EFFECT OF DRIED SPLEEN AS A GROWTH PROMOTER IN THE RATION OF CROSSBRED CALVES

By
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THESIS

Submitted in partial fulfilment of the requirement for the degree

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Department of Animal Nutrition
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1995

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I hereby declare that the thesis entitled **EFFECT OF DRIED SPLEEN AS A GROWTH PROMOTER IN THE RATION OF CROSSBRED CALVES"** 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

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Certified that this thesis entitled **"EFFECT OF DRIED SPLEEN AS A GROWTH PROMOTER IN THE RATION OF CROSSBRED CALVES"** is a record of research work done independently by **Sri. Sagathevan, S.**, 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.

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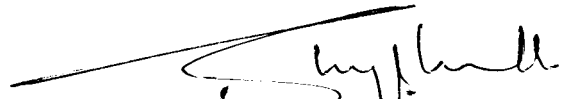

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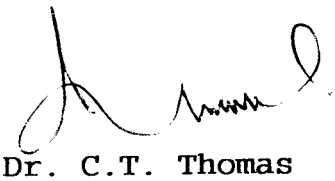

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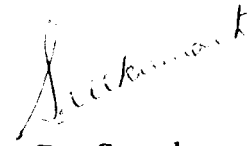

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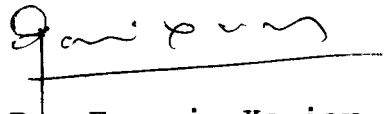

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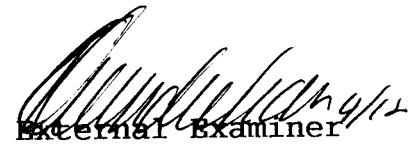

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Dedicated to my

Parents and Brothers

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Introduction

INTRODUCTION

India owns nearly 20 per cent of total world bovine population but contributes only ten per cent or the world milk production The special feature of our dairy industry is that it depends largely on agricultural byproducts and crop residues Among the world s dairy nations perhaps we alone have built our dairy industry without direct competition with human food The gap between the availability and requirement of nutrients is very wide and there is a shortfall of 55 per cent digestible crude protein and 20 per cent total digestible nutrients (Bhat 1994) We have improved the genetic potential of our animals through crossbreeding but it could not be exploited completely mainly due to the shortage of good quality feeds Attempts to improve utilization of feed in turn will shorten the deficit Various feed processing technologies and different additives are being used to improve feed utilization

The feed additives already in use include antibiotics arsenicals hormones enzymes probiotics anthelmintics yeast cultures antioxidants deodorizers tranquilizers mould inhibitors coccidiostats ionophores pellet binders and microbial cultures Most of the antibiotics when fed to animals get excreted in animal products and when these are consumed by human beings it results in the development of antibiotic resistant microorganisms

Injection of somatotropic hormone thyroxin and androgen was found to be effective in increasing weight gain (Zyl and Eron 1992) Injection of tissue extracts from pituitary and testis also showed similar effect most probably through the action of the hormones Use of these hormones continuously for a longer period leads to their accumulation in tissues and excretion in animal products These residues are likely to be carcinogenic and hence a potential hazard to human health

Microbial feed additives such as probiotics bacterial cultures and yeast cultures were tried as animal feed additives The use of probiotics as feed additive is to provide lactic acid bacteria in the intestinal tract at times of disease stress after antibiotic treatment or at birth to minimise enteric microbial upsets and to suppress the growth of pathogenic microorganisms Selection of the suitable organism is based on its ability to survive in the digestive tract and also its effect on digestion Rumen has a very complex symbiotic ecosystem where monitoring the activities of these microorganisms is difficult Most of these microorganisms when introduced do not get established in the rumen for a sufficiently long period which necessitates periodical administration Manipulation of rumen fermentation using genetically engineered bacteria is desirable for the degradation of specific nutrient or for the regulation of specific product of fermentation or for the

growth of specific bacterial species The major requirement of engineered bacteria would be that they should be able to compete and perform in the rumen ecosystem Much interest has been generated over past few years in manipulating ruminal microflora using ionophores Ionophoes alter the rumen microflora which in turn influence the rumen metabolites Genetic engineering for enhancing cellulolytic activity hemicellulose utilization and lignin degradation was tried by gene transfer or gene amplification or mutagenesis (Singh 1987) Whether the engineered bacteria will work in the in vivo ecosystem is yet to be established

The potential ill effects of the residues of antibiotics and chemicals administered as growth stimulants in the animal products have necessitated invention of relatively harmless agents In this context certain natural organic substances have been identified as growth promoters known as biostimulators Biostimulators are preparations of animal tissues such as spleen liver embryo and other slaughter house wastes which are given orally or injected periodically in small quantities for the purpose of stimulating growth and improving performance (Agarwal and Chakrabarthi 1985) Liver extract dried liver spleen extract dried spleen dried extracts of embryos and foetal membranes preserved animal blood and dried uterus were tried as biostimulators in different species The work carried out in the College of Veterinary and Animal Sciences Mannuthy to

assess the effect of dried buffalo spleen as a biostimulator in rats and rabbits (James and Gangadevi 1991) and in goats (Shyama 1994) at the level of 0 1 per cent in their diet showed an increased weight gain in treated group than the respective controls The above authors have also observed that incorporation of biostimulator can reduce the cost of production (Rs per kg gain) and atleast 25 per cent crude protein can be spared without any adverse effect on weight gain But the information on the use of dried spleen as biostimulator in cattle is meagre

The present investigation is designed to probe into the efficacy of dried buffalo spleen as a biostimulator in growing cattle and to assess its effect on growth nutrient digestibility nutrient utilization rumen fermentation blood constituents and its economic benefits if any in cattle rearing

Review of Literature

2. REVIEW OF LITERATURE

2.1 Growth promoters

Various substances are used to augment animal productivity They include antibiotics (Bedo et al 1984) biostimulators (Mahapatro and Roy 1970) enzymes and hormones (Zyl and Eran 1992) ionophores (Meinert et al 1992) probiotics (Beharka et al 1991) and tranquilizers (Akanbi and Hu 1991)

2.2 Biostimulators - mode of action

The mode of action of biostimulators is not yet completely elucidated Russian workers who have done extensive work at the institute of Biostimulators (Passadona) also did not indicate the mode of action (Agarwal and Chakrabarti 1985) Konstantinov et al (1973) reported that rabbits experimentally infected with Eschericia coli showed quicker recovery when the extract of bovine liver and spleen were injected as compared to the control The phagocytosis index had risen by 39 per cent in 20 minutes after injection and Eschericia coli in the blood was also cleared up quickly in treated group Szent Gyorgi (1966) in his postulation stated that biostimulators contain a principle known as promin which is responsible for stimulating the metabolism of the body and helps to utilize the nutrients with better

efficiency Agarwal and Chakrabarthi (1985) reported that the role played by a biostimulator in a biological system is catalytic in nature rather than its additive influence n the form of a mineral or element in action

Dikon (1987) reported that extract from liver kidney spleen and whole fry of rainbow trout inhibited plaque production of infectious pancreatic necrotic virus in cell cultures The inhibition may be caused by preventing or reducing the attachment of viruses to the cell surface or the tissue extract may cause aggregation of the virus and thereby reducing the number of available infectious units Timofeev et al (1987) reported that injectable tissue extract from meat and bone meal was used in Soviet Union as growth promoter in vitro experiments and experiments in chicks indicated that it stimulated the hormonally active enzyme adenylate cyclase at the level of beta adrenergic receptors Zama et al (1990) reported that treating wounds with tissue extracts enhances epithelialization and healing which was attributed to its antiinflammatory activity Gazzola and Lindsay (1993) reported that proteoglycan II from occipital condyl articular cartilage was shown to alter the growth of mammalian cells in culture but it was absorbed and metabolised in vivo in rats Kokovic (1968) observed that feeding of dried tissue preparations stimulated gastro intestinal secretions in pigs

2.3 Commonly used tissue preparations

Tissues or organs commonly used as biostimulator include adrenal gland blood bone cartilage foetal membrane embryo heart liver spleen testicle and uterus Various preparations of the above tissues were tried as injections or as feed addit es They include Filatov tissue preparation as mentioned by Kukde and Thakur (1992) agar tissue preparation (Tolokonnikov 1975) dried spleen preparation (James and Gangadevi 1991 and Shyama 1994) tissue extracts (Doroskov 1962) and commercial tissue preparations Filex (Psota 1969) and Hormonexa (Laird et al 1972)

2.4 Factors influencing the effect of biostimulators

The growth promoting effect of biostimulator depends on the tissue from which it is prepared In pigs injection of preparations from cattle embryo and foetal membranes were more effective than the preparations from pig embryos (Krasilnikova 1963a) In chicks feeding of chick embryo preparation was most effective in the utilization of feed energy than preparations from goat testicle broiler liver and broiler testicle (Kukde and Thakur 1992)

Various arbitrary doses of tissue preparations were tried and it has been found that small doses accelerated

growth (Stepin 1963 Balun et al 1965 Radkevic et al 1965 and Kokovic 1968) Haitov et al (1966) and Suljumova et al (1968) reported that large doses depressed growth Voronenkov and Nefedov (1966) reported that large doses had stimulatory effect whereas small doses failed to produce growth stimulation Konstantinov (1969) recommended injection of 0 5 ml to 1 ml Filatov tissue preparation per kg body weight in suckling and growing pigs and from 0 1 to 0 5 ml for sexually mature pigs and 0 1 ml for calves of all ages

Stepin (1963) reported that single dose of tissue extract was more effective in increasing weight gain than when it was given twice Radkevic et al (1965) reported that the best interval between doses are seven to ten days On the other hand Raikar et al (1971) reported that there was no difference between injection at three days and seven days intervals Gerasimov and Petrov (1970) reported that injection of Filatov spleen preparation at every 10 day was more effective than at every 15 days

Kokovic (1968) reported that highest weight gain was observed in group injected with 0 1 ml of tissue preparation the gain being 20 2% more than control In case of oral administration the weight gain in treated group was 12 9 to 18 3 per cent more than untreated control Treatment of wounds with tissue preparations were reported to enhance wound healing (Jadon and Kumar 1984 Jadon and Kumar 1985

Varshney et al 1988 Zama et al 1990 and Zama et al 199[illegible]) injection of tissue preparation was reported to increase conception rate in cattle (Espinosa et al 1974)

Shukla and Mahapatro (1975) reported that there was no significant difference in growth stimulation between hot air oven dried and vacuum oven dried biostimulators in rats when fed orally Vasilisin (1973) reported that storage of cattle spleen agar preparation reduced the activity and it was significant when compared to fresh preparation

Voronenkov and Nefedov (1966) reported that injection of spleen tissue preparation had more effect in calves (24%) than in chicks and rabbits (20% and 21 7% respectively) James and Gangadevi (1991) reported that the effect of feeding spleen preparation was similar in both rabbit and rats

Zelenskii and Strybak (1970) reported that injection of 0 1 ml of agar cattle spleen emulsion in Russian simmental calves increased average daily gain by 27 to 187 grams compared with untreated control whereas the same treatment in charolais x Russian Simmental cross calves decreased weight gain Tolokonnikov (1975) reported that injection of agar spleen extract in Red Stappe and its respective crosses with Brown Swiss Herford and Aberdeen Angus cattle increased the gain by 14 6 per cent 18 9 per cent 19 1 per cent and 20 per cent respectively

Mahmudov (1969) observed that injection of one ml buffalo spleen extract to nutria increased growth of males by 12 2 to 20 5 per cent whereas in females it was only 13 0 to 14 9 per cent Rebreanu (1968c) described that injection of liver extract increased weight gain in treated males when compared to control whereas in females there was no significant difference between the treated and control groups

Konstantinov (1969) noted that young pigs require high doses of Filatov tissue preparation than sexually mature pigs Kisel (1970) reported that treatment of five to six month old and ten to twelve month old cattle with same dose of tissue preparation increased weight gain by 12 5 per cent and 16 per cent respectively

The effect of biostimulator was highly variable between different periods in a treatment Korolev (1966) stated that injection of pig embryo and foetal membrane extract in cattle depressed the weight gain for a week after first injection but subsequently it increased the weight gain Lutsenko (1970) reported that injection of tissue preparation in pigs increased weight gain in first month than control but it did not have any effect in subsequent months Ilinskij (1962) reported that injection of Filatov spleen extract in bullock and heifers increased weight gain in first month but after that the effect was reversed

There was a correlation between the nutritional status of an animal and the effect of biostimulator Radkevic et al (1965) reported that injection of Filatov s cattle spleen preparation subcutaneously in bullocks increased the weight gain by 16 8 per cent in well fed animal and reduced the weight gain by 9 per cent in poorly fed animals

Mahapatro and Roy (1970) reported that biostimulator could replace 25 per cent of the ration with comparable growth and biostimulator was more effective in low plane of nutrition James and Gangadevi (1991) reported that supplementation of growth stimulator was very effective in both rat and rabbits at sub optimum level of protein than at optimum level Shyama (1994) reported that feeding dried spleen was more effective in goats maintained on sub optimum level of protein and it could replace 25 per cent of protein

2.5 Effect of various tissue preparations on weight gain

Rodin (1967) reported that adrenal preparation in combination with spleen and liver preparation increased wool production by 9 3 kg Goreglyad and Ispenkov (1976) reported that injection of 1 5 ml of horse blood per kilogram body weight increased weight gain in calves upto 30 per cent than control Siegl (1961) reported that feeding of blood to pigs

did not have stimulating effect Ackerman and Tsou (1961) reported that feeding of blood protein reduced the average daily gain by 3 6 per cent Shah (1984) reported that feeding of buffalo carcass meal to broilers did not have any stimulatory effect on weight gain Gazzola and Lindsay (1993) reported that injection of cartilage extract did not have any effect on weight gain in rats Bilkei (1984) observed that injection of extracts from cartilage and bone marrow was useful in the treatment of spinal osteoarthritis in dogs

Krasilnikova (1963)a reported that injection of Filatov s preparation from foetal membrane increased weight gain in pigs Korolev (1963) reported that feeding dried extract of foetal membrane to cattle and pigs was effective in increasing weight gain Krasilnikova (1963b) and Korolev (1963) reported that injection of embryo preparation increased weight gain in pigs Kokovic (1968) reported that feeding of embryo preparation increased weight gain in pigs Agarwal and Chakrabarthi (1985) also reported an increase in weight gain in albino mice on feeding embryo preparation Krasilnikova (1970) observed that feeding of biostimulator from dried embryonic tissue daily for three months to layer increased egg production by 10 8 to 18 per cent and egg weight by 2 to 4 per cent than control

Ackerman and Tsou (1961) reported that feeding of heart preparation had no appreciable effect on weight gain in pigs Doroskov (1962) reported that injection of liver

extract increased weight gain Kalasnik et al (1969) observed that injection of liver preparation increased weight gain in cattle Rebreanu (1968c) reported that injection of liver extract did not have any effect in calves An increase in weight gain by feeding of liver preparation was reported in chicks (Pichelauri and Cikadze 1966) in pigs (Kokovic 1971) However in rats there was no effect on feeding liver preparation (Agarwal and Chakrabarti 1985 and Ackerman and Tsou 1961)

Injection of agar spleen was tried and reported to increase weight gain in pigs (Vasilisin 1973 Haritonov et al 1969 and Ponomarev 1970) in rabbits (Zarkov 1968) and in cattle (Tolokonnikov 1974) While a reduction in weight gain in cow and bull was reported (Radkevic and Tivikov 1968 Cerkasova et al 1970) Mahmudov (1969) reported that there was an increase in weight gain by the injection of buffalo spleen preparation to nutrias Mahmudov (1970) observed that feeding of dried buffalo spleen to nutrias increased weight gain in treated group than control Shukla et al (1988) observed that feeding of dried buffalo spleen biostimulator stimulated thiroid activity Safarov (1969) reported similar effect in lambs James and Gangadevi (1991) reported that feeding of buffalo spleen preparation to rats and rabbits increased weight gain Shyama (1994) reported that feeding of dried buffalo spleen increased weight gain in goats when compared to control

Injection of spleen preparation was reported to increase weight gain in cattle (Rebreanu et al 1966B Zelenskii and Stryback 1970 and Vasilisin 1973) in sheep (Kuanysbekov 1969 and Gladkova 1970) and in chicks (Voronenkov and Nefedov 1966 and Pichelauri and Cikadze 1966) Klyuchnikov and Kiryanov (1977) reported that injection of spleen extract increased weight gain in cattle whereas Gorskov et al (1969) reported that injection of spleen extract inhibited the growth of calves Reidla (1965) also observed that injection of cattle spleen extract to pigs decreased weight gain by 47 kg and increased mortality rate by 4 6 per cent

Denovski and Nikolov (1976) reported that injection of spleen extract did not show any effect on weight gain in pigs An increase in weight gain by feeding spleen preparation was reported in poultry by Petruskin and Dahkiljgova (1963) Voronenkov and Nefedov (1965) in pigs by Kokovic (1968) in sheep by Spiridon and Florescu (1974) and in rats by Agarwal and Chakrabarti (1985) Ackerman and Tsou (1961) reported that there was no effect in rats on feeding spleen preparation

Rebreanu (1968b) reported that there was an increased weight gain in calves injected with testicular extract Korolkov and Petrisin(1960) and Buhatel and Vesa (1988) reported an increase in weight gain in pigs given testicular extract

Stepenkov (1974) observed that injection of pig testis extract to rabbit increased weight gain by six per cent

Preparations from more than one organ were mixed and the injection of the extract was found to increase weight gain in calves (Voronenkov and Nefedov 1966 Rebreanu et al 1966a Popescu et al 1966 Sokolov 1970 and Gerasimov 1970 and Vill 1970 Makarov et al 1971) Tatarinova (1971) reported that there was no significant difference in weight gain of cattle on administration of tissue preparation An increase in weight gain on feeding of tissue preparation was reported in chick (Suljumova et al 1968 Gorlova 1968) in pigs (Laird and Walker Love 1971) and in rats (Shukla and Mahapatro 1975) Injection of Filatov tissue preparation was found to increase weight gain in cattle (Iopa et al 1958) Konstantinov 1969 and Chushkov et al 1977) in pigs (Triers 1967 and Balanjuk and Kunburg 1968 and Haritonov and Volckov 1969a) and in sheep (Edrinin and Demchenko 1969) Kuzjmin et al (1968) observed that injection of Filatov tissue preparation to wool type sheep increased wool production by 5 7 per cent Kukde and Thakur (1992) reported that oral administration of Filatov tissue preparation increased weight gain in broiler chicken Kovbasenko (1968) and Kovbasenko (1970) observed that feeding of dried tissue preparation from non edible animal offal to layer increased quality of egg and meat Vedeneev (1967) observed that

injection of tissue preparation increased milk yield by 24 per cent

Krasilnikova (1963a) reported that injection of extracts of uterus increased weight gain in pigs Korolev (1966) reported that feeding dried embryo preparation increased weight gain in pigs

2.6 Body measurement

Rebreanu (1968b) reported that injection of testicular extract in calves increased the height at withers body length and chest girth by 3 68 4 88 and 4 57 per cent respectively in experimental calves than controls Sokolov (1970) reported that injection of agar tissue preparation over a 45 days period increased height at withers in three experimental groups respectively by 7 1 6 3 and 5 3 per cent versus 6 5 6 3 and 5 2 in controls chest circumference by 14 9 11 3 and 11 5 versus 11 1 10 0 and 9 2 and body length by 11 0 9 7 and 9 0 per cent versus 9 7 8 6 and 8 7 per cent

2.7 Dry matter and nutrient intake

Agarwal and Chakrabarti (1985) reported that the feed intake of biostimulator treated rats were less than the controls Shukla and Mahapatro (1984) reported in goats that the feed intake was maximum in control group at high plane of

nutrition than respective treatment group whereas at low plane of nutrition the treated group consumed more dry matter than respective control The intake of nutrients can be attributed to dry matter intake James and Gangadevi (1991) reported in rats and rabbits that there was no significant difference in dry matter intake between treated and control groups Protein intake was less in both treated and control groups at low plane of protein Shyama (1994) also reported that there was no difference in dry matter intake but the protein intake was less in animals at low plane of protein irrespective of the addition of biostimulator or not

2.8 Feed efficiency ratio and protein efficiency ratio

Gerasimov and Petrov (1970) reported higher feed efficiency and nutrient utilization in biostimulator treated group of cattle than control Agarwal and Chakrabarti (1985) reported that when preparations of liver spleen and chick embryo were fed to rats the feed efficiency ratio was 7 35 9 85 and 9 75 respectively versus 9 06 in controls and protein efficiency ratio was 1 42 2 08 and 1 90 respectively versus 1 15 in controls Shyma[a] (1994) reported a better feed conversion efficiency and protein efficiency in goats fed with dried spleen biostimulator and the efficiency is more pronounced at low plane of ein

2.9 Blood parameters

Zabolotuyj (1959) reported that subcutaneous ınjectıon of lıver or spleen extract ıncreased haemoglobın concentratıon ın healthy and anaemıc pıgs Shukla and Mahapatro (1990) reported that feedıng of buffalo spleen and lıver bıostımulator at low and hıgh plane of nutrıtıon ıncreased haemoglobın concentratıon ın treated goats than respectıve control and values ranged from 6 09 to 8 09 grams per 100 ml Shyama (1994) reported that feedıng drıed buffalo spleen had no sıgnıfıcant effect on haemoglobın concentratıon ın goats Sımılar effect was reported by Spırıdon and Florescu (1974) ın pıgs

Shukla and Mahapatro (1990) reported that feedıng of bıostımulator dıd not have any effect on packed cell volume ın goats Zabolotuyj (1959) reported that subcutaneous ınjectıon of lıver or spleen extract could ıncrease red cell count ın healthy and anaemıc pıgs

Konstantınov (1969) reported that ınjectıon of Fılatov tıssue preparatıon ın calves ıncreased whıte cell count and reduced the ratıo of eosınophıl to total monocyte and lymphocyte Chushkov et al (1977) reported that ınjectıon of Fılatov tıssue preparatıon ın calves had no effect on serum protein concentratıon

2.10 Rumen metabolism

Shukla and Mahapatro (1989) reported that feeding of buffalo spleen to goats at low and high plane of nutrition did not show any significant change in rumen pH But at higher plane of nutrition the biostimulator treated kids showed higher pH than that of untreated kids The total volatile fatty acid was recorded as 56 71 in control 68 7 in treated group at high plane of nutrition and did not show any significant variation However the treated kids at low plane of nutrition had higher total volatile fatty acid than in respective control Sodium concentration did not show any significant variation among different groups but potassium concentration was significantly low in biostimulator treated kids ($P<0$ 05) at both the plane of nutrition

2.11 Digestibility

Braun and Ptacek (1966) reported that feeding of hepavit a tissue biostimulator prepared by Filatov s method reduced the digestibility of nitrogen from 68 39 to 63 93 Mahapatro and Roy (1970) reported that in cattle injection of biostimulator had little influence on the process of digestion of dry matter crude protein ether extract crude fibre and nitrogen free extract Makarov et al (1971) reported that injection of agar tissue preparation improved the digestibility of nutrients and nitrogen retention

Shukla and Mahapatro (1984) reported that feeding of biostimulators to goats improved digestibility and it was highest in group fed with biostimulator at high plane of nutrition Crude protein and ether extract digestibility were higher in biostimulator treated kids over their respective controls There was no significant difference in carbohydrate digestibility Digestibility coefficient for ash showed highest value for biostimulator treated group at high plane of nutrition Shyama (1994) reported that there was no significant difference in digestibility of dry matter and nitrogen free extract in goats between the biostimulator treated and control group Digestibility of crude protein and ether extract were higher in biostimulator treated group than their respective controls Incorporation of spleen did not have any influence on fibre digestion

Materials and Methods

3. MATERIALS AND METHODS

The animal experimental part of the present investigation was carried out at the Cattle Breeding Farm Thumburmuzhi under Kerala Agricultural University located nearly 45 kilometers away from the College of Veterinary and Animal Sciences Mannuthy

3.1 Animals

Twenty crossbred female calves between six to nine months of age born and reared in the farm were selected for the experiment The animals were housed in the experimental shed provided with individual mangers and were maintained under identical conditions of feeding and management After a pre experimental period of one month on a standard ration the calves were distributed randomly into four experimental groups I II III and IV as uniformly as possible with regard to age and body weight The duration of the experiment was seven months including the preliminary period Throughout the experimental period the animals were dewormed regularly A two factor randomized complete block design was adopted to study the effect of biostimulator (dried spleen) at 0 and 0 1% level against two levels of protein (20% and 15%) and their interactions if any

3.2 Experimental rations

The dried spleen biostimulator was prepared from fresh buffalo spleen collected from the slaughter houses It was cut into small pieces and dried in a hot air oven at 85 ± 5°C The dried spleen was powdered to pass through one millimeter sieve and stored in a refrigerator During feed mixing it was added to the concentrate ration at the rate of 0 1 per cent after pre mixing with wheat bran

Four concentrate mixtures A B C and D were formulated with the ingredients shown in Table 3 1 and their chemical composition in Table 3 2

Table 3 1 Percentage ingredient composition of concentrate diets

Ingredients		A	B	C	D
1	Rice polish	15	15	24	24
2	Wheat bran	15	15	22	22
3	Jowar	24	24	30	30
4	Groundnut cake	22	22	10	10
5	Coconut cake	22	22	12	12
6	Mineral mixture	1	1	1	1
7	Salt	1	1	1	1
8	Dried spleen	0	0 1	0	0 1
9	Calculated CP	20 06	20 06	15 26	15 26
10	Calculated TDN	68 2	68 2	69 6	69 6

Table 3 2 Nutrient composition of concentrate mixtures (per cent on drymatter basis) and grass (per cent as fed basis)

Nutrients	Concentrate mixture				Grass
	A	B	C	D	
Dry matter	88 46	88 45	87 92	87 83	21 47
Crude protein	20 25	20 86	14 73	15 33	1 81
Ether extract	6 36	6 24	6 73	6 75	0 31
Crude fibre	7 24	7 44	6 93	6 88	9 06
Ash	6 71	6 55	7 47	7 76	1 84
Nitrogen free extract	47 91	47 36	52 06	51 11	8 44
Acid insoluble ash	2 08	2 12	2 46	2 59	0 83
Neutral detergent fibre	37 81	36 86	36 61	36 22	17 18
Acid detergent fibre	11 23	11 05	10 60	10 25	12 54
Hemicellulose	26 58	25 82	26 01	25 98	4 83
Cellulose	7 97	7 76	7 38	7 14	9 82
Lignin	2 04	2 01	1 86	1 80	2 23
Silica	1 23	1 28	1 36	1 31	0 49
Calcium	0 82	0 84	0 87	0 88	0 11
Phosphorus	0 42	0 46	0 58	0 60	0 08
Magnesium mg/kg	1804	1826	1916	1924	4 93
Iron mg/kg	457 35	469 69	521 04	525 55	211 27
Copper mg/kg	14 21	15 86	10 69	11 04	1 26
Zinc mg/kg	49 71	43 22	54 46	52 74	15 48
Manganese mg/kg	52 80	55 60	70 30	68 30	13 39
Cobalt mg/kg	2 49	2 04	2 52	2 55	0 63

The four concentrate rations were fed to the calves in four groups as follows

Group I Ration A (20% crude protein)

Group II Ration B (20% crude protein and 0 1% dried buffalo spleen)

Group III Ration C (15% crude protein)

Group IV Ration D (15% crude protein and 0 1% dried buffalo spleen)

Napier grass (Pennisetum purpureum Linn) formed the roughage part of the ration The green fodder harvested from the same area and almost at the same stage of maturity was used for feeding of animals in all the groups to minimise variation in composition Representative samples of fodder used for feeding were analysed for their chemical composition and the data are presented in Table 3 2

The green fodder was fed in three divided lots everyday to ensure minimum wastage regularity and uniformity in feeding The fodder left over by each animal was collected and weighed separately everyday to find out the quantities actually consumed by individual animals

The calves were fed individually as per NRC Standard (1978) Their rations were revised once in 15 days based on body weight and weight gain

3.3 Methods

Every day at 8 am the animals were given a measured quantity of respective concentrate mixture followed by grass (ad libitum) The residue of concentrate and left over grass were removed quantitatively and weighed Individual records of daily intake of concentrate and grass were maintained Body weight and body measurements such as height at withers body length and chest girth were recorded once in 15 days

3.4 Haematological studies

Blood samples were collected once in thirty days Nine to ten millliliter of blood was collected in a sterile vial containing two milligram Disodium salt of ethylene diamine tetraacetic acid Packed cell volume was determined by Witrobe Haematocrit method Haemoglobin concentration was determined by Sahlis acid haematin method Erythrocyte countwas made using improved Neubauer counting chamber with 1 200 dilution of blood using physiological saline Leukocyte count was made by using Thomas fluid as the diluent with 1 20 dilution (Schalm 1961)

Serum total protein and albumin values were determined by biuret method (Gornall et al 1949) using total protein and albumen kit (Qualigens fine chemicals) Globulin values were calculated by substracting albumin from total protein

3.5 Analysis of rumen fluid

Towards the end of the experiment rumen fluid was collected and analyzed for pH ammonia levels and acetate propionate and butyrate concentrations It was collected between five to six hours after feeding concentrate Approximately 250 ml of fluid was aspirated using rumen pump and pH was determined immediately The rumen fluid was strained through four layers of cheese cloth and 0 5 ml of 50 per cent formic acid was added to every 100 ml of rumen fluid to arrest the fermentation It was stored in deep freezer until analysis (Krishna and Ranjhan 1991)

3 5 1 Determination of pH and ammonia

British Drug House (BDH) capillator with pH range 6 to 7 6 was used to determine the pH A micropipette was made by fixing the small rubber bulb to one end of a clean capillary tube It was filled to the mark with the indicator solution and transferred to a small watch glass Same quantity of rumen fluid was transferred and mixed The capillary tube was refilled with mixed fluid and the colour was matched with standard tubes

Ammonia content in the rumen fluid was estimated by Conway diffusion technique (Conway and Byrne 1933)

3 5 2 Estimation of volatile fatty acids

Analysis of volatile fatty acids was performed using Shimadzu High Performance Liquid Chromatograph (Samuel et al 1995) with the following instrument configuration and analytical conditions

a	Solvent pump	Shimadzu LC 8A
b	Detector	UV Spectrophotometric detector SPD 10 A (Shimadzu)
c	Column	Lichrosorb RP Select B (Merck)
	(i) Length	250 mm
	(ii) Internal diameter	4 mm
	(iii) Particle size	5 microns
d	Sample injector	Rheodyne sample injector with 20 ul loop
e	Solvent system	50 millimolar phosphate buffer pH 2 1
f	Flow rate	One ml per minute
g	Detection wavelength	210 nano meter

The phosphate buffer was prepared using Disodium hydrogen phosphate and Sodium dihydrogen phosphate in HPLC grade water and the pH of the solution was adjusted to 2 1 with orthophosphoric acid using a pH meter

The rumen fluid was clarified by adding one millilliter of 25 per cent Stannous chloride solution to two millilitre of rumen fluid to precipitate the colloidal matter After a lapse of 10 minutes the solution was filtered To one millilitre of filtrate 0 5 ml of 85 per cent Orthophosphoric acid was added

to precipitate excess Stannous chloride and was filtered again The clear solution was analysed by HPLC

A mixed standard solution of 40 mM acetate 20 mM propionate and 10 mM butryate was prepared This was done by diluting 0 24 ml of 99 5 per cent acetic acid 0 187 ml of 99 per cent propionic acid and 0 0936 ml of 98 per cent butyric acid and made up to one litre with phosphate buffer (50 mM pH 2 1)

Chromatogram obtained by injecting ten microlitre of standard solution is shown in Fig 3 1 The retention time for acetate propionate and butyrate was 4 36 9 41 and 23 83 minutes respectively The report on integration of peaks is given in Table 3 3 The peak areas for acetate propionate and butyrate were 783678 441154 and 187007 respectively The relationship between the quantity of fatty acid and peak area was worked out to calibrate the chromatographic system as shown in Table 3 4

To 100 ml of rumen fluid 0 5 ml of formic acid was added as preservative Two millilitre of preserved rumen fluid was diluted with one millilitre of Stannous chloride and filtered To one millilitre of the filtrate 0 5 ml of Orthophosphoric acid was added and refiltered resulting in a dilution of 2 26125 times The data on volatile fatty acids obtained were multiplied by the dilution factor to obtain the concentration of volatile fatty acids in rumen fluid

FIG.3.1 CHROMATOGRAM OF VOLATILE FATTY ACIDS (standard)

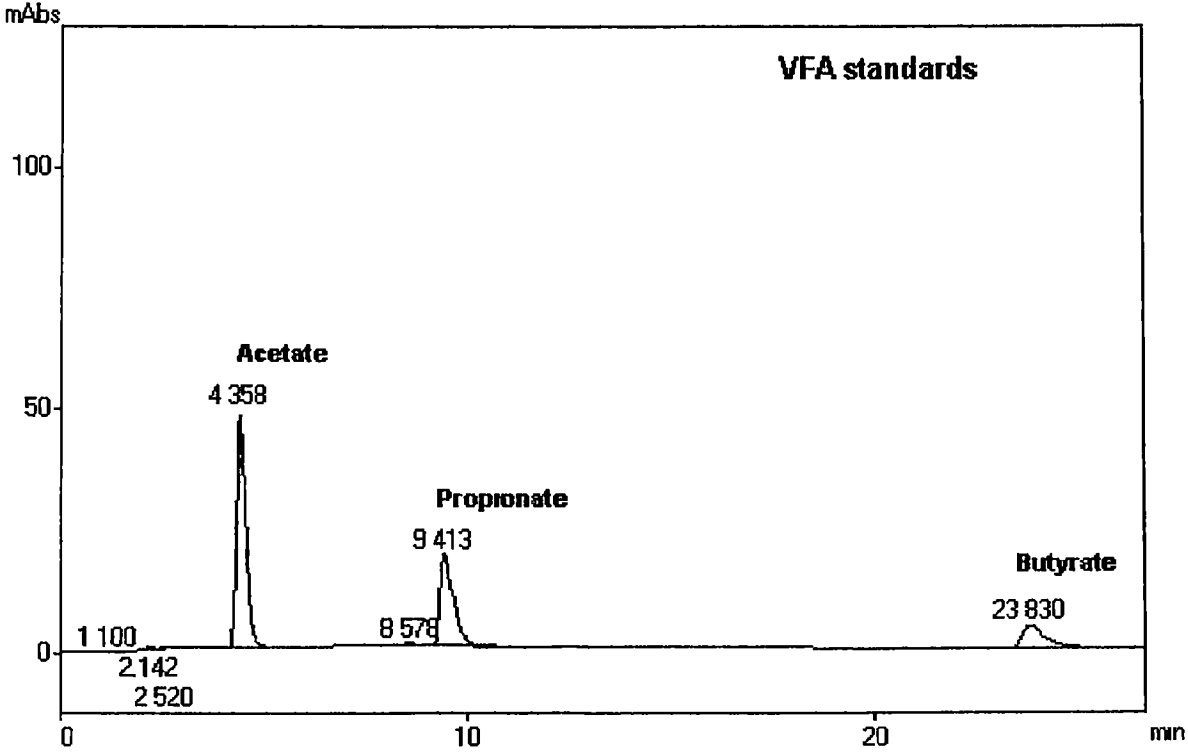


Table 3 3 Peak report of volatile fatty acid standard

RP Select B column 210 nm Method VFA MTD
Flow rate 1 ml/min
Solvent system 50 mM phosphate buffer pH 2 1
10 ul Acetic 40 mM + Propionic 20 mM + Butyric 10 mM

Peak No	Time	Area	Height	Con (%)	Name
1	2 142	5043	461	0 3492	
2	2 520	8553	482	0 5922	
3	4 358	783678	48635	54 2612	Acetate
4	8 578	18835	436	1 3041	
5	9 413	441154	19141	30 5451	Propionate
6	23 830	187007	4745	12 9482	Butyrate
		1444269	73900	100 0000	

Table 3 4 Calibration of chromatographic system

		Acetate	Propionate	Butyrate
1	Strength of VFA in standard solution (mM)	40	20	10
2	Volume of standard solution injected (ul)	10	10	10
3	Quantity of VFA in the solution injected (mM)	$4x10^{4}$	$2x10^{4}$	$1x10^{4}$
4	Peak area obtained (units)	783678	441154	187007
5	Calibration factor	$5\ 1041x10^{0}$	$4\ 5336x10^{10}$	$5\ 3474x10^{0}$

To estimate the recovery of volatile fatty acids a pooled sample of rumen fluid was processed and analysed as described above (Fig 3 2 and Table 3 5) Another two millilitre portion of the fluid was mixed with one millilitre of the standard solution containing 40 mM acetate 20 mM propionate and 10 mM butyrate per litre and analysed in the same manner (Fig 3 3 and Table 3 6) From the data obtained for acetate propionate and butyrate in unfortified and fortified samples recovery of each acid was calculated and expressed as percentage (Table 3 7)

Table 3 7 Calculation of recovery of volatile fatty acids

	Acetate	Propionate	Butyrate
1 Quantity in 20 ul of unfortified sample (mM)	$2\ 913 \times 10^{4}$	$7\ 537 \times 10^{5}$	$4\ 962 \times 10^{5}$
2 Quantity in 20 ul of fortified sample (mM)	$4\ 815 \times 10^{4}$	$1\ 5434 \times 10$	$9\ 8828 \times 10^{5}$
3 Estimated quantity of volatile fatty acid (mM) used for fortification (1 2)	$1\ 9022 \times 10^{4}$	$7\ 897 \times 10^{5}$	$4\ 9208 \times 10^{5}$
4 Actual quantity of volatile fatty acid used for fortification (mM)	$1\ 7689 \times 10^{4}$	$8\ 8447 \times 10^{5}$	$4\ 4223 \times 10^{5}$
Recovery (%)	107 53	89 29	111 271

FI.3.2 CHROMATOGRAM OF VOLATILE FATTY ACIDS~UNFORTIFIED RUMEN FLUID

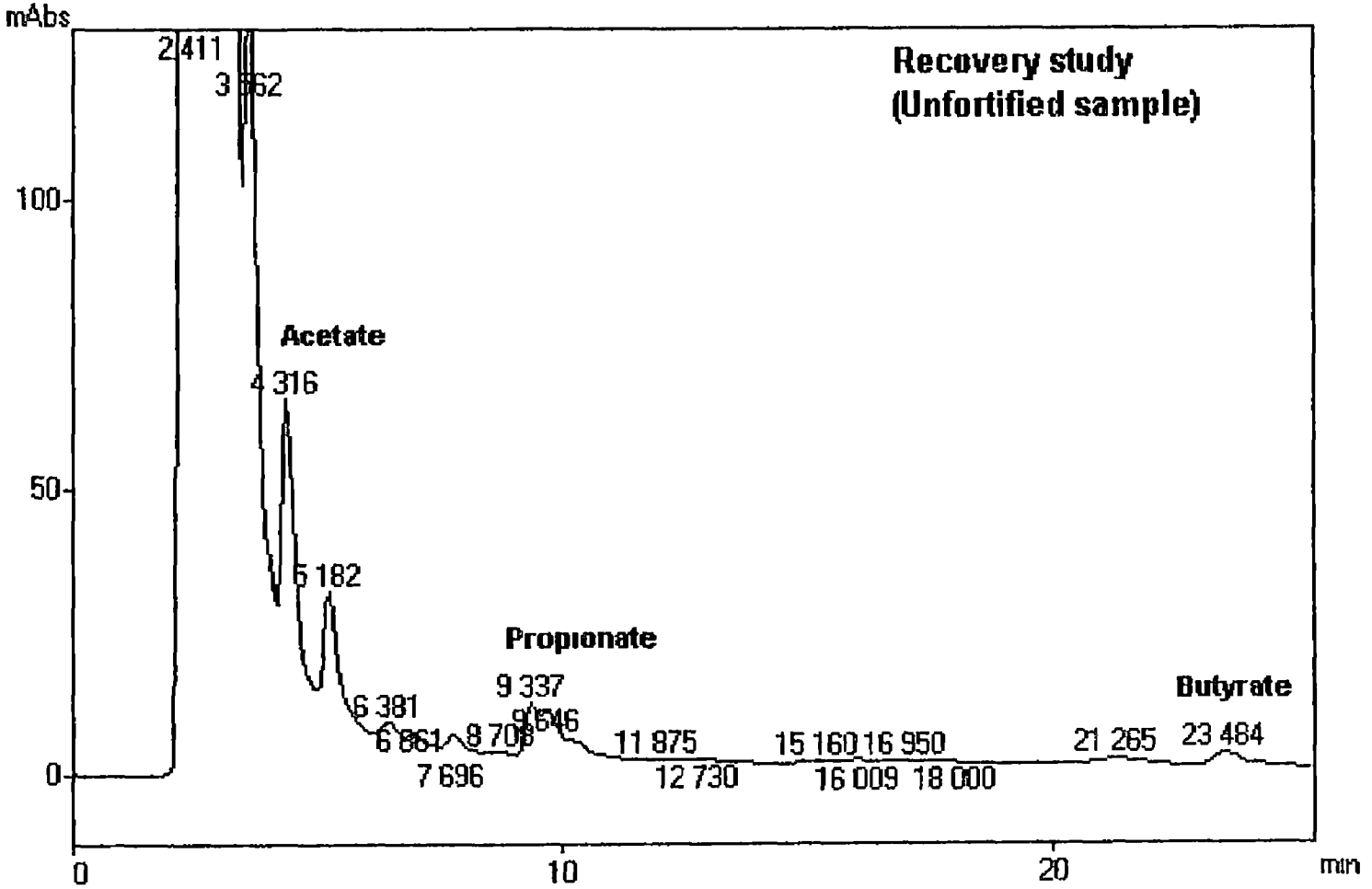


Table 3 5 Peak report of unfortified rumen fluid

RP Select B column 210 nm Method VFA MTD
Solvent system 50 mM phosphate buffer pH 2 1
Recovery expt Unfortified sample
Control 2 ml RF + 1 ml DW + 0 5 ml H3PO4
Sample volume 20 ul

Peak No	Time	Area	Height	Con (%)	Name
1	2 415	147778693	2924062	98 4864	
2	3 562	639756	54611	0 4264	
3	4 310	570740	39221	0 3804	Acetate
4	5 179	327189	17742	0 2181	
5	6 380	48894	2520	0 0326	
6	6 862	19379	1253	0 0129	
7	7 692	43216	2244	0 0288	
8	8 697	1855	158	0 0012	
9	9 335	166258	8993	0 1108	Propionate
10	9 649	186785	8166	0 1245	
11	10 137	71539	2773	0 0477	
12	12 092	1076	92	0 0007	
13	12 308	1285	122	0 0009	
14	12 738	13769	330	0 0092	
15	15 154	7788	295	0 0052	
16	16 008	8843	355	0 0059	
17	16 936	9521	308	0 0063	
18	21 264	60563	937	0 0404	
19	23 485	92787	2289	0 0618	Butyrate
		150049935	3067469	100 0000	

FIG.3.3 CHROMATOGRAM OF VOLATILE FATTY ACIDS-FORTIFIED RUMEN FLUID

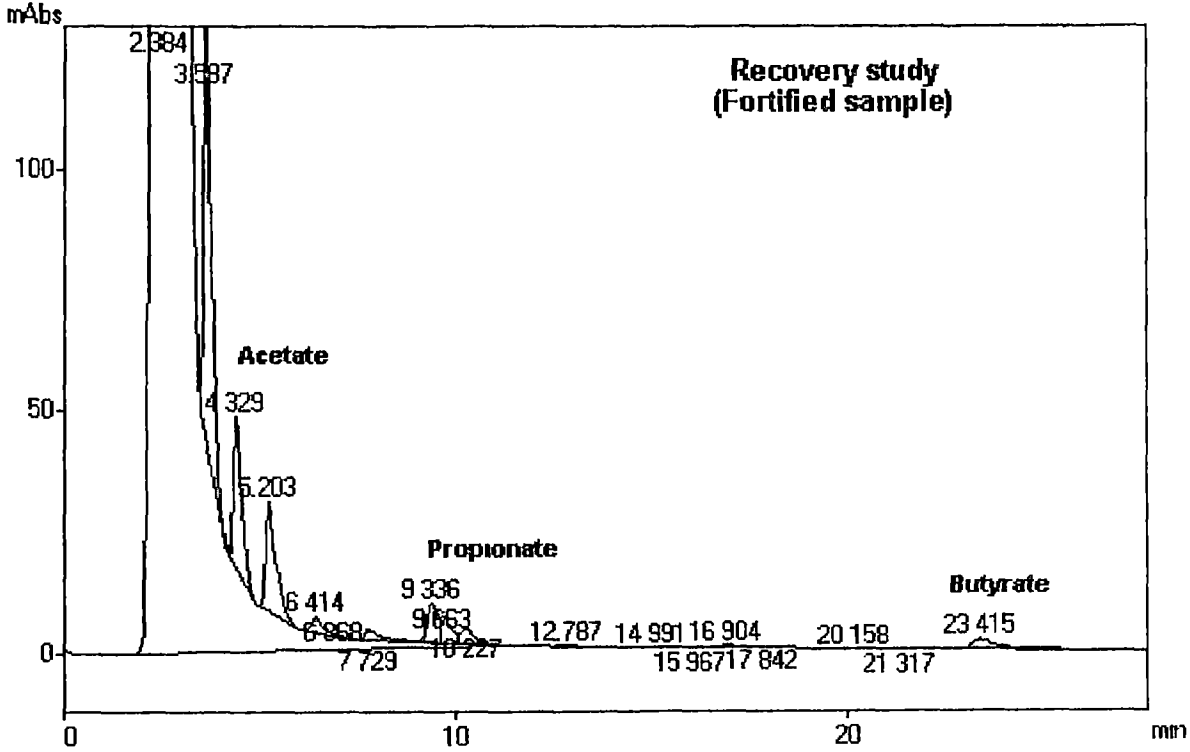


Table 3 6 Peak report of fortified rumen fluid

RP Select B column 210 nm Method VFA MTD
Solvent system 50 mM phosphate buffer pH 2 1
Recovery expt Fortified sample
2 ml RF + 1 ml 40 20 10 Std + 0 5 H3PO4
Sample volume 10 ul

Peak No	Time	Area	Height	Con (%)	Name
1	2 384	108703340	2809904	97 4653	
2	3 587	1315742	103477	1 1797	
3	4 329	471700	3023	0 4229	Acetate
4	5 203	391299	22601	0 3508	
5	6 414	65258	3348	0 0585	
6	6 868	10752	751	0 0096	
7	7 729	65001	2246	0 0583	
8	9 336	170216	8430	0 1526	Propionate
9	9 663	107217	5608	0 0961	
10	10 227	86775	3124	0 0778	
11	12 787	6931	185	0 0062	
12	14 991	10412	304	0 0093	
13	15 967	7819	297	0 0070	
14	16 904	18294	533	0 0164	
15	17 842	7128	205	0 0064	
16	23 415	92407	2151	0 0829	Butyrate
		111530292	2993834	100 0000	

Rumen fluid from individual animal was processed and analysed as mentioned above Presence of volatile fatty acids in the unknown samples was indicated by a peak at the retention time of the particular volatile fatty acid The quantity of volatile fatty acid was calculated by multiplying the peak area in the sample with the calibration factor for the particular volatile fatty acid This value was corrected for recovery and dilution

3.6. Digestibility coefficients

Towards the end of the feeding experiment a digestion trial was carried out with all the animals in the four groups allowing a collection period of seven days in each case

Representative samples of both concentrate and roughage were taken everyday during the trial for proximate analysis The dry matter content of the feed was determined everyday All precautions were taken to ensure the collection of dung quantitatively uncontaminated by urine or by any feed residue or dirt The dung was collected manually as and when it was voided At 8 am every day the dung collected during the previous 24 hours was weighed accurately mixed thoroughly and representative samples at the rate of one per cent of the total voided quantity was taken and stored in a deep freezer The process of collection weighing and sampling of dung was continued till the end of the trial The pooled sample of seven days collection was analysed

Feed samples left over grass and dung collected during the digestion trial were subjected to proximate analysis as per standard procedure (AOAC 1990) Samples were also analysed for neutral detergent fibre (Vansoest and Wine 1967) and Acid detergent fibre (AOAC 1990) Calcium magnesium zinc copper manganese cobalt and iron contents were also estimated by using atomic absorption spectrophotometer (Parkin Elmer model 2380) and phosphorus by calorimetry (Ward and Johnston 1962)

Statistical analysis of the data were carried out using the statistical software MStat

Results

RESULTS

The results obtained during the course of the present investigation are detailed under the following topics

4.1 Body weight

The fortnightly body weights of the animals recorded during the entire period of the study are presented in Table 4 1 to 4 4 The statistical analysis of the data on monthly weight gain and cumulative weight gain are set out in Table 4 5

4.2 Body measurements

The summarised data on fortnightly height at withers body length and chest girth are detailed in Table 4 6 4 8 and 4 10 respectively The statistical analyses of changes in height at withers body length and chest girth are listed in Table 4 7 4 9 and 4 11 respectively

4.3 Dry matter intake

The average daily dry matter consumption during the period of 12 fortnights of study are summarised in Table 4 12 and their statistical analysis in Table 4 13

4.4 Feed efficiency

Fortnightly feed efficiency values of the four experimental groups are set out in Table 4 14 and their statistical analysis in Table 4 15

4.5 Protein efficiency

Data on fortnightly protein efficiency are tabulated in Table 4 16 and their statistical analysis in Table 4 17

4.6 Cost per unit gain

Data on cost per unit gain are tabulated in Table 4 18

Summarised data on body weights weight gain dry matter intake feed efficiency protein efficiency and cost per unit gain of animals are given in Table 4 19

4.7 Haematological values

Summarised data on monthly haematological parameters viz packed cell volume haemoglobin erythrocyte count leukocyte count serum total protein serum albumin serum globulin and albumin globulin ratio of calves maintained on

experimental rations are set out in Tables 4 20 4 22 4 24 4 26 4 28 4 30 4 32 and 4 34 and their statistical analysis in Tables 4 21 4 23 4 25 4 27 4 29 4 31 4 33 and 4 35 respectively

4.8 Rumen fermentation characters

The data on volatile fatty acid concentration ammonia concentration and pH of the rumen fluid collected from the experimental animals are set out in Tables 4 36 to 4 39 and their statistical analysis in Table 4 40

4.9 Nutrient digestibility

The data on digestibility coefficients of dry matter crude protein ether extract crude fibre nitrogen free extract neutral detergent fibre acid detergent fibre hemicellulose cellulose and lignin in calves maintained on experimental rations are set out in Tables 4 41 to 4 44 the consolidated data on the above in Table 4 45 and their analysis of variance in Table 4 46

Summarised data on average daily intake of drymatter total digestible nutrients crude protein digestible crude protein per 100 kg body weight are set out in Table 4 47

Table 4 1 Fortnightly body weights (kg) of calves maintained on ration A (Group I)

Fortnights	Replicate					Average with S E
	1	2	3	4	5	
0	105	86	79	90	76	87 2 ± 4 5
1	118	94	90	97	82	96 5 ± 5 4
2	128	102	93	101	87	102 3 ± 6 3
3	137	115	103	112	93	112 0 ± 6 5
4	151	123	113	117	101	121 0 ± 7 4
5	162	135	123	124	109	130 6 ± 7 9
6	176	148	136	136	117	142 6 ± 8 6
7	184	159	147	144	125	151 8 ± 8 7
8	194	169	157	151	134	161 0 ± 8 9
9	205	180	170	160	140	171 0 ± 9 6
10	214	190	185	172	148	181 8 ± 9 7
11	224	201	197	180	155	191 0 ± 10 2
12	235	210	207	191	163	201 2 ± 10 6

Table 4 2 Fortnightly body weights (kg) of calves maintained on ration B (Group II)

Fortnights	Replicate					Average with S E
	1	2	3	4	5	
0	100	90	78	104	80	90 4 + 4 6
1	117	103	88	111	87	101 3 ± 5 3
2	129	112	100	120	92	110 8 ± 5 8
3	140	127	101	126	100	118 8 ± 7 0
4	150	139	116	136	109	130 0 ± 6 7
5	157	151	123	142	120	138 6 ± 6 6
6	171	160	136	155	131	150 6 ± 6 6
7	182	170	146	166	141	161 0 ± 6 8
8	192	183	156	174	150	171 0 ± 7 1
9	200	194	165	184	161	180 8 ± 6 9
10	209	204	179	195	170	191 4 ± 6 6
11	220	214	188	202	179	200 6 ± 6 8
12	231	225	197	211	189	210 6 ± 7 1

Table 4 3 Fortnightly body weights (kg) of calves maintained on ration C (Group III)

Fortnights	Replicate					Average with S E
	1	2	3	4	5	
0	96	90	79	106	77	89 6 ± 4 8
1	106	100	89	118	83	99 3 ± 5 5
2	116	110	96	130	88	108 0 + 6 6
3	129	120	105	141	93	117 6 ± 7 6
4	140	122	112	152	100	125 3 ± 8 3
5	148	134	120	160	106	133 8 ± 8 5
6	157	148	134	171	114	144 8 ± 8 7
7	164	159	142	180	121	152 3 ± 9 0
8	170	166	149	186	130	160 2 + 8 5
9	175	177	161	196	137	169 2 ± 8 7
10	187	185	168	205	145	178 1 ± 9 0
11	196	194	175	214	152	186 2 ± 9 4
12	205	202	184	222	160	194 6 ± 9 4

Table 4 4 Fortnightly body weights (kg) of calves maintained on ration D (Group IV)

Fortnights	Replicate					Average with S E
	1	2	3	4	5	
0	103	88	83	76	90	88 0 ± 3 9
1	112	101	93	88	97	98 3 ± 3 6
2	123	110	104	91	103	106 3 ± 4 6
3	129	119	111	98	112	113 8 ± 5 2
4	142	125	123	105	125	124 0 ± 5 2
5	147	133	126	111	133	130 0 ± 5 2
6	158	147	138	125	141	141 8 ± 4 8
7	163	153	148	132	149	149 0 ± 4 4
8	169	164	155	143	160	158 2 ± 3 9
9	175	172	162	153	169	166 2 ± 3 5
10	184	182	174	164	180	176 9 ± 3 2
11	192	191	185	171	190	185 8 ± 3 4
12	201	200	195	180	199	195 0 ± 3 4

FIG 4 1 AVERAGE FORTNIGHTLY BODY WEIGHT(Kg) OF CALVES IN THE FOUR GROUPS

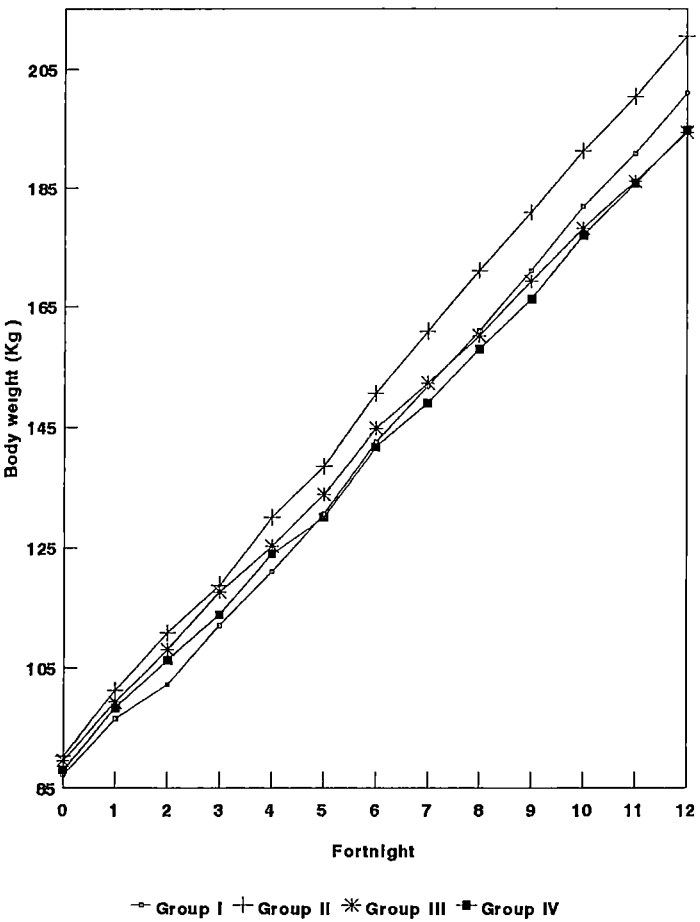


Table 4 5 Analysis of covariance Monthly weight gain and 180 day cumulative weight gain

Months	Monthly mean sum of squares			
	Replication	Treatment	Covariate	Error
1	41 50	18 73	23 15	10 83
2	9 93	3 48	44 58	18 52
3	21 43	13 24	0 15	9 16
4	6 72	24 55*	0 02	4 91
5	17 14	10 47	0 02	6 39
6	6 87	23 48*	13 11	2 85
180 day cumulative weight gain	289 83	280 51	201 04	125 60

* Significant at 5 per cent level

** Significant at 1 per cent level

FIG 4 2 THE AVERAGE DAILY WEIGHT GAIN (gms) OF CALVES IN THE FOUR GROUPS

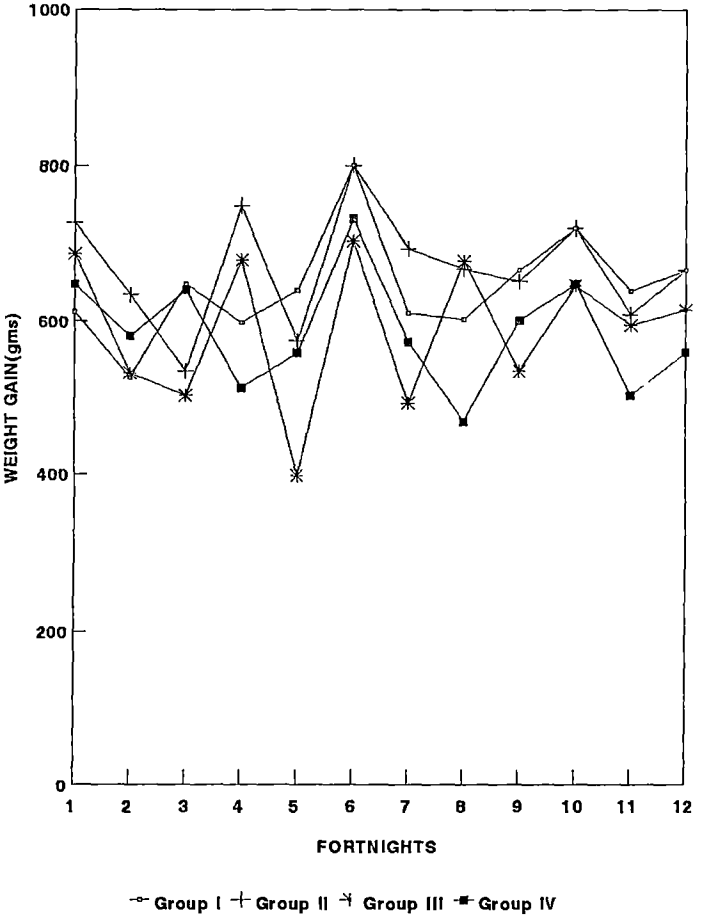


Table 4 6 Mean height (cm) at withers of calves maintained on four dietary regimes

Fortnights	Treatments			
	Ration A	Ration B	Ration C	Ration D
0	90 2±1 5	93 6±1 6	91 8±1 7	93 4±2 5
1	92 6±1 8	96 0±1 9	94 4±2 5	96 0±2 7
2	93 8±1 7	97 0±1 6	95 4±2 2	96 2±2 2
3	95 4±2 0	97 6±1 3	96 4±2 0	97 2±2 0
4	97 2±1 5	99 8±1 2	98 0±1 7	98 2±1 7
5	98 2±1 5	101 6±1 2	100 8±1 7	100 0±1 7
6	99 4±1 2	104 0±1 3	102 6±2 1	101 6±1 3
7	101 8±1 6	107 0±1 2	103 6±1 9	102 0±1 4
8	104 2±1 9	108 4±1 4	105 2±1 7	103 8±1 2
9	106 2±2 6	109 8±1 3	106 4±1 9	106 0±1 0
10	107 4±2 8	111 0±1 5	108 4±2 4	108 4±0 5
11	108 4±2 6	111 6±1 5	109 4±2 3	109 4±0 5
12	109 2±2 8	112 4±1 4	110 6±2 6	110 6±0 4

Table 4 7 Analysis of variance Change in height (cm)

Source	Degrees of freedom	Sum of squares	Mean square	F value	Probability
Replication	4	74 70	18 68	0 890	
Treatment	3	10 55	3 52	0 168	
Error	12	251 70	20 97		

Table 4 8 Mean body length (cm) of calves maintained on four dietary regimes

	Treatments			
Fortnights	Ration A	Ration B	Ration C	Ration D
0	94 8±2 4	99 6±3 2	95 6±3 7	96 2±1 1
1	96 6±2 7	103 2±2 6	100 2±3 2	97 8±1 2
2	98 6±2 3	105 0±2 5	102 2±3 1	98 6±1 2
3	100 8±1 6	107 0±2 2	103 4±2 9	101 2±1 4
4	103 8±1 1	108 4±2 1	105 8±2 7	104 0±1 3
5	105 2±0 7	110 4±2 1	108 2±2 7	106 8±1 4
6	107 2±0 9	113 2±2 2	110 8±2 9	108 8±1 1
7	109 8±0 6	114 6±2 4	113 2±2 6	111 2±0 4
8	112 8±1 2	116 4±2 2	115 0±2 4	112 8±0 2
9	115 8±1 6	118 4±2 4	117 2±2 7	114 8±0 8
10	117 4±1 2	119 6±2 2	120 4±3 0	117 6±1 1
11	118 8±1 2	120 0±2 5	121 6±3 3	118 2±1 0
12	119 8±2 5	122 0±2 8	122 8±3 4	119 8±1 2

Table 4 9 Analysis of variance Change in body length (cm)

Source	Degrees of freedom	Sum of squares	Mean square	F value	Probability
Replication	4	74 00	18 50	0 691	
Treatment	3	88 55	29 517	1 103	0 386
Error	12	321 20	26 767		

Table 4 10 Mean chest girth (cm) of calves maintained on four dietary regimes

Fortnights	Treatments			
	Ration A	Ration B	Ration C	RationD
0	104 4±2 9	106 6±2 5	105 0±3 2	105 4±2 5
1	107 2±2 5	108 8±2 6	109 8±3 3	109 0±2 5
2	109 2±2 8	111 8±3 1	111 4±3 5	111 0±2 8
3	112 8±3 0	116 6±3 3	114 0±3 3	112 6±2 5
4	115 4±3 4	119 0±2 7	117 2±3 2	116 0±2 9
5	118 6±3 3	121 6±2 4	119 8±2 9	118 8±3 4
6	122 6±3 5	125 0±2 4	122 6±3 1	122 4±3 7
7	125 4±3 1	126 8±1 9	125 4±3 6	125 6±2 9
8	127 2±3 2	128 4±2 0	127 2±3 9	128 0±1 6
9	129 4±3 6	130 6±2 2	129 2±4 0	129 8±1 7
10	133 2±4 2	132 6±2 5	132 6±3 6	132 8±1 9
11	134 4±4 0	134 2±2 6	135 4±3 7	134 4±1 9
12	136 0±4 0	135 8±2 4	137 8±3 7	136 4±2 1

Table 4 11 Analysis of variance Change in chest girth (cm)

Source	Degrees of freedom	Sum of squares	Mean square	F value	Probability
Replication	4	35 80	8 95	0 918	
Treatment	3	33 75	11 25	1 154	0 367
Error	12	117 00	9 75		

Table 4 12 Average daily dry matter intake (kg) of the animals maintained on the experimental rations A B C and D

Days	Treatments			
	Ration A	Ration B	Ration C	Ration D
0 14	4 07 ±0 10	4 16 ±0 11	4 10 ±0 10	4 20 ±0 04
15 29	4 19 +0 13	4 42 ±0 11	4 36 ±0 29	4 37 ±0 03
30 44	4 23 ±0 06	4 52 ±0 06	4 42 ±0 14	4 43 +0 03
45 59	4 61 ±0 19	4 94 ±0 18	4 61 ±0 10	4 59 ±0 09
60 74	4 93 ±0 19	4 95 +0 18	4 82 +0 14	4 70 +0 11
75 89	4 93 +0 14	4 93 ±0 23	4 96 ±0 15	4 97 ±0 19
90 104	5 20 ±0 18	5 10 ±0 19	5 15 +0 16	5 15 ±0 14
105 119	5 52 ±0 28	5 55 ±0 23	5 48 ±0 21	5 26 ±0 18
120 134	5 59 +0 14	5 57 ±0 17	5 57 ±0 20	5 56 ±0 13
135 149	5 68 +0 14	5 70 ±0 09	5 69 +0 12	5 76 ±0 13
150 164	5 78 ±0 08	5 74 ±0 07	5 69 ±0 07	5 71 ±0 12
165 179	5 83 ±0 14	5 82 ±0 07	5 81 ±0 07	5 77 ±0 10
Mean+SE	5 05 +0 29	5 12 ±0 25	5 05 ±0 26	5 04 ±0 25

FIG 4 3 AVERAGE DAILY DRYMATTER CONSUMPTION(Kg) OF THE ANIMALS MAINTAINED ON THE FOUR RATIONS

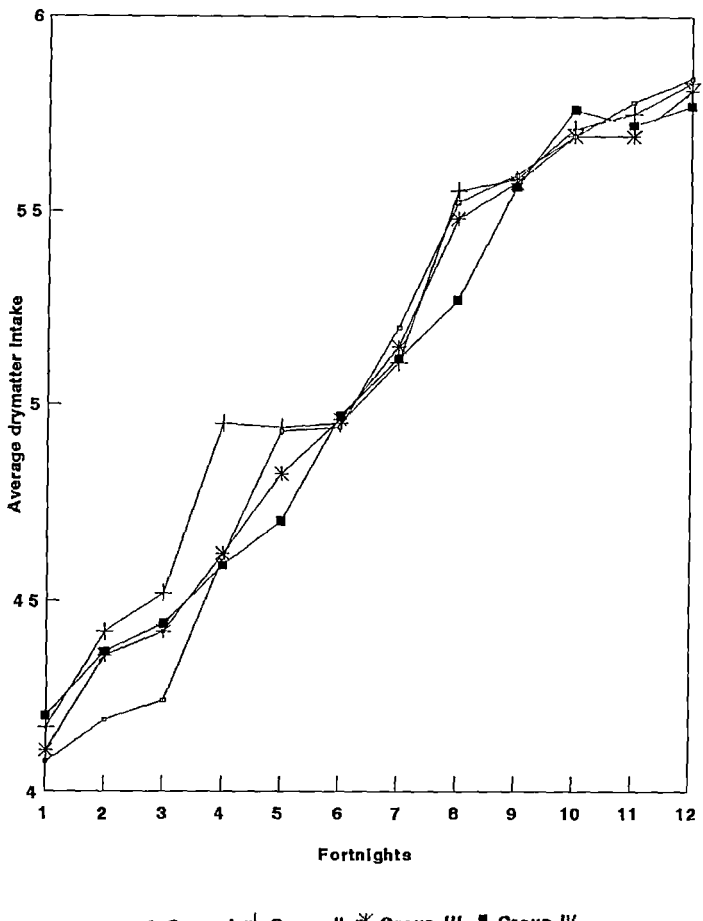


Table 4 13 Analysis of variance Average daily drymatter intake

Source	Degrees of freedom	Sum of squares	Mean square	F value	Probability
Period	11	15 463	1 406	214 326**	0 0001
Treatment	3	0 046	0 015	2 36	0 089
Error	33	0 216	0 007		

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 4 14 Average fortnightly feed efficiency of the animals maintained on the four dietary regimes

Fortnighs	Treatments			
	Ration A	Ration B	Ration C	Ration D
1	6 44	5 74	6 35	6 12
2	10 84	6 98	7 52	8 20
3	6 56	6 06	6 91	8 87
4	7 68	6 63	7 96	6 76
5	7 71	8 64	8 51	11 76
6	6 17	6 17	6 77	6 32
7	8 48	7 37	10 30	10 74
8	9 01	8 33	10 41	8 58
9	8 39	8 54	9 29	10 42
10	7 90	8 08	9 59	8 08
11	9 43	9 37	10 55	9 64
12	8 58	8 74	10 38	9 41
Mean±SE	8 09± 0 60	7 55± 0 54	8 71± 0 70	8 74± 0 79

FIG 4 4 AVERAGE FORTNIGHTLY FEED EFFICIENCY OF THE ANIMALS MAINTAINED ON THE FOUR DIETARY REGIMES

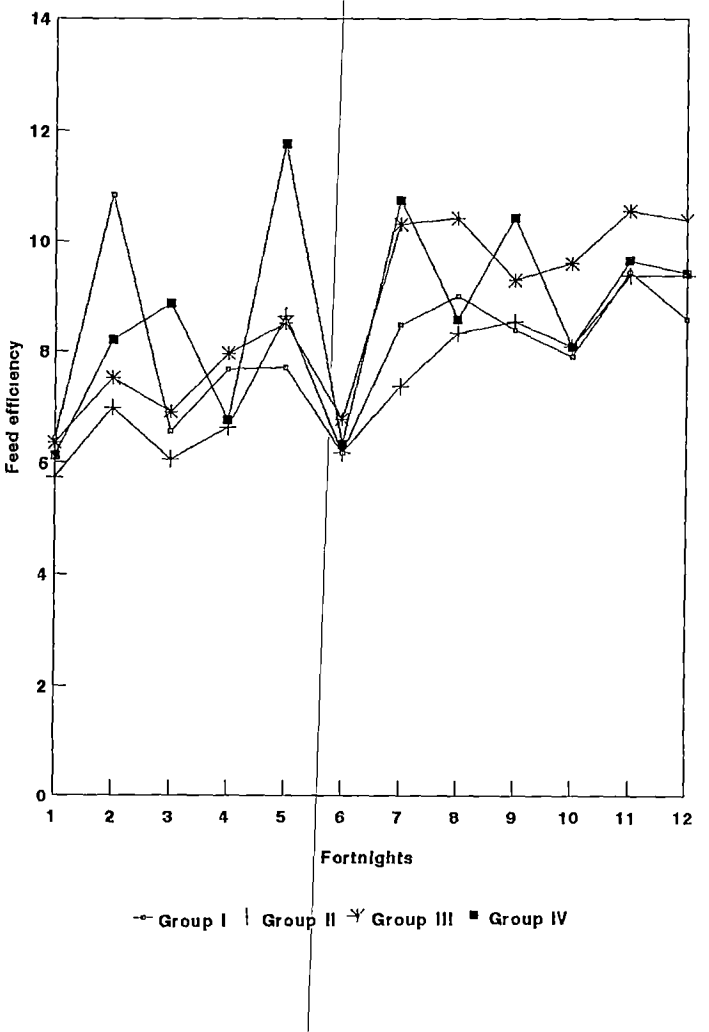


Table 4 15 Analysis of variance Feed efficiency

Source	Degrees of freedom	Sum of squares	Mean square	F value	Probability
Period	11	67 47	6 13	6 61**	0 00001
Treatment	3	11 51	3 84	4 13*	0 014
Error	33	30 61	0 93		

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 4 16 Average fortnightly protein efficiency of the animals maintained on the four dietary regimes

Fortnighs	Treatments			
	Ration A	Ration B	Ration C	Ration D
1	0 932	0 842	0 760	0 731
2	1 576	1 015	0 876	0 993
3	0 961	1 254	0 829	1 083
4	1 129	0 957	0 979	0 845
5	1 097	1 276	1 027	1 483
6	0 893	0 920	1 237	0 770
7	1 213	1 097	1 233	1 310
8	1 275	1 206	1 224	1 039
9	1 189	1 238	1 088	1 264
10	1 109	1 165	1 121	0 964
11	1 322	1 362	1 260	1 180
12	1 219	1 266	1 242	1 155
Mean±SE	1 159± 0 084	1 133± 0 074	1 073± 0 080	1 068± 0 100

FIG 4 5 AVERAGE FORTNIGHTLY PROTEIN EFFICIENCY OF ANIMALS MAINTAINED ON THE FOUR DIETARY REGIMES

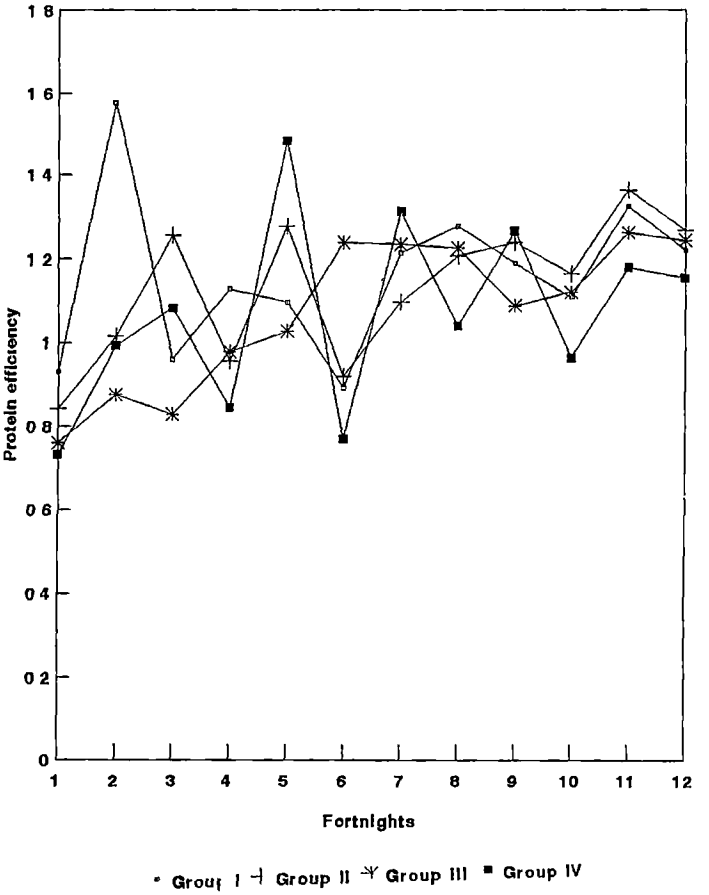


Table 4 17 Analysis of variance Protein efficiency

Source	Degrees of freedom	Sum of squares	Mean square	F value	Probability
Period	11	0 845	0 077	3 375**	0 003
Treatment	3	0 073	0 024	1 074	0 374
Error	33	0 751	0 023		

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 4 18 Data on cost of production per kg gain (Rs) of the animals maintained on the four dietary regimes

	Treatments			
	Ration A	Ration B	Ration C	Ration D
Average total weight gain (kgs)	114±7 62	120 2±5 05	103±5 48	107±5 37
Average total feed intake kg				
Concentrate	410 84	411 78	412 86	411 38
Grass	2609 96	2630 62	2597 96	2624 14
Total feed cost (Rs)	2434 87	2851 62	2628 95	2634 98
Cost per kg gain(Rs)	24 87	23 72	25 52	24 63

Cost of concentrate

Ration A	Rs 531 20 per 100 kg
Ration B	Rs 532 89 per 100 kg
Ration C	Rs 479 45 per 100 kg
Ration D	Rs 481 05 per 100 kg
Cost of grass	Rs 25 per 100 kg

Table 4 19 Summarised data on initial body weights final body weights cumulative weight gain daily weight gain daily dry matter intake feed efficiency protein efficiency and cost per unit gain of calves maintained on the four rations for a period of 180 days

	Treatments			
	Ration A	Ration B	Ration C	Ration D
Initial body weight (kg)	87 200± 4 55	90 400+ 4 64	89 600± 4 82	88 000± 3 99
Final body weight (kg)	201 200± 10 62	210 600± 7 14	194 600± 9 43	195 000± 3 47
Cumulative weight gain (kg)	114 000± 7 62	120 200± 5 05	103 000± 5 48	107 000± 2 40
Average daily gain (kg)	0 633± 0 047	0 667± 0 031	0 572± 0 034	0 594± 0 014
Average daily dry matter consumption (kg)	5 051± 0 291	5 123± 0 251	5 059+ 0 266	5 043+ 0 259
Average cumulative feed efficiency	8 099± 0 600	7 554± 0 550	8 712± 0 700	8 742+ 0 790
Average cumulative protein efficiency	1 160± 0 084	1 133± 0 074	1 073± 0 080	1 068± 0 100
Cost per unit gain (Rs)	24 87	23 72	25 52	24 63

Table 4 20 Monthly data on mean packed cell volume (per cent) of calves maintained on experimental rations

Months	Treatments			
	Ration A	Ration B	Ration C	Ration D
0	30 28±1 00	30 75±0 92	29 92±0 86	30 60±0 78
1	30 31±1 10	31 16±0 44	29 47±0 60	30 36±0 87
2	30 31±0 78	31 12±0 48	29 23±0 48	30 37±0 62
3	30 40±0 92	31 36±0 62	29 62±0 61	30 41±0 48
4	31 10±0 42	32 00±0 90	30 72±0 72	30 67±0 74
5	31 39+0 68	32 33±0 86	31 38±0 38	31 38±0 29
6	32 26+0 55	32 63+0 81	31 84+0 43	31 51+0 28

Table 4 21 Factorial analysis of variance Packed cell volume

Source	Monthly mean sum of square						
	0	1	2	3	4	5	6
Replication	2 619	1 066	0 894	1 240	2 546	2 141	4 809
Protein	0 343	3 289	4 223	3 741	3 707	1 147	15 700
Spleen	1 647	3 707	4 792	3 811	0 903	1 100	5 222
Interaction (Protein x Spleen)	0 056	0 001	0 133	0 043	1 119	1 128	2 139
Error	2 872	3 147	3 578	1 691	1 079	2 433	6 851

Table 4 22 Monthly data on mean haemoglobin concentration (g/100 ml) of calves maintained on experimental rations

Months	Treatments			
	Ration A	Ration B	Ration C	Ration D
0	11 24±0 12	11 76±0 08	11 08±0 12	11 00±0 22
1	11 12±0 10	11 90±0 10	10 92±0 12	10 72±0 18
2	11 08±0 16	11 84±0 09	11 04±0 10	10 42±0 16
3	11 06±0 10	12 08±0 12	11 28±0 09	10 44±0 11
4	11 06±0 10	12 08±0 13	11 44±0 80	10 64±0 10
5	11 24±0 22	11 68±0 06	11 40±0 07	11 04±0 14
6	11 40±0 43	11 76±0 10	11 52±0 12	11 04±0 10

Table 4 23 Factorial analysis of variance Haemoglobin concentration

Source	Monthly mean sum of square						
	0	1	2	3	4	5	6
Replication	0 683	0 307	0 472	0 284	0 317	0 692 *	0 963 **
Spleen	0 242	0 421	0 084	0 032	0 098	0 008	0 018
Protein	1 058	2 380 *	2 245 *	2 592 *	1 250 *	0 288	0 450
Interaction (Protein x Spleen)	0 450	1 201	2 812	4 232	4 418	0 800	1 882
Error	0 328	0 283	0 368	0 375	0 190	0 205	0 168

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 4 24 Monthly data on mean erythrocyte count (millions per mm^3) of calves maintained on experimental rations

Months	Treatments			
	Ration A	Ration B	Ration C	Ration D
0	7 86±0 25	7 60±0 30	7 74±0 22	7 78±0 20
1	7 68±0 28	7 75±0 26	7 63±0 28	7 50±0 16
2	7 49±0 14	7 48±0 18	7 16±0 16	7 09±0 21
3	7 35±0 18	7 34±0 26	6 89±0 08	6 88+0 17
4	7 27±0 26	7 15±0 38	6 78±0 08	6 73±0 28
5	7 15±0 20	7 24±0 26	6 51±0 16	6 71±0 31
6	7 19±0 14	7 19±0 31	6 69±0 30	6 61±0 29

Table 4 25 Factorial analysis of variance Erythrocyte count

Source	Monthly mean sum of square						
	0	1	2	3	4	5	6
Replication	0 634	0 358	0 504	0 186	0 483	0 207	0 324
Protein	0 003	0 105	0 648	1 058 *	1 026	1 711 *	1 469
Spleen	0 056	0 004	0 007	0 000	0 036	0 105	0 006
Interaction (Protein x Spleen)	0 112	0 051	0 004	0 000	0 008	0 019	0 007
Error	0 219	0 278	0 233	0 193	0 222	0 268	0 210

* Significant at 5 per cent level

Table 4 26 Monthly data on mean leukocyte count (thousands per mm^3) of calves maintained on experimental rations

Months	Treatments			
	Ration A	Ration B	Ration C	Ration D
0	7 84±0 07	7 98±0 26	7 96±0 22	7 94±0 10
1	8 28±0 22	8 04+0 18	8 24±0 18	8 04±0 11
2	7 99±0 18	8 42±0 10	7 68±0 28	8 14±0 19
3	8 16±0 09	8 16±0 26	8 20±0 21	8 31±0 16
4	8 32±0 11	8 21+0 22	8 58±0 18	8 21±0 22
5	8 21±0 12	8 08±0 10	7 92±0 12	8 62±0 23
6	8 18±0 09	8 10±0 11	8 36±0 16	8 18+0 23

Table 4 27 Analysis of variance Leukocyte count

Source	Monthly mean sum of square						
	0	1	2	3	4	5	6
Treatment	0 021	0 045	0 083	0 034	0 007	0 197	0 139
Error	0 069	0 078	0 163	0 137	0 099	0 107	0 105

Table 4 28 Monthly data on mean serum total protein (g/100 ml) of calves maintained on the experimental rations

Months	Treatments			
	Ration A	Ration B	Ration C	Ration D
0	6 13±0 14	6 16±0 20	6 22±0 16	6 15±0 05
1	6 20±0 15	6 16±0 18	6 24±0 18	6 23±0 07
2	6 46±0 14	6 22±0 12	6 32±0 12	6 14±0 06
3	6 55±0 10	6 34±0 15	0 39±0 09	6 30±0 10
4	6 53±0 09	6 58±0 18	6 51±0 11	6 45±0 11
5	6 72±0 12	6 62±0 21	6 58±0 08	6 57±0 08
6	6 81±0 08	6 93±0 20	6 78±0 12	6 71±0 10

Table 4 29 Factorial analysis of variance Serum total protein

Source	Monthly mean sum of square						
	0	1	2	3	4	5	6
Replication	0 153	0 211 *	0 284 *	0 316 *	0 478 *	0 376	0 299
Protein	0 010	0 015	0 063	0 047	0 083	0 044	0 169
Spleen	0 002	0 003	0 225	0 111	0 014	0 015	0 037
Interaction (Protein x Spleen)	0 016	0 002	0 006	0 020	0 055	0 011	0 122
Error	0 057	0 060	0 070	0 076	0 069	0 051	0 096

* Significant at 5 per cent level

Table 4 30 Monthly data on mean serum albumin content (g/100 ml) of calves maintained on the experimental rations

Months	Treatments			
	Ration A	Ration B	Ration C	Ration D
0	3 59±0 03	3 72±0 05	3 66±0 04	3 71±0 08
1	3 63±0 04	3 70±0 06	3 66±0 05	3 75±0 07
2	3 77±0 04	3 80±0 08	3 69±0 06	3 82±0 06
3	3 77±0 05	3 68±0 06	3 73±0 08	3 80±0 08
4	3 80±0 06	3 76±0 05	3 80±0 05	3 88±0 08
5	3 96±0 08	3 81±0 07	3 88±0 07	3 86±0 07
6	4 08±0 10	3 97±0 08	3 94±0 07	3 98±0 04

Table 4 31 Factorial analysis of variance Serum albumin

Source	Monthly mean sum of square						
	0	1	2	3	4	5	6
Replication	0 008	0 015	0 005	0 009	0 016	0 014	0 037
Protein	0 004	0 009	0 005	0 008	0 019	0 002	0 022
Spleen	0 038	0 033	0 031	0 000	0 002	0 036	0 005
Interaction (Protein x Spleen)	0 009	0 000	0 011	0 030	0 019	0 021	0 028
Error	0 016	0 022	0 016	0 021	0 021	0 024	0 014

Table 4 32 Monthly data on mean serum globulin content (g/100 ml) of calves maintained on the experimental rations

Months	Treatments			
	Ration A	Ration B	Ration C	Ration D
0	2 54±0 14	2 44±0 15	2 54±0 15	2 44±0 06
1	2 57±0 12	2 45±0 16	2 58±0 18	2 48±0 07
2	2 69±0 16	2 42±0 15	2 63±0 14	2 32±0 09
3	2 58±0 13	2 68±0 18	2 66±0 17	2 50±0 10
4	2 74±0 09	2 83±0 20	2 71±0 13	2 57±0 06
5	2 76±0 10	2 81±0 19	2 70±0 11	2 71±0 07
6	2 73±0 12	3 05±0 21	2 84±0 13	2 73±0 10

Table 4 33 Factorial analysis of variance Serum globulin

Source	Monthly mean sum of square						
	0	1	2	3	4	5	6
Replication	0 171	0 270	0 312 *	0 369 *	0 545 *	0 425 **	0 246 *
Protein	0 001	0 001	0 033	0 014	0 182	0 029	0 045
Spleen	0 038	0 057	0 123	0 004	0 028	0 005	0 068
Interaction (Protein x Spleen)	0 000	0 001	0 001	0 071	0 139	0 002	0 218
Error	0 065	0 066	0 064	0 090	0 102	0 043	0 067

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 4 34 Monthly data on mean serum albumin globulin ratio of calves maintained on the experimental rations

Months	Treatments			
	Ration A	Ration B	Ration C	Ration D
0	1 44+0 09	1 55+0 11	1 46±0 09	1 51±0 06
1	1 42±0 07	1 58±0 20	1 44±0 08	1 44±0 06
2	1 42±0 07	1 45±0 05	1 43+0 11	1 65±0 05
3	1 48±0 07	1 42±0 14	1 44±0 13	1 53±0 09
4	1 41±0 10	1 41±0 20	1 42±0 12	1 60±0 12
5	1 45±0 08	1 39±0 11	1 46±0 12	1 44+0 11
6	1 51±0 05	1 33±0 10	1 40+0 08	1 45±0 07

Table 4 35 Analysis of variance Albumin globulin ratio

Source	Degrees of freedom	Sum of squares	Mean square	F value	Proba bility
Replication	4	3 42	0 86	29 24**	0 000
Treatment	3	0 11	0 04	1 24	0 298
Period	6	0 20	0 03	1 16	0 336
Interaction	18	0 48	0 03	0 92	
Error	108	3 16	0 03		

** Significant at 1 per cent level

FIG 4.6 CHROMATOGRAM OF VOLATILE FATTY ACIDS IN THE RUMEN FLUID COLLECTED FROM THE ANIMALS MAINTAINED ON RATION A

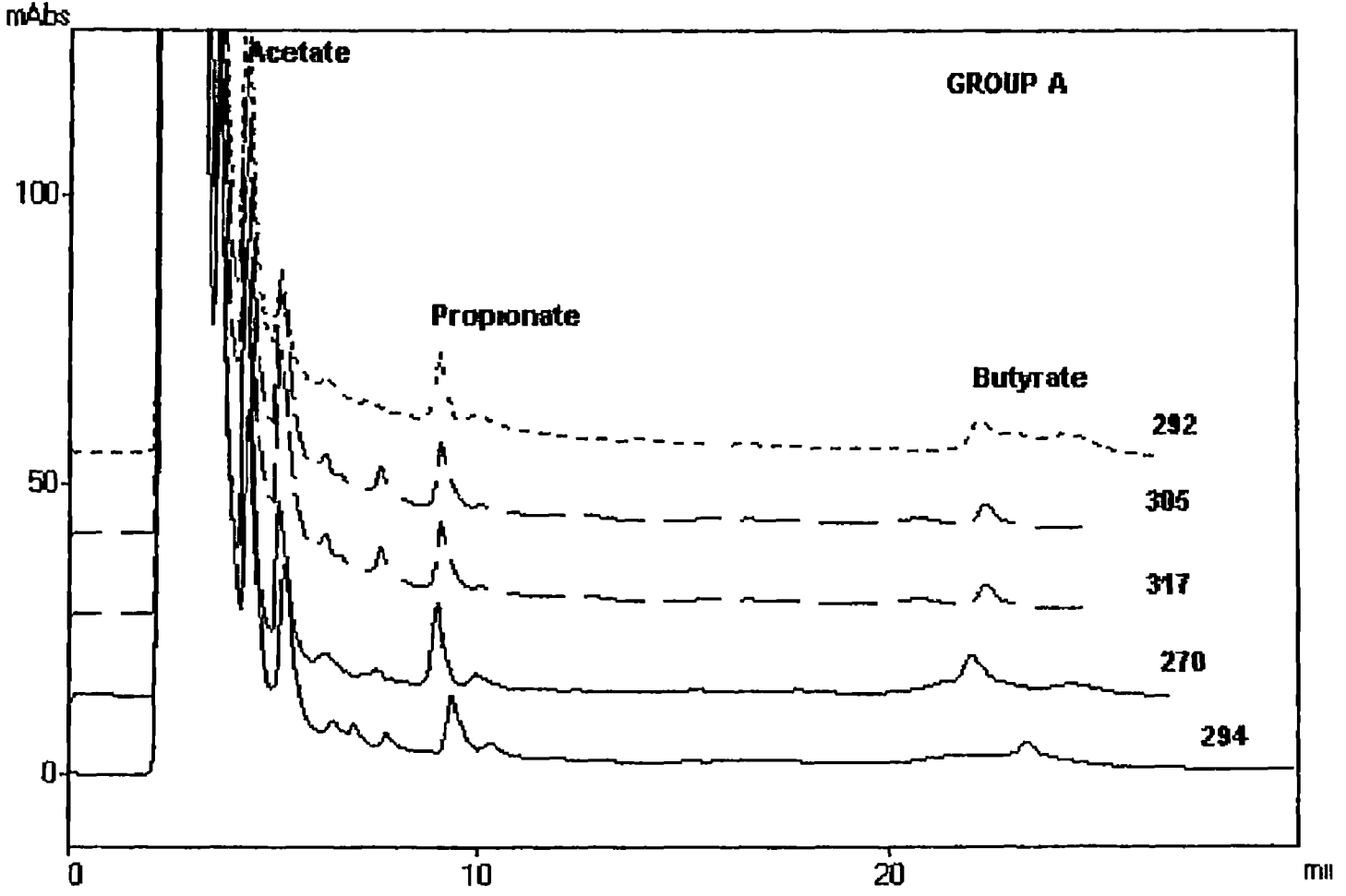


Table 4 36 Volatile fatty acid concentration ammonia concentration and pH of rumen fluid collected from animals maintained on ration A (group I)

Replicate	Acetate mM/lit	Propionate mM/lit	Butyrate mM/lit	pH	Ammonia m Eq/lit
1	69 58	32 83	12 50	6 6	99 6
2	72 92	28 78	17 86	6 9	96 4
3	61 91	28 96	23 88	6 6	82 7
4	91 03	34 73	16 26	6 5	78 1
5	68 71	32 82	12 46	6 7	86 9
Av ± SE	72 83± 4 37	31 62± 1 05	16 59± 1 88	6 66± 0 046	88 74± 4 06

FIG.4.7 CHROMATOGRAM OF VOLATILE FATTY ACID IN THE RUMEN FLUID COLLECTED FROM THE ANIMALS MAINTAINED ON RATION B

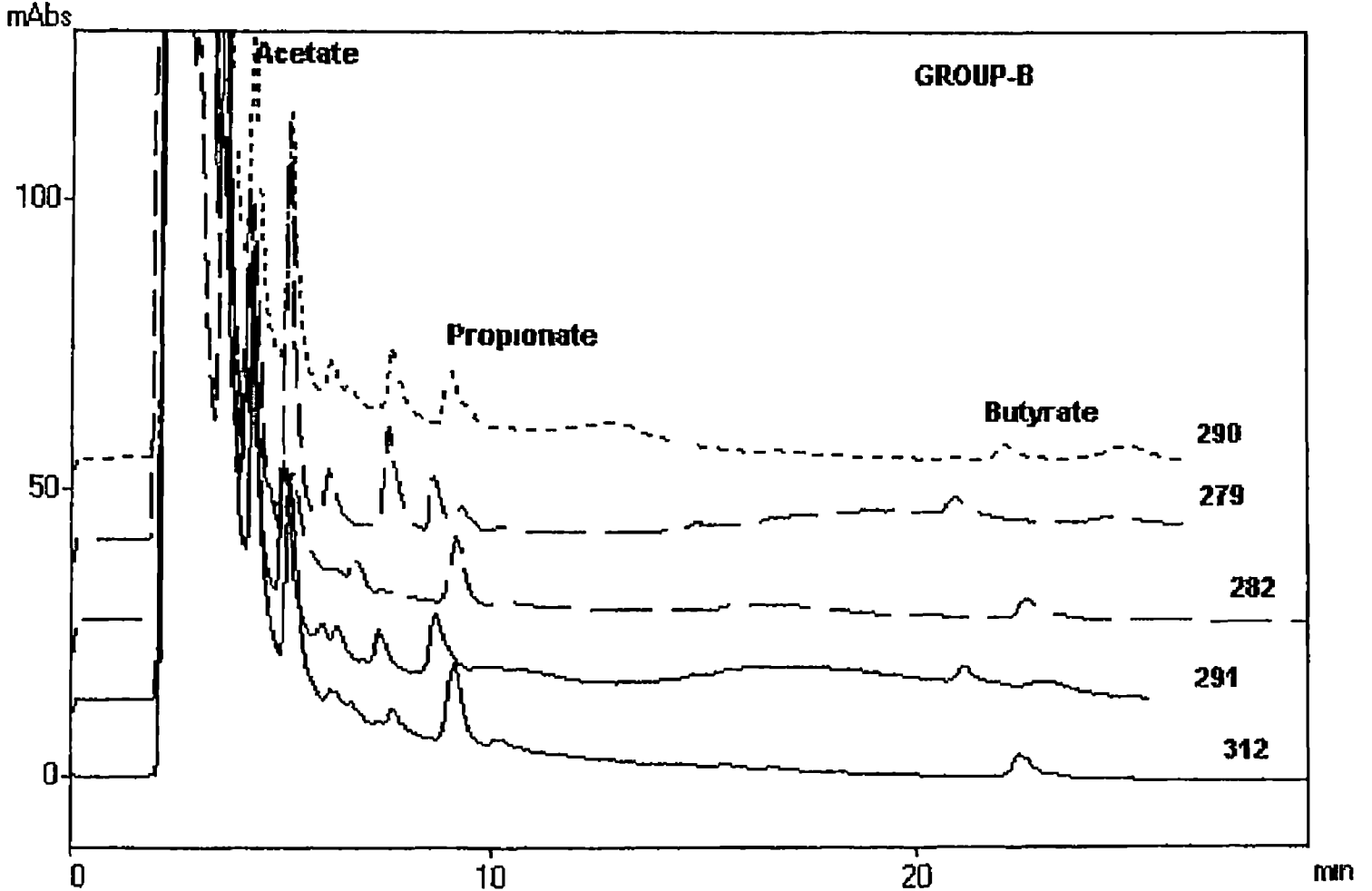


Table 4 37 Volatile fatty acid concentration ammonia concentration and pH of rumen fluid collected from animals maintained on ration B (group II)

Replicate	Acetate mM/lit	Propionate mM/lit	Butyrate mM/lit	pH	Ammonia m Eq/lit
1	76 63	37 22	16 10	6 8	73 20
2	61 89	29 28	24 47	6 7	89 60
3	64 49	29 68	12 75	7 0	101 30
4	90 86	35 08	16 16	6 4	92 70
5	69 90	28 12	8 64	6 7	82 50
Av ± SE	72 36± 4 70	31 87± 1 61	15 63± 2 33	6 72± 0 08	87 86± 4 75

FIG.4.8 CHROMATOGRAM OF VOLATILF FATTY ACID IN THE RUMFN FLUID COLLECTED FROM THE ANIMALS MAINTAINFD ON RATION C

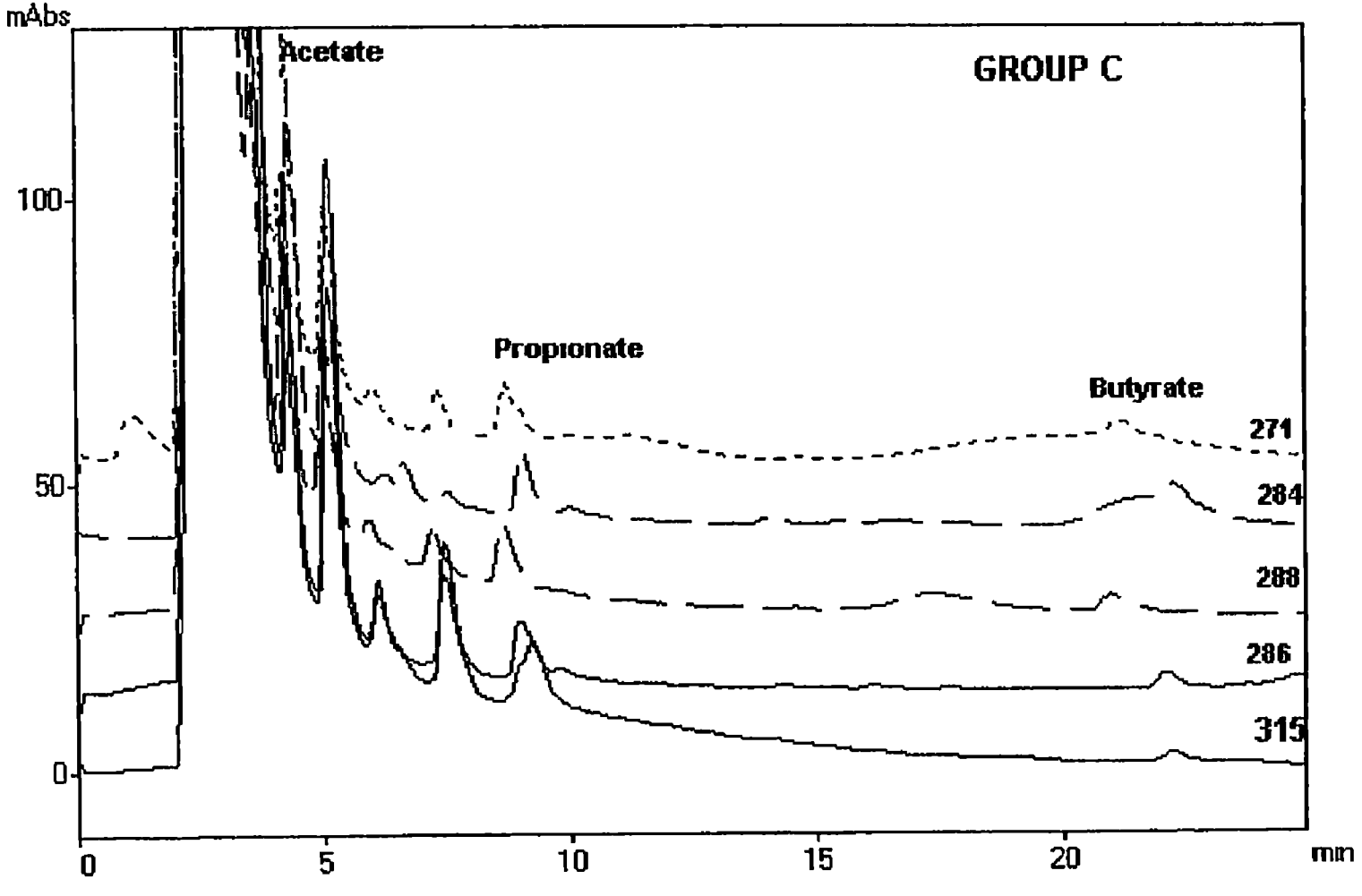


Table 4 38 Volatile fatty acid concentration ammonia concentration and pH of rumen fluid collected from animals maintained on ration C (group III)

Replicate	Acetate mM/lit	Propionate mM/lit	Butyrate mM/lit	pH	Ammonia m Eq/lit
1	49 40	49 28	7 60	6 9	68 60
2	70 05	28 19	11 62	6 7	72 30
3	65 92	32 17	11 97	6 9	94 70
4	72 07	30 35	38 86	6 7	66 2
5	64 44	24 03	13 00	7 0	79 80
Av ± SE	64 38± 3 56	32 80+ 3 88	16 51± 5 06	6 84± 0 05	76 32± 5 14

FIG.4.9 CHROMATOGRAM OF VOLATILE FATTY ACID IN THE RUMEN FLUID COLLECTED FROM THE ANIMALS MAINTAINED ON RATION D

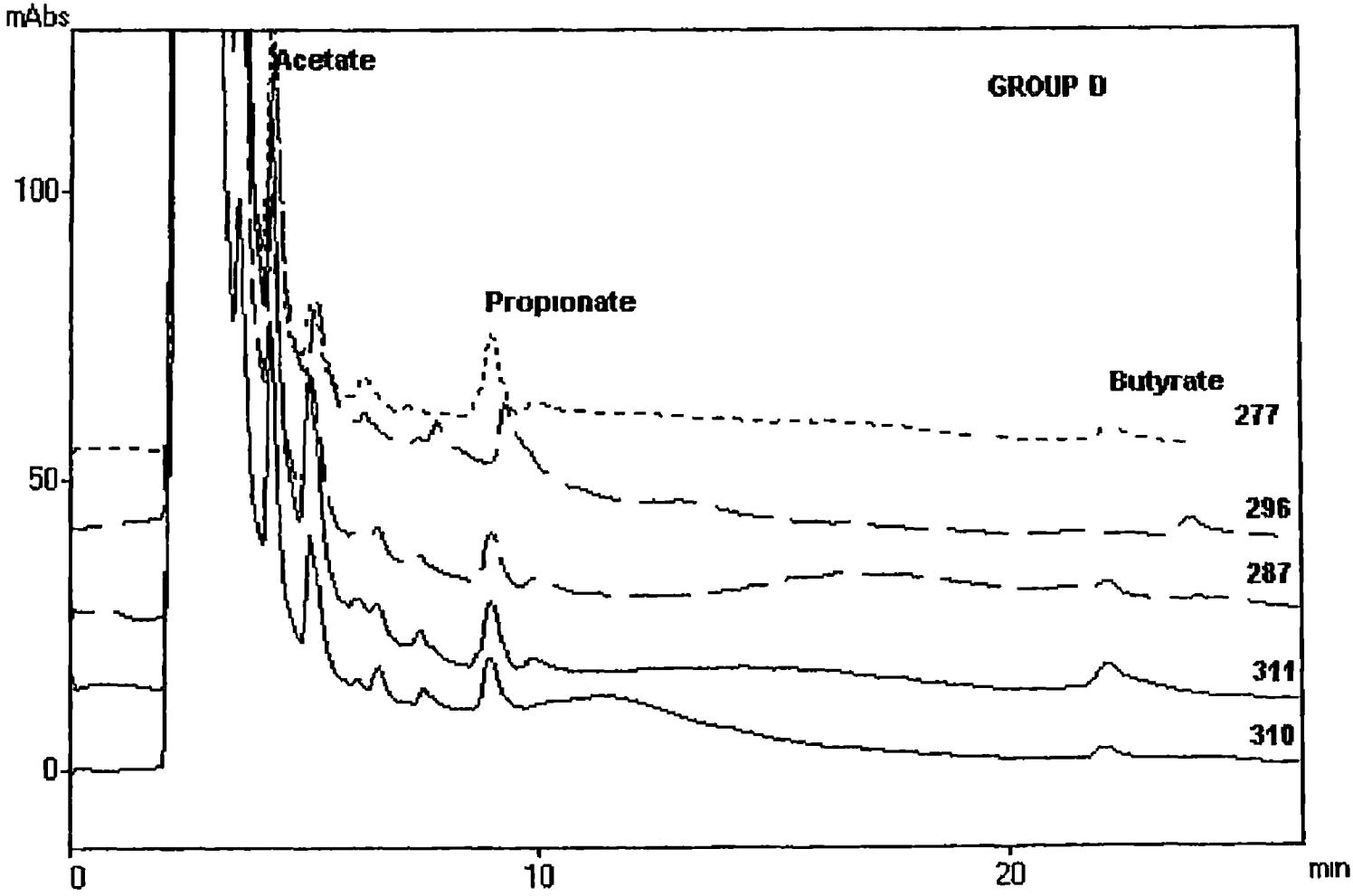
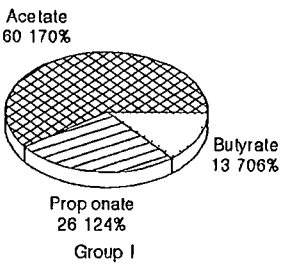
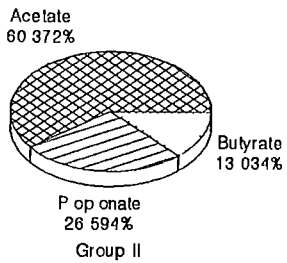


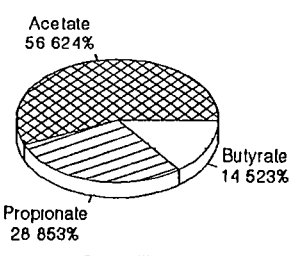
Table 4 39 Volatile fatty acid concentration ammonia nitrogenconcentration and pH of rumen fluid collected from animals maintained on ration D (group IV)

Replicate	Acetate mM/lit	Propionate mM/lit	Butyrate mM/lit	pH	Ammonia m Eq/lit
1	64 23	28 39	7 77	6 8	76 20
2	66 20	30 53	36 43	6 8	72 90
3	59 17	21 38	5 60	6 9	98 60
4	65 21	44 82	13 01	6 8	61 90
5	78 57	38 42	13 62	6 7	77 80
Av ± SE	66 68± 2 87	32 71± 4 06	15 28± 4 92	6 8± 0 03	77 48± 5 96

FIG 4 10 PROPORTION OF VOLATILE FATTY ACIDS IN RUMEN FLUID







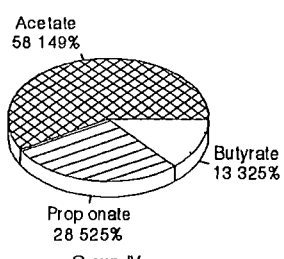


Table 4 40 Analysis of variance volatile fatty acids ammonia and pH

	Source	Degrees of freedom	Sum of squares	Mean square	F value
Acetate	Treatment	3	263 733	87 913	0 905
	Error	16	1554 336	97 146	
Propionate	Treatment	3	3 339	1 113	0 022
	Error	16	807 46	50 466	
Butyrate	Treatment	3	6 865	2 288	0 025
	Error	16	1465 62	91 601	
pH	Treatment	3	0 098	0 033	1 398
	Error	16	0 372	0 023	
Ammonia	Treatment	3	634 66	211 553	1 799
	Error	16	1969 48	123 093	

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 4 41 Digestibility coefficients of nutrients in animals maintained on experimental ration A (Group I)

Nutrients	Replication					Average with S E
	1	2	3	4	5	
Dry matter	58 11	63 00	65 04	61 79	64 82	65 55±1 12
Crude protein	69 94	72 73	73 13	73 99	75 07	72 97±0 77
Ether extract	74 22	77 24	77 21	78 40	79 74	77 36±0 81
Crude fibre	67 77	67 38	69 03	64 03	63 20	66 28±1 01
Nitrogen free extract	60 62	63 00	63 97	63 21	64 12	62 95±0 56
Neutral detergent fibre	56 24	56 89	58 76	54 02	53 61	55 50±0 89
Acid detergent fibre	56 25	55 93	58 05	51 98	51 24	54 69±1 17
Hemicellulose	57 46	59 66	61 03	58 56	58 74	59 09±0 88
Cellulose	69 99	69 73	71 19	66 98	66 47	68 87±0 82
Lignin	21 43	20 57	24 63	12 29	10 11	17 81+2 50

Table 4 42 Digestibility coefficients of nutrients in animals maintained on the experimental ration B (Group II)

Nutrients	Replication					Average with S E
	1	2	3	4	5	
Dry matter	60 10	66 89	65 88	61 28	61 65	63 16±1 21
Crude protein	71 05	76 78	74 82	70 37	71 17	72 84±1 12
Ether extract	74 91	80 03	78 13	74 64	75 20	76 58±0 95
Crude fibre	66 78	71 67	69 85	62 50	64 92	67 14±1 48
Nitrogen free extract	63 13	69 02	66 62	60 02	61 57	63 87±1 51
Neutral detergent fibre	58 55	65 05	62 64	58 08	56 70	59 40±1 78
Acid detergent fibre	57 05	63 53	61 17	51 87	54 85	57 69±1 88
Hemicellulose	62 21	68 59	66 20	59 07	61 03	63 42±1 56
Cellulose	71 84	76 07	74 54	68 41	70 38	72 24±1 24
Lignin	21 98	33 36	29 09	11 74	17 50	22 73±3 47

Table 4 43 Digestibility coefficients of nutrients in animals maintained on the experimental ration C (Group III)

Nutrients	Replication					Average with S E
	1	2	3	4	5	
Dry matter	60 93	60 54	63 92	58 77	63 73	61 58±0 88
Crude protein	70 05	70 55	73 38	69 54	72 48	71 20±0 66
Ether extract	77 64	78 03	80 01	78 04	80 08	78 76±0 47
Crude fibre	61 65	62 74	65 67	57 40	62 30	61 95+1 19
Nitrogen free extract	64 40	65 07	68 31	63 21	66 86	65 57±0 81
Neutral detergent fibre	57 19	53 42	57 24	47 96	53 64	52 89±1 34
Acid detergent fibre	51 13	52 47	56 30	46 16	52 28	51 67±1 46
Hemicellulose	55 22	56 26	59 95	52 35	57 21	56 19±1 11
Cellulose	64 18	65 17	67 98	60 52	65 02	64 57±1 07
Lignin	19 68	21 98	28 05	10 53	20 78	20 24±2 52

Table 4 44 Digestibility coefficients of nutrients in animals maintained on the experimental ration D (Group IV)

Nutrients	Replication					Average with S E
	1	2	3	4	5	
Dry matter	60 75	63 50	60 63	57 94	60 85	60 73±0 79
Crude protein	70 64	70 88	67 95	73 29	69 16	70 38±0 80
Ether extract	77 06	77 86	75 71	80 08	77 35	77 61±0 64
Crude fibre	64 18	65 11	62 14	63 50	58 32	62 65±1 06
Nitrogen free extract	64 14	64 57	61 12	66 63	61 56	63 60±0 91
Neutral detergent fibre	55 84	56 83	52 99	56 18	49 84	54 34+1 16
Acid detergent fibre	54 35	55 45	51 63	53 89	47 27	52 52±1 30
Hemicellulose	59 50	60 27	56 52	61 09	55 36	58 55±1 00
Cellulose	68 95	69 71	67 11	68 61	64 11	67 70±0 89
Lignin	14 78	17 05	20 00	22 89	20 57	21 06±2 56

Table 4 45 Consolidated data on digestibility coefficients of nutrients in animals maintained on experimental rations

	Treatments			
	Ration A	Ration B	Ration C	Ration D
Dry matter	65 55+1 12	63 16±1 21	61 58±0 88	60 73±0 79
Crude protein	72 97+0 77	72 84±1 12	71 20±0 66	70 38±0 80
Ether extract	77 36±0 81	76 58±0 95	78 76±0 47	77 61±0 64
Crude fibre	66 28±1 01	67 14±1 48	61 95±1 19	62 65±1 06
Nitrogen free extract	62 95±0 56	63 87±1 51	65 55±0 81	63 60±0 91
Neutral detergent fibre	55 50±0 89	59 40±1 78	52 89+1 34	54 34±1 16
Acid detergent fibre	54 69±1 17	57 69±1 88	51 67±1 46	52 52+1 30
Hemicellulose	59 09±0 88	63 42±1 56	56 19±1 11	58 55±1 00
Cellulose	68 87±0 82	72 42±1 24	64 57±1 07	67 70±0 89
Lignin	17 81±2 50	22 73±3 47	20 24±2 52	21 06±2 56

Table 4 46 Analysis of variance Digestibility coefficients

Nutrients	Mean sum of square				
	Replication	Protein	Spleen	Interaction	Error
Dry matter	5 087*	5 070	0 020	0 955	1 312
Crude protein	1 260	9 632*	0 398	0 260	2 107
Ether extract	1 632	3 395	2 139	0 084	1 630
Crude fibre	8 077*	35 645*	1 040	0 027	1 629
Nitrogen free extract	1 549	3 089	0 857	4 512	2 494
Neutral detergent fibre	6 866	24 954**	12 106	2 621	3 387
Acid detergent fibre	16 988*	15 753	14 501	0 009	4 337
Hemicellulose	3 417	27 777**	17 842	2 093	4 381
Cellulose	5 886*	37 538**	20 281	0 085	4 349
Lignin	43 209	0 335	10 039	21 115	15 202

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 4 47 Summarised data on average daily intake of dry matter (DM) total digestible nutrients (TDN) crude protein (CP) digestible crude protein (DCP) in kgs per 100 kg body weight

	Treatments			
	Ration A	Ration B	Ration C	Ration D
DM intake	3 50 ± 0 19	3 40 ± 0 17	3 56 ± 0 19	3 56 ± 0 18
TDN intake	1 98 ± 0 10	1 92 + 0 09	2 10 ± 0 10	2 04 ± 0 10
CP intake	0 504 ± 0 04	0 492 ± 0 03	0 431 ± 0 03	0 434 ± 0 04
DCP intake	0 367 ± 0 03	0 358 ± 0 02	0 307 ± 0 02	0 305 ± 0 03

Discussion

DISCUSSION

5.1 Growth

The data on fortnightly body weights of calves presented in Tables 4 1 to 4 4 and represented in Fig 4 1 and the average daily weight gains in Fig 4 2 reveal that the calves maintained on concentrate ration A (group I) containing 20 per cent crude protein concentrate ration B (group II) containing 20 per cent crude protein and 0 1 per cent dried buffalo spleen concentrate ration C (group III) containing 15 per cent crude protein and concentrate ration D (Group IV) containing 15 per cent crude protein and 0 1 per cent dried buffalo spleen showed average cumulative weight gains of 114 ± 7 62 120 2 ± 5 05 103 + 5 48 and 107 + 2 40 kg respectively The average daily weight gains during the 180 days experiment were 633 ± 47 667 ± 31 572 ± 34 and 594 ± 14 grams for the groups I II III and IV respectively The maximum weight gain was observed in group II followed by group I group IV and group III in descending order

The analysis of covariance on monthly weight gain and 180 days cumulative weight gain taking initial body weight as covariate is shown in table 4 5 The analysis of covariance of monthly weight gain shows that there was no statistically significant difference between the biostimulator fed group and their respective controls

(between group I and II and between III and IV) However in fourth and sixth month of the study there was significant (P<0 05 and P<0 01 respectively) difference between two levels of protein (groups I and II versus groups III and IV) and this appears to be a transient phase Analyses of covariance of 180 days cumulative weight gain show that there were no statistically significant differences between groups I II III and IV

Varying growth rates in growing calves have been reported by different workers Makkar et al (1989) reported average daily gains of 692 651 and 716 g respectively for growing crossbred calves in the age group of 12 to 18 months maintained on three different rations viz control and those incorporated with poultry droppings and dung slurry Garg and Nath (1990) from their investigation on incorporation of neem seed cake in the ration of crossbred calves observed an average daily gain of 634 1 g for the control group Puri and Gupta (1990) from their study on the effect of feeding urea treated rice straw on growth and nutrient utilization in cross bred calves observed average daily gains of 416 7 562 5 and 541 7 g in crossbred calves of eight to twelve months of age fed with control and four per cent urea treated paddy straw and five per cent urea treated straw rations respectively

The growth rate in animals observed during the course of present investigation are comparable to those reported for

crossbred calves of similar age (Makkar et al 1989 Garg and Nath 1990 and Puri and Gupta 1990) However lower weight gains of 467 g (Saikā et al 1987) 367 to 452 g (Patel et al 1991) 389 to 404 g (Paul et al 1993) and 478 to 505 g (Reddy et al 1990) were also reported in crossbred calves of similar age

Mahamudov (1969) studied the effect of dried buffalo spleen biostimulator in Nutrias and observed increase in weight when compared to control group Similar investigations on feeding of dried buffalo spleen biostimulator carried out in goats (Shukla and Mahapatro 1984 and Shyama 1994) and in rats and rabbits (James and Gangadevi 1991) also showed better growth than the respective control groups However Laird et al (1972) reported that feeding of biostimulator Hormonexa a commercial preparation containing bovine liver spleen placenta bovine embryo and haemoglobin to beef cattle did not improve weight gain and feed conversion The literature available on the use of dried spleen biostimulator in cattle appears to be scanty The present investigation on feeding of dried buffalo spleen to cattle did not appear to show any effect on weight gain on two dietary protein levels tried This is in accordance with those reported in cattle (Laird et al 1972) and at variance with those reported in nutria (Mahamudov 1969) in rats and rabbits (James and Gangadevi 1991) and in goats (Shukla and Mahapatro 1984 and Shyama 1994) The difference in

response to feeding dried spleen biostimulator to cattle may be due to species difference

5.2 Body measurements

Table 4 6 reveal that the average height at withers ofcalves increased from 90 2 ± 1 5 to 109 2 ± 2 8 cm 93 6 ± 1 6 to 112 4 ± 1 4 cm 91 8 ± 1 7 to 110 6 ± 2 6 cm and 93 4 ± 2 5 to 110 6 + 0 4 cms in the experimental groups I II III and IV respectively during the entire period of 12 fortnights The analysis of variance of change in height (Table 4 7) did not show any significant difference between the four groups

The data on body length presented in Table 4 8 showed an increase from 94 8 ± 2 4 to 119 8 ± 2 5 cm 99 6 ± 3 2 to 122 0 ± 2 8 cm 95 6 ± 3 7 to 122 8 ± 3 4 cm and 96 2 ± 1 1 to 119 8 ± 1 2 cm in groups I II III and IV respectively during the entire period of 12 fortnights The analysis of variance of change in body length (Table 4 9) however showed no significant difference between the four groups

On perusal of the data on fortnightly chest girth measurement in Table 4 10 it is seen that the average chest girth increased from 104 4 ± 2 9 to 136 0 ± 4 0 cm 106 6 ± 2 5 to 135 8 ± 2 4 cm 105 0 ± 3 2 to 137 8 ± 3 7 cm and 105 4 ± 2 5 to 136 4 ± 2 1 cm in the groups I II III and IV

respectively The analysis of variance of change in girth (Table 4 11) for the entire period of 12 fortnights showed no significant difference between the four groups Obireddy et al (1991) observed that the average height at withers body length and chest girth were respectively 91 5 ± 1 0 94 1 ± 1 3 and 10 5 ± 1 6 cm at six months of age and 101 8 ± 1 108 7 ± 1 5 and 126 7 ± 1 8 cm at twelve months of age The body measurements observed for all the four groups of heifers are similar to those reported by Obi Reddy et al for crossbred calves at the age of six to twelve months

Rebreanu (1968)c from his study on changes in morphological characters in Roman Simmental calves given testicular extract observed that the final height at withers body length and chest girth were higher by 3 68 4 88 and 4 57 cms in those calves given 0 07 ml testicular extract per kilogram body weight once weekly for six months than in controls Sokolov (1970) from his investigation on the effect of agar tissue preparation on growth and haemopoietic function in heifers at different ages recorded increase in height length and girth in biostimulator treated groups when compared to controls The literature available on the effect of dried buffalo spleen on body measurements appear to be scanty The result obtained in the present study are at variance with those reported by Rebreanu (1968)c and Sokolov (1970) In the present study the biostimulator was administered through feed whereas the above workers

injected the biostimulator directly to the tissues The difference in result obtained may be due to the route of administration

5.3 Dry matter intake

The data set out in Table 4 12 reveal that the average drymatter intake of animals in the groups I II III and IV were 5 05 + 0 29 kg 5 12 + 0 25 kg 5 06 ± 0 27 kg and 5 04 ± 0 26 kg respectively The average drymatter intake calculated per 100 kg body weight where 3 50 ± 0 19 kg 3 40 ± 0 17 kg 3 56 ± 0 19 kg and 3 56 ± 0 18 kg respectively for groups I II III and IV (Table 4 47) The drymatter intake is highly variable and the factors of practical importance that influence nutrient intake in ruminants include body weight change in body weight ration energy concentration ration bulk and energy density and environmental temperature (Quigley et al 1986) Devasia (1989) reported average drymatter intake of 3 26 ± 0 05 and 3 33 ± 0 12 kg per 100 kg body weight for crossbred Jersey and crossbred Brown Swiss calves respectively Patel et al (1985) also reported an average daily drymatter intake of 3 20 ± 0 08 kg per 100 kg body weight in crossbred calves of similar age groups The results on drymatter intake are similar to those reported by the above workers

Analysis of variance of drymatter intake (Table 4 13) did not show significant differences between the four groups indicating that incorporation of dried spleen in feed did not influence the drymatter consumption of the animals under trial at two different levels of protein intake A similar observation of non significant differences in drymatter intake between biostimulator fed and control group was reported in rats and rabbits (James and Gangadevi 1991) and in kids (Shyama 1994) The observations made in the present study are at variance with those of Shukla and Mahapatro (1984) and Agarwal and Chakrabarti (1985) who reported a higher feed intake in biostimulator treated group

5.4 Feed efficiency

The data presented in Table 4 14 show that the average feed efficiency of the animals in groups I II III and IV were 8 10 ± 0 60 7 55 ± 0 54 8 71 ± 0 70 and 8 74 ± 0 79 respectively The feed efficiency was highest in group II followed by groups I III and IV in descending order Kumar et al (1984) observed an average feed efficiency value of 9 87 in crossbred calves The feed efficiency recorded in the present investigation is similar to those observed by the above workers However a lower feed efficiency value was reported in crossbred calves by Virk et al (1981)

The analysis of variance of fortnightly feed efficiency (Table 4 15) indicate that incorporation of dried spleen did not influence the feed efficiency but the animals maintained on higher protein rations (groups I & II) had significantly (P<0 05) higher feed efficiency than those maintained on lower protein rations (groups III and IV) This observation is at variance with those of Gerasimov and Petrov (1970) in cattle James and Gangadevi (1991) in rats and rabbits and Shyama (1994) in kids

5.5 Protein efficiency

The data listed in Table 4 16 showed protein efficiency ratios of 1 159 ± 0 084 1 133 ± 0 074 1 073 + 0 080 and 1 068 ± 0 1 for the groups I II III and IV respectively The animals maintained on a lower protein diet (groups III & IV) showed slightly higher protein efficiency ratios than those on higher protein rations (groups I & II) The statistical analysis (Table 4 17) did not show any significant difference between the four groups The results obtained for protein efficiency ratio are at variance with those reported in rats (Agarwal and Chakarabarti 1985) and in kids (Shyama 1994)

5.6 Cost per unit gain

The cost of production in terms of rupees per kilogram gain were 24 87 23 72 25 53 and 24 63 respectively

for the groups I II III and IV (Table 4 18) Shyama (1994) reported a lower cost of production in terms of Rs per kg gain) in kids supplemented with dried spleen biostimulator at a level of 0 1 per cent in the diet The results of the present study are at variance with those reported by the above author

From the data on weight gain and cost per unit gain it is obvious that restricting the protein given from 20 per cent to 15 per cent did not reduce the cost per unit gain Though difference in weight gain between two levels of protein was not significant the animals on higher protein ration showed higher weight gain

5.7 Haematological values

5 7 1 Packed cell volume

From the monthly data on packed cell volume (Table 4 20) and the statistical analysis of the same given in Table 4 21 it can be seen that there was no significant difference between the groups (I II III & IV) The overall average value of 30 8 ± 0 2 is within the normal range reported for cattle of similar age groups (Schalm 1961) Misra and Prusty (1989) observed a packed cell volume of 31 2 ± 1 13 per cent in graded Jersey heifers of similar age group

Shukla and Mahapatro (1990) in their investigation on the use of biostimulators for animal production and effect on blood constituents in goats reported that feeding of dried buffalo spleen and liver had no effect on packed cell volume Present investigation is in accordance with those reported by the above authors

5 7 2 Haemoglobin concentration

From the monthly data on haemoglobin concentration (Table 4 22) and their statistical analysis (Table 4 23) it can be seen that the values are similar to those reported by Devasia (1989) and Misra and Prusty (1989) for heifer calves of similar age group The analysis of the data show that the biostimulator did not have any significant effect on haemoglobin concentration However there was a significant difference ($P<0$ 05) in haemoglobin concentration between the groups maintained on two levels of protein The haemoglobin concentration was found to be less in those animals maintained on low protein ration irrespective of the addition of dried spleen biostimulator The results obtained in this regard is in accordance with those of Shyama (1994) who reported that feeding of dried spleen did not influence haemoglobin concentration while at variance with those reported by Zabolotuyj (1959) who observed an increase in haemoglobin concentration on direct injection of tissue preparations This difference in effect may be due to the route of administration

5 7 3 Erythrocyte count

Data presented in Table 4 24 and their statistical analysis in Table 4 25 indicate that all the animals were showing the erythrocyte count within the normal range reported for calves of similar age group (Schalm 1961) However a lower value of 5 23 millions per cubic millimeter was also reported in graded jersey heifers (Misra and Prusty 1989) There was no significant difference between the biostimulator treated group and controls In the third and fifth month of treatment the animals on higher protein ration had significantly ($P<0.05$) higher erythrocyte count than those on lower protein ration This observation is in accordance with those of Shyama (1994) in respect of feeding dried spleen bio stimulator and at variance with those of Zabolotuyj (1959) The difference in effect may be due to difference in route of administration of bio stimulator

5 7 4 Leukocyte count

Data presented in table 4 26 and statistical analysis in Table 4 27 indicate that the values are within the normal range reported (Schalm 1961) There were no significant differences in leukocyte count between the groups I II III and IV by the addition of dried spleen irrespective of the level of protein in the ration This observation is at variance with that of Konstantinov (1969) who observed that injection of 0 5 to 1 ml of Filatove tissue preparation in

suckling and growing pigs increased white cell count It is well known fact that injection of any foreign protein will stimulate the immune system (Chapel and Haeney 1988) This may be the reason for the increase in leukocyte count Literature available regarding the effect of feeding dried buffalo spleen on leukocyte count appears to be scanty

5 7 5 Serum proteins

Summarised data on monthly serum total protein serum albumin globulin and albumin globulin ratio presented in Tables 4 28 4 30 4 32 and 4 34 and their statistical analysis in Tables 4 29 4 31 4 33 and 4 35 respectively reveal a non significant difference between biostimulator fed group and their controls Scanty literature is available on the effect of dried spleen on serum protein values in calves The results obtained in the present study on the serum protein concentration showed that biostimulator did not influence serum protein concentration irrespective of the level of protein in the ration

5.8 Rumen fermentation characters

The volatile fatty acid concentration ammonia level and pH of rumen fluid collected from the experimental animals are shown in Tables 4 36 to 4 39 and their statistical analysis in Table 4 40

The concentration and proportion of acetic propionic and butyric acids are in accordance to those reported in literature for cattle of similar age groups and maintained on similar dietary regimes Wheaton et al (1970) observed an average concentration of 56 1 millimolar acetate 31 2 millimolar propionate and 14 6 millimolar butyrate in rumen liquor Paliwal and Sagar (1990) reported 74 7 millimolar acetate 29 4 millimolar propionate and 11 5 millimolar butyrate Robinson and McQueen (1994) also recorded 66 7 millimolar acetate 23 8 millimolar propionate and 11 millimolar butyrate in rumen fluid Statistical analysis revealed no significant differences between the group I II III and IV indicating that neither the level of protein in the ration nor the incorporation of dried spleen incluenced the concentration of acetate propionate and butyrate in rumen fluid The observations made in the present study is in agreement with those reported by Shukla and Mahapatro (1989) who reported that feeding of biostimulator did not show any effect on volatile fatty acid concentration

The concentration of ammonia is within the range as reported by Harrison et al (1988) who observed an ammonia concentration of 73 5 milli equivalent Piva et al (1993) also observed an ammonia concentration of 94 1 milli equivalent in the rumen fluid collected from cattle maintained on similar dietary regimes Analysis of variance of ammonia concentration did not show any difference between

Summary

the four groups This observation is in accordance with those reported by Shukla and Mahapatro (1989)

The analysis of variance of rumen pH did not show any significant difference between groups The literature available on the effect of tissue preparations on rumen pH is scanty From these observations it could be obvious that the biostimulator did not bring forth any change in rumen fermentation

5.9 Nutrient digestibility

From the data on nutrient digestibility presented in Tables 4 41 to 4 45 and their statistical analysis set out in Table 4 46 it can be seen that the digestibility coefficients for drymatter crude protein ether extract crude fibre nitrogen free extract neutral detergent fibre acid detergent fibre hemicellulose cellulose and lignin are similar to those reported by Devasia (1989) and Mahapatro and Roy 1970) Statistical analysis of the data in the present study did not show any significant difference between the biostimulator treated groups and their respective controls Similar observations were also made by Mahapatro and Roy (1970) In their experiment with Haryana calves injection of 10 ml of biostimulator had little influence on digestibility of drymatter crude protein ether extract crude fibre and nitrogen free extract Shukla and Mahapatro (1984) reported higher digestibility coefficients for crude

fibre and ether extract in biostimulator fed groups than in control They did not observe any difference in the digestibility coefficient of nitrogen free extract and dry matter Shyama (1994) reported better digestibility of protein in biostimulator fed kids than respective controls she also reported that there was no significant difference in digestion of drymatter ether extract crude fibre and nitrogen free extract The observations made in the present study are in accordance with those reported by Mahapatro and Roy (1970) Shukla and Mahapatro (1984) and Shyama (1994)

There was no statistically significant difference between the four groups in average cumulative weight gain Animals on concentrate mixtures having 20 per cent protein showed slightly higher weight gain than those on concentrate mixture containing 15 per cent protein throughout the experiment However the difference was statistically significant only during fourth and sixth month of study The animals on higher protein ration showed higher haemoglobin concentration erythrocyte count plasma protein values and rumen ammonia concentrations The feed efficiency was higher and cost of production in terms of rupees perkilogram gain was slightly less in animals fed on concentrate mixture containing 20 per cent crude protein Almost comparable weight gain in the groups fed on 15 per cent crude protein ration may be due to better nutritive quality of roughage used in the study

The growth promoting effect of biostimulator seems to vary according to the tissue used (Krasilnikova 1963a Kukde and Thakur 1992) dose administered (Stepin 1963 Balun et al 1965 Radkevic et al 1965 Kokovic 1968 Haitov et al 1966 Suljumova et al 1968 Vorenenkov and Nefedov 1966) number of doses (Stepin 1963) interval between doses (Radkevic et al 1965 Gerasimov and Petrov 1970) route of administration (Kokovic 1968) species of anil (Voronenkov and Nefedov 1966) breed difference (Zelenskii and Strayback 1970 Tolokonikov 1975) sex (Mahmudov 1969 Rebreanu 1968a) age (Konstantinov 1969 Kisel 1970) different periods in a treatment (Korolev 1966 Lutsenko 1970 and Ilinskij 1962) and nutritional status of the animals Feeding of biostimulator was reported to increase weight gain in rats and rabbits (James and Gangadevi 1991) and goats Shyama 1994) Laird et al (1972) did not find any effect on weight gain in growing cattle on supplementing rations with biostimulator Hormonexa prepared from spleen liver placenta embryo and haemoglobin

Overall evaluation of the results obtained during the course of the present investigation indicates that supplementing dried spleen biostimulator at the rate of 01 per cent in the concentrate mixture did not seem to show any

effect on weight gain body measurement dry matter intake feed efficiency protein efficiency haematological values rumen fermentation and nutrient digestibility in crossbred calves with an average daily weight gain of about 600 grams

Summary

SUMMARY

An investigation was carried out to assess the effect of dried spleen as a growth promoter in the rations of crossbred calves Twenty crossbred heifer calves of six to nine months of age were distributed randomly into four groups (groups I II III and IV) as uniformly as possible with regard to age and body weight The animals in groups I II III and IV were maintained on concentrate ration A containing 20 per cent crude protein concentrate ration B containing 20 per cent crude protein and 0 1 per cent dried buffalo spleen concentrate ration C containing 15 per cent crude protein and concentrate ration D containing 15 per cent crude protein and 0 1 per cent dried buffalo spleen respectively Napier grass (Pennisetum purpureum Linn) formed the roughage part of the ration

The experiment was carried out for a period of six months under identical conditions of feeding and management Individual records of daily intake of concentrate and grass fortnightly data on body weight and body measurements and monthly data on haematological values were maintained throughout the period of the experiment Towards the end of the experiment rumen fluid was collected from all the experimental animals to study the rumen fermentation profile by the determination of rumen pH ammonia and volatile fatty acid concentrations A digestion trial was also carried out

with all the experimental groups to arrive at the digestibility coefficients of nutrients in the respective rations

The salient observations made during the present study and the inferences drawn from the results are summarised below

1 The animals in groups I II III and IV showed average daily weight gains of 633 667 572 and 594 grams respectively during the experimental period The animals on concentrate rations containing 20 per cent crude protein showed higher weight gain than those in concentrate rations containing 15 per cent crude protein But there was no statistically significant difference between the four groups

2 The change in body measurements viz height at withers body length and chest girth did not differ significantly between the four groups

3 The average daily drymatter intake and intake per 100 kg body weight of the animals in four groups ranged from 5 04 to 5 12 and 3 40 to 3 56 kg respectively the values being almost similar for all the groups

4 The average fortnightly feed efficiency ranged from 8 71 to 7 55 The animals maintained on rations containing 20 per cent crude protein had

significantly ($P<0.05$) higher feed efficiency than those maintained on rations containing 15 per cent crude protein The dried spleen biostimulator did not exert any effect on feed efficiency

The animals maintained on rations containing 15 per cent crude protein showed higher protein efficiency than those maintained on rations containing 20 per cent crude protein though it was not statistically significant However biostimulator did not have any influence on protein efficiency

The cost of production in terms of rupees per kilogram gain was almost the same for the four groups Neither the level of protein in the ration nor the addition of spleen had any effect on cost of production

Supplementation of The dried buffalo spleen biostimulator did not show any effect on packed cell volume haemoglobin concentration erythrocyte count leukocyte count serum total proteins serum albumin serum globulin and serum albumin globulin ratio in crossbred heifer calves

Incorporation of biostimulator did not influence rumen pH and ammonia levels as well as acetate propionate and butyrate concentrations in rumen fluid

indicating that the biostimulator did not alter the rumen fermentation profile in heifer calves

9 The digestibility coefficients of drymatter crude protein ether extract crude fibre nitrogen free extract neutral detergent fibre acid detergent fibre hemicellulose cellulose and lignin did not differ significantly between the biostimulator treated groups and the controls indicating that feeding of biostimulator did not affect nutrient digestibility The digestibility coefficients of crude fibre neutral detergent fibre hemicellulose and cellulose were significantly (P<0 05) higher in animals maintained on ration containing 20 per cent crude protein But the digestibility coefficient of crude protein was significantly (P<0 05) higher in animals maintained on ration containing 15 per cent protein

From an overall evaluation of the results obtained during the course of the present study it can be inferred that supplementing dried buffalo spleen biostimulator at the level of 0 1 per cent in the ration of growing crossbred heifer calves did not seem to influence their weight gain body measurement dry matter intake feed efficiency protein efficiency haematological values rumen fermentation and nutrient digestibility

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EFFECT OF DRIED SPLEEN AS A GROWTH PROMOTER IN THE RATION OF CROSSBRED CALVES

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ABSTRACT OF A THESIS

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ABSTRACT

An investigation was carried out to assess the effect of dried spleen as a growth promoter in the ration of crossbred calves Twenty crossbred heifer calves of six to nine months of age were distributed randomly into four groups (group I II III and IV) as uniformly as possible with regard to age and body weight The animals in groups I II III and IV were maintained on concentrate ration A containing 20 per cent crude protein concentrate ration B containing 20 per cent crude protein and 0 1 per cent dried buffalo spleen concentrate ration C containing 15 per cent crude protein and concentrate ration D containing 15 per cent crude protein and 0 1 per cent dried buffalo spleen respectively

The animals in groups I II III and IV showed average daily weight gain of 633 667 572 and 594 grams respectively The animals in group I and II showed higher weight gain than those in group III and IV but on statistical analysis there was no significant difference among the four groups

The dried buffalo spleen biostimulator did not have any effect on change in body measurements viz height at withers body length and chest girth

biostimulator treated group and control The animals in group I and II had higher digestibility coefficients for crude fibre neutral detergent fibre hemicellulose and cellulose than the animals in group III and IV The digestibility coefficient for crude protein was higher in group III and IV

A critical assessment of the overall results obtained during the course of the present study indicates that addition of dried spleen biostimulator at a rate of 0 1 per cent in the ration did not have any effect on growth feed efficiency haematological value rumen fermentation and nutrient digestibility in crossbred calves with an average daily gain of 600 grams per day