comparing fourth and seventh day values.

‡ = Mean values of SAT were compared after logarithmic transformation.

Table 9. Changes in mineral status and sedimentation activity time (SAT) of rumen liquor before, during and after treatment in group III animals (modified therapy).

Parameter	First day (Mean ± SE)	Fourth day (Mean ± SE)	Seventh day (Mean ± SE)	't' value
Calcium (mg %)	10.35±0.61	11.99±0.36	13.19±0.29	3.68[a]**
				7.90[b]**
				6.00[c]**
Phosphorus (mg %)	7.98±0.38	9.11±0.36	10.29±0.20	4.78 **
				7.70 **
				5.35 **
Magnesium (mg %)	5.86±0.12	6.80±0.44	7.95±0.39	2.66 *
				5.99 **
				5.40 **
Sodium (mEq/L)	137.40±6.09	145.50±5.88	144.64±3.90	NS
				NS
				NS
Potassium (mEq/L)	23.60±2.84	23.93±1.42	23.58±1.31	NS
				NS
				NS
* SAT (minutes)	35.33±1.33	19.33±1.35	14.50±0.76	8.13 **
				11.56 **
				7.11 **

* Significant at P = 0.05. ** Significant at P = 0.01.

NS - Not Significant.

a - 't' value for comparing first and fourth day values.

b - 't' value for comparing first and seventh day values.

c - 't' value for comparing fourth and seventh day values.

* - Mean values of SAT were compared after logarithmic transformations.

Table 10. Comparative efficacy of conventional and modified treatments for simple indigestion in crossbred cattle - Mean difference in mineral status and sedimentation activity time (SAT) of rumen liquor.

Parameter	First and fourth day		't' value	First and Seventh day		't' value	Fourth and Seventh day		't' value
	Group II	Group III		Group II	Group III		Group II	Group III	
Calcium (mg %)	1.15	1.63	NS	1.95	2.84	NS	0.80	1.20	NS
Phosphorus (mg %)	1.02	1.23	NS	2.06	2.41	NS	1.05	1.18	NS
Magnesium (mg %)	1.13	0.95	NS	2.91	2.09	NS	1.78	1.42	NS
Sodium (mEq/L)	7.61	8.11	NS	10.78	7.25	NS	3.17	-0.87	NS
Potassium (mEq/L)	-0.17	0.35	NS	3.07	0.00	NS	2.57	-0.35	NS
‡ SAT (minutes)	7.34	6.0	NS	12.34	10.83	NS	5.0	4.83	NS

NS - Not Significant.

‡ - Mean differences of SAT were compared after logarithmic transformation.

Table 11. Mean levels of minerals in the blood of healthy and cross-bred cattle with simple indigestion.

Parameter	Healthy cattle (Mean ± SE)	Diseased cattle (Mean ± SE)	't' value
Calcium (mg %)	10.95 ± 0.06	10.17 ± 0.096	6.06**
Inorganic phosphorus (mg %)	5.97 ± 0.05	5.17 ± 0.093	6.47**
Magnesium (mg %)	2.33 ± 0.024	2.12 ± 0.028	5.44**
Sodium (mEq/L)	148.81 ± 1.41	150.35 ± 1.30	NS
Potassium (mEq/L)	5.37 ± 0.18	4.61 ± 0.13	NS

** Significant at P = 0.01

NS = Not Significant.

Table 12. Changes in mineral levels of blood in cattle with simple indigestion before, during and after treatment (conventional therapy - Group II).

Parameter	First day (Mean ± SE)	Fourth day (Mean ± SE)	Seventh day (Mean ± SE)	't' value
Calcium (mg %)	10.20 ±0.18	10.37±0.24	10.70±0.24	NS[a] 3.27[b]** 4.69[c]**
Inorganic phosphorus (mg %)	5.25±0.15	5.27±0.17	5.42±0.14	NS 5.49 ** 2.19 *
Magnesium (mg %)	2.13±0.05	2.21±0.053	2.39±0.07	NS 4.07 ** 7.51 **
Sodium (mEq/L)	151.79±1.52	153.25±2.30	150.36±2.82	NS NS NS
Potassium (mEq/L)	4.92±0.18	4.86±0.36	4.75±0.08	NS NS NS

* Significant at P = 0.05. ** Significant at P = 0.01.

NS - Not Significant.

a - 't' value for comparing first and fourth day values.

b - 't' value for comparing first and seventh day values.

c - 't' value for comparing fourth and seventh day values.

Table 13. Changes in mineral levels of blood in cattle with simple indigestion before, during and after treatment (modified therapy - Group III).

Parameter	First day (Mean ± SE)	Fourth day (Mean ± SE)	Seventh day (Mean ± SE)	't' value
Calcium (mg %)	10.15±0.11	10.64±0.15	10.83±0.19	4.06^{a**} 4.97^{b**} 3.76^{c**}
Inorganic phosphorus (mg %)	5.10±0.12	5.43±0.14	5.60±0.16	5.30 ** 9.20 ** 3.61 **
Magnesium (mg %)	2.10±0.024	2.32±0.032	2.45±0.052	8.01 ** 5.54 ** 2.87 *
Sodium (mEq/L)	148.91±2.08	148.54±2.89	149.5±1.65	NS NS NS
Potassium (mEq/L)	4.29±0.07	4.34±0.13	4.59±0.11	NS NS NS

* Significant at P = 0.05. ** Significant at P = 0.01.

NS = Not Significant.

a = 't' value for comparing first and fourth day values.

b = 't' value for comparing first and seventh day values.

c = 't' value for comparing fourth and seventh day values.

Table 14. Comparative efficacy of conventional and modified treatments for simple indigestion in cross-bred cattle - Mean difference in mineral status of blood.

Parameter	First and Fourth day		't' value	First and Seventh day		't' value	Fourth and Seventh day		't' value
	Group II	Group III		Group II	Group III		Group II	Group III	
Calcium (mg %)	0.1833	0.505	2.24*	0.5166	0.68	NS	0.266	0.295	NS
Inorganic phosphorus (mg %)	0.16	2.01	2.93*	0.17	0.5066	5.06**	0.1433	0.1717	NS
Magnesium (mg %)	0.075	0.0219	2.73*	0.2016	0.3476	NS	0.1267	0.13	NS
Sodium (mEq/L)	1.63	-0.4160	NS	-1.433	0.3616	NS	-2.8967	0.0067	NS
Potassium (mEq/L)	-0.062	0.0516	NS	-0.1719	0.293	NS	-0.11	0.239	NS

* Significant at P = 0.05. ** Significant at P = 0.01.

NS - Not Significant.

Illustrations

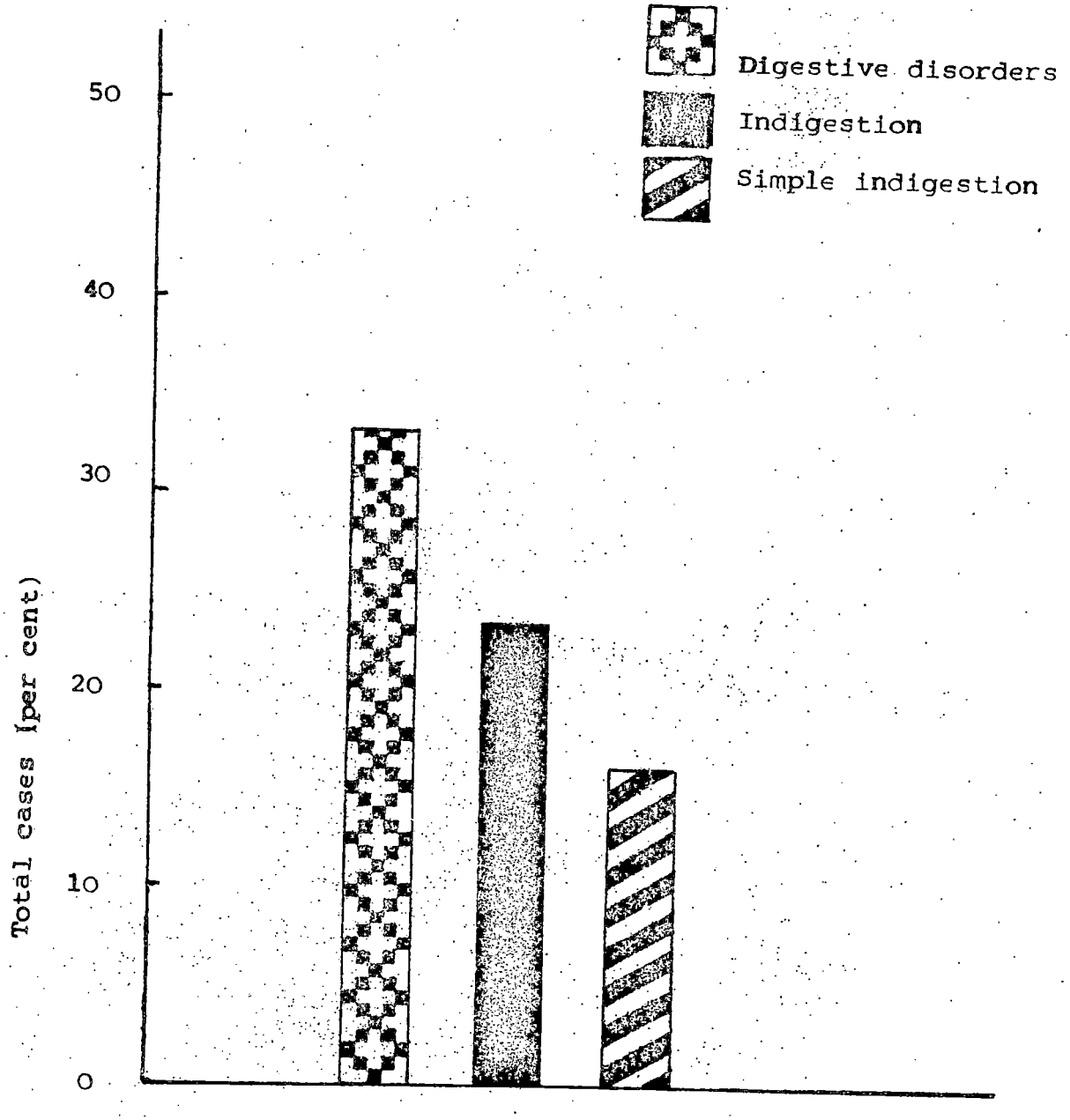

Fig. 1. Percentage incidence of digestive disorders in cattle.

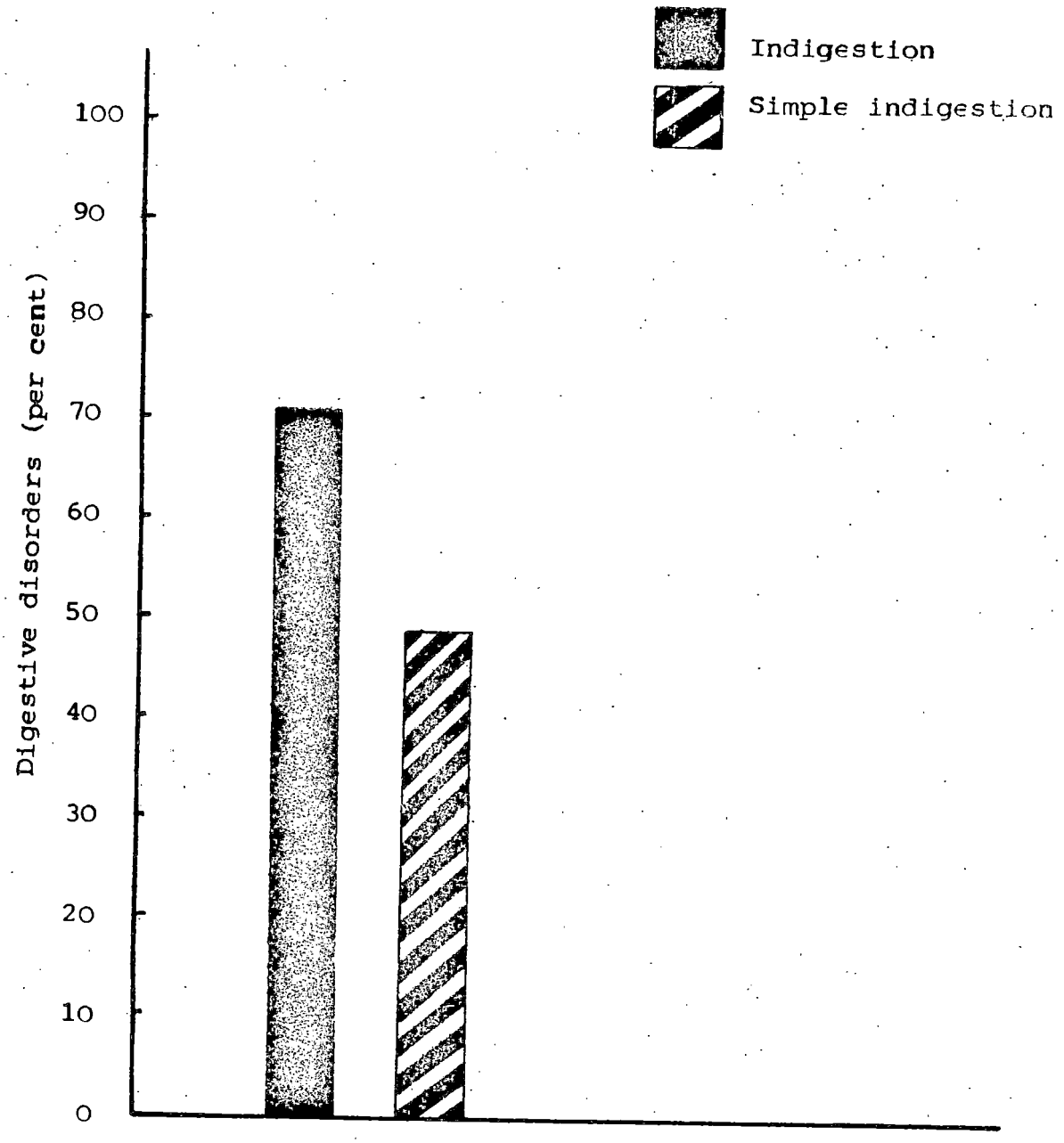

Fig. 2. Percentage incidence of indigestions and simple indigestion among digestive disorders in cattle.

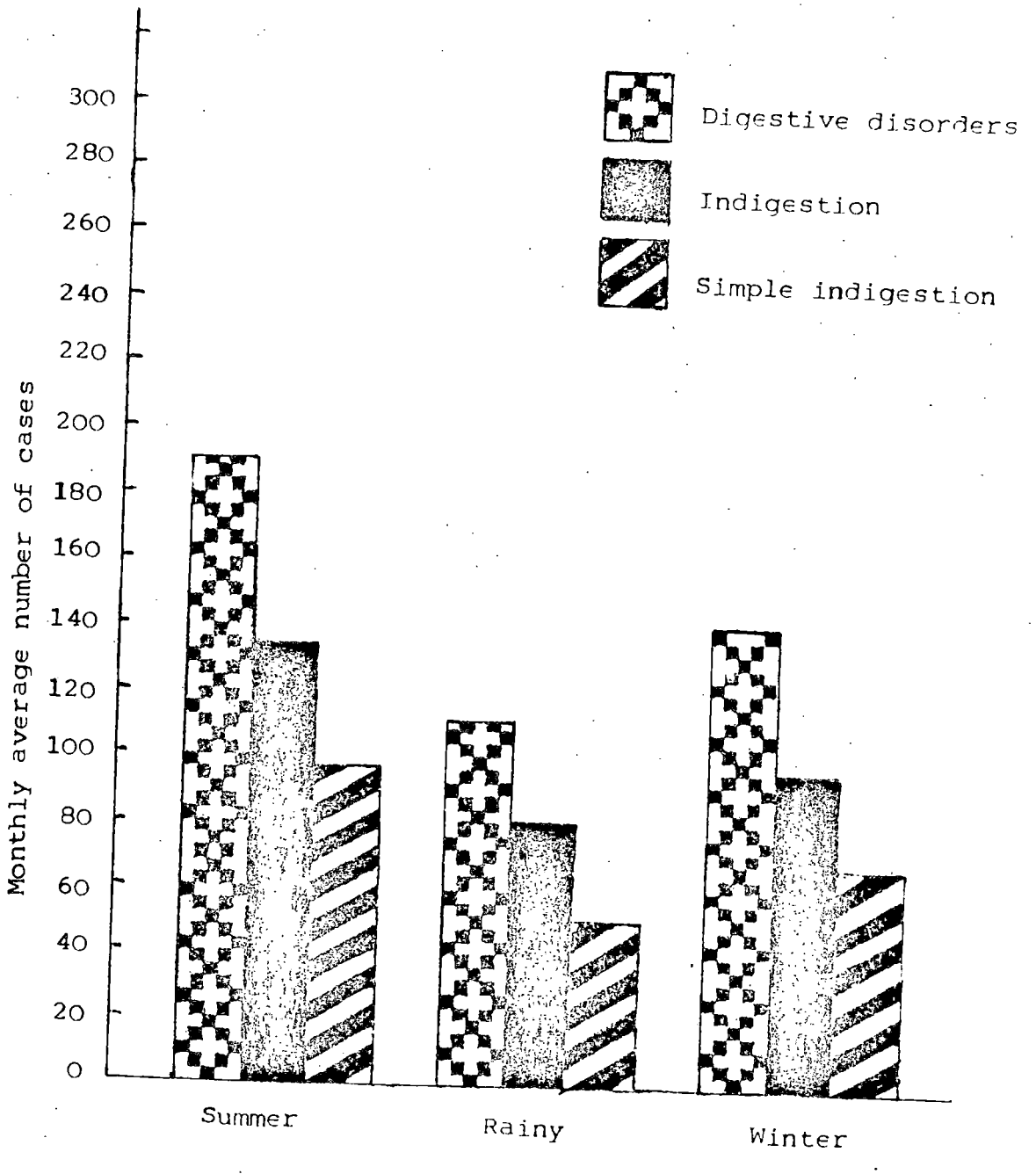

Fig. 3 . Seasonal incidence of digestive disorders in cattle.

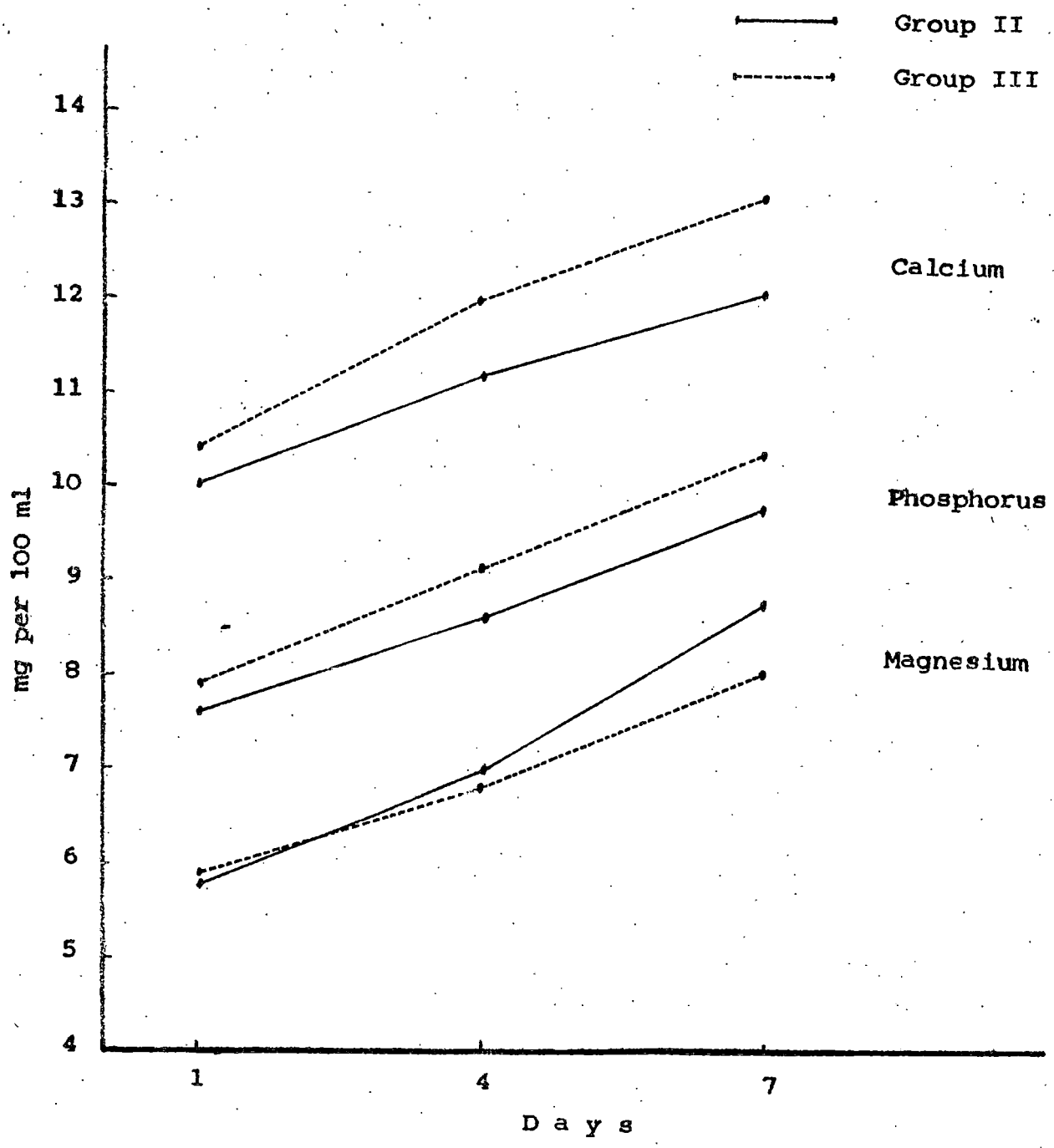

Fig. 4. Changes in levels of calcium, phosphorus and magnesium of rumen liquor in animals of Group II (conventional therapy) and Group III (modified therapy).

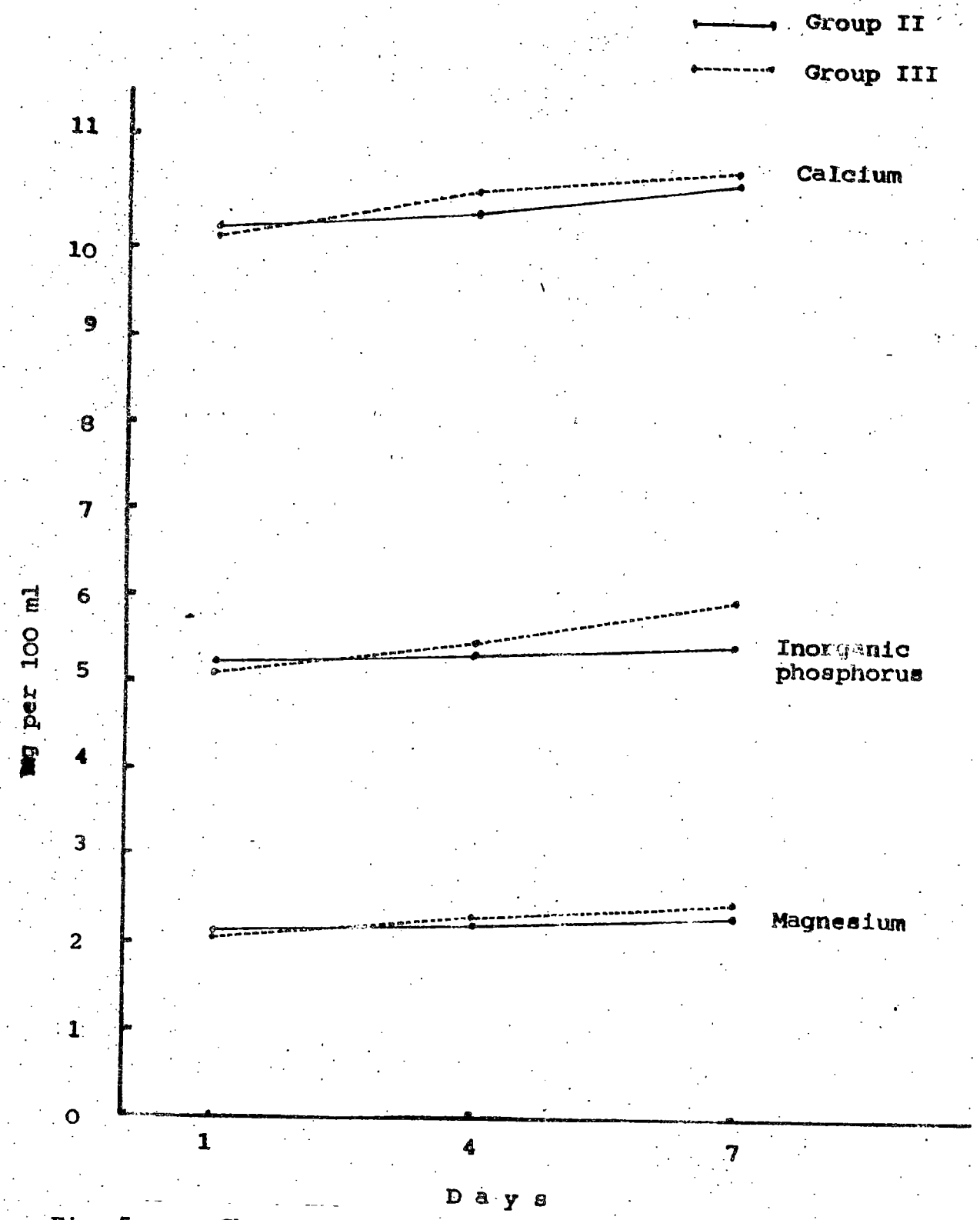

Fig. 5. Changes in serum calcium, inorganic phosphorus and magnesium levels in animals of group II (conventional therapy) and group III (modified therapy).

Discussion

Discussion

5.1. Incidence

Analysis of data on the incidence showed that digestive disorders constitute a major category of disease in cattle accounting for 33.10 per cent of the total cases reported from the field (Table 1 and Fig. 1). Similar observations were made by Nichols (1963) and Sindunadhav and Krishnamurthy (1979) who recorded an incidence of 40.0 per cent and 36.60 per cent respectively of all categories of cases investigated. Present study showed among digestive disorders indigestion as a whole formed 70.07 per cent (Table 2 and Fig. 2). This is in conformity with the earlier reports of Balasubramanian and Ganapathy (1965) and Verma and Ganapathy (1973) that indigestion formed the major category of digestive disorders in cattle with the incidence observed 80.02 and 75.7 to 81.57 per cent, respectively. High incidence of digestive disorders in cattle in Kerala could be attributed to sudden changes in the quality and quantity of feeds and fodder depending on their availability under different agro-climatic conditions prevailing, locally. Ingestion of variety of unconventional feeds without sufficient adaptation make them prone to suffer from such conditions. Ruminant digestion being a microbial process could easily be disturbed by

conditions unfavourable for the growth and survival of the microbiota (Hoflund, 1967 and Alonso, 1979). The reason for high incidence (48.90 per cent) of simple indigestion among digestive disorders could be attributed to ill defined and irregular feeding incorporating a variety of unconventional fodder and errors in managemental practices under local conditions etc.

Present study indicated that incidence of digestive disorders are highest during summer followed by winter and rainy seasons (Table 3 and Fig. 3). Similar trend in the incidence of indigestion from tropical areas of India was observed by Joshi (1970), Joshi and Misra (1974) and Prasad and Rekib (1979a). Shortage of good quality green fodder and ingestion of low grade dry and coarse roughage, scarcity of good drinking water coupled with stress due to high environmental temperature, especially in case of cross-bred cattle might probably contribute to the high incidence of rumen disorders in cattle during summer season. A reduction in the incidence of the disease during rainy season might be due to gradual and continous feeding of animals on palatable green fodder and ad libitum supply of good quality water during this season. Proportionately higher incidence of the disease during the winter compared to rainy season could be associated with feeding poorly processed and

stored fodder under bad weather conditions. This makes them spoiled due to growth of moulds and fungi. However, Chakrabarthy et al. (1974) observed higher incidence of rumen dysfunctions during south-west monsoon in Assam which could be due to variations in the agro-climatic conditions and in the availability of feeds and fodder from region to region.

5.2.Clinical findings

Clinical signs recorded in animals with simple indigestion in the present study were in fair agreement with those reported by previous workers (Hoflund, 1967; Misra et al. 1972b; Joshi and Misra, 1977; Blood et al. 1979 and Prasad, 1979). Loss of appetite and reduced feed intake, cessation or depressed rumen motility and suspended rumination observed presently support the earlier findings of Joshi and Misra (1977); Prasad (1979) and Blood et al. (1979). Consistency of dung as normal or pasty and scanty or loose were also observed by Blood et al. (1979). Mild diarrhoea observed in cases suddenly fed on green grass at the beginning of rainy season could be associated with sudden change in the ration as well the effects of physical nature of the ration. Grinding of teeth noticed in some cases suggested abdominal pain associated with the disease. Normal body temperature and the rates of pulse and

respiration indicate absence of any systemic reaction. Slight depression and dullness could be resulted from general weakness and reduced supply of nutrients. Fall in milk yield could be associated with derrangement in the rumen metabolism so that availability of precursors for the secretion of milk were reduced considerably.

5.3. Rumen liquor

5.3.1. Physical characters.

The colour of rumen liquor in healthy cattle under the present study was greenish yellow whereas a yellowish brown colour was reported by Misra et al. (1972a) and Misra and Singh (1974) and grey and olive to brownish green colour was observed by Dirksen (1979). Colour of rumen liquor depends upon the type of ration (Alonso, 1979) and animals utilised for present study were maintained on a ration rich in green fodder to impart the greenish yellow colour to their rumen liquor. Alonso (1979) has observed that the colour of rumen liquor varied with nature of feed ingested and time after feeding or stage of digestion. The odour of the rumen liquor was characteristically related to conditions in the rumen. Aromatic odour and thick consistency of rumen liquor of healthy animals observed in the present investigation was similar to the findings of Misra et al. (1972a), Misra and Singh (1974) and

Dirksen (1979). Aromatic odour of rumen liquor was attributed to the volatile fatty acids and products of normal protein digestion. Consistency of rumen liquor was also affected by the type of diet; in animals fed mostly on roughages liquid consistency was observed while in those fed roughage - concentrate rations thick consistency was observed (Misra et al. 1972a).

In cattle with simple indigestion the rumen liquor was brownish yellow or brownish in colour (Table 5 and 6). This could be due to deprivation of normal intake of feeds and fodder or variations in the type of feeds ingested and low intake of water. Faintly aromatic or faintly sour odour may be due to reduced rate of volatile fatty acids production and protein digestion in the rumen. Similar observations were made by Dash and Misra (1972) and Misra et al. (1972b). The consistency of rumen liquor in diseased animals was thin to thick while Misra et al. (1972b) reported thin consistency only and Dash and Misra (1972) observed slightly viscous consistency in simple indigestion due to sudden change of feed in cattle. Physical characters of rumen liquor became normal by fourth day of treatment in 75 per cent of clinical cases while in others it was delayed upto seventh day. Variation in time required for restoration of normalcy of physical

characters in different cases could be related to the differences in the severity and effect of the disease. Restoration of the physical characters of rumen liquor suggested that the rumen functions returned to normal as rumen environment has gradually been improved.

5.3.2. pH.

Mean pH of rumen liquor (6.81 ± 0.044) obtained in case of animals of healthy group agrees with the values reported by Misra et al. (1972a) and Blood et al. (1979). However, values falling under wider ranges (5.5 to 7.0) has been reported (Dirksen, 1979). The nature and composition of diet influences the products of fermentation in the rumen and hence the pH of rumen fluid. Animals fed mostly on concentrates had a lower pH (Wilson, 1967 and Blood et al. 1979). The total volatile fatty acids and ammonia production in the rumen influenced the rumen pH (Hoflund, 1967; Prasad et al. 1972; Sethuraman and Rathor, 1979a and Randhawa et al. 1981). Breukink and Ruyter (1977) observed variations in normal pH of rumen liquor between rations as well the samples collected before and after feeding.

The change in rumen pH between healthy and animals with simple indigestion were not significant and this might be because that unlike in other types of indigestion

there was not much alterations in the pattern of rumen fermentation and hence the products formed. Anorexia observed in the present cases of simple indigestion in cattle was of mild nature and was associated with irregularities in feeding and management. The rumen pH in simple indigestion observed in the present study is in agreement with the ranges of pH reported by Moflund (1967); Misra et al. (1972b); Prasad et al. (1972) and Vihan et al. (1973b).

5.3.3. Protozoal motility.

The protozoal motility in rumen liquor of healthy animals varying from moderate (++) to vigorous (+++) in the present study was in agreement with the observations of Misra et al. (1972a) and Misra and Singh (1974). The number of protozoa in the rumen liquor normally varied according to composition of ration, feeding time and level of rumen from where samples were collected (Dirksen,1979). For the proper growth and activity of the microbiota optimum rumen conditions like pH, temperature, substrate availability etc. are important.

Suppressed protozoal motility ranging from slow (+) to moderate (++) in simple indigestion observed in the present study agreed with the findings of Dash and Misra (1972) and Misra et al. (1973b). Variations in rumen

environment especially in the pH was detrimental for survival of rumen micro-organisms and as such in acid and alkaline indigestions the rumen protozoa were absent or scanty (Moflund, 1967; Dash et al. 1972; Prasad et al. 1973; Choudhuri et al. 1977 and Nauriyal and Dixi,1981). In simple indigestion though rumen pH remained without much significant variations from normal, decreased motility of protozoa might be due to changes in the substrates associated with changes in feeds or the reduced availability of substrates as a result of reduced intake of feed. The protozoal motility became vigorous in the diseased animals following improved feed intake after therapy (Table 5 and 6).

5.3.4. Sedimentation activity time (SAT).

The mean sedimentation activity time of 14.625 ± 0.65 minutes (Table 4) obtained for healthy cross-bred animals under the present investigation falls well within the range of 8.0 to 18.0 minutes reported by Misra et al. (1972a) for Indian cattle. But lower values were reported for exotic animals by Blood et al. (1979) and Dirksen (1979). This suggested that the rumen microbiota of the cross-bred cattle have adopted to the feeding practices under the local conditions and they were not different from those of the other regions. SAT values indicating the level of microbial activity in the rumen varied between animals and in the same animal from time to time (Nichols and Penn,1958).

There was significant prolongation in SAT from 14.625 ± 0.65 to 26.16 ± 1.70 in simple indigestion indicating decreased rate of microbial activity in the rumen (Table 7). Misra et al. (1972b) observed significant increase in SAT with an average of 39.9 minutes but without significant change in pH of rumen liquor in subacute primary indigestion in cattle. Disturbance in microbial function might be due to the change in environment in the rumen by way of changes in the feed or reduced availability of substrates for micro-organisms with the associated anorexia. Following treatment SAT values decreased significantly by fourth to seventh day when microbial activity was regained with fermentation in the rumen reestablished on revival of appetite and feed intake (Table 8 and 9).

5.3.5. Mineral status.

In the present study the concentrations of calcium and phosphorus in rumen liquor in animals of healthy control group were comparable to the ranges reported by Fenner et al. (1969) and Prasad and Raghavan (1973). The calcium and magnesium levelsin rumen liquor obtained for healthy animals were well within the ranges reported for cattle by Lampila (1964). Lower sodium and higher potassium levels in rumen liquor compared to their levels in plasma observed in the present study corroborates the observations of Phillipson (1977). Fenner et al. (1969)

suggested that the level of feeding and sampling time significantly affected the concentrations of sodium, potassium, calcium, phosphorus and magnesium in rumen liquor. Similar opinions were expressed by Erickson (1970) in respect of rumen calcium and phosphorus levels and by Prasad and Raghavan (1973) in case of rumen sodium and potassium levels.

Significant decrease in the concentrations of calcium, phosphorus and magnesium in rumen liquor of cattle with simple indigestion observed before therapy might be on account of reduced dietary intake, the main clinical manifestation of the disease. Cakala and Albrycht (1976) reported that the concentrations of calcium, magnesium and potassium in the rumen fluid decreased and the levels of phosphorus and sodium and pH of rumen fluid increased after 12 to 24 hours of deprivation of food and water in cattle. The importance of optimum levels of minerals viz. calcium, phosphorus, magnesium, sodium and potassium for growth and multiplication of bacteria in the rumen and their essential role in the rumen metabolism were reported earlier (Watson, 1933; Hubert et al.1950; Hungate, 1966 and Caldwell and Hudson, 1974). As such decreased activity of rumen microbes in cattle with simple indigestion could be correlated with the depressed mineral levels in the rumen

liquor noticed under the present investigations.

Progressive increase in the concentrations of calcium, phosphorus and magnesium in rumen liquor was observed as the appetite of the animal revived and feed intake increased (Table 8 and 9). Fenner et al. (1969) observed that high levels of an all roughage ration in cattle increased the concentrations of calcium, phosphorus and magnesium in rumen liquor, but lowered that sodium. The improvement in the concentration of calcium, phosphorus and magnesium in the rumen liquor over different days in the two treatment groups in the present study though different, were statistically not significant. This indicates that the increase in the concentration of these minerals in rumen fluid may be exogenous associated with the increase in feed intake on revival of appetite. The concentrations of sodium and potassium in rumen fluid remained without much variations in diseased animals under the present study. This might be due to the fact that unless indigestion is prolonged and severe enough to be associated with changes in pH, there might not be any appreciable changes in the sodium and potassium levels in rumen fluid and blood. But in acid and alkaline indigestions associated with deviation from normal pH ranges, disturbances in the status of sodium and potassium were reported (Huber, 1971 and Choudhuri et al. 1991).

5.4. Blood analysis

Mean concentrations of calcium, inorganic phosphorus, magnesium, sodium and potassium in blood of healthy control animals in the present study were well within the range reported by Benjamin (1961), Cornelius and Koneko (1963), Phillips (1977) and Blood et al. (1979).

Reduced blood calcium level in simple indigestion in cattle observed in the present investigation was in agreement to the earlier report by Prasad et al. (1972) who observed a hypocalcaemic state in some of the cases of simple indigestion analysed by them. Low serum inorganic phosphorus associated with simple indigestion in cattle observed in the present investigation was similar to the finding of Hoflund (1965) who recorded low serum inorganic phosphorus in calves with indigestion. Serum magnesium level was low in cattle with simple indigestion and this might cause atony of gastro-intestinal system as observed by Bueno (1980) in experimental hypomagnesaemia in sheep. The effects of simple indigestion in cross-bred cattle under the present investigation appears to be a state of deprivation of feed and water for a short duration. However, the observed effects on serum calcium and magnesium and phosphorus were a decrease in all while corresponding observations in induced starvation were a decrease in serum

calcium and magnesium and increase in the serum phosphorus detected at 48 hours (Cakala and Albrycht, 1976).

Reduced blood calcium, inorganic phosphorus and magnesium of cattle suffering from simple indigestion might have been due to the decreased exogenous supply of these minerals associated with inappetance and reduced feed intake. The effects of low normal values of these minerals in blood during the disease might probably be sub-clinical and hence not associated with any apparent clinical signs. Calcium plays significant role in muscle contraction and also in neuromuscular irritability and transmission of impulses. Atony of rumen musculature in simple indigestion might probably be related to a decreased level of ionised blood calcium rather than merely due to a simple low blood calcium level. Disturbances in transmission of impulses interfere with nervous control of rumen motility. Huber (1931) observed significant correlation between the level of serum diffusible calcium and contractile strength of rumen musculature and rumen dysfunctions could occur considerably before the onset of clinical signs of hypocalcaemia. Phosphorus is mainly involved in the transfer of biological energy through adenosine tri-phosphate (ATP) (Phillips, 1977). Deficiency of phosphorus may result in reduced availability of ATP as an energy source for muscle function and might affect rumen movements also. The levels

of calcium,phosphorus and magnesium in the crude diet could affect their status in the body and hence influence the health and production of the animals. In biological system, the levels of these minerals are inter-related (Phillips, 1977). Experimentally it has been shown that sub-clinical hypomagnesaemia reduced the ability of cows to mobilise calcium in response to hypocalcaemia (Sansom et al. 1983). As the condition of the animal improved clinically following therapy and as the appetite revived, the levels of calcium, phosphorus and magnesium in blood also improved (Tables 12 and 13).

The concentrations of serum sodium and potassium did not show any significant alteration before, during or after therapy. Simple indigestion is a benign conditions without appreciable dehydration or change in osmolarity or pH of rumen liquor and blood, unlike in case of acid and alkaline indigestions. As such no apparent fluctuations in the sodium and potassium concentrations in serum in simple indigestion could be expected.

5.5. Treatment

Conventional therapy of rumen dysfunction using stomachic alone is of minimal therapeutic value (Prasad et al. 1976a and Prasad and Rekib 1979b). Therefore,improvements

in the line of therapy of indigestion in cattle on the basis of recent developments pharmacology and microbiology of rumen and clinico-biochemical aspects of the condition are needed.

Conventional therapy adopted for animals of group II with simple indigestion comprised of bitter stomachics orally and liver extract parenterally. Liver extracts as hepatotrophic agents were beneficial in the treatment of bovine anorexia since in some cases of anorexia the liver function was depressed due to absorption of toxic amines produced in the rumen or toxins derived from mouldy and spoiled feeds. Oral administration of 'Liv 52' (The Himalaya drug Co.) an ayurvedic hepatic stimulant was reported to be effective in 91 per cent of cases of bovine anorexia (Prasad and Rekib, 1979b). Therapeutic trials using liver extract and 'Himalayan Ratisa' as stomachic subsequent to correction of pH in the clinical management of acid and alkaline indigestions were successful (Misra and Singh, 1974). Parenteral use of liver extract and vitamin B-complex were found effective in the treatment of bovine anorexia (Kadvedkar and Murkibhave, 1971; Prasad, 1977 and Prasad and Rekib, 1979b). Thiamine, vitamin B_{12} and other vitamins in the B-complex series play important role in carbohydrate metabolism in ruminants. However, the above lines of therapy were not adequate to supplement

the depressed mineral levels due to anorexia and hence a more rational approach in therapy was adopted.

In the modified therapy in animals of group III, calcium was immediately made available to produce the beneficial effect of treatment by improving the tonicity of rumen musculature. Similar effects on parenteral administration of calcium in case of atony of rumen in bovines was observed (Blood et al. 1979). 'Anorexon' tablets were included in the modified therapy as it contain essentially required agents for the synthetic activity of the rumen micro-organisms. Use of a combination of rumenatoric agents like potassium-antimony tartrate and 'Anorexon' in the clinical management of indigestion in sheep and goat was found to be superior to the use of rumenatorics alone (Prasad et al. 1976a). Gupta et al. (1976) observed reduced thiamine level in the rumen and suggested it as probable cause for rumen dysfunction in cattle. Being essential for microbial synthesis of vitamin B_{12}, cobalt is considered a dietary requirement in ruminants. Supplementation of cobalt and copper to basal rations were found beneficial for rumen fermentation as evident from better levels of production of volatile fatty acids, total nitrogen and ammonia nitrogen and better rumen microbial counts (Saxena and Ranjhan, 1980 and Saxena and Srivastava, 1980).

Clinical recovery though achieved in both groups of animals treated with conventional and modified lines of therapy, the revival of appetite and clinical recovery were earlier in animals treated with modified line of therapy. Clinical recovery was obtained in two to three days time in animals of group III against three to four days required in case of animals of group II. Recovery period was reduced by an average 33.0 per cent in group III animals and proportionate loss of production was restricted. Rumen motility was restored to normal frequency and strength by second to third day in group III animals whereas in group II animals it was delayed upto third or fourth day or more. This might be due to the effect of calcium supplementation parenterally toning up the rumen musculature in case of group III animals. In lactating animals of group III milk production returned to original level at an earlier period compared to animals of group II due to earlier return of appetite and feed intake in this group. Also supplementation of calcium parenterally might have hastened this process. As evident from the results reestablishment of protozoal motility was observed to be comparetively earlier and efficient in group III animals provided with oral therapy of 'Increxon' tablets. This could be due to early restoration of favourable environment in the rumen in this group favouring increased microbial activity.

On termination of treatment all the animals under treatment commenced consuming original quantities of feed and water. Though mineral status in rumen liquor in both the groups were found enhanced, proportionate increments in the levels of calcium, phosphorus and magnesium in rumen liquor over different days in them when compared statistically were not significantly different (Table 10). This might be due to the fact that the main factor influencing the status of above minerals in rumen liquor was their exogenous source and revival of appetite and improvement in feed intake might have achieved equally in both the groups by fourth day when the second samples were collected for analysis. But with regard to the levels of calcium, inorganic phosphorus and magnesium in blood, the improvement on account of treatment and return of appetite was higher in case of group III animals. In group II animals treated with conventional line of therapy the improvement in the levels of calcium, inorganic phosphorus and magnesium from first to fourth day was not significant (Table 12) whereas in group III animals undergone modified therapy the improvement in the status of above minerals from first to fourth day was significant (Table 13). This indicate that the modified line of therapy is more efficient in hastening clinical recovery and improving the status of these minerals in the body. The mean increment in the

concentrations of blood calcium, inorganic phosphorus and magnesium from first to fourth day was significantly higher in group III animals compared to group II animals. Similarly the mean increment in the plasma inorganic phosphorus level from first to seventh day was significantly higher than the respective increase in case of group II animals. The advantageous position in the mineral status of calcium, phosphorus and magnesium in blood and an early revival of appetite and clinical recovery observed in group III animals compared to group II animals indicate the superiority of modified therapy over conventional therapy. Indigestion being a clinical problem affecting health and production in cattle, early clinical recovery and return to production are beneficial.

Summary

SUMMARY

Digestive disorders in ruminants being an important clinical problem in the field, investigations on the incidence, clinical observations, microbial activity of the rumen liquor, mineral status in the rumen liquor and the blood in simple indigestion in cross-bred cattle and based on the results obtained from the above therapeutic studies were carried out during the present study.

Sample survey conducted through field veterinary hospitals and the hospitals under the Kerala Agricultural University revealed that digestive disorders constituted a sizeable proportion (33.10 per cent) of all diseases among cattle. Among digestive disorders the incidence of indigestion as a whole (70.07 per cent) and simple indigestion in particular were high (48.00 per cent). The incidence of these conditions was found highest during summer followed by winter and rainy seasons.

Eight apparently healthy adult cross-bred cattle from the University Livestock Farm, Mannuthy, formed the healthy control animals (Group I). Twelve selected clinical cases of simple indigestion in adult cross-bred cattle divided into groups of six each (Group II and III) were utilized for clinical and therapeutic investigations. Evaluation of

physical characters, pH and microbial activity viz., protozoal motility and sedimentation activity time of the rumen liquor and estimation of selected minerals viz., calcium, phosphorus, magnesium, sodium and potassium in rumen liquor and blood were carried out. Two therapeutic regimens were tried in animals of group II and III to compare the efficiency of the treatment. Animals of group II were given conventional therapy consisting of bitter stomachics orally and liver extract parenterally and in group III animals modified therapy comprising of bitter stomachics and 'Anorexon' tablets orally and 'Calborol' intravenously were tried.

Course of the disease was followed daily and samples of rumen liquor and blood were collected for analysis on the first, fourth and seventh day of admission in the clinic. Slight general depression and dullness, partial or complete loss of appetite, cessation or depression of rumen motility, suspension of rumination, normal or pasty and scanty dung or mild diarrhoea and drop in milk yield were observed as the important clinical signs.

In cattle with simple indigestion the rumen liquor was brownish yellow/brownish in colour with faintly aromatic/faint sour odour and thin/thick consistency. Variations in the pH of rumen liquor in diseased group was not

significant compared to the healthy control group. Depressed protozoal motility and prolonged sedimentation activity time (26.16 ± 1.70 minutes) of the rumen liquor were noticed.

Significant lowering in the concentrations of calcium, phosphorus and magnesium in both rumen liquor and blood was observed in the diseased animals and these changes could be due to loss of appetite and reduced feed intake during the disease. However, the sodium and potassium concentrations in rumen liquor and blood did not show significant variations. Mean concentrations of calcium, phosphorus, magnesium, sodium and potassium in the rumen liquor were 10.20 ± 0.37 mg/dl, 7.76 ± 0.23 mg/dl, 5.85 ± 0.20 mg/dl, 132.33 ± 1.17 mEq/L and 23.93 ± 1.74 mEq/L respectively while the corresponding values in blood were 10.17 ± 0.096 mg/dl, 5.17 ± 0.093 mg/dl, 2.13 ± 0.028 mg/dl, 150.35 ± 1.30 mEq/L and 4.61 ± 0.13 mEq/L in the animals of the diseased group.

Following therapy in diseased animals the physical characters and protozoal motility of the rumen liquor and the mineral status in both the rumen liquor and the blood improved and sedimentation activity time of rumen liquor decreased. Based on the level of clinical response to treatment as revival of appetite in two to three days in the

animals of group III compared to three to four days required in the case of animals of group II, reduction in the recovery period by an average of 33.0 per cent, early restoration of normal strength and frequency of rumen contractions, protozoal motility and milk yield and improvement in mineral status in the blood and the rumen liquor, the modified therapy was found superior to the conventional therapy in the clinical management of simple indigestion in cross-bred cattle. Results obtained during the present investigations suggested that the associated changes in common clinical condition like simple indigestion in cattle need rational therapeutic approach for better clinical gains in the field.

References

REFERENCES

Aleyas, N.M. and Vijeyan, S. (1981). Acute indigestion - Report on clinical cases. Kerala J. vet. Sci. 12(1): 77-82.

Alikutty, K.M. (1981). Effect of alkaline indigestion on rumen liquor, blood and internal organs with particular reference to liver functions in cattle and its therapy. Ph.D.Thesis, Punjab Agricultural University, Ludhiana.

Alonso, A.N. (1979). Diagnostic analysis of rumen fluid. Vet. Clinic N. Am. Large Anim. Pract. 1 (2): 363-375.

Annison, E.F. and Lewis, D. (1959). Metabolism in the rumen. Methun and Co., Ltd., London, pp. 167-169.

Balasubramanian, R. and Ganapathy, M.S. (1965). A clinico-pathological study of indigestion in bovines. Indian vet. J. 42 (2): 89-92.

Benjamin, M.M. (1961). Outline of veterinary clinical pathology. The Iowa State University Press, Iowa. 2nd Ed. pp. 175.

Bindumadhav, A. and Krishnamurthy, R. (1979). The survey on the case records of the large animal clinic of Madras Veterinary College Hospital. Cherion. 8 (4): 269-272.

*Blancou, J. (1978). Comparison of the microbial population of the rumen and its seasonal metabolism in Zebu and sheep in Senegal. Revue Elev. Med. vet. Pays trop. 31 (1): 21-36.

Blood, D.C., Henderson, J.A. and Radostits, O.M. (1979). Veterinary Medicine. The English Language Book Society and Bailliere Tindall, London, 5th Ed. pp. 161-169.

Boddie, G.F. (1962). Diagnostic methods in veterinary medicine. Oliver and Boyd, Edinburgh, 6th Ed.pp.42-43.

*Breukink, H.J. and Ruyter, T.De. (1977). Displacement of bovine abomasum : effect of diet on the composition of the rumen fluid and that of the contents of the abomasum and Duodenum. Faculteit der Diergeneeskunde. 102 (9): 554-565.

Bueno, L., Fioramonti, J., Geux, E. and Raissiguier, Y. (1980). Gastro-intestinal hypomotility in magnesium - deficient sheep. Can. J. Anim. Sci. 51 (3): 293-301.

*Cakala, S. and Albrycht, A. (1976). Effect of starvation on electrolyte concentrations in serum and ruminal fluid of cattle. Polskie Archwm wet. 19 (3): 427-437.

*Caldwell, D.R. and Hudson, R.F. (1974). Sodium, an obligate growth requirement for predominant rumen bacteria. Appl. Microbi. 27 (3): 549-552.

Chakraborthy, A.K., Kalita, C.C. and Roychoudhury, R.K. (1974). Seasonal dynamics of rumen dysfunction in cattle. Indian vet. J. 51 (11): 695-697.

*Choudhuri, P.C., Sandhawa, S.S. and Misra, S.K. (1980). Effect of lactic acidosis on electrolyte changes in blood and rumen liquor in buffaloe-calves. Zentbl. Vet. Med. 27A (5): 359-363.

Choudhuri, P.C., Prasad, B. and Misra, S.K. (1981). Note on the use of rumen liquor in the treatment of chronic alkaline indigestion in cows. Indian J. Anim. Sci. 51 (3): 356-357.

Cornelius, C.E. and Kaneko, J.J. (1963). Clinical biochemistry of domestic animals. Academic Press, New York and London. pp. 448, 449, 473, 522.

Dash, P.K., Misra, B.K. and Mohanty, G.P. (1972). Effect of acute indigestion on the rumen protozoa population and blood pictures of Indian cattle. Indian vet. J. 49 (7): 672-679.

Dash, P.K. and Misra, B.K. (1972). Effect of sudden change of feed from normal to salseed supplemented ration on the ruminal activities of dairy cows and the results of stomach therapy on these animals. Indian vet. J. 49(10): 1035-1040.

Davidovich, A., Bartley, E.E., Chapman, T.E., Dechtle, R.M., Dayton, A.D. and Frey, R.A. (1977). Ammonia toxicity in cattle. II. Changes in carotid and jugular blood components associated with toxicity. J. Anim. Sci. 44 (4): 702-709.

Dirksen, G. (1979). "Digestive system" in Clinical examination of cattle. ed. Rosenberger, G. (1979). Verlag Paul Parey. Berlin and Hamburg. pp. 200-213.

*Dunlop, R.H. (1972). Pathogenesis of ruminant lactic acidosis. Adv. vet. Sci. Comp. Med. 16: 359-393.

Erickson, E.O., Dinusen, E.E., Bolin, D.W., Hauger, C.H. and Buchanan, M.L. (1970). Composition of rumen contents and digestion as related to the type of feed and time of sampling in sheep. J. Anim. Sci. 30 (2): 362-367.

Fenner, H., Dickinson, F.N. and Barner, H.D. (1969). Effect of level of feed intake and time of sampling after feeding on concentrations of dissolved sodium, potassium, calcium, magnesium and phosphorus in bovine rumen fluid. J. Dairy Sci. 52 (2): 205-210.

Fiske, C.H. and Subbarow, Y. (1925). The colorimetric estimation of phosphorus. J. Biol. Chem. 66: 375.

*Gupta, S.C., Joshi, B.S. and Rai, P. (1976). The levels of thiamine in the rumen fluid and blood serum in spontaneous bovine rumen dysfunction. Acta vet. Brno. 45 (3): 205-210.

*Hoflund, S. (1955). Cited by Prasad, J. and Rekib, A.(1979). Studies on dietetic abnormalities in ruminants. II - Some therapeutic aspects of simple anorexia, legume bloat and rumen impaction. Indian vet. med. J. 3: 175-180.

Hoflund, S. and Hedstrom, H. (1949). Disturbances in rumen digestion as predisposing factor for appearance of acetonemia. Cornell Vet. 39 (4): 465-477.

Hoflund, S. (1967). Animal diseases associated with the use of deteriorated feeding stuffs under Swedish conditions. Vet. Bull. 37 (10): 701-715.

Hubert, F (Jr), Cheng, B. and Burrough, E. (1958). The influence of potassium, sodium, rubidium, lithium and cesium on in vitro cellulose digestion by rumen microorganism with observations on sodium and potassium influences in content fattening ration. J. Anim. Sci. 17: 576-585.

Huber, T.L. (1971). Effect of acute indigestion on compartmental water volumes and osmolarity in sheep. Am. J. Vet. Res. 32 (6): 887-895.

Huber, T.L., Wilson, R.C., Battalsan, A.J. and Seetach, D.D. (1981). Effect of hypocalcaemia on motility of the ruminant stomach. Am. J. vet. Res. 42 (9): 1488-1495.

Hungate, R.E. (1966). The rumen and its microbe. Academic press, New York and London. pp. 344.

*Jägos, P. Bouda, J., Dvorak, R., Illek, J. and Jurajdova, J. (1977). Chronic metabolic acidosis in dairy cows. Vet. Med. 22 (3): 143-151.

Joshi, B.P. (1970). Seasonal incidence of bovine indigestion in tropics. Indian Vet. J. 47 (11): 1005-1007.

Joshi, B.P. and Misra, S.S. (1974). Epizootological studies of bovine rumen dysfunction with reference to the incidence. Indian J. Anim. Sci. 44 (10): 742-746.

Joshi, B.P. and Misra, S.S. (1977). Clinico-therapeutic basis of classification of spontaneous rumen dysfunctions in zebu and buffaloes. Indian Vet. J. 54 (12): 1005-1007.

Joshi, S.V. (1980). Studies on some aspects of histochemistry, haematology in blood, impaction and anoestrus in cattle with evaluation of some of the clinico-therapeutic drugs. Vet. Res. J. 3 (1): 64.

*Juhasz, B. and Szegedi, B. (1968a). Pathogenesis of rumen overload in sheep. Acta vet. hung. 18: 63-80.

*Juhasz, B.and Szegedi, B. (1968b). Pathogenesis of ruminal digestive disorders caused by easily digestible carbohydrates. Magy. Allatory. Lap. 23: 66-80.

Kadvekar, L.K. and Murkibhavi, C.R. (1971). Modern clinical concepts of aetiology and classification of anorexia in dairy bovines, its treatment with vitamin B-complex and liver extract. Indian J. Anim. Sci. 41 (1): 16-17.

Kahlon, T.S., Ranhotra, G.S. and Langer, P.N. (1970). Partial defaunation of rumen and its influence on the biochemical activity. I. Effect of partial defaunation on the intra-ruminal environment of the buffalo and Zebu. Indian J. Anim. Sci. 40 (6): 593-599.

*Lampila, M. (1964). Volatile fatty acids, pH and microbial activity in the rumen of cow. Ann. Agr.Fenniae. 3:1.

*Meyer, H. and Ruatige, M. (1958). Influence of the ammonia content of the rumen on the calcium and magnesium content of blood of cattle. Dtsch. tierärztl. Wschr. 65: 131-135.

Misra, S.K. and Tripathy, N.C. (1963). Studies on rumen liquor from cattle fed exclusively on paddy straw. Indian vet. J. 40 (8): 496-500.

Misra, S.K., Dash, P.K. and Mohanty, P. (1972a). The protozoan fauna of the rumen and reticulum of Indian cattle. Indian vet. J. 49 (5): 463-469.

Misra, S.K., Dash, P.K. and Mohanty, P. (1972b). Effect of sub-acute primary indigestion on the rumen protozoa populations of milch cattle. Indian vet. J. 49 (6): 585-592.

Misra, S.K. and Singh, U. (1974). Studies on the clinico-pathological and therapeutic aspects of indigestion in cattle. Indian vet. J. 51 (11): 698-704.

Moodie, E.M. (1959). Some aspects of hypocalcaemia in cattle. Vet. Rec. 72 (50): 1145-1149.

Nagarajan, V.V. and Rajamani, S. (1973). Alkaline indigestion and rumen putrefaction in a cow. Indian vet. J. 50 (11): 1147-1151.

*Nauriyal, D.C. and Dixi, K.K. (1978). Bio-medical profile of cross-bred cattle and buffaloes in experimentally induced ruminal lactic acidosis. I. Intraruminal molasses administration. Zentbl. VetMed. 25A (6): 450-457.

Nauriyal, D.C. and Dixi, K.K. (1981). Bio-medical profile of cross-bred cattle and buffaloes in experimentally induced ruminal lactic acidosis. III. Intra-ruminal crushed barley grain administration. Indian J. vet. Med. 1 (1): 51-57.

Nichols, R.E. and Penn, K.E. (1958). Simple methods for the detection of unfavourable changes in rumen digesta. J. Am. Vet. med. Ass. 133 (5): 275-277.

Nichols, R.E. (1963). 'Ruminal indigestion' in Diseases of Cattle. ed. Gibbson, W.J. (1963). American veterinary publications, INC., California. 2nd Ed. pp. 211-218.

Oser, B.L. (1971). Hawk's physiological chemistry. Tata Mc-Graw Hill publishing Ltd., New Delhi. 14th Ed. pp. 1135, 1139-1142.

Phillips, R.W. (1977). 'Nutritional pharmacology' in Veterinary Pharmacology and therapeutics. eds. Jones, M.L., Booth, N.H. and Mc Donald, L.E. (1977). Oxford and IBH Publishing Co., New Delhi. 4th Ed. pp. 787-796, 800, 804-806.

Phillipson, A.T. (1977). "Ruminant digestion" in Duke's physiology of domestic animals. ed. Swenson, M.J.(1977). Comstock publishing associates, Ithaca and London, 9th Ed. pp. 275-276.

Prasad, J., Ahluwalia, S.S. and Joshi, B.P. (1972). Clinico-biochemical studies in indigestion in cattle and buffaloes. Indian J. Anim. Sci. 42 (11): 911-914.

Prasad, J., Ahulwalia, S.S. and Joshi, B.P. (1973). A note on clinico-biochemical aspects on experimental indigestion in buffaloes. Indian J. Anim. Sci. 43 (3): 245-248.

Prasad, J. (1975). A study of rumen protozoa in clinical and experimental indigestion in zebu and buffaloes. Maha vet. 2 (1): 5-8.

Prasad, J. and Joshi, B.P. (1975). Biochemical exploration of primary rumen impaction in zebu and buffaloes. Indian vet. J. 52 (5): 366-369.

Prasad, J., Joshi, S.V. and Rakib, A. (1976a). Studies on physico-chemical and therapeutic aspects of primary anorexia in sheep and goat. Maha vet. 3 (3): 11-14.

Prasad, J., Rakib, A. and Joshi, S.V. (1976b). Clinical trials with Anorexon (Pfizer) in anorexia syndrome of ruminants. Indian vet. J. 53 (4): 297-299.

Prasad, J. (1977). Further clinico-biochemical studies in secondary rumen dysfunctions associated with hypocalcaemia, pregnancy and non-specific diarrhoea. Indian vet. J. 54 (5): 352-355.

Prasad, J. (1979). A study on reticulo-ruminal movements and rumen pH in clinical indigestion in cattle and buffaloes. Indian vet. J. 56 (6): 474-477.

Prasad, J. and Rakib, A. (1979a). Studies on dietetic abnormalities in ruminants. I - Seasonal dynamics and etio-diagnosis of primary anorexia. Indian vet. med.J. 3: 171-174.

Prasad, J. and Rakib, A. (1979b). Studies on dietetic abnormalities in ruminants. II - Some therapeutic aspects of simple anorexia, legume bloat and rumen impaction. Indian vet. med. J. 3: 175-180.

Prasad, V.L. and Raghavan, G.V. (1973). Effect of the level of intake on reticulo-rumen cations of cattle and buffaloes. Indian J. Anim. Sci. 43 (8): 693-698.

Randhawa, S.S., Gupta, P.P. and Misra, S.K. (1981). Histopathological changes in experimental rumen acidosis in buffalo calves. Indian J. Anim. Sci. 51(5):519-521.

Sansom, B.F., Maneton, R. and Vagg, M.J. (1983). Magnesium and milk fever. Vet. Rec. 112 (19): 447-449.

Saxena, K.K. and Ranjhan, S.K. (1980). Effect of cobalt and copper supplementation on the ruminal pH, total nitrogen, ammonia and total volatile fatty acids concentration in Hariana calves. Indian J. Anim. Sci. 50 (1): 21-24.

Saxena, K.K. and Srivastava, B.V.N. (1980). Effect of cobalt and copper supplementation on the ruminal volatile fatty acids concentration and microbial population in Hariana calves. Indian J. Anim. Sci. 50 (6):471-475.

Sethuraman, V. and Rathor, S.S. (1979a). Physical and biochemical studies on rumen fluid and urine in experimentally produced acute acid and alkaline indigestion in cattle and buffaloes. Indian J. Anim. Sci. 49 (3): 189-193.

Sethuraman, V. and Rathor, S.S. (1979b). Clinical studies and therapy of experimental rumen acute and alkaline indigestion in bovines. Indian vet. J. 56 (1):23-26.

Singh, R.V., Lakhchaura, B.D. and Sud, S.C. (1980). Note on the effect of different diets on rumen microbial population of the buffalo. Indian J. Anim. Sci. 50(6): 528-530.

*Slanina, L. (1969). Role of hypocalcaemia and haemoconcentration in the pathogenesis of acute acidosis and alkalosis of ruminants. Vet. med. Praha. 14: 23-29.

Snedecor, G.W. and Cochran, W.G. (1967). Statistical Methods. Oxford and IBH Publishing Co., New Delhi. 6th Ed. pp. 59-62, 250-298, 549.

*Sodhi, S.P.S., Randhawa, S.N.S. and Setia, M.S. (1981). Physiological changes in experimental rumen lactic acidosis in cross-bred calves. Zentbl.VetMed.28 (3): 252-258.

Stevens, C.E., Hammond, P.B. and Nielsen, M.O. (1959). Phlegmonous gastritis in cattle, resulting from rumenatoric doses of tartar emetic. J. Am. Vet. med. Ass. 134 (7): 323.

Suber, R.L. and Hentger, J.F. (1979). Blood and ruminal fluid profiles in carbohydrate foundered cattle. Am. J. Vet. Res. 40 (7): 1005-1008.

*Svendsen, P. (1974). Gastro-intestinal atony in ruminants. Thesis Abstract. Cited from Vet. Bull. (1974). 44 (11): Abstr. 5594.

*Timet, D., Herak, M., Emanovic, D., Mitin, V. and Kraljevic, P. (1979). Calcium absorption from digestive tract of ruminants. III. Influence of pH on the calcium absorption from calcium chloride solutions of different concentrations within compartments of bovine stomach. Vet. Arh. 48 (6): 299-311.

*Timet, D., Emanovic, D., Herak, M., Kraljevic, P and Mitin, V. (1981a). Role of sodium ions in the gastric absorption of calcium in ruminants. Annales de Recherches Veterinaires. 12 (1): 45-56.

*Timet, D., Emanovic, D., Herak, M., Kraljevic, P. and Mitin, V. (1981b). The influence of phosphate upon the stimulative effect of sodium ions in the gastric absorption of calcium in cattle. Vet. Arh. 51: S 119- S 131.

*Tressol, J.C. and Lamand, M. (1979). Emergence and treatment kinetics of cobalt deficiency in sheep. Annales de Recherches Veterinaires. 10 (1): 71-75.

Udall, D.H. (1964). The practice of veterinary medicine. Oxford and IBH publishing Co., New Delhi, 6th Ed. pp. 103.

*Vasquez, C.A.S. (1975). Studies on the ruminal fluid of healthy cattle and cattle with indigestion of various origin (with special reference of pH values, total acidity and lactate and chloride content). Inaugural dissertation. Tierarztliche Hochschule. Hannover. Cited from Vet. Bull. (1976). 46 (8): Abstr. 4538.

Verma, D.D. and Ganapathy, M.S. (1973). Studies on the blood histamine level in indigestion in bovines. Indian vet. J. 50 (5): 400-405.

Verma, D.N. and Singh, V.B. (1980). Studies on the production rate of bacteria in the rumen and their relationship with drymatter, nitrogen, digestable organic matter, total digestable nutrients and volatile fatty acid production in buffaloe calves. Indian J. Anim. Sci. 50 (4): 335-339.

Vihan, V.S., Joshi, B.P. and Rai, P. (1973a). Experimental studies on cellulose digestion in acid and alkaline indigestion in buffaloes. Indian J. Anim. Sci. 43 (6): 503-504.

Vihan, V.S., Joshi, B.P. and Rai, P. (1973b). Observations on changes in pH and lactic acid in rumen fluid and lactic acid in blood in bovine indigestion. Indian vet. J. 50 (12): 1178-1181.

*Watson, R.H. (1933). The influence of saliva on digestion in ruminants. Austr. J. exp. Biol. med. Sci. 11:67.

Wilson, J.H., Ward, G.M., Wilson, D.V., Tyler, T.R. and Bennick, M. (1967). Relationships between ion concentration in rumen fluid. J. Dairy Sci. 50 (6): 930.

Yano, H., Matsui, H. and Kawashima, R. (1979). Effect of dietary calcium levels on concentration and solubility of macro-minerals in the digestive tract of sheep. J. Anim. Sci. 48 (4): 954-960.

* Originals not consulted

THE ROLE OF SELECTED MINERALS IN RUMINAL INDIGESTION IN CROSS-BRED CATTLE

By

GEORGE THOMAS

ABSTRACT OF A THESIS

Submitted in partial fulfilment of

the requirement for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences

Kerala Agricultural University

Department of Clinical Medicine

COLLEGE OF VETERINARY AND ANIMAL SCIENCES

Mannuthy - Trichur

1983

ABSTRACT

The present investigations were taken up with the objectives to survey the incidence and seasonal dynamics of digestive disorders in cattle in Kerala, to study the associated changes in physical characters, pH, protozoal motility and sedimentation activity time of rumen liquor and the status of selected minerals in rumen liquor and blood in clinical cases of simple indigestion in cross-bred cattle and based on the findings in the above to modify and compare the line of therapy for the same.

Data collected from selected veterinary hospitals in the field and under the Kerala Agricultural University showed that digestive disorders formed 33.10 per cent of the total of the incidence of diseases in cattle. Among the digestive disorders, cases of indigestion as a whole were 70.07 per cent and simple indigestion mostly associated with dietetic errors were 48.90 per cent. Influence of season on the incidence of these conditions was significant, being highest in summer. This could be attributed to irregularities in feeding associated with non-availability of good quality fodder throughout the year and feeding cattle predominantly on dry and coarse locally available unconventional animal rations and inadequate supply of water during the season.

Eight apparently healthy adult cross-bred cattle from the University Livestock Farm, Mannuthy, formed the healthy control animals (Group I). Twelve clinical cases of simple indigestion in adult cross-bred cattle divided at random into two groups of six each constituted the treatment groups (Group II and III). In Group II animals conventional therapy consisting of bitter stomachics orally and liver extract parenterally was tried. In animals of group III modified therapy comprising of bitter stomachics and 'Anorexon' (Pfizer Pvt. Ltd.) tablets orally and 'Calborol' (M & B Pvt. Ltd.) intravenously was adopted. Course of the disease was studied and samples of rumen liquor and blood were collected for analysis on the first, fourth and seventh day of admission in the clinic.

Important clinical signs of the disease were slight general depression and dullness, partial or complete loss of appetite, suspension of rumination, cessation or depressed rumen contractions, normal or pasty and scanty dung or presence of mild diarrhoea and drop in milk yield. The body temperature and rates of pulse and respiration were normal.

Physical characters of the rumen liquor from cattle with simple indigestion were altered in that the colour was brownish yellow/brownish with faintly aromatic/faintly sour odour and thin/thick consistency compared to the greenish

yellow colour, aromatic odour and thick consistency of rumen liquor from healthy control animals. Protozoal motility was suppressed (slow (+) to moderate (++)) and RRT was prolonged to 26.16 ± 1.70 minutes. Levels of calcium, phosphorus and magnesium in the rumen liquor and blood were significantly reduced ($P<0.01$) in the cases studied. However, the levels of sodium and potassium did not show any significant variations before, during or after therapy. Mean calcium, phosphorus, magnesium, sodium and potassium levels of rumen liquor in affected animals were 10.20 ± 0.37 mg/dl, 7.76 ± 0.23 mg/dl, 5.35 ± 0.20 mg/dl, 132.33 ± 1.17 m'eq/L and 23.93 ± 1.74 m'eq/L respectively and the corresponding values in blood were 10.17± 0.096 mg/dl, 5.17±0.093 mg/dl, 2.12 ± 0.028 mg/dl, 150.35 ± 1.30 m'eq/L and 4.61 ± 0.13 m'eq/L.

Physical characters, protozoal motility and RRT of the rumen liquor have almost returned to normal ranges following therapy. Improvements in calcium, phosphorus and magnesium level in rumen liquor and blood could presumably be associated with revival of appetite and increased intake of feed following therapy. On the basis of better clinical response as judged by early return of appetite and milk yield, better improvements in the microbial activity of rumen liquor and mineral status of rumen liquor and blood and shorter recovery period, the modified therapy was found superior to the conventional therapy for the clinical management of simple indigestion in cross-bred cattle.