EFFECT OF DRIED SPLEEN AS GROWTH STIMULATOR IN KID RATIONS

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THESIS

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Department of Animal Nutrition

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DECLARATION

I hereby declare that this thesis entitled **"EFFECT OF DRIED SPLEEN AS GROWTH STIMULATOR IN KID RATIONS"** 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 similiar title of any other University or Society.

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Certified that this thesis entitled **"EFFECT OF DRIED SPLEEN AS GROWTH STIMULATOR IN KID RATIONS"** is a record of research work done independently by Smt. Shyama K. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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DEDICATED

TO MY PARENTS AND HUSBAND

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INTRODUCTION

INTRODUCTION

Constant effort to produce human food from animal sources more efficiently and at lower cost to the consumer, has stimulated continued search for more suitable combinations of known nutrients and for new additives, that will increase the efficiency and rate of growth and the level of production of animals. These wide spread efforts, have led to the present use of antibiotics, hormones, enzymes, chemicals and other materials as feed additives in animals.

Considerable information is available with regard to the utility of feed additives, to improve growth rate, productivity and efficiency of feed utilisation. These feed additives are not nutrients, but act basically by stimulating the growth of rumen microbes or by altering the animal metabolism. The feed additives already tested are antibiotics, arsenicals, hormones, enzymes, anthelmintics and antimycotics.

Certain antibiotics which are being used for animal feeding are Tylosin, Flavomycin, Lincomycin and Neomycin. The continued use of antimicrobials in livestock feeding results in the development of microorganisms resistant to the microbials which are being used. There is some indication that this may result in adverse effect on human health. Since 1977, the Food and Drug Administration has proposed a ban on the use of Penicillin and Tetracycline in animal feed because, these two antibiotics are widely used to treat human health problems.

Anabolic hormones which usually exert effect on skeletal growth and protein metabolism are somatotropic hormone, thyroxine and androgens. Use of hormones continuously for longer period, is likely to prove carcinogenic, because of their accumulation in tissues, which would be a potential hazard to human health. There may be possible contamination of pasture through excreta of hormone treated animals and this may affect the breeding performances of animals grazing on such pastures.

Enzymes are of little use in the case of ruminants, as these are likely to be degraded in the rumen. Burroughs et al. (1954) reported that, growing fattening cattle attained seven per cent faster gain on equal feed intake when a crude enzyme mixture was added to the feed, but only negative results have been obtained with dairy calves. Enzymes may be useful as feed additives in the case of poultry. Certain enzyme preparations which are being marketed are Agrozyme, Diazyme and Avizyme.

Addition of enzymes to feeds is based mainly on the enzyme carrying out its work in the digestive system of animals. In direct addition of enzyme to feed, the enzyme acts as a supplement to normal digestive enzymes.

Many cereals have a portion of their energy contents locked up in the form of non-starch polysaccharides, that the animal is unable to digest. Addition of selected microbial enzymes will release this non-starch polysaccharides (NSP), rendering it available to the animal. In addition, removal of NSP will also release starch masked by the cell structures, leading to an overall increase in true metabolisable energy (TME).

New concepts which have been added in the area of feed additives are live yeast cultures, antioxidants, detoxificants, deodourisers, tranquillizers, mould inhibitors, coccidiostats, pellet binders and preservatives, probiotics and direct fed microbial organisms. Yeast cultures affect hydrogen ion exchange, methane production in the lower gut and increased cellulolysis. Cole et al. (1992) reported that supplementation of morbid calves with yeast culture can have beneficial effects and these effects may be mediated by improved nitrogen, zinc and iron metabolism.

Tranquillizers like reserpine, hydroxyzine, etc. are found to improve daily gain in fattening chicks. Their action is on central nervous system which protect the birds against stress.

Recently, the use of probiotics in the ration of ruminant has attracted the attention of investigators. Probiotics are bacterial (and yeast combination) preparations, most often lactic acid producing, that are administered orally or added to feeds. The probiotic hypothesis postulates that if sufficient lactic acid bacteria can be introduced into the intestinal tract at a time of stress or disease (when the balance of intestinal flora favours pathogens) or at birth or after antibiotic treatment (when minimal lactic acid bacteria are present), then enteric microbial upsets can be minimised. Many studies have reported that the addition of Lactobacilli in animal feed can retard the growth of pathogenic microorganisms in the intestine and also improve growth rate and feed efficiency in poultry and other livestock feed. The most recently advanced and most provocative mode of action attributed to probiotics is immunostimulation.

Non-bacterial direct fed microbials like Aspergillus cryzae fermentation extract or Saccharomyces cerevisiae culture or both added to ruminant diets appear that these direct fed microbials provide soluble factors that stimulate lactate utilisation by <u>Selenomonas ruminantium</u> (Martin and Nisbet, 1992). Growing concern over the use of antibiotics and other growth stimulants in the animal feed industry increased interest in evaluating the effect of direct fed microbials (DFM) on animal performance. However, compared to the ionophores, little research have been done to evaluate the effects of DFM on ruminal microbial fermentation and ruminant performance. In addition, limited information is available documenting the effects of DFM on the physiology of predominant ruminal microorganisms.

Much interest has been generated over the past few years in manipulating the ruminal microflora to enhance feed stuff utilisation and to alleviate problems associated with current feeding practices. Stabilization of ruminal pH by enhancing the lactate utilising capability of ruminal bacteria without using antibiotics or ionophores has the potential to improve performance by overcoming the economic losses associated with acidosis of rumen. The growing concern by consumers about the use of antibiotics in the animal feed industry as well as the need for a safe food supply provided motivation to investigate and develop new non-antibiotic or natural feed additives.

An area that deserves attention in this context is the improvement of the natural biostimulators as feed additives. In this category, the biostimulators which are commonly tried as feed additives are liver extract, extract prepared from spleen, dried form of liver and spleen, testicular extract, preserved animal blood, dried extracts of slaughter house embryos of cattle and pigs or of uterus and foetal membranes.

In the present investigation an attempt has been made to probe in depth the efficacy of dried buffaloe spleen as growth stimulator and its effect on nutrient utilisation in growing Malabari kids and if possible, to elucidate the probable mechanism of action of biostimulator on nutrient utilisation in animals.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

2.1 Antibiotics

An antibiotic is a compound synthesized by a living organism capable of inhibiting the growth of another organism. Antibiotics are therapeutic agents and not nutrients, but the responses observed in the nutrition of animals are only secondary. The specific method of action of antibiotics has not been fully explained. The different modes of action attributed to antibiotics are nutrient sparing action, increased absorption of nutrients and inhibition of toxin producing bacteria. Among many other antibiotics produced, those exhibited growth responses or other beneficial effects are Tylosin, Flavomycin, Lincomycin, Monensin, Neomycin, Oleandomycin etc. The recently evolved antibiotic, Rumensin (Monensin sodium), an antibiotic produced from a strain of *Streptomyces cinnamonensis*, is found to be an anticoccidial agent for broilers and lambs and is also used in beef cattle rations for enhancing feed nutrient utilisation by modifying rumen fermentation. Pallazzotto (1959) reported an enhancement of growth rate of calves by the administration of Terramycin associated with vigofac.

Lassister et al. (1960) observed that, either Aureomycin or Erythromycin, added to the diet increased the rate of gain and feed consumption, and reduced the incidence of scours in young dairy calves. Bush et al. (1960) studied the effect of Chlortetracycline on nutrient utilisation in dairy cows and noticed that, the calves given Chlortetracycline consume more feed, and attain significant weight gain than the control. Macfadden et al. (1960) probed in depth, the mode of action of antibiotics as feed additives in dairy calves and postulated that, the action of antibiotics in enhancing growth rate, as well as the well being of calves is by suppressing the possibly virulent intestinal bacteria in such a way, as to make them more susceptible to the normal defence mechanism of the body. In a study, Bedo et al. (1984) investigated the effect of growth stimulants on the metabolism of young lambs and reported an improved nutrient utilisation and nitrogen balance on administering daily doses of 4 mg Salinomycin, 8 or 12 mg Flavomycin and 13.3 mg Monensin. Buresova and Zednik (1992), reported an increased live weight gain and improved feed efficiency on the addition of the nutritive antibiotic Nourseothricin (Jenapharm) in the ration of pigs.

However, controversial opinions exist regarding the use of antibiotics as feed additives in livestock.

Continued use of antibiotics results in the development of resistant type microorganisms against the microbials that are being used.

2.2 Ionophores

Ionophores are compounds that form lipid soluble complexes with certain cations and facilitate their transport across biological membranes. Monensin and lasalocid are carboxylic ionophores that have been widely used as anticoccidial agents in poultry and are extensively used in growing and finishing beef cattle to augment feed efficiency and/ or weight gain. Males et al (1980) reported faster gain in steers fed monensin in the ration. Scott et al. (1984) observed that both monensin and lasalocid increased the apparent absorption of sodium, magnesium and phosphorus. They also noticed that, retention of magnesium and phosphorus were higher for steers receiving either lasalocid or monensin. Meinert (1987) probed in depth, the effect of feeding monensin on the growth and body composition of dairy heifers in two age groups and reported an average daily gain of 0.87 kg for old treatments, 0.82 kg for old controls, 0.82 kg for young treatment and 0.80 kg for young controls. In another study Nieto et al. (1990) reported an increased mean daily weight gain in lambs fed with monensin and observed fewer coccidial oocytes in lambs from weaning to

17th week. Thompson (1991) reported an improved growth with oestradiol or oestradiol plus monensin in Brahman cross steers. In another study Roberzynski et al. (1991) reported greater body weight gain in male lambs given Bovatec (lasalocid). Meinert et al. (1992) reported that, monensin could reduce age at puberty in Holstein heifers without affecting their body weight and composition. In a study Owens et al. (1992) reviewed the influence of ionophores on metabolism, growth, body composition and meat quality.

2.3 Hormonal compounds

Natural hormones are specific chemical substances produced by living cells, and present in extremely small amounts to evince considerable effect. Extensive use of these compounds either synthetic or purified such as estrogens, androgens, progestogens, growth hormones and thyroxine or thyroprotein (iodinated casein) are being used as additives to stimulate growth and fattening of meat producing animals. Some of the hormones increase rate and efficiency of gain while others improve quality of the products. The use of synthetic stilboesterol, hexoestrol, have attracted more attention in recent years and these are in commercial use as growth promoter in many countries.

Jordan (1950) reported a significant increase in the daily gain of lambs, implanted with a 12 mg pellet of stilboesterol. Shroder and Hansard (1959) reported more efficient utilisation of absorbed calcium and phosphorus in stilboestrol treated lambs. From a study, Brumby (1960) observed that, use of growth hormone could significantly increase live weight gain in young cattle. Samberev and Atraskov (1966) reported an increased rate of gain by 15.4 per cent over that of untreated animals like bullocks and heifers, by the use of anabolic preparation 3-3' diallyl diethyl stilboesterol. In another study, Valnev (1973) noticed that steers with implants of testosterone plus dienoestrol diacetate in the ratio of 2:1 or 5:1 had attained higher weight gain by 12 to 32 per cent than non-implanted controls. Spradling and Ross (1986) observed that, lambs implanted with zeranol exhibited greater average daily gain to that of non-implanted lambs. They also noticed that, lasalocid supplementation improved growth rate only in lambs implanted with zeranol. Frais *et al*. (1990) reported an increased live weight gain by 5.2 to 10.7 per cent with the anabolic steroids in young bulls. Pell *et al*. (1990) observed that, the use of somatotropin increased daily body weight gain for restricted, but not for *ad libitum* fed lambs. They also found that somatotropin increased combined muscle weight for both restricted and ad libitum fed lambs. whereas visceral fat depots were decreased only in ad libitum fed lambs. In another investigation Zyl (1992) observed that, calves implanted with 200 mg testosterone propionate plus 200 mg oestradiol benzoate had attained a higher weaning weight. (256.7 vs 239.1 kg) and a higher average daily gain (1043 vs 888 g).

It has been well documented in the foregoing paragraphs regarding the beneficial role of hormones as growth promoters by various authors, the question whether hormones can be used as growth promoters is still debatable, and it seems logical that, with any feeding system, the economic advantages, however great, should never take precedence over any potential risk to human health. But, it cannot be ruled out whether these substances can induce cancer in human beings if the products of the treated animals are consumed for a prolonged period.

2.4 Probiotics

Recently, the use of probiotics in the ration of ruminants has attracted the attention of workers. The definition of probiotic encompass microbial cultures, microbial cells and microbial metabolites. The most commonly used probiotics are strains of the lactic acid bacteria (LAB) Lactobacillus and Streptococcus. Besides

LAB, other microbial products that contain Bacillus, yeasts, enzymes and other agents are also classified as probiotics. Probiotics aid in feed conversion, but in some countries it is used as prophylactic agent against enteritis. Although the probiotic concept has been recognized for many years, the absolute mode of action has been elusive. Lactobacilli have been reported to produce various types of antibiotics. Some of the Lactobacilli produce sufficient hydrogen peroxide to inhibit various microorganisms. Through the constant infusion of safe and beneficial organisms in the diet, colonization of the gastrointestinal tract by pathogenic organisms can be altered, improving health and life expectancy. The most recently advanced and most provocative mode of action attributed to probiotics is immunostimulation.

From a study, Fallon _et al_. (1987) observed that the inclusion of yeast culture in a barley/ soya diet promoted dry matter intake and increased live weight gain in calves. Gomez-alarcon _et al_. (1990) found that primary effect of _Aspergillus oryzae_ is stimulation of fibre digestion by rumen microbes in cows. Bakshi and Langer (1990) reported an increase in dry matter intake, nutrient digestibility, and availability of metabolic energy in buffalo calves receiving Lactobacillus culture, although the daily weight gain did not show significant difference.

Beharka et al. (1991) observed that the Aspergillus oryzae fermentation extract supplemented calves had higher total volatile fatty acids, propionate and acetate concentrations in the rumen than unsupplemented calves. Cole et al. (1992) from their investigation suggested that, supplementation of morbid calves with yeast culture can have beneficial effects which are mediated by improved nitrogen, zinc and iron metabolism.

Probiotics are not an alternative to antibiotic treatment of acute diseases. In the strict sense, they are not growth promoters, but rather, growth permittants allowing the host to best express its genetic potential.

2.5 Enzymes

Burroughs et al. (1954) reported that growing fattening cattle had 7 per cent faster gain on equal feed intakes when a crude enzyme mixture was added to the feed. They found that digestibility of the feed was not affected. Wetscherek and Zollitsch (1991) investigated the use of enzyme preparation, Polans in calf feeding. They found that there were no significant differences in performance criteria due to addition of Polans to milk substitutes for calves. Less extensive tests at other stations have not confirmed the results, and the true role of added enzymes in livestock feeding remains undefined.

2.6 Tranquillizers and other stimulants

Tranquillizers are normally used to reduce hypertension and nervousness. Reserpine and hydroxyzine are found to improve daily gain in fattening chicks. Chlorpromazine and reserpine are used to reduce excitability in fowl. These drugs act on central nervous system which protect the birds from stress. Kim et al. (1987) reported improved total weight gain and feed efficiency in lambs by the use of Cimaterol. Akanbi et al. (1991) reported growth promoting effect of Cimaterol in rabbits.

2.7 Biostimulators

Reports on search for natural biostimulators and for its viable application in livestock farms are many. Initially the investigators used injections of biostimulators to increase the weight gain in fattening animals. These preparations cannot be recommended for field application. As such, the biostimulator was prepared in dried form by which it could be mixed with the feed.

Iopa et al. (1958) studied the use of Filatov's tissue preparations in livestock farms in the Rajazan district and obtained best results when injections were given at 5 day intervals. Korolkov (1959) observed that the weight gains in pigs received subcutaneous injections of the Filatov's tissue preparations were 18 to 39 per cent better than those of untreated pigs. Scerbakov (1959) noticed that the symptoms of rickets disappeared in biostimulator treated pigs and the pigs gained on an average 64 per cent more than the untreated controls. Romanov (1960) reported a production of more than 2600 tonnes more meat in the collective and state farms of Crimea by the use of tissue preparations. Gernigov and Mihajlov (1960) reported that use of tissue preparations stimulated growth and prevented disease in piglets. Karpenko et al. (1960) observed an increase in weight gain of fattening pigs by the use of preparations of spleen and liver. Korolkov and Petrisin (1960) noticed that preserved testicular tissue from boars stimulated weight gain in pigs. Torosjan (1960) found that the biostimulant (prepared from animal, plant and microbial tissues) treated pigs weighed 1.7 kg more than untreated littermates. Furtunescu et al. (1963) reported an increased weight gain in cattle and pigs treated with spleen and liver. Makarov and Soloves (1963) observed that an agar preparation evolved by a modification of Filatov's method increased mean daily weight gain of pigs by 51 g and calves by 79 g, while the ordinary extract increased the body weight of pigs and calves by 53 g respectively. Nica et al. (1964) observed an increase in body weight of pigs by 10 per cent over that of untreated controls, by the administration of an extract of pig spleen at intervals of 10-15 days.

Doroskov (1965) reported an increased average daily gain of the two experimental groups injected with placenta preparation and liver preparation than those of the controls injected with physiological solution. In another investigation Korolev (1966) reported an increase in mean daily weight gains in cattle and pigs by use of biogenic stimulators prepared from the embryos of slaughtered animals. Sare (1967) in his study, observed an increase in post weaning daily gains of pigs by 33-139 g and of cattle by 4-6 kg per month when compared to untreated controls. Phonomarev (1971) from an investigation reported effectiveness of the activity of agar tissue preparations on the development of young pure bred and cross bred fattening stock. Rebreanu (1971) reported higher height at withers, body length and heart girth in Romanian Simmental calves given testicular extract. Safarov (1971) observed improved post natal growth of offsprings of ewes treated with biostimulator. In another study, Zarkov (1971) observed increased weight gain of 27.0 and 32.4 percentages respectively in two groups of rabbits injected with 0.23 ml agar-spleen preparation per kilogram body weight and 0.22 ml agar-spleen lysate preparation per kilogram body weight respectively than that of controls. Kovalevskaja and Gluhovcev (1971) from their investigation on three groups of rabbits, one treated with a preparation of embryonic tissue plus agar, the second with dried embryonic tissue in the ration and the three, with sterile solution of the agar tissue preparation alone, observed a gain of 14, 16 and 3 per cent more than the controls respectively. Sokolova (1971) reported that in poultry, the weight gain upto 60 days of age of birds fed tissue preparation exceeded from that of control by 14.3 per cent. Kukde and Thakur (1992) studied the effects of biostimulators on metabolizability of feed energy and reported a highest utilisation of energy in chick embryo group than goat testicle group, broiler liver group and broiler testicle group.

It is clearly understood from the foregoing paragraphs that most of the biostimulators which were being used in the investigations were injectable forms of the tissue preparations. A natural biostimulator, cheap and easily usable by farmers is an imperative need at present, for the development of animal industry.

MATERIALS AND METHODS

MATERIALS AND METHODS

3.1 Experimental animals

Twentyfour female Malabari kids, four to six months of age and weighing on an average 8.5kg, after being dewormed and sprayed against ectoparasites were used in the present investigation. The animals were selected from the herd of goats maintained at the Goat Farm attached to the College of Veterinary and Animal Sciences, Mannuthy, Trichur. The kids were distributed randomly to four experimental groups of six animals each as uniformly as possible, with regard to age, sex and weight. All the kids were maintained under identical conditions of management and were fed individually. Wholesome water was made available at all time. The experimental duration lasted for 120 days.

3.2 Experimental rations

Two basal concentrate mixtures were formulated, one containing 16 per cent crude protein, consisting of 33 per cent yellow maize, 16 per cent gingelly oil cake, 34 per cent wheat bran, 14 per cent bengal gram, 2 per cent mineral mixture and 1 per cent common salt, and the other containing 12 per cent crude protein, consisting of 45 per cent yellow maize, 5 per cent gingelly oil cake, 42 per cent wheat bran, 5 per cent Bengal gram, 2 per cent mineral mixture and 1 per cent common salt. Vitablend AB_2D_3 was incorporated at the rate of 25 g per 100 kg of each of the concentrate mixture so that each kilogram of the mixture had 10,000 i.u. of vitamin A, 6.25 mg of vitamin B_2 and 1,500 i.u. of vitamin D_3. On chemical analysis, the concentrate mixture containing 16 per cent protein and that containing 12 per cent protein were found to possess 90.63 and 91.43 per cent dry matter, 16.35 and 12.24 per cent crude protein, 5.21 and 3.55 per cent ether extract, 3.56 and 5.97 per cent crude fibre, 7.58 and 6.52 per cent total ash, 67.3 and 71.72 per cent nitrogen free extract, 0.768 and 0.751 per cent calcium, 0.416 and 0.409 per cent phosphorus and 0.367 and 0.302 per cent magnesium respectively. Jack (Artocarpus heterophyllus) leaves used as roughage were found to contain dry matter 57.47 per cent, crude protein 15.09 per cent, ether extract 4.03 per cent, crude fibre 18.61 per cent, total ash 11.25 per cent, nitrogen free extract 51.02 per cent, calcium 1.586 per cent, phosphorus 0.410 per cent and magnesium 0.488 per cent. ICAR recommendations (1985) have been followed for the feeding of kids. A concentrate-roughage ratio around 2:1 (ranging between 1.5: 1 to 2: 1) was maintained in all the experimental groups.

Of the 24 kids, 12 kids were maintained on a concentrate mixture containing 16 per cent crude protein plus roughage (high plane of nutrition), while the remaining 12 kids were maintained on a concentrate mixture containing 12 per cent of crude protein plus roughage (low plane of nutrition).

Of the 12 animals maintained on 16 per cent protein, six animals constituting group I were maintained on concentrate mixture supplemented with dried spleen at the rate of 0.1 per cent (ration A), while the remaining six animals constituting group II were maintained on concentrate mixture alone without any supplementation of dried spleen, which served as the control for high plane of nutrition (ration B). The remaining 12 animals maintained on concentrate mixture containing 12 per cent protein were subdivided into two groups of six animals each (group III and group IV) wherein group III fed with concentrate mixture supplemented with dried spleen at the rate of 0.1 per cent (ration C) while the group IV maintained on concentrate mixture alone, without any supplementation of dried spleen (ration D), which served as the control for low plane of nutrition. Weighed and measured quantity of dried spleen were mixed thoroughly with the concentrate part of each ration. The animals were fed individually, their requirements being periodically determined on the basis of their body weight.

3.3 Methods

The kids were weighed at weekly intervals and record of daily feed intake, both concentrate and roughage, were maintained throughout the course of the study. A digestibility cum metabolism trial was carried out towards the terminal period of the feeding trial wherein, quantitative and separate collection of urine and faeces were carried out for five consecutive days, using metabolism cages specifically fabricated for the purpose. Everyday at 9 AM the animals were given a measured quantity of the respective ration. At the same time, the residue from the previous day's feed was removed and quantified.

3.3.1 Sampling of the rations

Known quantities of the feed given were taken every day in polythene bags during the collection period for estimation of moisture content and also known quantities of the residual feed were collected everyday for estimation of moisture content of the balance feed.

3.3.2 Collection and sampling of faeces and urine

All precautions were taken to ensure the collection of dung and urine quantitatively, uncontaminated with any feed residue or dirt. The dung was collected manually as and when it was voided. The urine was collected in bottles kept under the funnel of the metabolism cages with frequent rinsing with distilled water. Concentrated sulphuric acid (25 per cent) at the rate of 20 ml were added in each bottle before the collection of urine. At 10 AM everyday , dung and urine voided during the previous 24 hours were measured accurately, mixed thoroughly and separately. Representative samples of both dung and urine at the rate of 10 per cent of the total voided quantity were taken and stored in a refrigerator. The samples collected from each animal, preserved during the entire collection period were later pooled and used for further analyses.

3.3.3 Digestibility coefficients

The digestibility of the nutrients of the rations given during experimental period were determined by the conventional method.

3.3.4 Chemical analysis

The feed samples and dung collected during the metabolism trial were subjected to proximate analysis as per standard procedures (AOAC 1990). Calcium and magnesium content of feed and dung samples were estimated by using atomic absorption spectrophotometer (Perkin Elmer-model 2380) and phosphorus by colorimetry (Ward and Johnston

1962). The urine samples collected during the metabolism trial were analysed for nitrogen (Kjedahl method, AOAC 1990), calcium and magnesium by Atomic Absorption Spectrophotometer (Perkin Elmer model 2380) and phosphorus by modified metol method using phosphorus kit supplied by Stangen Immunodiagnostics.

3.3.5 Haematological studies

Blood samples for the analysis were collected from the jugular vein of the animals into sterile citrated tubes. Red cell counts were made using improved Neubauer counting chamber with 1:200 dilution of blood using Hayems fluid. White blood cell counts were made by using Thomas fluid as the diluent with 1:20 dilution. Haemoglobin content of the samples were determined by Cyanmeth haemoglobin method (Benjamin, 1974). Plasma protein values were determined by Biuret method(Gornall *et al*., 1949) using total protein and albumin kit supplied by Stangen Immunodiagnostics. Plasma calcium and magnesium were determined by Atomic Absorption Spectrophotometer (Perkin Elmer- model 2380). Plasma inorganic phosphorus was determined by colorimetry (Fiske and Subba Row, 1925).

Statistical analyses of the data were carried out as per methods described by Snedecor and Cochran (1967).

RESULTS

RESULTS

Results obtained during the course of the present investigation are detailed under the following heads:

4.1 Body weight gain

The body weight gain of animals recorded during the entire period of the study and their average daily gain are presented in Tables 1 to 4 represented by Fig.1 and the summarised data on average initial body weight, average final body weight, average cumulative weight gain and average daily gain of kids maintained on four dietary treatments are presented in Table 5.

4.2 Dry matter intake

The average daily dry matter consumption during the period of 16 weeks of study are summarised in Table 8.

4.3 Feed efficiency

Data on weekly feed efficiency are tabulated in Table 9, represented by Fig. 2

4.4 Protein efficiency

Results of the weekly protein efficiency are set out in Table 10, represented by Fig. 3

4.5 Cost per unit gain

Data on cost per unit gain is shown in Table 11, represented by Fig.4.

Consolidated data on weight gain, dry matter intake, feed efficiency, protein efficiency and cost per unit gain of animals are detailed in Table 12, and the statistical analyses of the parameters are set out in Tables 6 and 7 and Tables 13 to 16 respectively.

4.6 Haematological parameters

Data on the haemotological parameters such as R.B.C, W.B.C, haemoglobin and plasma protein concentrations are set out in Table 17 and plasma calcium, phosphorus and magnesium are presented in Table 18, and the statistical analyses of these parameters are detailed in Tables 19 to 25.

4.7 Digestibility of nutrients

Results of the digestibility trial are set out in Tables 26 to 30 and the consolidated data in Table 31, and the data on statistical analyses are detailed in Tables 32 to 36.

4.8 Nitrogen and mineral balances

Results of the nitrogen and mineral balances are shown in Tables 37 to 40 represented by Figs. 5 to 8. Consolidated data on per cent retention of nitrogen, calcium, phosphorus and magnesium are presented in Table 41 and the corresponding statistical analyses in Tables 42 to 45.

Table 1. Weekly body weight (kg) of kids maintained on Ration A (Group 1) containing 16 per cent crude protein plus 0.1 per cent dried spleen on dry matter basis.

	Animal number						Av. with S.E
Week	1	2	3	4	5	6	
0	9.9	9.4	8.8	8.4	7.6	7.0	8.52±0.445
1	10.4	10.3	9.6	9.1	7.9	7.5	9.13±0.496
2	10.5	10.4	9.9	9.2	8.4	7.8	9.37±0.449
3	11.5	10.6	10.7	9.5	9.4	8.2	9.98±0.481
4	11.8	10.7	10.8	10.1	10.1	8.6	10.35±0.433
5	12.2	10.9	10.9	10.2	10.4	8.8	10.57±0.454
6	12.5	11.4	11.4	10.9	11.2	8.9	11.05±0.484
7	13.0	11.5	11.6	11.2	11.5	9.5	11.38±0.457
8	13.8	11.9	11.8	11.8	12.0	10.0	11.86±0.492
9	14.3	12.0	12.2	12.2	12.3	10.3	12.22±0.519
10	14.4	12.3	12.5	12.5	13.0	10.6	12.55±0.500
11	14.5	12.6	13.1	13.2	13.4	11.2	13.00±0.442
12	15.2	13.0	13.8	13.8	14.3	11.9	13.67±0.460
13	15.6	13.5	14.6	14.2	15.0	12.3	14.20±0.478
14	15.9	14.0	15.1	14.7	15.3	12.6	14.60±0.476
15	16.2	14.2	15.4	15.5	16.2	13.1	15.10±0.499
16	17.0	15.1	16.1	16.2	17.1	14.0	15.92±0.484

Table 2. Weekly body weight (kg) of kids maintained on Ration B (Group II, control)

	Animal number						Av. with S.E
Week	1	2	3	4	5	6	
0	10.2	9.2	9.0	8.1	7.8	6.3	8.43±0.551
1	10.7	9.8	9.4	8.2	8.3	6.9	8.88±0.552
2	10.9	10.1	10.0	8.7	8.5	7.0	9.20±0.575
3	11.5	10.6	10.8	9.0	9.1	7.3	9.72+0.629
4	11.9	11.0	11.2	9.4	9.5	7.8	10.13+0.616
5	12.5	11.7	11.3	9.5	9.6	8.0	10.43±0.686
6	13.0	12.0	12.0	9.6	10.1	8.5	10.87±0.705
7	13.2	12.3	12.2	9.8	10.4	9.0	11.15±0.674
8	14.0	12.8	12.4	10.4	11.0	9.5	11.68±0.683
9	14.2	13.0	12.8	11.2	11.4	9.8	12.07±0.640
10	15.0	13.7	13.0	11.4	12.0	10.3	12.57±0.688
11	15.5	14.1	13.3	12.0	12.5	10.9	13.05±0.663
12	16.1	14.8	13.8	12.8	12.8	11.3	13.60±0.690
13	16.8	15.5	14.2	13.0	13.3	11.8	14.10±0.739
14	17.4	16.2	14.5	13.4	13.9	12.2	14.60±0.777
15	17.5	16.6	14.7	13.9	14.5	12.8	15.00±0.712
16	18.0	17.1	14.8	14.2	14.8	13.0	15.32±0.739

Table 3. Weekly body weight (kg) of kids maintained on Ration C (Group III) containing 12 per cent crude protein plus 0.1 per cent dried spleen on dry matter basis.

	Animal number						Av. with S.E
Week	1	2	3	4	5	6	
0	9.5	9.4	8.8	8.6	7.2	7.1	8.43±0.429
1	10.1	10.5	9.3	9.3	7.5	7.3	9.00±0.541
2	10.4	10.6	9.9	9.4	7.7	7.7	9.28±0.529
3	11.0	11.5	10.5	9.5	7.9	8.3	9.78±0.599
4	11.6	11.7	10.9	10.2	8.3	8.7	10.23±0.593
5	11.8	12.2	11.2	10.4	8.8	9.0	10.57±0.583
6	12.0	13.0	11.6	10.8	9.1	9.4	10.98±0.621
7	12.2	13.6	12.2	11.1	9.2	9.7	11.33±0.681
8	13.2	14.1	12.8	11.6	9.3	10.1	11.85±0.762
9	13.4	14.4	13.4	12.2	9.8	10.4	12.27±0.746
10	14.3	14.7	14.0	13.4	10.4	10.9	12.95±0.750
11	14.9	15.5	14.3	13.7	10.7	11.4	13.42±0.793
12	15.5	16.0	15.2	14.5	11.1	12.1	14.07±0.815
13	16.1	16.7	15.6	15.2	11.7	12.7	14.67±0.817
14	16.3	16.9	16.0	15.6	12.2	13.0	15.00±0.785
15	16.8	17.1	16.7	16.0	12.6	13.4	15.43±0.790
16	17.4	17.6	17.1	16.5	13.2	13.9	15.95±0.779

Table 4. Weekly body weight (kg) of kids maintained on Ration D (Group IV, control)

	Animal number						Av. with S.E
Week	1	2	3	4	5	6	
0	10.2	9.2	8.8	8.3	7.6	7.0	8.52±0.468
1	10.5	9.5	9.3	8.7	7.9	7.3	8.87±0.472
2	10.6	9.8	9.8	8.8	8.0	7.5	9.08±0.486
3	10.9	9.9	10.2	8.9	8.6	8.3	9.47±0.417
4	11.1	10.4	10.6	9.0	8.7	8.6	9.73±0.445
5	11.4	10.5	11.2	9.3	9.0	8.8	10.03±0.468
6	11.8	10.7	12.0	9.5	9.3	9.3	10.43±0.511
7	12.0	10.9	12.2	9.6	9.4	9.5	10.60±0.525
8	12.4	11.0	12.5	9.7	9.9	9.8	10.88±0.531
9	13.0	11.5	12.6	9.8	10.3	9.9	11.18±0.570
10	13.7	11.6	13.0	10.1	10.7	10.3	11.57±0.609
11	14.0	11.7	13.4	10.2	11.0	10.5	11.8±0.640
12	14.5	11.9	14.0	10.7	11.5	11.0	12.27±0.653
13	15.0	12.1	14.3	11.1	11.9	11.5	12.65±0.654
14	15.4	12.4	14.4	11.2	12.3	12.0	12.95±0.653
15	15.6	12.7	14.6	11.6	12.6	12.2	13.22±0.630
16	15.8	13.0	14.9	11.9	13.0	12.5	13.52±0.614

Fig.1 BODY WEIGHT OF KIDS MAINTAINED ON FOUR EXPERIMENTAL RATIONS

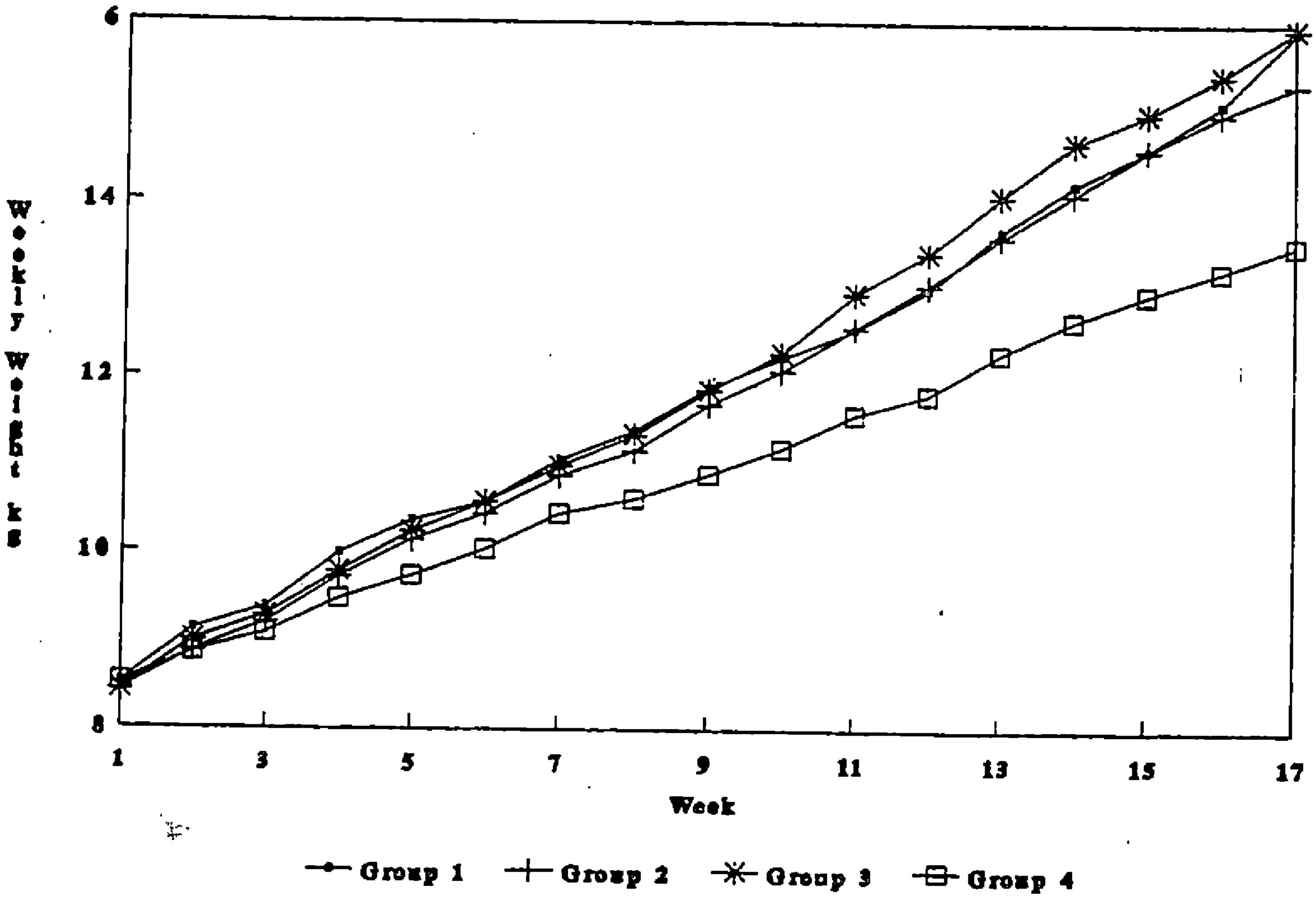

Table 5. Summarised data on average initial body weight, average final body weight, average cumulative weight gain and average daily gain of kids maintained on four dietary treatments (Rations A,B,C and D)

Treatments	Ration A (16 per cent protein containing dried spleen at the rate of 0.1 per cenet on dry matter basis)	Ration B (16 per cent crude protein control	Ration C (12 per cent protein containing dried spleen at the rate of 0.1 per cenet on dry matter basis)	Ration D (12 per cent crude protein control)
Number of kids	6	6	6	6
Initial body weight (kg)	8.52±0.445	8.43±0.551	8.43±0.429	8.52±0.468
Final body weight (kg)	15.92±0.484	15.32±0.764	15.95±0.779	13.52±0.614
Cumulative weight gain (kg)	7.40±0.507	6.88±0.352	7.52±0.374	5.00±0.423
Daily gain (g)	61.67±4.230	57.36±2.92	62.64±3.11	41.67±3.530

Table 6. Analysis of variance - cumulative weight gain

Source	df	SS	MSS	F
Treatment	3	24.5088	8.1696	7.7924**
Error	20	20.97	1.0484	
Total	23	45.48		

** P< 0.01

Table 7. Analysis of variance - average daily gain

Source	df	SS	MSS	F
Treatment	3	1699.969	566.6563	7.5686**
Error	20	1497.3782	74.8689	
Total	23	3197.3492		

** P< 0.01

Table 8. Average daily dry matter intake in grams(g) on dry matter (DM) basis of the animals maintained on the experimental rations A,B,C and D

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
0-7 days	386.93	357.93	362.07	375.48
7-14	331.72	359.88	344.17	330.72
14-21	452.65	437.46	452.74	438.34
21-28	508.56	526.13	511.80	509.66
28-35	580.28	591.03	602.30	585.75
35-42	578.51	596.60	595.93	577.58
42-49	621.53	655.69	610.10	638.42
49-56	617.76	631.37	615.99	602.01
56-63	630.28	651.05	653.55	627.76
63-70	626.35	654.13	656.42	627.60
70-77	626.08	688.04	682.76	688.90
77-84	674.04	682.67	695.64	700.15
84-91	700.34	707.30	729.41	728.96
91-98	742.32	730.60	729.89	721.74
98-105	773.63	777.18	779.11	754.57
105-112	800.06	802.47	793.04	780.35

Table 9. Average weekly feed efficiency of the animals maintained on the four dietary regimes

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
0-7 days	4.89	8.06	5.67	7.84
7-14	15.22	10.57	12.49	14.83
14-21	7.50	6.50	11.09	14.82
21-28	17.98	8.99	9.59	18.96
28-35	24.41	25.60	14.88	18.35
35-42	12.89	14.00	11.83	12.61
42-49	18.66	18.53	16.69	28.97
49-56	10.41	10.16	11.92	21.44
56-63	17.00	15.59	13.28	25.96
63-70	18.40	13.00	8.09	14.31
70-77	14.34	10.72	10.44	27.19
77-84	7.45	9.43	7.87	11.63
84-91	9.89	11.55	8.80	14.68
91-98	13.97	10.92	17.61	25.86
98-105	14.33	22.42	14.79	21.57
105-112	6.97	23.12	10.91	19.61

Fig.2 FEED EFFICIENCY OF KIDS MAINTAINED ON FOUR DIETARY REGIMES

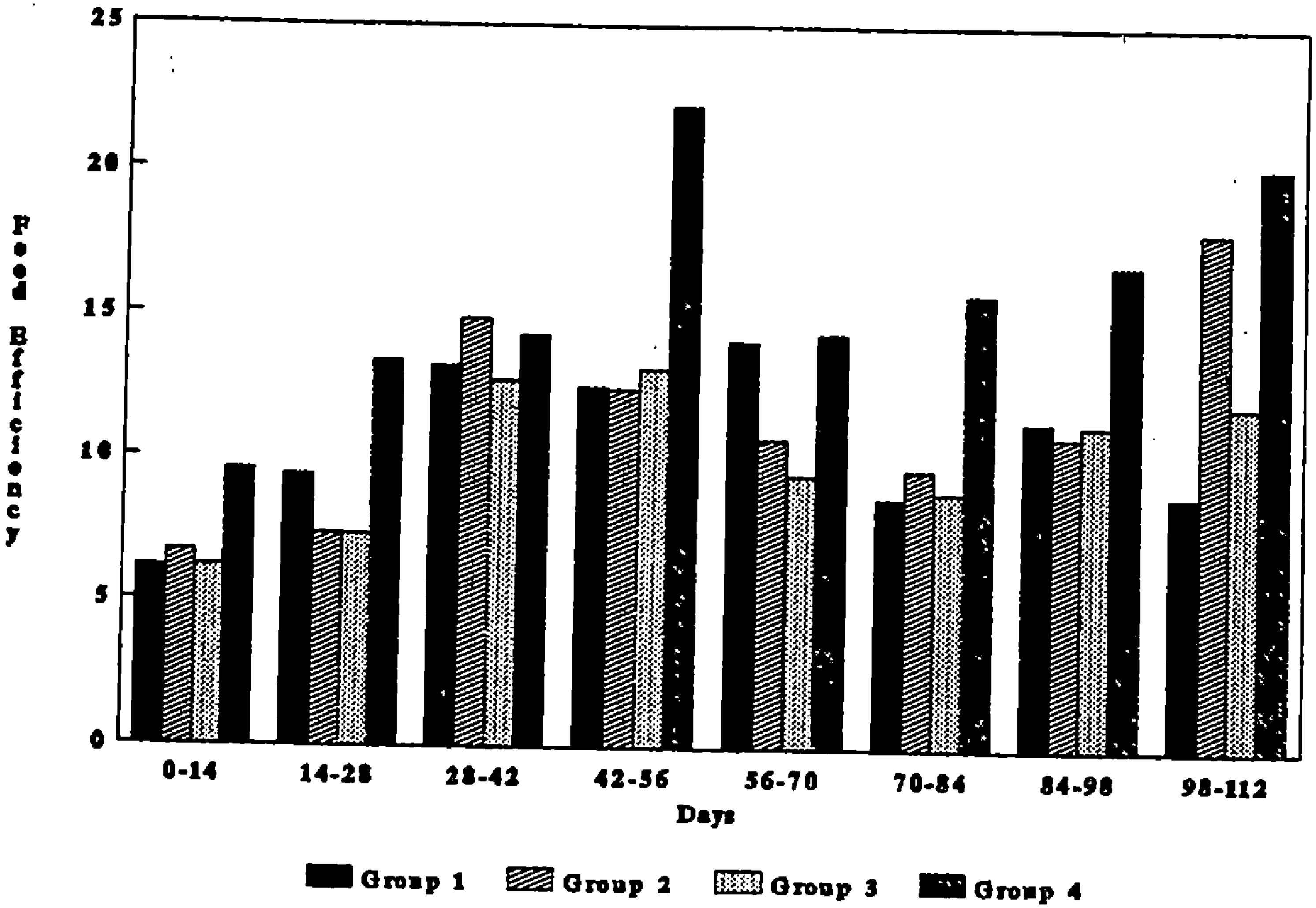

Table 10. Average weekly protein efficiency of the animals maintained on the four dietary regimes

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
0- 7 days	1.45	1.18	1.61	1.01
7-14	0.66	0.79	0.85	0.67
14-21	1.24	1.09	1.18	0.98
21-28	0.68	0.75	0.96	0.55
28-35	0.34	0.44	0.91	0.54
35-42	0.76	0.68	0.73	0.79
42-49	0.52	0.42	0.58	0.29
49-56	0.64	0.80	0.85	0.50
56-63	0.47	0.57	0.70	0.49
63-70	0.48	0.69	1.14	0.63
70-77	0.64	0.67	0.72	0.35
77-84	0.87	0.73	0.99	0.69
84-91	0.69	0.63	0.88	0.55
91-98	0.50	0.61	0.51	0.44
98-105	0.58	0.50	0.60	0.38
105-112	0.94	0.35	0.70	0.42

Fig.3 PROTEIN EFFICIENCY OF KIDS MAINTAINED ON FOUR DIETARY REGIMES

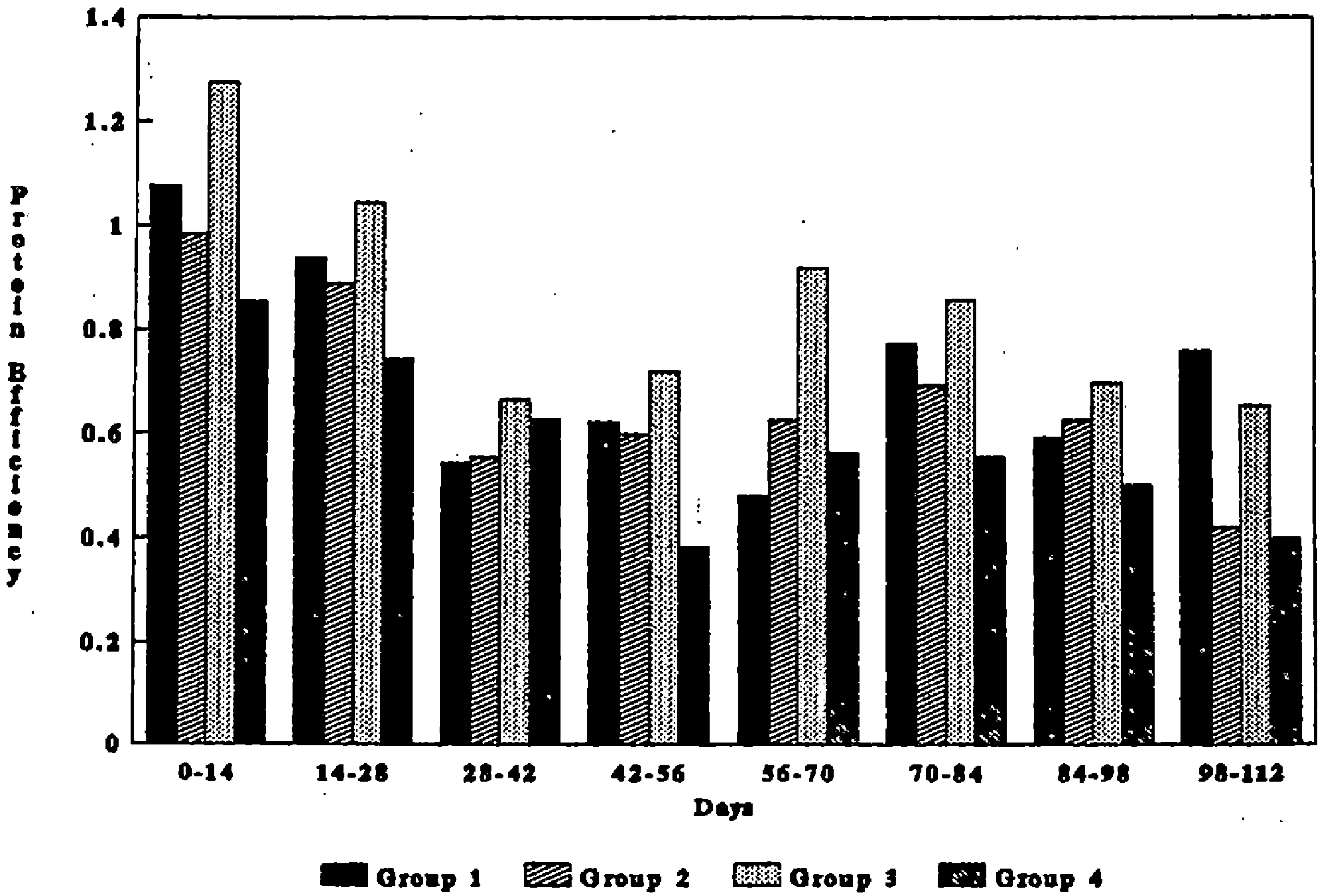

Table 11. Data on cost of production per kg gain (Rs.) of the animals maintained on the four dietary regimes

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Average total weight gain (kg)	7.40	6.88	7.52	5.00
Total feed consumption (kg) concentrate	42.40	42.37	43.87	42.77
roughage	52.01	53.60	51.03	55.72
Total feed cost (Rs.)	241.09	241.35	196.57	193.15
Cost of production per kg gain (Rs.)	32.58	35.08	26.14	38.63

Cost of concentrate

16 per cent protein	Rs. 538.00/quintal
12 per cent protein	Rs. 419.00/quintal
Cost of roughage	Rs. 25.00/quintal

Fig.4 COST OF PRODUCTION PER KG GAIN OF KIDS MAINTAINED ON FOUR EXPERIMENTAL RATIONS

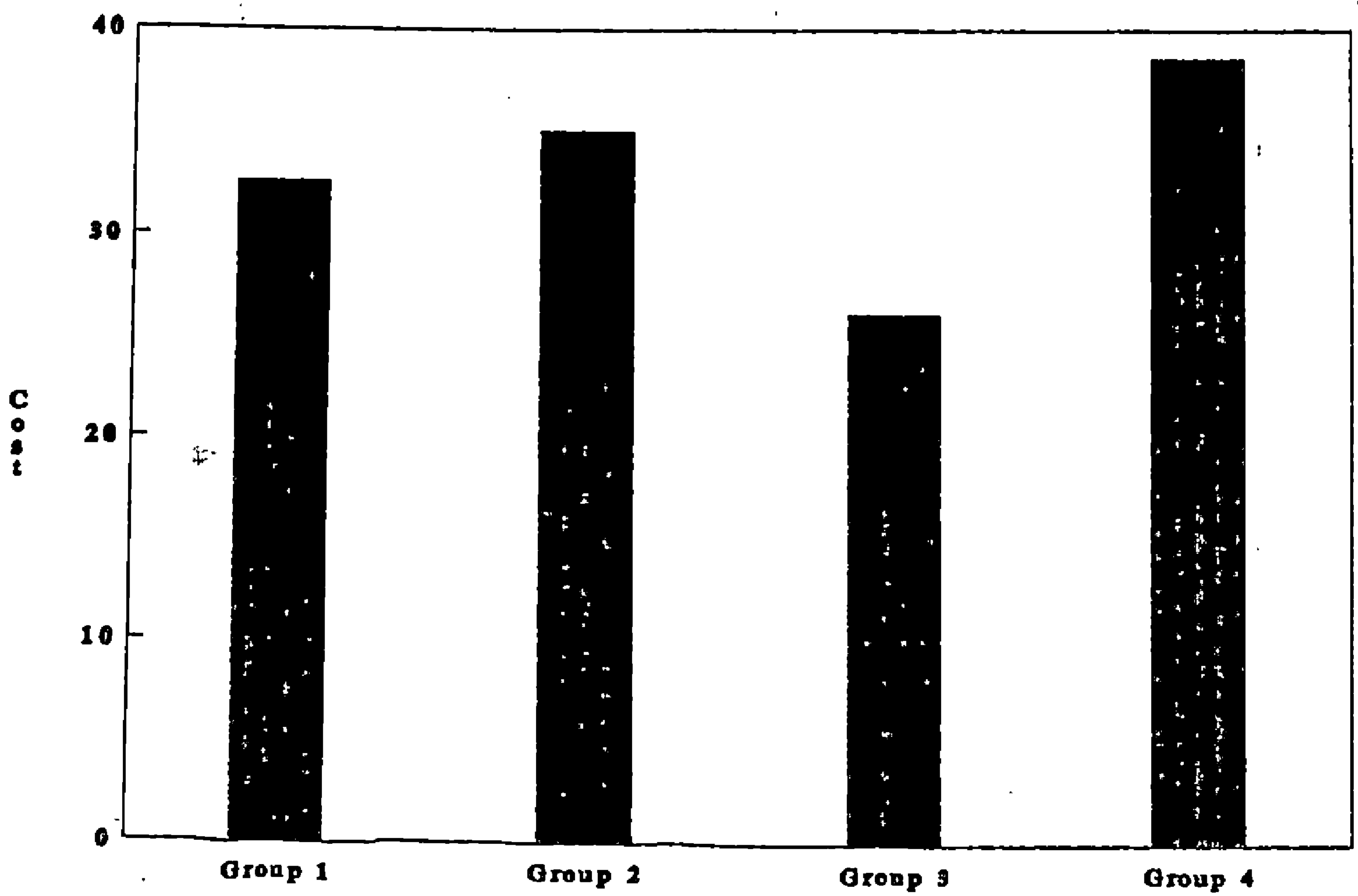

Table 12. Consolidated data on dry matter intake, weight gain, feed efficiency, protein efficiency and cost per unit gain recorded for the kids maintained on the four rations for a period of 112 days.

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Average daily dry matter consumption (g)	562.9±20.28	574.5±36.81	572.3±30.40	564.0±25.21
Average daily gain (g)	61.67±4.23	57.36±2.92	62.64±3.11	41.67±3.53
Average cumulative gain in 120 days (kg)	7.40±0.51	6.88±0.35	7.52±0.37	5.00±0.42
Average cumulative feed efficiency	9.31±0.62	10.07±0.61	9.13±0.15	14.01±1.25
Average cumulative protein efficiency	0.70±0.05	0.64±0.04	0.81±0.02	0.55±0.05
Cost per unit gain	32.58±2.10	35.08±2.02	26.14±0.99	38.63±3.31

Table 13. Analysis of variance - average daily dry matter intake

Source	df	SS	MSS	F
Treatment	3	611.5	203.8333	0.040862 NS
Error	20	99767.5	4988.375	

Table 14. Analysis of variance - feed efficiency

Source	df	SS	MSS	F
Treatment	3	94.39844	31.46615	8.978835 **
Error	20	70.0896	3.50448	

Table 15. Analysis of variance - protein efficiency

Source	df	SS	MSS	F
Treatment	3	0.2259846	0.0753282	8.187083 **
Error	20	0.1840172	9.20E-03	

Table 16. Analysis of variance - cost of production

Source	df	SS	MSS	F
Treatment	3	498.6621	166.2207	5.418009 **
Error	20	613.586	30.6793	

NS Not significant

** $P < 0.01$

Table 17. Data on R.B.C, W.B.C, haemoglobin and plasma protein concetrations of kids maintained on the experimental rations.

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
RBC (10^6/cumm)	14.50±0.43	14.00±0.34	14.42±0.35	13.42±0.27
WBC (10^3/cumm)	10.66±0.49	10.58±0.46	10.50±0.45	10.33±0.56
Haemoglobin (g/100 ml)	11.92±0.35	11.75±0.53	11.83±0.36	10.75±0.53
Plasma protein (g/100 ml)	11.20±0.41	10.92±0.61	11.60±0.25	10.17±0.36

Table 18. Data on calcium, phosphorus and magnesium concentrations in blood of kids maintained on the experimental rations

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Calciuml mg/100 ml	9.37±0.23	9.65±0.23	10.43±0.47	9.05±0.19
Inorganic phosphorus mg/100 ml	4.42±0.30	4.17±0.31	4.67±0.28	3.92±0.30
Magnesium mg/100 ml	3.50±0.26	3.23±0.09	3.18±0.08	3.12±0.08

Table 19. Analysis of variance - R.B.C.

Source	df	SS	MSS	F
Treatment	3	4.416504	1.472168	1.973813 NS
Error	20	14.91699	0.7458496	

Table 20. Analysis of variance - W.B.C.

Source	df	SS	MSS	F
Treatment	3	0.364502	0.1215007	0.084156 NS
Error	20	28.875	1.44375	

Table 21. Analysis of variance - haemoglobin

Source	df	SS	MSS	F
Treatment	3	4.484375	1.494792	1.511919 NS
Error	20	19.77344	0.9886719	

NS Not significant

Table 22. Analysis of variance - plasma protein

Source	df	SS	MSS	F
Treatment	3	5.641602	1.880534	1.991382 NS
Error	20	18.88672	0.9443359	

Table 23. Analysis of variance - plasma calcium

Source	df	SS	MSS	F
Treatment	3	5.693848	1.897949	3.882535 *
Error	20	9.776856	0.4888428	

Table 24. Analysis of variance - plasma phosphorus

Source	df	SS	MSS	F
Treatment	3	3.834961	1.27832	1.17465 NS
Error	20	21.76514	1.088257	

Table 25. Analysis of variance - plasma magnesium

Source	df	SS	MSS	F
Treatment	3	1.161133	0.3870443	1.23478 NS
Error	20	6.269043	0.3134522	

NS Not significant

* $P < 0.05$

Table 26. Digestibility coefficients of dry matter (DM) of the animals maintained on the experimental rations.

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Dry matter intake g/day				
From concentrate	340.04	417.91	383.42	383.13
From roughage	282.02	366.47	304.01	305.20
Total	622.06	784.38	687.43	688.33
Out go g/day	168.92	195.66	200.25	210.22
Difference g/day	453.14	588.72	487.18	478.11
Digestibility coefficient (per cent)	72.85	75.06	70.87	69.46

Table 27. Digestibility coefficients of crude protein of the animals maintained on the four dietary regimes.

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Prtein intake (g/day)				
From concentrate	55.66	68.33	46.93	47.00
From roughage	52.85	55.42	46.05	46.05
Total	108.51	123.75	92.98	93.05
Protein out go (g/day)	28.44	37.79	29.38	32.24
Difference (g/day)	80.07	85.96	63.60	60.81
Digestibility coefficient (per cent)	73.79	69.46	68.40	65.35

Table 28. Digestibility coefficients of ether extract of the animals maintained on the four dietary regimes.

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Intake of ether extract g/day				
From concentrate	17.74	21.77	13.61	13.60
From roughage	11.38	14.79	12.30	12.30
Total	29.12	36.56	25.91	25.90
Out go (g/day)	6.15	7.82	6.88	7.5
Difference (g/day)	22.97	28.74	19.03	18.40
Digestibility coefficient (per cent)	78.88	78.61	73.45	71.04

Table 29. Digestibility coefficients of crude fibre of the animals maintained on the experimental rations.

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Intake of crude fibre g/day				
From concentrate	12.12	14.21	22.89	22.87
From roughage	52.53	68.20	54.93	56.80
Total	64.65	82.41	77.82	79.67
Out go (g/day)	25.65	30.33	34.23	37.41
Difference (g/day)	39.00	52.08	43.59	42.26
Digestibility coefficient (per cent)	60.32	63.20	56.01	53.04

Table 30. Digestibility coefficients of nitrogen free extract of the animals maintained on the four dietary regimes.

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Intake of nitrogen free extract g/day				
From concentrate	229.09	281.25	274.99	274.78
From roughage	144.01	186.97	155.71	155.71
Total	373.10	468.22	430.70	430.49
Out go (g/day)	81.63	87.84	97.94	96.3
Difference (g/day)	291.47	380.38	332.76	334.19
Digestibility coefficient (per cent)	78.12	81.24	77.26	77.63

Table 31. Consolidated table on digestibility coefficients of nutrients of the animals maintained on the experimental rations (vide Tables 26-30)

Digestibility coefficients of nutrients	Treatments Ration A	Ration B	Ration C	Ration D
No. of kids	6	6	6	6
Dry matter	72.85± 0.92	75.06± 1.33	70.87± 1.41	69.46± 1.88
Crude protein	73.79± 1.00	69.46± 1.18	68.40± 1.61	65.35± 2.03
Ether extract	78.86± 2.20	78.60± 0.96	73.45± 1.72	71.04± 1.57
Crude fibre	60.32± 2.37	63.20± 2.17	56.02± 1.62	53.04± 2.50
Nitrogen free extract	78.12± 1.06	81.24± 1.89	77.26± 1.56	77.63± 1.71

Table 32. Analysis of variance - digestibility coefficient of dry matter

Source	df	SS	MSS	F
Treatment	3	43.45313	14.48438	2.924982 NS
Error	20	99.03906	4.951953	

Table 33. Analysis of variance - digestibility coefficient of crude protein

Source	df	SS	MSS	F
Treatment	3	85.24219	28.41406	5.49728 **
Error	20	103.375	5.16875	

Table 34. Analysis of variance - digestibility coefficient of ether extract

Source	df	SS	MSS	F
Treatment	3	116.8672	38.95573	5.103197 **
Error	20	152.6719	7.633594	

NS Not significant

** $P < 0.01$

Table 35. Analysis of variance - digestibility coefficient of crude fibre

Source	df	SS	MSS	F
Treatment	3	125.1289	41.70964	4.240451*
Error	20	196.7227	9.836133	

Table 36. Analysis of variance - digestibility coefficient of nitrogen free extract

Source	df	SS	MSS	F
Treatment	3	30.92969	10.3099	1.39954 NS
Error	20	147.2891	7.364454	

NS Not significant

* P< 0.05

Table 37. Data on nitrogen balance and per cent retention of the animals during metabolism trial.

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Nitrogen intake g/day				
From concentrate	8.89	11.43	7.60	7.57
From roughage	8.48	8.40	7.27	7.42
Total	17.37	19.83	14.87	14.99
Nitrogen out go g/day				
Faecal	4.51	6.05	4.69	5.09
Urinary	1.5	2.44	1.08	1.57
Total g/day	6.01	8.49	5.77	6.66
Nitrogen balance g/day	11.36	11.34	9.10	8.33
Per cent retention of nitrogen	65.40	57.19	61.20	55.57

Fig.5 PERCENT RETENTION OF NITROGEN OF KIDS MAINTAINED ON FOUR EXPERIMENTAL RATIONS

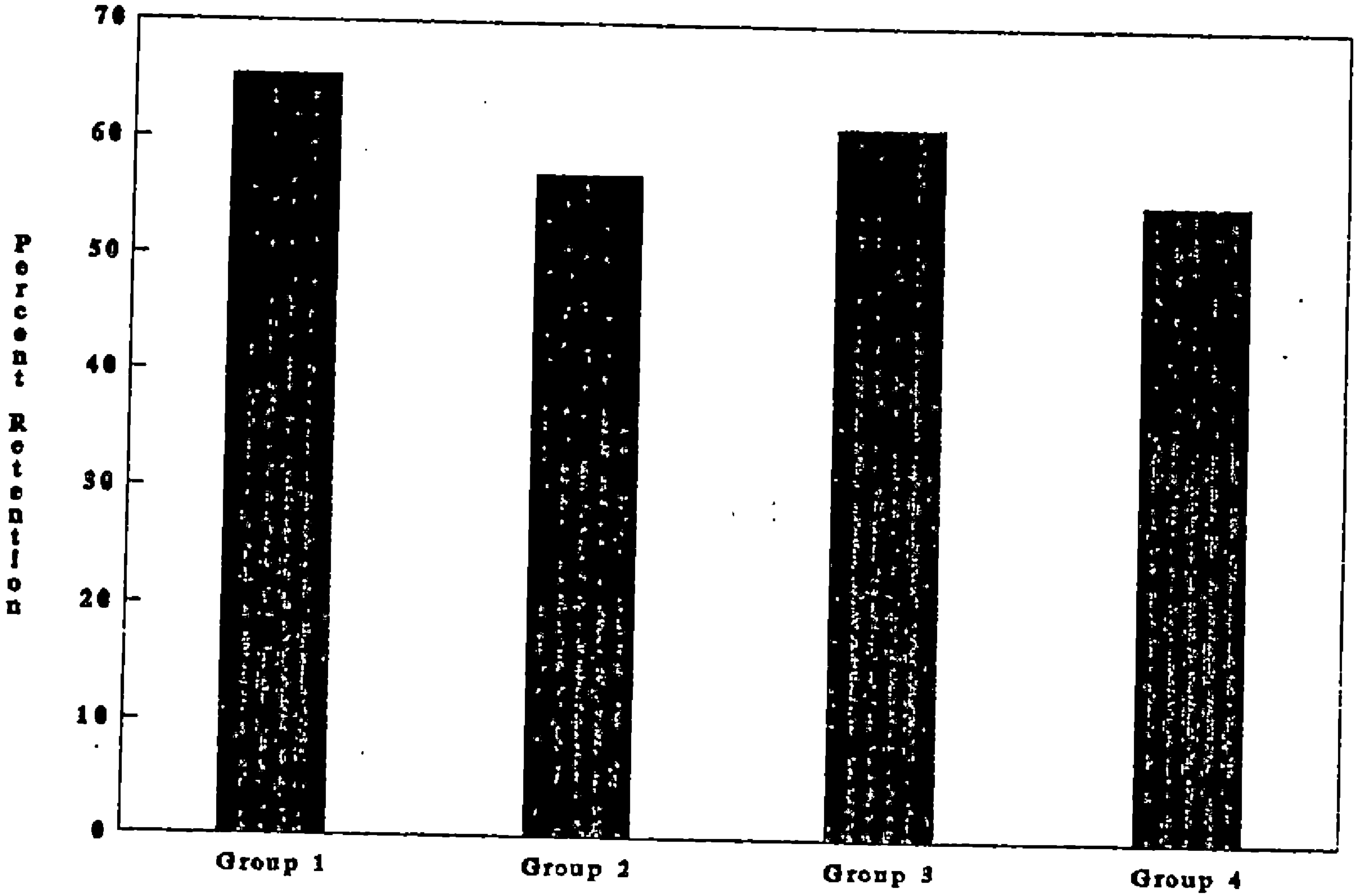

Table 38. Data on calcium balance and per cent retention of the animals during metabolism trial.

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Calcium intake g/day				
From concentrate	2.61	3.23	2.88	2.91
From roughage	4.92	5.84	4.60	4.87
Total	7.53	9.07	7.48	7.78
Calcium out go g/day				
Faecal	1.72	3.27	2.18	3.17
Urinary	0.04	0.04	0.06	0.07
Total g/day	1.76	3.31	2.24	3.24
Calcium balance g/day	5.77	5.76	5.24	4.54
Per cent retention of calcium	76.63	63.51	70.05	58.35

Fig.6 PERCENT RETENTION OF CALCIUM OF KIDS MAINTAINED ON FOUR EXPERIMENTAL RATIONS

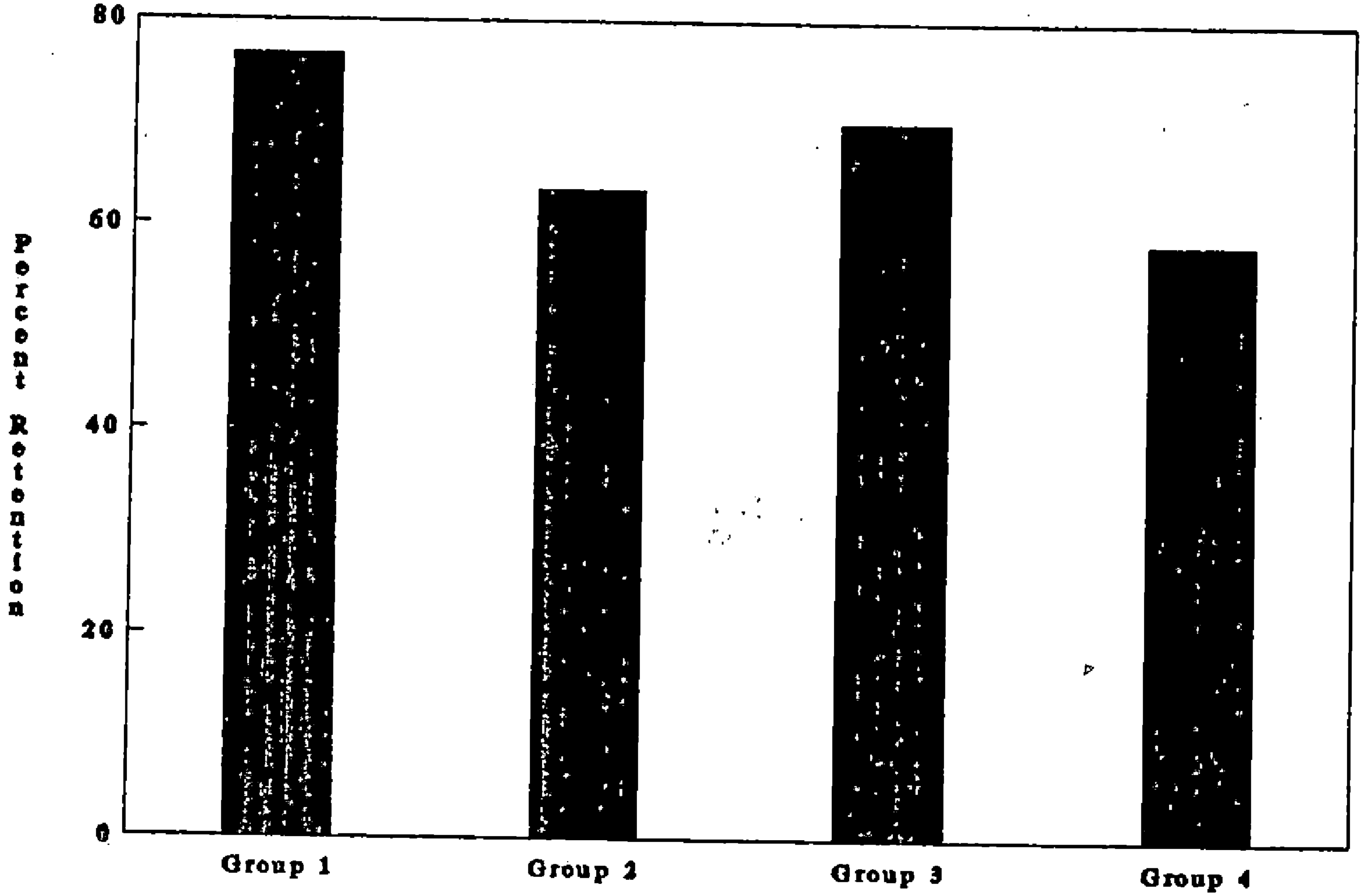

Table 39. Data on phosphorus balance and per cent retention of the animals during metabolism trial.

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Phosphorus intake g/day				
From concentrate	1.43	1.71	1.62	1.49
From roughage	1.14	1.46	1.22	1.25
Total	2.57	3.17	2.84	2.74
Phosphorus out go g/day				
Faecal	1.24	1.84	1.45	1.67
Urinary	0.05	0.06	0.12	0.13
Total g/day	1.29	1.90	1.57	1.80
Phosphrus balance g/day	1.28	1.27	1.27	0.94
Per cent retention of phosphorus	49.80	40.06	44.72	34.31

Fig.7 PERCENT RETENTION OF PHOSPHORUS OF KIDS MAINTAINED ON FOUR EXPERMENTAL RATIONS

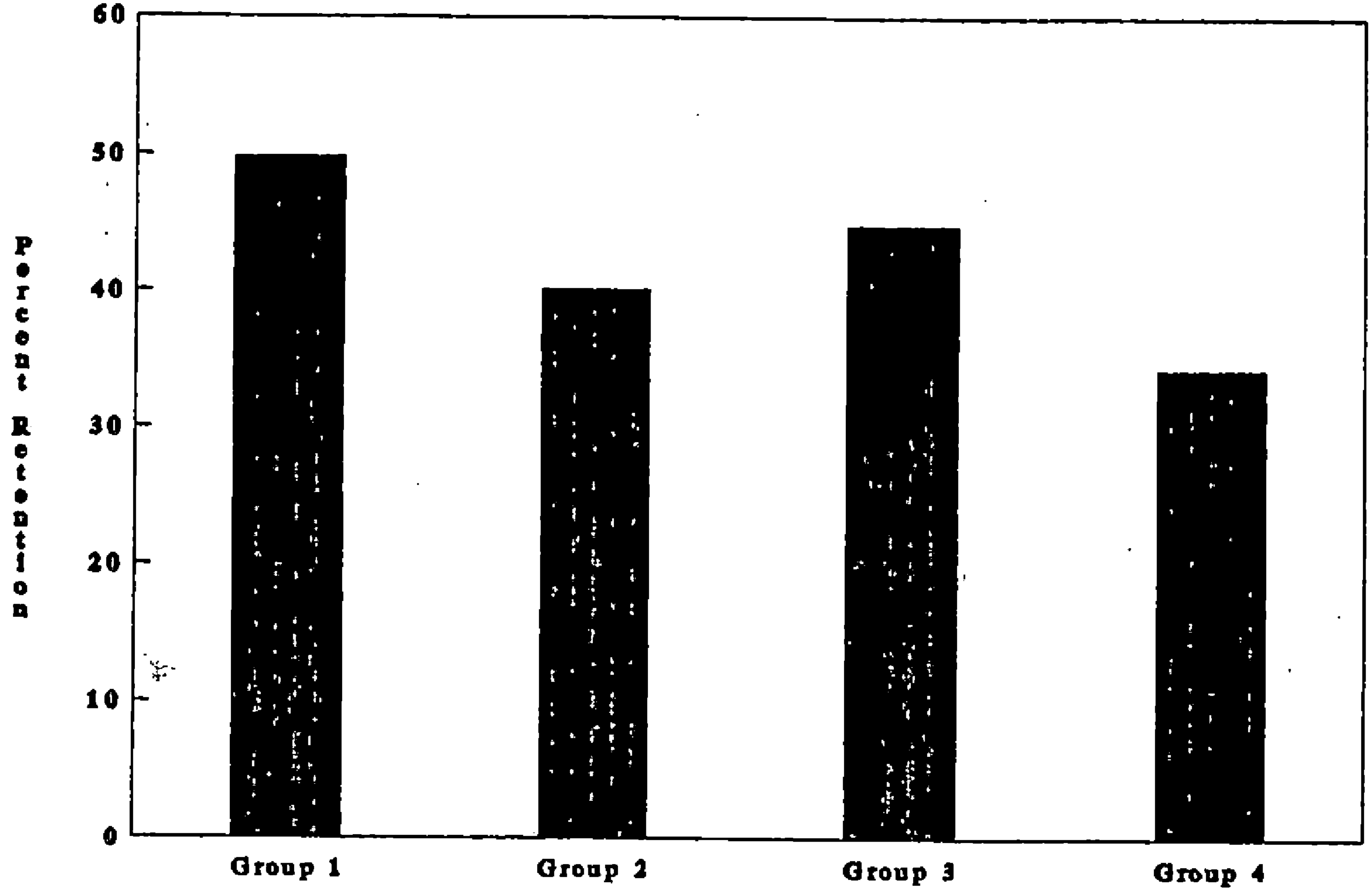

Table 40. Data on magnesium balance and per cent retention of the animals during metabolism trial.

Treatments	Ration A	Ration B	Ration C	Ration D
Number of kids	6	6	6	6
Magnesium intake g/day				
From concentrate	1.25	1.57	1.16	1.26
From roughage	1.36	1.50	1.48	1.52
Total	2.61	3.07	2.64	2.78
Magnesium out go g/day				
Faecal	1.21	1.62	1.34	1.57
Urinary	0.20	0.21	0.20	0.22
Total g/day	1.41	1.83	1.54	1.79
Magnesium balance g/day	1.20	1.24	1.10	0.99
Per cent retention of magnesium	45.97	40.39	41.67	35.61

Fig.8 PERCENT RETENTION OF MAGNESIUM OF KIDS MAINTAINED ON FOUR EXPERIMENTAL RATIONS

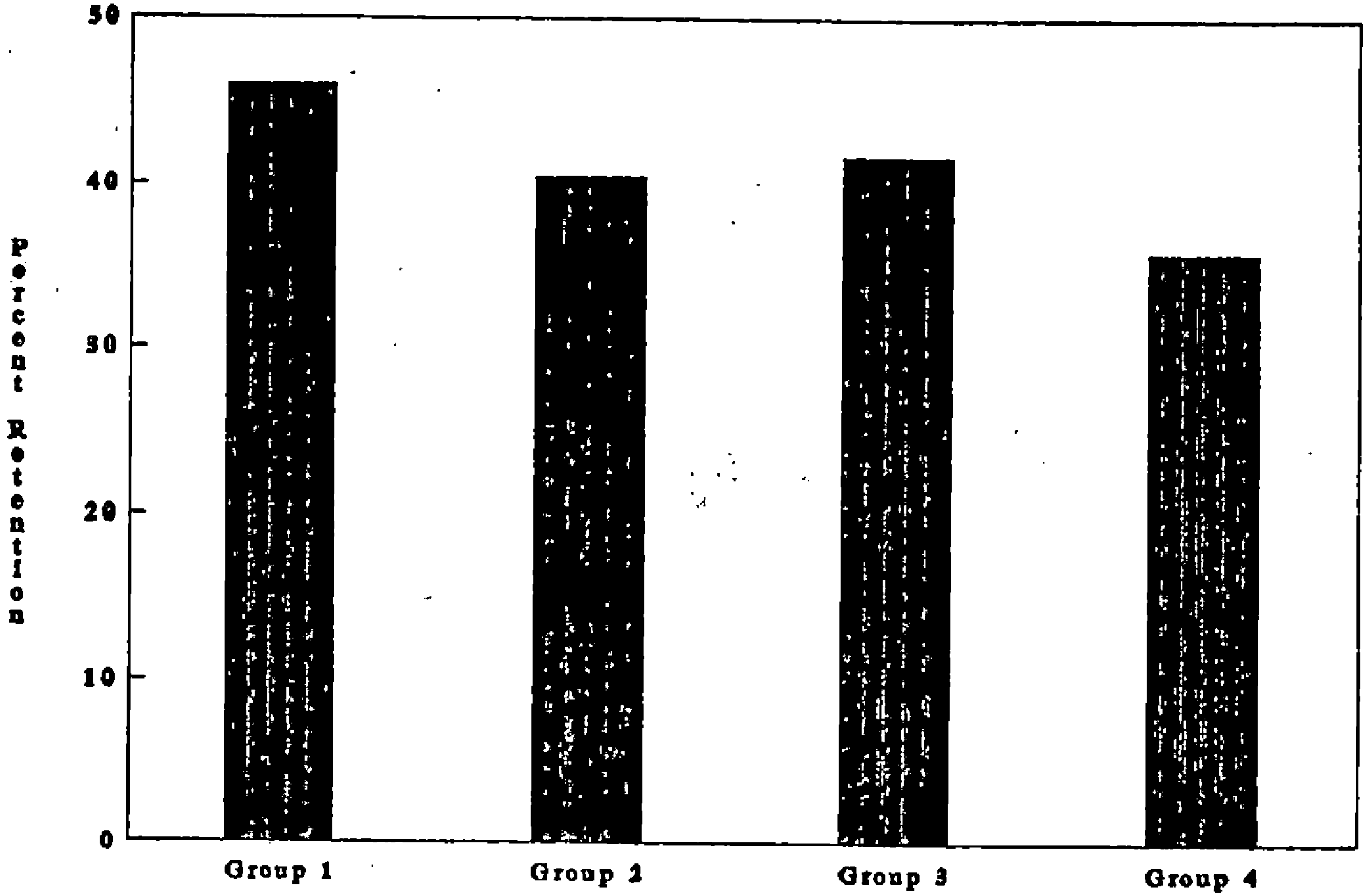

Table 41. Consolidated data on per cent retention of nitrogen, calcium and magnesium of the animals maintained on the experimental rations (vide Tables 37-40)

Percentage retention	Treatments Ration A	Ration B	Ration C	Ration D
No. of kids	6	6	6	6
Nitrogen	65.41± 0.66	57.03± 1.16	61.27± 1.59	54.89± 2.57
Calcium	76.63± 1.17	63.51± 2.90	70.05± 1.06	58.35± 2.76
Phosphorus	49.80± 3.01	40.06± 3.02	44.72± 3.09	34.31± 2.06
Magnesium	45.97± 2.73	40.39± 3.17	41.67± 1.60	35.61± 1.98

Table 42. Analysis of variance - per cent retention of nitrogen

Source	df	SS	MSS	F
Treatment	3	126.5274	42.17578	8.386671**
Error	20	100.5781	5.028907	

Table 43. Analysis of variance - per cent retention of calcium

Source	df	SS	MSS	F
Treatment	3	341.7656	113.9219	6.537695**
Error	20	348.5078	17.42539	

Table 44. Analysis of variance - per cent retention of phosphorus

Source	df	SS	MSS	F
Treatment	3	273.7969	91.26562	5.64682**
Error	20	323.2461	16.1623	

Table 45. Analysis of variance - per cent retention of magnesium

Source	df	SS	MSS	F
Treatment	3	108.4609	36.15365	2.955182 NS
Error	20	244.6797	12.23398	

NS Not significant

** P< 0.01

DISCUSSION

DISCUSSION

The results obtained during the course of the present investigation are discussed under separate heads.

5.1 Growth

It can be seen from the data on body weight gain of kids presented in Tables 1 to 4 represented by Fig.1, summarised in Table 5 and the results of statistical analysis set out in Tables 6 and 7, that the animals maintained on ration A(group I) containing 16 per cent crude protein plus 0.1 per cent of dried spleen, ration B (group II) containing 16 per cent crude protein without incorporation of dried spleen, ration C(group III) containing 12 per cent crude protein plus 0.1 per cent dried spleen and ration D (group IV) containing 12 per cent crude protein without incorporation of dried spleen, exhibited a characteristic increase in body weight gain during the experimental period of 120 days and the effect is more appreciated in animals maintained on rations C, A, B and D in that descending order, the cumulative and average daily gain registered during the period being 7.52 kg and 62.64 g, 7.40 kg and 61.67 g, 6.88 kg and 57.36 g and 5.00 kg and 41.67 g respectively. Statistical analysis of the data on weight gain reveals that, a significant increase (P< 0.01) in growth response was observed in animals maintained on rations A ,B and C, while growth response exhibited by the animals maintained on ration D was not well pronounced when compared to that of animals maintained on rations A, B and C, as can be noticed from significant difference between the groups I and IV , II and IV and III and IV and a non-significant difference between the groups I and II, I and III and II and III,indicating that, incorporation of dried spleen at the rate of 0.1 per cent in the ration influenced the growth response of animals maintained on the respective rations (rations A and C), but the growth response was more pronounced in animals maintained on spleen incorporated ration containing 12 per cent of crude protein (ration C).

Varying growth rates and daily gains in growing kids have been reported by different workers. James and Chandran (1975) reported average daily gains of 64.9, 59.8 and 71.7 g respectively for growing cross bred Malabari kids in the age group of 3-9 months, maintained on different rations fortified with either supplemental calcium or magnesium. James (1978 b) from his study on comparative evaluation of conventional and unconventional feed for evolving cheap and economic ration for goats, observed an average daily gain of 96.40, 80.95 and 78.57 g in Saanen-Malabari cross kids and 90.5, 82.2 and 81.5 g in Malabari kids of 4-5 months of age, fed with three different rations ,viz. farm ration, experimental conventional ration and experimental unconventional ration respectively. James (1978 a) reported an average daily gain of 26.2 g in Saanen-Malabari cross kids in the age group of 7-8 months maintained on Leucaena leucocephala. James and Mukundan (1978) reported average daily weight gains of 58.3, 59.5 and 58.3 g in Malabari kids in the age group of 6-9 months fed with three different rations with varying concentrate-Jack leaves ratio. Mercy *et al*. (1981) from their investigation to assess the nutrient requirement of Alpine- Malabari crossbred kids, observed average daily gains of 63.7, 64.4 and 67.6 g in three groups of kids maintained on different planes of nutrition. The growth rate and average daily gain in the control group observed during the course of present investigation are comparable to those reported by the above workers for kids of similar age groups.

A study on growth rate and digestibility of nutrients carried out by Mahapatro and Roy (1970) using nine Hariana castrated male calves administered with an agar tissue preparation of spleen subcutaneously showed that, the biostimulator induced better growth response when compared to that of control group. Makarov *et al*.

(1970) studied the effect of an agar tissue perparation on the productivity of young Red Steppe cattle and observed a better growth response in animals receiving 0.1 ml or 0.2 ml of tissue preparation per kilogram body weight. Shukla and Mahapatro (1975) observed that, biostimulator preparation has a favourable influence on growth rate of rats. James and Gangadevi (1991) from their investigation on dried spleen as growth stimulator for laboratory animals observed that, incorporation of dried spleen at a rate of 0.1 per cent in the ration increases the growth rate in rabbits and rats. The growth response obtained during the course of the present investigation is in agreement with the results reported by these authors. (Mahapatro and Roy, 1970; Makarov et al., 1971; Shukla and Mahapatro, 1975 and James and Gangadevi, 1991).

5.2 Dry matter consumption

Data presented in Table 8, consolidated data given in Table 12 and the statistical analysis set out in Table 13 on feed intake of kids maintained on the four rations under trial, reveal no significant difference between the groups, the average daily dry matter intake (g) recorded for the kids maintained under groups I,II,III and IV being 562.9, 574.5, 572.3 and 564.0 g respectively, indicating that incorporation of dried spleen had not influenced the dry matter consumption of the animals under trial, whether the animals are maintained on high or low plane of nutrition.

Shukla and Mahapatro (1984) from their investigation on effect of biostimulator feeding in goats recorded a high intake in biostimulator fed kids at low plane of nutrition and indicated an increased nutrient requirement to compensate the higher growth rate, as construed from their work on effect of biostimulator on growth of Barbari and Black Bengal kids (Shukla and Mahapatro 1982). The observation made during the course of the present investigation is at variance with the results reported by Shukla et al. 1982 and 1984, probably because, Shukla et al. (1982 and 1984) designed the experiment in such a way that, the low plane of nutrition was achieved by restricting 25 per cent of the concentrate mixture of the ration, while in the present investigation, 25 per cent of crude protein was restricted.

5.3 Feed efficiency

It can be seen from the data presented on feed efficiency in Table 9, represented by Fig. 2, consolidated data in Table 12 and the statistical analysis in Table 14 of animals maintained on the respective rations that, the efficiency of feed utilisation is decreased in that descending order, in animals maintained on rations C (9.13), A (9.31), B (10.07) and D (14.01). On critical evaluation of the statistical analysis of the data, it can be seen further that, a significant difference could be noticed between the groups I and IV, II and IV and III and IV, while no significant difference could be detected between the groups I and II, I and III and II and III, indicating that, the animals maintained under the groups I, II and III are identical with regard to their efficiency of feed utilisation, attributing that, incorporation of dried spleen in the ration significantly ($P<0.01$) enhances the efficiency of feed nutrient utilisation, that particularly noteworthy, in animals maintained on ration C containing low level of crude protein. As between groups of kids maintained on rations B and D, it can be further noticed that the feed conversion efficiency is better in kids maintained on high level of crude protein (ration B) when compared to kids maintained on low level of protein (ration D). This observation is in keeping with the results reported by Grebing et al. (1973), Lakshminarayana and Raghavan (1979) and Gangadevi (1981) who also could find increase in feed efficiency in lambs and kids with increase in dietary protein level. Almost similar feed efficiency values have been reported for kids of different breeds receiving different protein levels in concentrate mixtures by various authors (Thomas et al., 1976; James, 1978; Singh, 1980 and Mercy et al., 1981).

Better feed conversion efficiency and nutrient utilisation was also reported by Gerasimov and Petrov (1970) in steers given biostimulator at 14 days interval at the rate of 0.1 ml/ kg body weight. James and Gangadevi (1991) also reported a better feed conversion efficiency in laboratory animals like rabbits and rats maintained on ration containing dried spleen as growth stimulator. The results obtained during the course of present investigation is in accordance with those reported by Gerasimov and Petrov (1970) and James and Gangadevi (1991).

5.4 Protein efficiency ratio

Protein efficiency ratio registered with regard to the respective rations presented in Table 10, represented by Fig.3, summarised in Table 12 and the statistical analysis in Table 15 reveal that, maximum efficiency was obtained with ration C containing low level protein,the animals maintained on rations C, A, B and D exhibiting efficiency of protein utilisation in that descending order. Statistical analysis of the data clearly indicates that, a significantly ($P < 0.01$) better protein efficiency could be observed in animals maintained under group III, as can be substantiated by a significant difference between the groups II and III, III and IV and a non-significant difference between the groups I and III. On further evaluation of the response obtained between animals maintained on rations A and C, each incorporated with dried spleen, an appreciably better response in efficiency of protein utilisation could be noticed with ration containing low level of protein (ration C) when compared to that containing high level of protein (ration A), as can be appreciated from a non-significant difference between the groups I and II. The results of the study indicated that, efficiency of protein utilisation is more in animals maintained on spleen incorporated rations (ration A and C), the effect is more pronounced in ration containing low level of protein. The results of the present study fully endorse the findings of James and Gangadevi (1991) from their investigation on dried spleen as growth stimulator in laboratory animals.

5.5 Cost efficiency

Comparative data on economics and cost per unit kg gain due to the four rations for a period of 120 days presented in Table 11 represented by Fig.4, consolidated data in Table 12 and statistical analysis in Table 16 reveal that, the cost efficiency in terms of cost per unit gain recorded for the four groups in the descending order being, Rs. 26.14, 32.58, 35.08 and 38.63 for the groups III, I, II and IV respectively. On critical evaluation of the data, it can be seen further that, while a cost of production per kg gain of Rs. 32.58 and 26.14 was only registered for animals maintained on spleen incorporated groups (rations A and C, groups I and III), the same for the animals maintained on the corresponding control groups (rations B and D, groups II and IV), recorded as Rs. 35.08 and 38.63 respectively indicating that, the cost efficiency is comparatively better in spleen incorporated groups, especially in animals maintained on low level of protein (ration C).

From an investigation carried out in Hariana calves, Mahapatro and Roy (1970) observed that, animals receiving injections of biostimulator and consuming 25 per cent less concentrate than the control, gained 225 g per day as against 228 g per day in the control animals, confirming that administration of biostimulator replaces 25 per cent of ration with comparable growth. James and Gangadevi (1991) reported that, rabbits and rats maintained respectively on diets containing 12 per cent and 15 per cent crude protein, with dried spleen as growth stimulator, resulted in similar weight gains as those maintained on diets containing 16 per cent and 20 per cent crude protein without growth stimulator and suggested that, at least 25 per cent of crude protein can be spared on incorporating dried spleen in the ration. The results obtained now contribute further evidence to support the results reported by these authors (Mahapatro and Roy, 1970 and James and Gangadevi, 1991).

5.6 Haematological parameters

5.6.1 Red Blood Cell, W.B.C., Haemoglobin and Plasma protein concentrations.

Data presented in Table 17 clearly indicate that, all the kids showing values within the normal range, irrespective of the level of protein in the ration or dried spleen as growth stimulator incorporated in the ration or not, as can be seen from a non-significant change in between the groups (group I, II, III and IV) on statistical analysis. However, there is a tendency for an increase in haemoglobin content in animals maintained on spleen incorporated rations, over their respective control rations, but the values are not being statistically significant (Tables 19 to 22).

Zabolotuyj (1959) reported that, subcutaneous injection of liver or spleen extract could induce a rise in haemoglobin and red cell counts in healthy and anaemic pigs. Similar rise in haemoglobin content after the feeding of biostimulator has also been observed by Spiriden and Phlorescu (1971). Shukla and Mahapatro (1990) from their investigation on two groups of kids fed with biostimulator prepared from buffalo spleen and liver in oral dry form at low and high planes of nutrition observed that, haemoglobin values were significantly higher in biostimulator fed kids at both planes of nutrition, biostimulator fed kids exhibited higher haemoglobin content than that of their respective controls, but the differences were more pronounced at high plane of nutrition. No significant results could be drawn from the present study either on red cell concentration or haemoglobin level, as reported by the above authors.

5.6.2 Calcium, Phosphorus and Magnesium concentration

The summarised values (Table 18) for blood plasma calcium, inorganic phosphorus and magnesium concentrations in kids receiving rations with or without incorporation of dried spleen and their statistical analyses (Tables 23 to 25) did not disclose any significant change in these parameters, except for plasma calcium and the experimental animals maintained these values within the normal range. Statistical analysis of the data reveals a significant increase ($P < 0.01$) in plasma calcium level in animals maintained on ration C, as can be appreciated from a significant difference between the groups I and II and groups III and IV, indicating that, incorporation of dried spleen significantly enhances the dietary calcium absorption, particularly in animals maintained on low level of protein.

The values recorded in the present study are found to agree well with those reported by other workers and lie within the normal range reported for the species (James and Chandran, 1975; Thomas et al., 1976; James, 1978; James and Mukundan, 1978; Gangadevi, 1981 and Mercy et al., 1981) and it is clear that all the kids were in good nutritional status, since the values obtained for the various parameters are well within the range reported for the species by the various workers.

Eventhough Shukla and Mahapatro (1989) reported the effect of biostimulator on ruminal fermentation in goats, no attempt has been made to evaluate the variation in mineral concentration of blood, as they did evaluate the sodium and potassium concentrations in strained rumen liquor. Shukla and Mahapatro (1990) have also reported the effect of biostimulator on blood constituents in goats, but no evaluation has been made on variations if any, on mineral concentration in blood on feeding biostimulator. Comparable data on these aspects are rather scanty in the literature.

5.7 Metabolism trial data

5.7.1 Digestibility of nutrients.

5.7.1. 1 Dry matter

Dry matter digestibility of experimental animals presented in Table 26, consolidated data set out in Table

31 and the statistical analysis in Table 32 reveal no significant difference between the groups, indicating that, neither the level of protein in the ration nor the incorporation of dried spleen, brings forth any significant change in the dry matter digestibility of the animals under the trial.

Shukla and Mahapatro (1984) reported a high rate of digestibility coefficient for dry matter (70.29 ± 2.04 per cent) in biostimulator fed group at high plane of nutrition and suggested that, the dry matter digestibility was higher in experimental groups than in their respective control groups. The digestibility coefficient for dry matter obtained during the course of the present investigation varies from 69.46 to 75.06, the values being not statistically significant between the groups.

5.7.1.2 Crude protein

Data on digestion coefficient of protein set out in Table 27, consolidated in Table 31 and statistical analysis in Table 33 reveal a significantly better digestibility of protein in animals maintained on rations A and C, supplemented with dried spleen when compared to that of their respective control groups (rations B and D), as disclosed from a significant difference between the groups I and II ($P < 0.01$) and an apparent difference between the groups III and IV.

As between the groups of kids maintained on ration B and ration D containing 16 per cent and 12 per cent crude protein respectively (control rations), the results on digestibility studies tend to suggest that, there is an increase in digestibility of crude protein with an increase in dietary protein level, the digestibility coefficient values recorded for the two groups (groups II and IV) being 69.46 per cent and 65.35 per cent respectively. The trend of the result is essentially in agreement with those reported by Dabadghao _et al_. (1976) in Barbari goats and Lakshminarayana and Raghavan (1979) in lambs and Gangadevi (1981) in kids.

In an effort to find out the effect of biostimulator feeding on digestibility and utilisation of nutrients in goats, Shukla and Mahapatro (1984) observed that, crude protein digestibilities were higher for biostimulator treated kids over their respective controls and was also noticed that biostimulator treated kids of high plane of nutrition had a significantly higher digestibility of protein than that of the kids under low plane of nutrition. Similar trend of results were obtained during the course of the present investigation and the finding concurs with the observations made by Shukla and

Mahapatro (1984).

5.7.1.3 Ether extract

The digestibility coefficient of the ether extract presented in Table 28, summarised in Table 31 and the statistical analysis of the data presented in Table 34 show a trend towards better digestibility of ether extract in spleen incorporated groups I and III over their respective control groups II and IV, irrespective of their level of protein in the ration, the effect is more appreciated in low protein spleen incorporated group (group III) over its control group (group IV), the values recorded between the groups being not statistically significant. It is to be observed that higher rate of digestibility coefficient for ether extract was recorded in animals maintained on high protein groups.

Shukla and Mahapatro (1984) observed a higher ether extract digestibility in biostimulator fed groups than that of the respective controls, the biostimulator fed kids, at low plane of nutrition had higher ether extract digestibility which was significantly different from that of control groups. Similar trend of results have been obtained during the course of the present investigation also.

5.7.1.4 Crude fibre

Data on digestion coefficient values for crude fibre presented in Table 29, summarised in Table 31 and its statistical analysis in Table 35 reveal no significant difference between groups I and II and groups III and IV, indicating that incorporation of dried spleen in the ration could not evince any influence on fibre digestion in goats. But on consideration of plane of nutrition of animals, as between the groups II and IV respectively, the digestibility of crude fibre is significantly higher ($P<0.01$) in animals maintained under group II when compared to that of group IV.

In Hariana Calves Mahapatro and Roy (1970) reported no significant difference in the digestibility coefficients of nutrients in the control group as compared to the biostimulator injected group. The results on influence of biostimulator on crude fibre digestibility is essentially in agreement with the results reported by Mahapatro and Roy (1970).

5.7.1.5 Nitrogen free extract

Digestion coefficient values for nitrogen free extract presented in Table 30, summarised data in Table 31 and statistical analysis in Table 36 reveal no significant difference between the groups of animals maintained on different ration treatments, indicating that, neither the plane of nutrition nor the incorporation of dried spleen did influence the digestibility of soluble carbohydrate in the ration. Results of similar nature have been reported by Mahapatro and Roy (1970) in Hariana calves injected with biostimulator and Shukla and Mahapatro (1984) in Black Bengal kids fed with biostimulator maintained at high and low plane of nutrition.

The digestibility values obtained during the course of the present investigation for various nutrients, in kids maintained on control rations (rations B and D) are almost similar to those reported by Singh and Sengar (1970) for Jamnapari and Barbari kids, Prasad and Mudgal (1975) for Saanen-Beetal goats, Mudgal and Kaur (1976) for Alpine-Beetal kids, Singh and Sengar (1978) for Beetal kids and Mercy et al. (1981) for Alpine-Malabari crossbred kids.

5.7.2 Nitrogen and mineral balances

5.7.2.1 Nitrogen balance

Nitrogen balance data presented in Table 37, represented by Fig.5, the consolidated data in Table 41 and statistical analysis set out in Table 42, reveal that, a significantly higher ($P < 0.01$) percentage retention of nitrogen has been recorded in animals maintained on dried spleen incorporated rations (rations A and C) over their respective controls (rations B and D), irrespective of whether the animals are maintained on high or low plane of nutrition, as can be substantiated by a statistically significant difference between groups I and II and groups III and IV respectively. On scrutiny of the data, it can be seen further that, while there is a significant increase in excretion of faecal and urinary nitrogen in animals maintained on rations B and D, a significantly lower rate of faecal and urinary excretion of nitrogen could be noticed in animals maintained on rations A and C (spleen incorporated rations), confirming that the digestibility and utilisation of nitrogen is more in animals maintained on spleen incorporated groups and hence the result substantiates the higher percentage retention of nitrogen in animals maintained on these rations.

Mahapatro and Roy (1970) from their investigation on biostimulator treated Hariana calves reported that, biostimulator exerted a favourable influence on nitrogen retention of animals, even with low digestible crude protein intake, the animals showed even better nitrogen retention than the control group. Makarov et al. (1970) also indicated that biostimulator improves daily nitrogen retention and the effect was more pronounced at low plane of nutrition. Similarly, Chorey (1973) reported higher nitrogen retention in the Mandya lambs treated with biostimulator. The results obtained during the course of the present investigation lend further evidence to support the results of the above authors (Mahapatro and Roy, 1970; Makarov et al., 1970; Chorey, 1973 and Shukla and Mahapatro, 1984).

5.7.2.2 Calcium balance

Data on calcium balance and percentage retention of calcium of animals maintained on different ration treatments are presented in Table 38 represented by Fig.6, summarised in Table 41 and statistical analysis in Table 43. It can be noticed that a significantly higher ($P < 0.01$) percentage retention of calcium has been recorded in animals maintained on rations A and C (spleen incorporated rations) over their respective control rations B and D, irrespective of their plane of nutrition, as can be seen from a significant difference ($P < 0.01$) in percentage retention of calcium, between the groups I and II and groups III and IV. On critical evaluation of the data, it can be further probed that there is a marked increase in faecal and urinary excretion of calcium in animals maintained on rations B and D (rations without incorporation of spleen) when compared to that of animals maintained on rations A and C (spleen incorporated rations), as confirmed by a significant difference ($P < 0.01$) between the groups I and II, and groups III and IV with regard to faecal calcium and an apparent difference between the groups I and II and III and IV with regard to urinary calcium, reflecting the effect on higher percentage retention in animals maintained on spleen incorporated rations.

5.7.2.3 Phosphorus balance:

Data set out in Table 39 depicted by Fig. 7 consolidated data presented in Table 41 and statistical analysis in Table 44 show a significantly higher ($P< 0.01$) percentage retention of phosphorus in animals maintained on rations A and C (spleen incorporated rations) when compared to their respective control groups (rations B and D) maintained on high and low plane of nutrition. Statistical analysis of the data reveals a significant difference ($P< 0.01$) between groups I and II and groups III and IV respectively. On further scrutiny of the data, it can be observed that, a significant and a non-significant difference exist between the groups I and II and groups III and IV respectively with regard to faecal phosphorus excretion, tending to suggest that, animals maintained on spleen incorporated groups (groups I and III) excrete lesser quantity of faecal phosphorus than that of animals maintained on the respective control rations (groups II and IV), the pattern of urinary phosphorus excretion, though not statistically significant, is comparatively more in control groups, indicating that the utilisation of phosphorus is augmented in animals maintained on spleen incorporated rations, A and C, which reinforce the statement of higher percentage retention of phosphorus in kids maintained on spleen incorporated rations.

5.7.2.4 Magnesium balance.

Data on magnesium balance in Table 40 represented by Fig.8, summarised in Table 41 and statistical analysis in Table 45 show an appreciably higher percentage retention of magnesium in animals maintained on spleen incorporated rations A and C, over their respective controls (rations B and D), the analysis of the data being not statistically significant. On further evaluation of the excretory pattern of magnesium in animals maintained on spleen incorporated rations and their respective controls, it can be perceived that, though not statistically significant, there is a trend towards an increased excretion of magnesium through faeces and urine in animals maintained on control rations B and D when compared to that of animals maintained on spleen incorporated rations A and C, indicating that, the utilisation of magnesium in animals maintained on rations B and D is low when compared to that of animals maintained on rations A and C, attributing better per cent retention in animals maintained on spleen incorporated rations.

As far as could be gathered from the literature, the information on mineral absorption, utilisation, mineral balance and percentage retention, due to the administration of biostimulators to various species of animals are rather scanty and hence comparable data on calcium, phosphorus and magnesium balances and percentage retentions are not available at present.

From a critical evaluation of the overall results obtained during the course of the present investigation on the performance of kids maintained on high and low level of dietary protein supplemented with dried spleen as growth stimulator, it can be reasonably concluded that incorporation of dried spleen in the ration of goats at the rate of 0.1 per cent on dry matter basis certainly play a positive role in augmenting the nutrient utilisation by increasing the digestibility and retention and that dried spleen can be utilised as a harmless natural growth promotant in animal production with economic benefit.

5.8 Economic implications

It is a well known fact that weight of the animal plays an important role in deciding its market value. The development of a harmless natural growth promotant, without causing any deleterious effect on the normal physiological function of the animal system is an imperative need, especially when the cost of livestock feed is augmenting day by day. Buffalo spleen is a slaughter house waste material which if properly chopped and dried below 100^{o} C and powdered, can be used as a cheap growth promotant for goats. The spleen of an adult buffalo weighs about one kilogram and on drying, nearly 400 grams of the material sufficient to fortify 400 kilograms of the concentrate mixture, will be obtained. Since the growth promoting effect is more pronounced and even better in animals maintained on low plane of nutrition than that of animals maintained on high plane of nutrition and the cost difference between the two feeds being about Rs 1.2 per kg, fortification of the feed with dried spleen at the rate of 0.1 per cent on dry matter basis will accrue a minimum saving of Rs. 1200/- per tonne. This will be a viable method for the livestock producers to adopt.

SUMMARY

SUMMARY

An investigation was carried out to ascertain the effect of dried spleen as a growth promotant in kid rations. Twenty four female Malabari kids with an average body weight of 8.5 kg were distributed randomly and as uniformly as possible into four groups (Groups I, II, III and IV) of six animals each, with regard to age and body weight. The four dietary treatments A, B, C and D were assigned to the kids in the groups I, II, III and IV respectively. Out of the 24 kids, 12 kids were maintained on concentrate mixture containing 16 per cent of crude protein and the remaining 12 were maintained on concentrate mixture containing 12 per cent of crude protein, the rations being isocaloric. Jack leaves offered _ad libitum_ formed the sole source of roughage to the animals. The animals were maintained on their respective feeding regime for a period of 120 days.

Of the animals maintained on high level of protein, six animals constituting group I, were maintained on concentrate mixture supplemented with dried buffalo spleen at the rate of 0.1 per cent (ration A), while the remaining six animals constituted group II served as control (ration B). The kids maintained on low level of

protein were subdivided into groups of six animals each constituting group III and group IV, wherein group III was fed with concentrate mixture supplemented with dried buffalo spleen at the rate of 0.1 per cent (ration C) while group IV was kept as the control (ration D). The animals were fed individually, their requirements being periodically determined on the basis of their body weight.

Records of daily feed intake and weekly body weights were maintained throughout the experimental period. A digestion cum metabolism trial including a collection period of five days was carried out towards the terminal period of the feeding trial. Blood samples were collected towards the end of the trial for haematological studies.

The criteria used for evaluation of the diets were, the average daily gain, dry matter consumption, feed efficiency, protein efficiency, data on economic efficiency, haematological parameters and metabolism trial.

The kids maintained on the rations A,B,C and D exhibited marked increase in body weight gain during the experimental period of 120 days and the effect was more pronounced in animals maintained on rations C,A,B and D in that descending order, the cumulative and average daily gain registered during the period being 7.52 kg and 62.64 g, 7.4 kg and 61.67 g, 6.88 kg and 57.36 g and 5.00 kg and 41.67 g respectively. Incorporation of dried spleen in the ration influenced the growth response of animals maintained on the respective rations, but the growth response was more pronounced in animals maintained on low level of crude protein. The kids maintained on the four dietary regimes registered no significant difference between the groups with regard to dry matter consumption.

The efficiency of feed utilisation was decreased in animals maintained on rations C,A,B and D in that descending order, the feed efficiency values recorded for the animals maintained on the rations being 9.13, 9.31,10.7 and 14.01 respectively. The protein efficiency of kids also exhibited the same trend as that of feed efficiency. Economic efficiency in terms of cost per kg gain of kids maintained on the spleen incorporated rations (rations A and C) registered an amount of Rs 32.58 and 26.14 respectively, the same arrived at for the control groups (rations B and D) being Rs 35.08 and 38.63 respectively, indicating better economic efficiency in spleen incorporated groups.

The haematological parameters studied (R.B.C., W.B.C., haemoglobin, plasma protein, plasma calcium, phosphorus and magnesium) were within the normal range.

There were no significant difference between the groups regarding these parameters, except for plasma calcium, which showed a significant increase (P< 0.01) in animals maintained on ration C.

Data on digestibility studies revealed no significant difference in digestibility of dry matter and nitrogen free extract between the four groups. The digestibility of crude protein showed a tendency to increase with an increase in dietary protein level. Animals in the spleen incorporated groups (group I and III) showed better digestibility (P< 0.01) of protein than the respective control groups (groups II and IV). The animals in the spleen incorporated groups also exhibited a trend towards better digestibility of ether extract than their respective controls. The incorporation of dried spleen could not bring forth any influence on fibre digestion.

Data on nitrogen balance revealed a significantly better (P< 0.01) per cent retention of nitrogen in animals maintained on spleen incorporated rations (rations A and C) over their respective controls (rations B and D) irrespective of the plane of nutrition. On scrutiny of the data, it could be seen further that, while there was a significant increase in excretion of faecal and urinary nitrogen in animals maintained on rations B and D, a significantly lower rate of faecal and urinary excretion of nitrogen could be noticed in animals maintained on rations A and C, confirming that the digestibility and utilisation of nitrogen was more in animals maintained on spleen incorporated groups and hence the results substantiate the higher per cent retention of nitrogen in animals maintained on these rations.

Calcium balance studies showed a significantly higher ($P < 0.01$) per cent retention of calcium in animals maintained on spleen incorporated rations over their respective controls . On critical evaluation of the data, it can be further proved that, there was a marked increase in faecal and urinary excretion of calcium in animals maintained on rations B and D than that of animals maintained on spleen incorporated rations (A and C), substantiating the higher per cent retention of calcium in animals maintained on spleen incorporated rations.

Phosphorus balance studies showed a significantly higher($P < 0.01$) per cent retention of phosphorus in animals maintained on spleen incorporated rations, than their respective control groups, supported by lower faecal and urinary phosphorus excretion in animals maintained on spleen incorporated rations.

Magnesium balance studies showed an appreciably higher per cent retention of magnesium in animals maintained on spleen incorporated rations. It could also be observed that there was a trend towards an increased excretion of magnesium through faeces and urine, in animals maintained on control rations, when compared to that of animals maintained on spleen incorporated rations, indicating that, the utilisation of magnesium in animals maintained on rations B and D were low.

From an over all assessment of the data gathered during the course of the present investigation, it can be reasonably concluded that incorporation of dried spleen in the ration of goats, at the rate of 0.1 per cent on dry matter basis certainly plays a positive role in augmenting the nutrient utilisation by increasing their digestibility and retention and that dried spleen can be utilised as a harmless natural growth promotant in animal production with economic benefit.

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EFFECT OF DRIED SPLEEN AS GROWTH STIMULATOR IN KID RATIONS

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ABSTRACT OF A THESIS

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The results indicated that incorporation of dried spleen in the ration enhanced the growth performance of animals, especially in animals maintained on low level of protein , as evidenced by the cumulative and average daily weight gain registered in that descending order being 7.52 kg and 62.64 g, 7.4 kg and 61.67 g, 6.88 kg and 57.36 g and 5.00 kg and 41.67 g for the animals maintained on rations C, A, B and D respectively. The efficiency of feed and protein utilisation also exhibited the same trend. It was also noticed that, a cost of production per kilogram gain of Rs. 32.58 and 26.14 were registered for animals maintained on spleen incorporated rations (rations A and C) as against Rs. 35.08 and 38.63 respectively for the animals maintained on corresponding control groups (ration B and D) indicating a better cost efficiency in spleen incorporated groups, especially in animals maintained on low level of crude protein in the ration.

The haematological studies reveal that R.B.C., W.B.C., haemoglobin, plasma protein, plasma calcium, phosphorus and magnesium were within the normal range prescribed for the species. The animals maintained on ration C showed a significant increase ($P<0.01$) in plasma calcium level when compared to that of the control.

Digestibility studies reveal no significant difference in digestibility of dry matter and nitrogen free extract between the four groups. Animals maintained on the spleen incorporated rations (groups I and III) showed better digestibility ($P<0.01$) of crude protein and ether extract than the respective control groups (groups II and IV). Incorporation of dried spleen could not bringforth any influence on fibre digestion.

The results of the balance experiment showed better retention of nitrogen, calcium, phosphorus and magnesium in the animals maintained on spleen incorporated diets. The higher retention of these parameters could be substantiated by the comparatively lower faecal and urinary excretion of these, in animals maintained on spleen incorporated rations (rations A and C). An over all assessment of the results, indicated that incorporation of dried buffalo spleen in the ration of goats, at the rate of 0.1 per cent, certainly augment the nutrient utilisation by increasing the digestibility and retention, and can be recommended as a harmless natural growth promotant with economic benefit.