STUDIES ON THE NUTRIENT REQUIREMENTS OF KIDS.

BY

MERCY A. D.

THESIS

Submitted in partial fulfilment of the requirements for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences

Kerala Agricultural University

Department of Animal Nutrition

COLLEGE OF VETERINARY & ANIMAL SCIENCES

Mannuthy - Trichur.

1979

DECLARATION

I hereby declare that this thesis entitled "STUDIES ON THE NUTRIENT REQUIREMENTS OF KIDS" 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.

Mercy A.D.

MANNUTHY, MERCY, A.D.

31-12-1979.

CERTIFICATE

Certified that this thesis entitled "STUDIES ON THE NUTRIENT REQUIREMENTS OF KIDS" is a record of research work done independently by Kum. Mercy, A.D. 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.

DR. E. SIVARAMAN,
B.V.Sc.,M.Sc.,Ph.D.,
(Chairman, Advisory Board)
Professor.

MANNUTHY,
31-12-1979.

ACKNOWLEDGEMENTS

The author is indebted to:

Dr. E. Sivaraman, B.V.Sc., M.Sc., Ph.D., Professor, Department of Animal Nutrition, under whose guidance this work was carried out.

Dr. P.G. Nair, B.Sc., B.V.Sc., M.Sc., Ph.D., Dean, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy, for granting permission and providing facilities to undertake the study.

Dr. (Mrs.) N. Kunjikutty, B.V.Sc., M.Sc., F.R.V.A.C., and Dr. C.T. Thomas, B.Sc., B.V.Sc., M.Sc., Ph.D., Associate Professors, Department of Animal Nutrition for their valuable help and advice rendered during the course of the work.

Dr. K. Pavithran, B.V.Sc., M.Sc., Ph.D., Associate Professor, Department of Dairy Science for his help and suggestions.

Dr. B.R. Krishnan Nair, B.V.Sc., M.Sc., Geneticist, for permitting to use the facilities in the A.I.C.R.P. on Goats.

Dr. C.R. Ananthasubramaniam, B.V.Sc., M.S ., Ph.D., Research Officer, I.C.A.R. Co-ordinated Project (Agricultural and Industrial bye-products) for his advice.

Dr. (Mrs.) Annamma Kurian, B.V.Sc., Junior Assistant Professor, A.I.C.R.P. on Goats for her assistance in carrying out the experiments.

Dr. P.U. Surendran, M.A., Ph.D., Professor of Statistics for his assistance in the statistical analyses of the results.

The staff of the Department of Animal Nutrition for their valuable technical help.

The Indian Council of Agricultural Research, New Delhi for the award of a Junior Fellowship.

CONTENTS

INTRODUCTION

INTRODUCTION

The domestic goat, *Capra hircus* is found all over the world. The world goat population is about 383 million and approximately 70 per cent of it is found in the tropical environments (Verma and Mishra, 1978). India has the highest goat population among the countries of the world and according to the 1972 census, the 68 million goats of the country constitute about 19 per cent of the world goat population (National Commission Report, Government of India, 1976). In India, the density of goat population is highest in West Bengal followed by Uttar Pradesh, Kerala and Madras.

Goats contributed 1.65 per cent of the total world's milk production in 1974 (FAO, 1974). In India, goats produced about 675 thousand tonnes of milk constituting about 3 per cent of the total milk produced in 1971-72 (National Commission Report, Government of India, 1976). There is enormous variation in milk production of goats throughout the world. While some of the high producing goats of Europe yield about 3-5 kg milk per day for about 300 days, the goats in tropical areas yield only 0.9 to 1.0 kg per day for about 200 days (Sands and Mc. Dowell, 1978).

Goats show higher feed efficiency for milk production than cows (Verma and Mishra, 1978). The amount of feed per pound of milk produced was reported to be 0.38 lb in goats and 0.8 lb in cows (Frederick, 1975). Morand Fehr and Sauvant (1978) also compared the milk producing capacity of goats and cows and found that the average fat corrected milk yield per day per kg live weight was 22.0 g for cow and 35.6 g for goats.

The goat is the principal meat animal in India, contributing approximately 35 per cent to the total meat produced from livestock except poultry. Out of the 355 million kg of meat obtained from sheep and goats in 1967-68, 244 million kg were contributed by goats. The number of animals slaughtered was around 27 million which constituted about 36 per cent of the total population of goats (1976) in the country(National Commission Report, Government of India, 1976). According to Devendra (1976), the energy and protein efficiency for meat production in goats were found to be 4.7 and 5.1 respectively on a ration of grass alone and 6.7 and 10.2 respectively with grass and concentrate. The goat husbandry with special reference to meat production appears to be a highly economical concern under range conditions. The average dressed percentage was found to be 47 per cent (Johri and Talapatra, 1971).

India is the single largest goat-skin producing country. West Bengal produces skins of the finest quality. They contribute a major item of India's export trade, particularly to U.S.A. where they are mostly used in foot wear industry. Goats contribute about 36 million skins every year. Of this, 30 per cent is exported in the raw state, 55 per cent is tanned for making dried skins and 2.5 per cent is tanned in village tanneries (Bhatnagar, 1977).

The hair obtained from goats differ in quality depending upon the breed. Mohair obtained from Angora goat is used for making blankets, pile fabrics, summer suitings, lining nets, rugs, shoe laces etc. Mohair is produced in Uttar Pradesh and Himachal Pradesh. Pashmina is the hairy under coat obtained from the Pashmina goat and is used for making robes, blankets, namdas, bags, etc. On an average, these goats produce 112 g of pashmina (Bhatnagar, 1977). The total quantity of hair obtained from goats in India annually is estimated to be 4,516 metric tonnes which include 40 tonnes of Pashmina (Mudgal and Devendra, 1979).

The solid excreta of the goat is several times richer in nitrogen and phosphorus content than that of cow or buffalo. Goat's urine is equally rich in nitrogen and potash and more valuable than that of any other species of animals. One hectare of land receives sufficient dressing of manure if 4,800 goats are folded there for a night (Bhatnagar, 1977). The total quantity of manure obtained from goats is estimated to be 34 million quintals every year.

Feeding Habits.

Goats are sensitive animals with peculiar feeding habits. They are fastidious about cleanliness and like frequent changes in the feed. Feeds must be clean and fresh, since the goats eat nothing that is dirty or foul smelling.

Goats are browsers and thrive in areas richer in bushy plants where they get enough opportunity for browsing. They have a liking for leaves and prefer dry green feeds over the succulent ones. They can distinguish between bitter, sweet, salty and sour tastes and show a higher tolerance for bitter taste than cattle (Bell, 1959; Goatcher and Church, 1970). Indian breeds of goats do not relish much of straw or silage.

Goats prefer grains and oilseed cakes in cracked form rather than in ground form. But the browse forms an important part of the diet of goats. Goats may be used to convert otherwise useless browse plants into meat and milk. The special feeding habits of goats are particularly significant in areas where the quantity and quality of feeds are low as in the case of many parts of the tropics.

Though the domestic goat serves mankind providing very valuable milk, meat, hair, manure etc, very little is known about the nutritional requirements of this class of animal. The main reason for the lack of this information is that the part played by goats is little less when compared with cattle in tropical and in the developed countries. This animal species has not been the subject of much interest and study for years in many countries. Realising the importance of goats in the rural economy of the developing countries, several workers in different parts of the world have earnestly started attempts to develop this species of animal. Not much detailed studies have been carried out in India and abroad to establish the nutritive requirements of goats for various physiological functions such as maintenance, growth, reproduction and lactation.

The limited data available at present would stress the need to carry out more further detailed investigation to find out the precise nutritive requirements of our native goats for optimum growth and reproduction. This aspect of study on goat nutrition has assumed particular importance because of the fact that the success in goat rearing essentially depends upon a scientific rearing of kids from birth to puberty. This study was, therefore, undertaken to find out the levels of various nutrients for optimum growth in kids.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Limited information is available regarding the nutrient requirements of goats, most probably because, this animal species has not been the subject of interest for scientists for many years when compared to other domestic animals. However, it has now been well recognised that the goat has specific feeding habits and nutritional characteristics just like any other species of domestic animals.

Drymatter Consumption.

Goats differ from other ruminants by virtue of their capacity for higher feed intake and more particularly for forage consumption. The apparent superiority of goats over other species in digesting some feeds more efficiently has been confirmed by many workers in India (Mia *et al.* 1960a and 1960b). Pant *et al.* (1962) reported that the rumen liquor from goats digested significantly more cellulose than that from sheep under identical conditions of experimentation. They have further attributed this superiority to the differences either in certain physiological factors or in the selection of herbage.

Majumdar (1960b) recorded a drymatter intake of 2.6 lb per 100 lb body weight in adult goats. Brannon (1966), on the other hand, reported substantially higher drymatter intake of 6.5 - 11 per cent of body weight in goats as compared to only 2-3 per cent recorded for sheep or cattle. Mackenzie (1967) stated the drymatter requirement as 5-7 per cent of liveweight in the case of dairy goats, while Devendra (1967) recorded 2.75 kg drymatter intake for 100 kg body weight in Kambing Katjang goats. Singh and Sengar (1970) reported the drymatter consumption of goats as 1.86 - 2.65 per cent and 2.67 - 3.42 per cent of liveweight in Jamunapari bucks and doe respectively. They also reported 2.03 - 2.82 per cent and 3.42 - 4.20 per cent of body weight as dry matter intake in Barbari bucks and doe respectively. While the drymatter consumption was found to be 2.42 to 3.58 kg per 100 kg body weight in Jamunapari goats maintained at Chakkranagar, it was only 1.42 to 2.65 kg per 100 kg liveweight in similar animals kept at Mathura, (Saxena and Maheswari, 1971). Maheswari and Talapatra (1975) recorded drymatter intake of 3 kg and 4.05 kg per 100 kg body weight in Jamunapari goats, in feeding trials using fresh cowpea fodder and cowpea hay respectively. Rindsig (1977) reported that although goats could consume drymatter only about one sixth as that of cows, the drymatter consumption by goat in proportion to the body weight was more than that by cow or sheep, it being in the range of 4-7 per cent of liveweight. Experiments conducted at the University Goat Farm, Mannuthy, revealed an average drymatter intake of 4.11 kg per 100 kg body weight in adult male goats fed to appetite on concentrates and jack leaves and 3.6 - 4.2 kg per 100 kg body weight in lactating goats fed on limited concentrates and ad.lib. guinea grass (Annual Progress Report on A.I.C.R.P. on Goats, 1978).

Digestive Efficiency.

One unique characteristic of goats, often associated with their wider distribution especially in the tropical climates, is their ability to thrive in very adverse environments where the rainfall is often below 70 mm. They tend to flourish even under these situations feeding on a wide range of browse plants and shrubs when the availability of grasses is often very low. Goats can thrive and maintain their body condition satisfactorily in such extremes and adverse circumstances when animals like cattle or sheep cannot. One of the reasons attributed to such an ability of goat to adapt to any environment is its relatively greater capacity to digest cellulose or crude fibre.

According to Devendra (1978), the estimates of digestive efficiency in the goat are quite comparable to those reported for other species of ruminants, the gross efficiency varying from 14.1 - 15.1 per cent. However, there is considerable evidence that goats are comparatively more efficient in digesting crude fibre or cellulose. Devendra (1978) has discussed in detail the possible reasons for the better digestive efficiency of goats which include such factors as the nature of the diet, level of feed intake, rate of salivary secretion, pattern of rumen fermentation, and rate of movement of ingests along the alimentary tract. Higher digestibility coefficients for organic matter and crude fibre have also been observed in goats when compared to either cow or buffalo by Jang and Majumdar, (1962) in feeding experiments to compare the digestibility coefficients of nutrients by different ruminant species with a ration made up of spear grass hay and ground nut cake fed at 8 per cent of their metabolic body weight.

Frederick (1975) reported a higher feed efficiency of milk production for goats when compared to that for cows, the quantities of feed required for producing each pound of milk in the two species being 0.38 and 0.8 lbs respectively. Similar studies have been carried out by Verma and Mishra (1978). They have found that the average yield of milk per 100 kg of digestible organic matter was 125.6 kg in the case of British Alpine Goats while it was 86.0 kg for the cross bred (Zebu x Holstein) cows.

Maintenance Requirements.

The nutrient requirements of goats for maintenance have been studied by many workers both in India and abroad. Ritzman *et al*. (1936) showed that the basal metabolism of goats was considerably lower than that of any other farm stock. In comparison with sheep of almost similar body size, the basal metabolism in goats was lower by 40 per cent in females and 15 per cent in males.

French as early as in 1944 reported the energy requirement of browsing goats for maintenance as 0.59 kg S.E. per day per 45.4 kg 0.73 body weight. Almost similar values of 0.43 - 0.45 kg S.E. per 50 kg body weight were recorded by Tasaki (1960) for maintenance of adult goats. Majumdar (1960a) determined the minimum protein requirements of goats for maintenance using a low nitrogen as well as a nitrogen free ration. The excretion of endogenous urinary nitrogen was 0.052 g per kg body weight while that of metabolic faecal nitrogen was 0.41 g per 100 g dry feed intake. The protein requirement for maintenance as calculated from the endogenous urinary nitrogen values was found to be 0.65 lb per 1,000 lb body weight. From balance experiments carried out, the above author has calculated the requirement for crude protein as 2.63 g per kg body weight and that of digestible crude protein as 1.14 g per kg body weight. Mackenzie (1967) reported the maintenance requirement of energy as 0.4 kg S.E. per day per 45.4 kg body weight and that of digestible crude protein as 0.9 g per kg body weight in the case of temperate dairy goats. Devendra (1967) has reported almost similar values of energy requirement (0.41 $\pm$ 0.1 kg S.E. per day) for 45.5 kg body weight. He also reported the protein requirement as 45 - 64 g digestible crude protein per 100 kg body weight. Kentleach and Rayburn (1976) suggested the maintenance requirements for a dairy goat weighing 100 lb as 1.38 lb T.D.N., 0.21 lb D.C.P., 0.007 lb calcium and 0.006 lb phosphorus while Rindsig (1977) stated the D.C.P., T.D.N., calcium and phosphorus requirements for maintenance of lactating dairy goats weighing 100 lb as 0.14 lb, 1.36 lb, 4 g and 3 g respectively. Nawab Singh and Mudgal (1977) calculated the digestible crude protein requirement of goats for maintenance on the basis of endogenous urinary nitrogen and metabolic faecal nitrogen values and it was found to be 116.89 g per 100 kg body weight.

Lindahl (1972) calculated the maintenance requirement of goats taking into account the degree of exercise they performed. For a goat weighing 20 kg, the T.D.N. requirements were found to be 0.26, 0.34 and 0.37 kg for light, moderate and extensive exercise respectively. Huston (1978) used a factorial approach to estimate the nutritive requirements of Angora goats and found that these estimates were considerably higher than those generally accepted for sheep. The digestible energy and digestible protein required for a 45 kg goat were found to be 3.7 M cal. per day and 86 g per day respectively. Haenlein (1978) reported the maintenance requirements of 50 kg dairy goat as 500 European starch units and 50 g digestible protein. The energy and protein requirements for maintenance of adult Malabari goats as determined from feeding trials and balance experiments are found to be 8.57 g and 9.88 g of S.E. and 0.79 g and 0.83 of D.C.P. per kilogram body weight for adult female and male goats respectively (Progress Report on A.I.C.R.P. on Goats for the year 1978).

<u>Production Requirements</u>.

Very few systematic studies have been carried out to establish the requirements of goats for various physiological functions such as growth and milk production. French (1944) calculated the production requirements of lactating goats based on the fat content of milk. According to him, the energy required for each kilogram of milk testing 4 per cent fat was found to be 0.61 kg S.E. or 0.69 kg T.D.N. Tasaki (1960) calculated the energy requirements for milk production as 1,550 K cal for producing milk of 1,000 K cal. Mackenzie (1967) stated the requirements in terms of starch equivalent and digestible protein for each litre of milk as 325g and 50 g respectively. Kentleach and Rayburn (1976), on the other hand, recommended higher requirements viz, 0.32 lb T.D.N. and 0.057 lb D.C.P. for each pound of milk testing 4 per cent fat. Their recommendations for calcium and phosphorus were 0.0025 lb and 0.001 lb respectively for each pound of milk with 4 per cent fat. According to Rindsig (1977), the requirements of D.C.P., T.D.N., calcium and phosphorus for producing each pound of milk testing 4 per cent fat were shown to be 0.051 lb, 0.33 lb, 1.2 g and 0.9 g respectively. Devendra and Burns (1970) recorded the energy and protein requirements for each litre of milk as 300 g S.E. and 70 g D.C.P. respectively. According to some recent estimates (Huston, 1978), the production requirements were found to be 5.5 M cal of digestible energy and 172 g digestible protein for each kilogram of milk produced.

Very little information is available at present on the requirements of goats for optimum growth. French reported the energy requirements of kids weighing from 9 kg in terms of S.E. and protein equivalent. Mackenzie (1967) has suggested a ration with 1 part of digestible protein for every 7 parts of starch equivalent for optimum growth in kids. Devendra and Burns, (1970) recorded the energy requirements for growth in goats as 3.0 g of S.E. per gram liveweight gain. Haenlein (1978) has recommended the nutritive requirements of kids from 1st to 8th month of their growth period, the body weight ranging from 6.5 to 29 kg. The requirements are given separately for males and females and stated in terms of dry matter, digestible protein, fat, fibre, N.F.E. and European starch units.

MATERIALS AND METHODS

MATERIALS AND METHODS

Animals.

Alpine - Malabari crossbred kids belonging to the University Goat Farm, Mannuthy formed the experimental subjects for the study. Twenty four crossbred kids of 3 - 4 months of age and weighing on an average 9 kg were selected and divided into three groups, (Group I, II and III) of eight animals each as uniformily as possible with regard to sex, age and weight. All the animals were dewormed and sprayed against ectoparasites before the commencement of the experiment.

Diet.

The percentage composition of the concentrate mixture used in this study is given below:

Ingredients	Percentage
Ground nut cake	30.0
Coconut cake	10.0
Yellow maize	32.0
Horse gram	15.0
Rice bran	10.0
Mineral mixture	2.0
Salt	1.0

Vitablend AD_3 (Glaxo) containing 50,000 I.U.

of Vit. A and 5000 I.U. of Vit. D per gram, was also incorporated in the mixture at the rate of 20 g for each 100 kg of the mixture. Jack leaves formed the sole roughage for all the three groups of animals.

The percentage chemical composition of the concentrate mixture and jack leaves are shown below:

	Concentrate mixture	Jack leaves
Drymatter	93.5	42.4
Crude protein	21.3	12.8
Ether extract	5.6	4.1
Crude fibre	5.1	19.7
Total ash	9.1	9.6
Nitrogen-free extract	58.9	53.8
Calcium	1.44	1.96
Phosphorus	1.00	0.57

Methods.

The animals in the three experimental groups I, II and III were given the concentrate mixture and jack leaves as detailed below:

	Concentrate mixture	Jack leaves
Group I	250 g	300 g
Group II	300 g	400 g
Group III	350 g	500 g

The feeding experiment was conducted in three stages of approximately 1½ months each, the total duration of the trial being 4½ months. At the end of each stage, the concentrate allowance for the experimental animals in each group was increased by 50 gms each taking into consideration, the increased nutrient needs of the animals commensurate with advancing growth. The quantities of jack leaves fed to the animals in the respective groups were kept constant in all the three stages of the experiment. The concentrate mixture was always given after moistening it in order to prevent dustiness and to stimulate feed consumption. All the animals were provided fresh water *ad libitum*.

Records of daily feed consumption, water intake and weekly body weights of animals were maintained throughout the experiment. Two separate digestion-cum-metabolism trials involving in each case five days collection period, were conducted one at the beginning and the other at the end of the experiment. Only male animals were used for the metabolism trials. During the collection period, the animals were kept in separate metabolism cages with all the facilities for feeding and collection of dung and urine uncontaminated by any feed residue or dirt. The balance residues of concentrate as well as jack leaves were collected each day separately for all animals for the determination of moisture content and to calculate the drymatter intake. The dung was collected manually as and when it is voided. The dung collected each day was weighed accurately, mixed and a representative sample at the rate of one fifth of the total quantity was stored in a refrigerator. The samples preserved during the entire collection period were pooled and used for chemical analysis. Specially made rubber lined funnel shaped conduits with accessories were used for the collection of urine from each animal, the urine being collected in amber coloured bottles containing sufficient quantities of 25% sulphuric acid as the preservative. The total quantities collected each day were measured accurately and an aliquot at the rate of one tenth of the total volume was stored in amber coloured bottles under refrigeration. The pooled samples of urine were used for further chemical analysis.

Blood samples were collected from all the animals at the beginning, middle and towards the end of the feeding experiments, sodium citrate being used as the anticoagulant. The haematological studies included estimation of haemoglobin, packed cell volume, plasma protein, plasma calcium and plasma inorganic phosphorus. Haemoglobin was estimated by Cyanmethaemoglobin method, (Benjamin, 1974) using an Erma Hemophotometer. Biuret method (Gornall *et al*. 1949) was employed for the determination of plasma protein. Plasma calcium was determined by the Clark and Collip modification (1925) of Kramer-Tisdall method (1921) and inorganic phosphorus by Fiske and Subba Row (1925) method.

The feed and dung samples collected during the metabolism trial were subjected to proximate analysis as per standard procedures (A.O.A.C., 1970). The nitrogen content of urine was determined by the Kjeldahl method (A.O.A.C., 1970). The calcium content of the urine was estimated by the method described by Clark and Collip (1925) and inorganic phosphorus by Fiske and Subba Row method (1925).

Statistical analysis of the results was done following the method given by Snedecor and Cochran (1967).

From the data gathered from the metabolism trials, the nutrient requirements for growth were calculated in terms of D.C.P., T.D.N., Calcium and Phosphorus per unit gain in body weight. In arriving at the above requirements, the data on animal number 6,319 were not taken into consideration since wide variations in growth rate and feed efficiency was shown by that animal.

ESTIMATION OF HAEMOGLOBIN
(Cyanmethaemoglobin Method)

Principle.

Ferrous iron of haemoglobin reacts with pottasium ferricyanide and forms methaemoglobin which contains ferric iron. Methaemoglobin then reacts quickly with potassium cyanide and becomes cyanmethaemoglobin. Cyanmethaemoglobin is a stable pigment and its concentration is directly proportional to its optical density.

Reagents.

Drabkin's diluent.

Dissolved 1.0 g sodium bicarbonate, 50 mg potassium cyanide and 200 mg potassium ferricyanide in distilled water and made up the volume to 1,000 ml.

Procedure.

Using 5 ml of Drabkin's diluent, checked the zero of the instrument. Then added 0.02 ml of well mixed sample of whole blood to 5 ml of the reagent. Mixed thoroughly and let stand for at-least 15 minutes.

Replaced the blank tubes with the unknown sample tubes and noted the readings which gave the haemoglobin content in gram percentage.

DETERMINATION OF PLASMA PROTEIN (Biuret Method)

Principle.

Substances containing two or more peptide bonds form a purple complex with copper salts in alkaline solution and the colour intensity is proportional to its concentration.

Reagents.

(1) Biuret reagent.

Dissolved 1.5 g of cupric sulphate ($CuSO_4 . 5H_2O$) and 6.0 g of sodium potassium tartarate in 500 ml water. Added with constant stirring, 300 ml of 10 per cent sodium hydroxide solution (prepared from the stock carbonate free 65 - 75% NaOH solution). Diluted to 1 litre with water and stored in a paraffin lined bottle.

(2) Standard Solution.

Dissolved 250 mg of Bovine serum albumin in 50 ml distilled water so that 1 ml contains 5 mg.

Procedure.

Prepared the standard by adding 4 ml Biuret reagent to 1 ml standard bovine serum albumin solution and 50 µl water. Prepared the unknown solution by adding 4 ml Biuret reagent to 1 ml distilled water and 50 µl plasma. Prepared the blank by adding 4 ml Biuret reagent to 6 ml of distilled water. Made up the volume to 10 ml in all cases. Read the optical density of the unknown and standard solutions at 540 m µ using the blank for adjusting the instrument.

<u>Calculation</u>.

Plasma protein content (g per cent) =

$$\frac{\text{Reading of unknown} \times 0.005 \times 100}{\text{Reading of standard} \times 0.05}$$

ESTIMATION OF CALCIUM CONTENT OF URINE
(Clark and Collip Method)

<u>Principle</u>.

Calcium is precipitated from urine as the oxalate. The precipitate is dissolved in acid and the oxalate ion determined titrimetrically by using potassium permanganate.

<u>Reagents</u>.

(1) Methyl Red Solution.

Dissolved 1 g of methyl red in sufficient alcohol to make 1 litre.

(2) Ammonium Oxalate Solution.

Dissolved 10g of Ammonium oxalate in sufficient distilled water to make 1,000 ml.

(3) O.I.N. Potassium Permanganate Solution.

Dissolved 3.162 g pure potassium permanganate in one litre of distilled water allowed to stand for a few days, and filtered through glass wool. Standardised against 0.1 N. oxalic acid solution or against pure dry sodium or potassium oxalate.

Procedure.

Mixed 25 ml of the centrifuged urine sample with 1 g of activated charcoal and filtered. Transferred 1 ml of the cleared urine to a test tube, added 2 drops of methyl red solution, 2 ml of 1 per cent ammonium oxalate solution and adjusted the PH to 4.5 with 1 N Hcl or 2.5 per cent ammonium hydroxide solution. Let stand for 12 to 24 hours at room temperature. Centrifuged and poured off the supernatent liquid. Wiped the inside surface of the centrifuge tubes with absorbent paper to remove any adhering drops of supernatent liquid. Dissolved the precipitate in 4 ml 1 N H_2SO_4 and placed in a boiling water bath. Mixed frequently to facilitate complete solution. Titrate with 0.1 N potassium permanganate solution until the first drop ~~which~~ gives the solution a pink colouration which persists for atleast 15 seconds.

Calculation.

Titre value x 2 = mg of calcium/ml of urine

ESTIMATION OF INORGANIC PHOSPHORUS IN URINE
(Fiske and Subba Row Method)

Principle.

Phosphate reacts with molybdic acid to form phosphomolybdic acid. On treatment with 1, 2, 4 amino-naphtholsulfonic acid, phosphomolybdic acid is selectively reduced to produce a deep blue colour, which is probably a mixture of lower oxides of molybdinum.

Reagents.

(1) Molybdate Solution.

Dissolved 25 g of reagent-grade ammonium molybdate in about 200 ml of water. In a 1 litre volumetric flask, placed 300 ml of 1 N sulphuric acid. Added the molybdate solution and diluted with washings to 1 litre and mixed.

(2) Aminonaphthol sulfonic acid Reagent.

Placed 195 ml of 15 per cent sodium bisulfite solution in a glass stoppered cylinder. Added 0.5 g of 1, 2, 4 aminonaphthol sulfonic acid. Added 5 ml of 20 per cent sodium sulfite. Stoppered and shaked until the powder is dissolved. If the solution is not complete, add more sodium sulphite, 1 ml at a time with shaking, but avoid an excess. Transferred the solution to a brown-glass bottle and stored in the cold.

(3) Standard Phosphate Solution.

Dissolved exactly 0.351 g of pure dry monopotassium phosphate in water and transferred quantitatively to a one litre volumetric flask. Added 10 ml of 10 N sulphuric acid, diluted to the mark with water, and mixed. This solution contains 0.4 mg of phosphorus in 5 ml.

Procedure.

Measured out 250 µl of the urine sample in a test tube and added 1 ml of molybdate solution. Mixed by gently shaking and added 0.4 ml of aminonaphthol sulfonic acid reagent and then the volume was made up to 10 ml with distilled water. Again mixed by inversion and allowed to stand for 5 minutes.

At the same time, transferred to a test tube 5 ml of the standard phosphate solution containing 0.4 mg of phosphorus and the same reagents that were added to the urine sample and the volume was made upto 10 ml with distilled water. Prepared a blank solution by using the same reagents that were used for the standard and unknown, and diluted to 10 ml with distilled water. Then determined the density of the standard and of the unknown in a photometer at 660 to 720 mμ, setting the photometer to zero density with the blank.

RESULTS

RESULTS

Data on weekly body weights of animals in groups I, II and III maintained on the experimental rations are set out in Tables 1a to 1c and represented in Fig. I. The average daily gains of the animals are 63.7 ± 5.3, 64.4 ± 5.0 and 67.6 ± 2.0 g for the groups I, II and III respectively, the data being presented in Tables 2a to 2c and statistically analysed in Table 3.

The feed efficiency of the experimental animals maintained on the three dietary regimes are 7.01 ± 0.7, 7.50 ± 0.5 and 7.90 ± 0.3 respectively for the groups I, II and III, these values being set out in Tables 4a to 4c, represented in Fig. II and statistically analysed in Table 5.

The drymatter consumption of animals expressed per 100 kg body weight recorded during the second metabolism trial are found to be 3.1 ± 0.2, 3.5 ± 0.3 and 3.6 ± 0.3 kg for the groups I, II and III respectively and are shown in Tables 6a to 6c. The data on average water intake of the animals with their statistical analysis are presented in Tables 7 and 8.

The percentage chemical composition of dung and the crude protein, calcium and phosphorus contents in urine voided by animals during the two metabolism trials are shown in Tables 9 to 11.

The digestibility coefficients of nutrients in the ration calculated from the two metabolism trials are detailed in Tables 12a to 12c and the statistical analysis of the results in Tables 13 to 17. The data on the daily retention of calcium and phosphorus of the experimental animals are shown in Tables 18a to 18c with their statistical analysis in Table 19.

The results of the haematological studies carried out during the course of the feeding experiment are presented in Tables 20 to 22 and the statistical analysis of the data in Tables 23 to 27.

The digestible crude protein requirements expressed per unit body weight gain calculated from the results of the present study are 0.86 ± 0.08, 0.90 ± 0.06 and 0.89 ± 0.03 respectively for groups I, II and III. The total digestible nutrient requirements for unit increase in body weight are found to be 4.84 ± 0.04, 5.2 ± 0.3 and 5.31 ± 0.19 respectively for groups I, II and III, the values being set out in Tables 28a to 28c with their statistical analysis in Tables 30 and 31.

The calcium and phosphorus requirements for unit gain in body weight as calculated from the results obtained are shown to be 18.7 ± 4.4, 15.5 ± 8.4 and 24.9 ± 2.8 g, and 17.2 ± 1.1, 13.0 ± 5.6 and 22.5 ± 2.5 g respectively for kids maintained under the three dietary regimes (groups I, II and III), the data being presented in Tables 29a to 29c.

Table 32 presents a summary of D.C.P., T.D.N., S.E., Calcium and Phosphorus requirements arrived at from the results obtained during the course of the experiment.

Table 1a. Body weights (in kg) of animals maintained on the experimental rations.

Group I.

Weeks: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
.7	12.0	12.4	12.8	13.1	13.5	13.9	14.0	14.3	14.7	15.2	15.5	16.4	16.5	17.3	17.6	18.3	18.5	19.0	19.3	19.4
.2	9.5	9.5	9.8	10.0	10.0	10.6	11.2	11.7	12.2	13.1	13.4	14.3	14.5	15.4	16.0	16.7	17.2	17.5	17.8	18.7
.1	8.2	8.9	9.5	10.2	10.5	10.5	11.0	11.8	12.0	12.6	12.9	13.5	14.3	14.5	14.5	15.2	16.5	17.0	17.3	17.9
.0	7.7	8.4	8.6	9.2	9.5	9.8	10.5	11.3	11.8	12.4	12.9	13.6	14.3	15.0	15.5	15.8	17.0	17.5	18.0	18.5
.8	13.1	13.2	13.6	13.8	14.3	14.5	15.8	15.2	15.2	15.4	15.9	16.3	16.5	17.3	17.2	17.5	17.8	18.4	18.0	18.4
.7	8.9	9.2	9.5	9.7	10.2	10.0	10.6	10.8	10.8	11.3	11.8	12.4	12.5	13.0	13.5	14.1	14.2	14.7	15.0	15.4
.4	8.4	9.2	9.5	9.9	10.7	10.8	11.1	11.1	11.2	12.0	12.6	13.0	13.7	14.3	14.5	14.8	15.3	16.0	15.8	16.4
.9	7.3	7.6	8.0	8.5	9.2	8.9	9.6	10.1	10.8	11.2	11.8	12.5	13.3	14.0	15.0	15.8	16.4	17.6	18.0	18.5
.2	9.4	9.8	10.2	10.6	11.0	11.1	11.7	12.0	12.3	12.9	13.4	14.0	14.5	15.1	15.5	16.0	16.6	17.2	17.4	17.9
.7	±0.7	±0.7	±0.7	±0.7	±0.7	±0.7	±0.7	±0.6	±0.6	±0.6	±0.5	±0.6	±0.5	±0.5	±0.4	±0.5	±0.5	±0.5	±0.5	±0.5

Table 1b. Body weights (in kg) of animals maintained on the experimental rations.

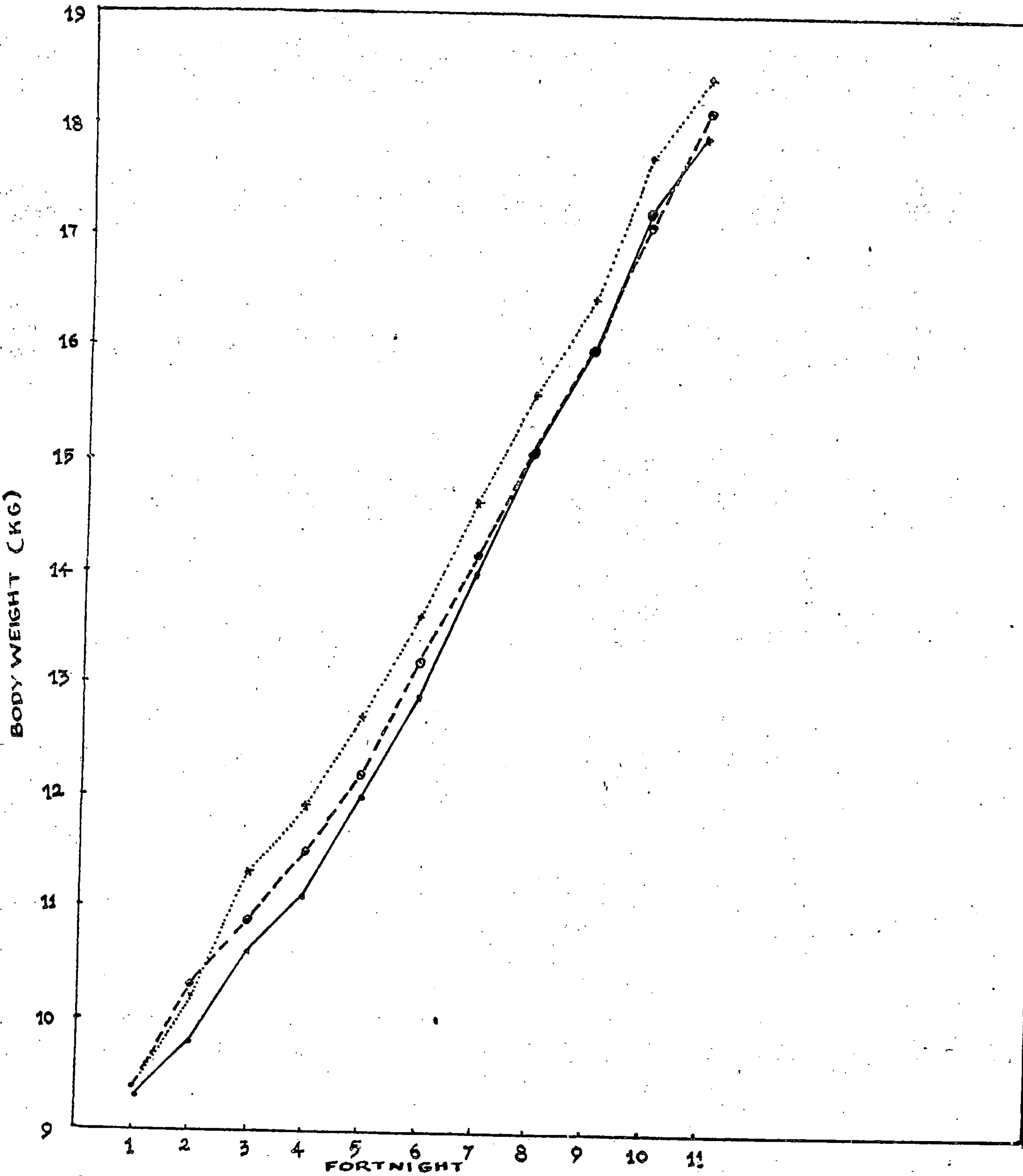
Group II.

Weeks																				
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
11.7	11.8	12.7	13.0	13.5	14.0	14.3	15.0	15.0	15.2	16.1	16.3	17.1	17.6	18.0	18.5	19.2	19.5	20.6	21.0	21.8
11.2	11.1	11.5	12.8	13.0	14.0	13.7	14.6	15.1	15.7	16.2	16.4	17.2	17.6	18.2	18.3	19.0	19.6	20.3	20.0	21.7
7.7	8.5	8.8	9.3	9.5	10.0	10.0	10.8	11.3	11.6	12.5	13.3	13.8	14.4	14.9	14.8	15.6	16.7	17.3	17.2	18.8
7.2	7.4	8.5	8.8	9.3	9.7	9.8	9.3	9.8	10.1	10.8	11.3	11.5	11.5	12.1	12.0	12.3	12.9	13.3	13.5	14.0
11.2	11.3	12.0	12.4	12.5	13.0	13.2	13.5	13.6	13.7	14.3	14.5	15.0	15.3	15.6	15.7	16.5	17.2	17.5	17.7	18.2
7.6	8.3	9.1	9.2	8.7	9.3	8.9	9.2	9.5	9.7	10.3	10.0	10.8	11.3	12.0	12.5	13.2	13.8	14.2	14.5	15.3
8.8	8.9	9.4	9.6	9.8	10.1	10.3	11.0	11.3	11.5	12.1	12.7	13.3	14.3	14.6	15.0	15.9	16.2	16.7	16.9	16.9
9.3	9.6	10.3	10.7	10.9	11.4	11.5	11.9	12.2	12.5	13.2	13.5	14.1	14.6	15.1	15.3	16.0	16.6	17.1	17.4	18.1
±0.8	±0.7	±0.6	±0.8	±0.8	±0.8	±0.7	±0.9	±0.8	±0.9	±0.9	±0.8	±0.9	±0.9	±0.9	±0.9	±0.9	±1.0	±1.0	±0.5	±1.1

Table 1c. Body weights (in kg) of animals maintained on the experimental rations.

Group III.

Weeks																				
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
11.8	11.5	12.2	13.8	14.2	14.3	14.5	15.4	16.0	16.6	17.0	17.9	18.2	19.3	19.4	19.0	19.5	20.3	21.6	21.3	22.2
12.5	12.6	13.6	13.9	14.5	15.1	15.4	16.2	16.7	17.0	17.3	18.0	18.0	18.9	19.5	19.5	20.2	20.5	21.3	21.8	22.3
9.8	10.4	11.3	12.2	12.7	13.2	13.4	13.1	13.7	14.5	14.9	15.1	15.7	15.8	16.2	15.6	15.7	16.0	17.0	16.8	17.6
7.2	8.6	8.9	9.6	9.8	10.2	10.4	10.3	9.8	10.6	11.4	12.0	12.4	12.8	13.6	13.5	14.2	14.8	15.6	15.3	16.0
10.0	10.5	10.8	11.2	11.4	11.8	12.3	12.4	12.7	13.5	13.9	14.8	15.2	15.6	16.1	16.7	17.5	18.7	19.6	18.8	20.0
8.6	8.5	9.3	10.0	10.2	10.6	10.8	11.2	11.7	11.9	11.9	12.4	13.0	13.4	14.0	15.0	15.2	15.8	16.1	16.2	17.1
6.2	5.8	6.7	7.3	7.4	8.0	8.2	8.9	9.2	9.5	10.0	10.5	10.9	11.5	12.0	12.5	13.7	13.9	14.7	14.7	15.5
7.6	8.5	9.0	9.4	9.8	10.1	10.5	11.0	11.6	11.8	12.2	13.0	13.6	13.9	14.3	14.5	15.5	14.8	15.8	15.9	16.5
9.2	9.6	10.2	10.9	11.3	11.7	11.9	12.3	12.7	13.2	13.6	14.2	14.6	15.2	15.6	15.8	16.4	16.9	17.7	17.6	18.4
+0.8	+0.8	+0.8	+0.8	+0.9	+0.8	+0.9	+0.9	+1.0	+1.0	+0.9	+1.0	+1.0	+1.0	+1.0	+0.9	+0.9	+1.0	+1.0	+1.0	+1.0



Average body weight of kids maintained on three experimental rations.

GROUP I
GROUP II
GROUP III

Table 2a. Average daily gain (in g) of animals maintained on the experimental rations for a period of 136 days.

Group I.

Animal number	Initial body weight (kg)	Final body weight (kg)	Total body weight gain (kg)	Daily gain (g)
6326	11.7	19.4	7.7	56.6
6338	9.2	18.7	9.5	69.9
6332	8.1	17.9	9.8	71.3
6349	8.0	18.5	10.5	77.2
6313	12.8	18.4	5.6	41.2
6320	8.7	15.4	6.7	49.3
6327	8.4	16.4	8.0	58.8
6368	6.9	18.5	11.6	85.3
Average	9.2	17.9	8.4	63.7
S.E.	±0.7	±0.5	±0.8	±5.3

Table 2b. Average daily gain (in g) of animals maintained on the experimental rations for a period of 136 days.

Group II.

Animal number	Initial body weight (kg)	Final body weight (kg)	Total body weight gain (kg)	Daily gain (g)
6335	11.7	21.8	10.1	74.3
6328	11.2	21.7	10.5	77.2
6329	7.7	18.8	11.1	81.6
6363	7.2	14.0	6.8	50.0
6315	11.2	18.2	7.0	51.5
6377	7.6	15.3	7.7	56.6
6376	8.8	16.9	8.1	59.6
Average	9.3	18.1	8.8	64.4
S.E.	±0.8	±1.1	±0.6	±5.0

Table 2c. Average daily gain (in g) of animals maintained on the experimental rations for a period of 136 days.

Group III.

Animal number	Initial body weight (kg)	Final body weight (kg)	Total body weight gain (kg)	Daily gain (g)
6351	11.8	22.2	10.4	76.5
6325	12.5	22.3	9.8	72.1
6316	9.8	17.6	7.8	57.4
6341	7.2	16.0	8.8	64.7
6323	10.0	20.0	10.0	73.5
6339	8.6	17.1	8.5	62.5
6355	6.2	15.5	9.3	68.4
6365	7.6	16.5	8.9	65.4
Average	9.2	18.4	9.2	67.6
S.E.	±0.8	±1.0	±0.3	±2.0

Table 3. Analysis of Covariance - average daily gain

Source	df	SS(x)	SP(xy)	SS(y)	Residual SS	df	MSS	F
Between groups	2	0.0757	- 0.989	68.125	66.5984	2	33.2992	0.22(N.S.)
Error	20	85.6809	-67.74	2903.808	2850.2522	19	150.0133	
Total	22	85.7566	-68.729	2971.933				

Regression coefficient B = - 0.79 (N.S.)
N.S. - Not Significant

Table 4a. Feed efficiency (kg feed/unit weight gain) of animals maintained on the three dietary regimes.

Group I.

Animal number	Drymatter intake from concentrates (kg)	Drymatter intake from jack leaves (kg)	Total drymatter intake (kg)	Total weight gain (kg)	Feed efficiency
6326	38.6	16.4	55.0	7.7	9.8
6338	38.6	16.4	55.0	9.5	5.8
6332	38.6	16.4	55.0	9.8	5.7
6349	38.6	16.4	55.0	10.5	5.2
6313	38.6	16.4	55.0	5.6	9.8
6320	38.6	16.4	55.0	6.7	8.2
6327	38.6	16.4	55.0	8.0	6.9
6368	38.6	16.2	54.8	11.6	4.7
Average	38.6	16.38	54.98	8.4	7.01
S.E.	±0.0	±0.02	±0.02	±0.8	±0.7

Table 4b. Feed efficiency (kg feed/unit weight gain) of animals maintained on the three dietary regimes.

Group II.

Animal number	Drymatter intake from concentrates (kg)	Drymatter intake from jack leaves (kg)	Total drymatter intake (kg)	Total weight gain (kg)	Feed efficiency
6335	44.7	21.8	66.5	10.1	6.6
6328	44.5	21.5	66.1	10.5	6.3
6329	44.5	21.2	65.7	11.1	5.9
6363	41.0	21.5	62.5	6.8	9.2
6315	39.6	21.8	61.4	7.0	8.8
6377	40.2	21.6	61.8	7.7	8.0
6376	40.1	21.5	61.7	8.1	7.6
Average	42.1	21.6	63.7	8.8	7.5
S.E.	±0.9	±0.1	±0.4	±0.6	±0.5

Table 4c. Feed efficiency (kg feed/unit weight gain) of animals maintained on the three dietary regimes.

Group III.

Animal number	Drymatter intake from concentrates (kg)	Drymatter intake from jack leaves (kg)	Total drymatter intake (kg)	Total weight gain (kg)	Feed efficiency
6351	48.4	27.2	75.6	10.4	7.3
6325	47.5	26.9	74.4	9.8	7.6
6316	46.1	26.9	73.0	7.8	9.4
6341	39.2	26.7	65.9	8.8	7.5
6323	47.9	27.2	75.1	10.0	7.5
6349	47.4	27.2	77.4	8.5	8.8
6355	42.4	26.6	69.0	9.3	7.4
6365	42.3	26.0	68.3	8.9	7.7
Average	45.2	26.8	74.8	9.2	7.9
S.E.	±0.9	±0.1	±1.3	±0.3	±0.3

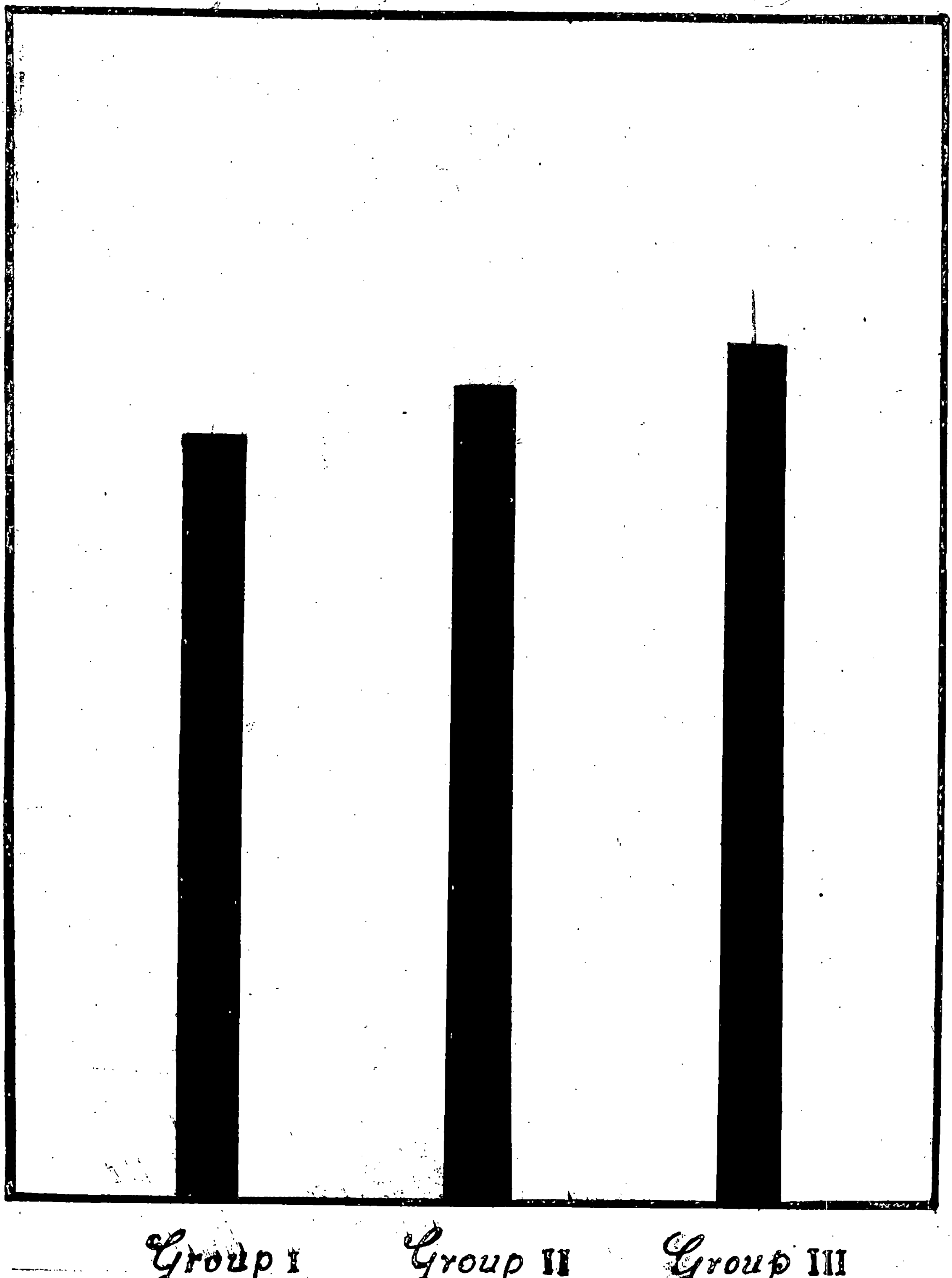


Fig: 2. Feed efficiency of animals maintained

Table 5. Analysis of Covariance - feed efficiency

Source	df	SS(x)	SP(xy)	SS(y)	Residual SS	df	MSS	F
Between groups	2	0.0757	0.02	3.18	3.18	2	1.59	0.16(N.S.)
Error	20	85.6809	20.88	196.22	191.13	19	10.06	
Total	22	85.7566	20.90	199.40				

Regression coefficient B = 0.24 (N.S.)

N.S. - Not Significant

Table 6a. Drymatter consumption (in kg) of animals recorded during the second metabolism trial.

Group I.

Animal number	Body weight (kg)	Daily drymatter intake from jack leaves (g)	Daily drymatter intake from concentrates (g)	Total drymatter intake/day (g)	Drymatter intake per 100 kg body weight
6326	16.5	118.5	327.6	446.1	2.7
6338	13.3	118.5	327.6	446.1	3.4
6332	14.3	118.5	327.6	446.1	3.1
6349	14.3	118.5	327.6	446.1	3.1
Average	14.6	118.5	327.6	446.1	3.1
S.E.	±0.4	±0.0	±0.04	±0.04	±0.2

Table 6b. Drymatter consumption (in kg) of animals recorded during the second metabolism trial.

Group II.

Animal number	Body weight (kg)	Daily drymatter intake from jack leaves (g)	Daily drymatter intake from concentrates (g)	Total drymatter intake/day (g)	Drymatter intake per 100 kg body weight
6335	17.6	158	374.4	532.4	3.0
6328	17.6	158	374.4	532.4	3.0
6329	14.4	158	374.4	532.4	3.7
6363	11.5	158	322.9	480.92	4.2
Average	15.3	158	361.5	519.5	3.5
S.E.	±1.5	±0.0	±12.9	±11.5	±0.3

Table 6c. Drymatter consumption (in kg) of animals recorded during the second metabolism trial.

Group III.

Animal number	Body weight (kg)	Daily drymatter intake from jack leaves (g)	Daily drymatter intake from concentrates (g)	Total drymatter intake/day (g)	Drymatter intake per 100 kg body weight
6351	19.3	197.5	421.2	618.7	3.2
6325	18.9	197.5	387.9	585.4	3.1
6316	15.8	197.5	415.2	612.7	3.9
6341	12.9	197.5	344.0	541.5	4.2
Average	16.7	197.5	392.1	589.6	3.6
S.E.	±1.6	±0.0	±17.6	±17.3	±0.3

Table 8. Analysis of variance - Daily water intake in litres.

Source	df	SS	MSS	F
Between groups	2	0.41	0.21	0.55 (N.S.)
Between period	1	1.17	1.17	3.08 (N.S.)
Error	20	7.6	0.38	
Total	23	9.18		

N.S. - Not Significant

Table 9. Percentage chemical composition of dung (on drymatter basis) voided by the animals during the first metabolism trial.

Group	Animal number	Total quantity of dung voided (g)	Dry-matter	Crude protein	Ether extract	Crude fibre	Total ash	Nitrogen free extract	Calcium	Phos-phorus
I	6326	950	58.3	18.1	4.3	11.7	20.6	45.3	3.0	1.8
	6338	990	55.8	18.6	3.0	12.8	22,1	43.2	4.3	1.8
	6332	925	61.8	21.9	3.4	15.7	21.1	37.9	3.7	1.1
	6349	922	60.0	17.2	2.8	13.2	20.7	46.0	4.4	1.9
II	6335	1,225	59.1	22.5	3.4	16.7	18.1	38.3	3.0	1.4
	6328	1,324	52.5	15.0	3.0	11.5	16.7	52.9	3.9	1.6
	6329	1,396	54.3	20.2	4.3	15.3	19.7	42.1	3.8	1.7
	6363	768	59.5	21.6	2.8	14.8	20.1	38.8	4.6	2.3
III	6351	1,383	65.3	18.9	5.2	9.5	19.1	47.3	3.6	1.5
	6325	1,728	54.8	20.6	3.7	14.1	20.3	41.3	3.5	1.7
	6316	1,284	60.7	20.1	3.6	16.0	18.9	41.5	3.5	1.7
	6341	920	66.1	18.7	4.5	14.1	17.6	45.1	3.5	1.2

Table 10. Percentage chemical composition of dung (on drymatter basis) voided by the animals during the second metabolism trial.

Group	Animal number	Total quantity of dung voided (g)	Dry-matter	Crude protein	Ether extract	Crude fibre	Total ash	Nitrogen free extract	Calcium	Phos-phorus
I	6326	1,205	55.8	21.7	4.2	16.4	18.4	39.3	3.7	1.4
	6338	1,094	57.3	18.7	3.2	15.8	19.2	42.9	3.1	1.3
	6332	1,100	59.4	22.7	3.3	16.7	18.5	38.7	3.9	1.5
	6349	1,116	58.0	20.2	3.3	16.7	18.8	31.1	3.4	1.2
II	6335	1,467	57.3	21.5	2.5	15.6	18.7	41.7	3.9	1.6
	6328	1,984	52.7	20.4	3.1	15.0	16.8	44.7	3.1	1.6
	6329	1,517	54.6	23.3	3.8	14.4	19.2	39.3	3.8	1.7
	6363	1,267	57.9	14.5	2.6	17.0	17.4	48.4	3.6	1.6
III	6351	1,789	62.6	18.6	2.8	17.2	17.5	44.0	3.5	1.2
	6325	1,523	60.6	16.6	2.9	18.0	19.2	43.3	3.6	1.5
	6316	1,848	55.3	16.1	2.7	17.6	16.4	47.3	3.4	1.5
	6341	1,362	60.8	22.6	2.6	18.3	16.3	40.3	3.9	1.7

Table 11. Data on the crude protein, calcium and phosphorus contents in urine voided by animals during the first and second metabolism trials.

Group	Animal number	Total volume of urine voided during the trials (ml)		Crude protein(%)		Calcium (mg/ml)		Phosphorus(mg/ml)	
		First trial	Second trial	First trial	Second trial	First trial	Second trial	First trial	Second trial
I	6326	5,165	7,420	3.4	3.1	1.0	0.3	0.2	0.5
	6338	3,450	5,475	4.6	3.2	1.2	0.6	0.3	0.7
	6332	2,980	4,910	4.3	4.4	1.5	1.8	0.4	0.8
	6349	4,140	4,020	3.6	4.4	1.0	0.8	0.4	0.7
II	6335	12,515	16,570	1.4	1.6	1.0	0.4	0.3	0.4
	6328	3,830	5,825	4.1	4.0	1.0	0.5	0.2	0.3
	6329	2,450	4,745	5.6	5.0	1.5	0.2	0.3	0.2
	6363	1,120	2,610	12.4	8.5	1.8	0.2	0.2	0.2
III	6351	5,190	7,545	4.2	4.1	1.3	0.2	0.2	0.2
	6325	4,320	7,135	4.1	3.8	1.5	0.5	0.2	0.3
	6316	1,355	4,355	11.4	6.1	1.9	0.4	0.2	0.4
	6341	1,230	1,800	7.5	9.6	1.2	0.2	0.3	0.5

Table 12a. Digestibility coefficients of nutrients in the rations obtained during the first and second metabolism trials.

Group I.

Animal number	Drymatter		Crude protein		Ether extract		Crude fibre		Nitrogen free extract	
	First trial	Second trial	First trial	Second trial	First trial	Second trial	First trial	Second trial	First trial	Second trial
6326	69.3	69.8	69.0	66.3	74.1	67.8	64.8	55.9	75.6	78.9
6338	69.4	71.9	68.8	72.9	81.8	76.2	61.7	60.4	76.7	78.5
6332	68.3	70.7	62.2	65.7	79.0	75.4	51.4	56.4	79.0	79.8
6349	69.3	71.0	71.1	69.9	83.2	75.7	60.4	56.8	75.3	83.9
Average	69.1	70.9	67.8	68.7	79.5	73.8	59.6	57.4	76.6	80.3
S.E.	±0.3	±0.3	±1.9	±1.7	±2.0	±2.0	±2.9	±1.0	±0.8	±1.3

Table 12b. Digestibility coefficients of nutrients in the rations obtained during the first and second metabolism trials.

Group II.

Animal number	Drymatter		Crude protein		Ether extract		Crude fibre		Nitrogen free extract	
	First trial	Second trial	First trial	Second trial	First trial	Second trial	First trial	Second trial	First trial	Second trial
6335	67.9	68.4	60.1	64.3	72.0	79.7	49.4	57.5	78.4	76.6
6328	69.1	69.1	74.5	57.9	73.0	68.6	66.5	49.1	71.3	68.8
6329	66.3	68.9	62.5	61.9	82.0	69.5	51.3	61.3	75.1	78.3
6363	72.9	69.5	67.2	76.2	74.4	79.3	63.9	56.5	81.4	73.8
Average	69.1	69.0	66.1	65.1	75.3	73.7	57.8	56.1	76.6	74.4
S.E.	±1.4	±2.1	±3.2	±3.2	±2.2	±2.6	±4.4	±2.6	±2.2	±2.0

170

Table 12c. Digestibility coefficients of nutrients in the rations obtained during the first and second metabolism trials.

Group III.

Animal number	Drymatter		Crude protein		Ether extract		Crude fibre		Nitrogen free extract	
	First trial	Second trial	First trial	Second trial	First trial	Second trial	First trial	Second trial	First trial	Second trial
6351	66.5	63.8	67.8	63.9	65.7	74.2	62.6	47.5	70.0	71.7
6325	64.2	68.5	58.7	68.8	73.9	76.4	53.9	52.9	73.9	75.8
6316	64.8	67.0	55.4	67.1	73.2	77.1	52.8	51.0	75.9	72.0
6341	60.7	69.5	54.9	61.9	62.4	78.7	59.9	54.9	68.3	78.2
Average	64.0	67.2	59.2	65.4	68.8	76.6	57.3	51.6	72.0	74.4
S.E.	±1.2	±1.3	±3.0	±1.8	±2.8	±1.0	±2.3	±1.6	±1.8	±1.6

Table 13. Analysis of variance - Digestibility coefficients of drymatter.

Source	df	SS	MSS	F
Between groups	2	85.78	42.89	51.15**
Between periods	1	16.01	16.01	19.09**
Error	20	16.77	0.8385	
Total	23	118.56		

** Significant at 1% level.

Table 14. Analysis of variance - Digestibility coefficients of crude protein.

Source	df	SS	MSS	F
Between groups	2	141.6	70.8	2.51(N.S.)
Between periods	1	25.0	25.0	0.89(N.S.)
Error	20	563.71	28.1855	
Total	23	730.31		

N.S. - Not Significant

Table 15. Analysis of variance - Digestibility coefficients of ether extract.

Source	df	SS	MSS	F
Between groups	2	36.29	18.15	0.58(N.S.)
Between periods	1	5.52	5.52	0.18(N.S.)
Error	20	623.21	31.16	
Total	23	665.02		

N.S. - Not Significant.

Table 16. Analysis of variance - Digestibility coefficients of crude fibre.

Source	df	SS	MSS	F
Between groups	2	66.815	33.4075	1.41(N.S.)
Between periods	1	61.441	61.4410	2.59(N.S.)
Error	20	473.967	23.6985	
Total	23	602.225		

N.S. - Not significant.

Table 17. Analysis of variance - Digestibility coefficients of nitrogen-free extract.

Source	df	SS	MSS	F
Between groups	2	110.81	55.41	4.86 *
Between periods	1	10.14	10.14	0.85(N.S.)
Error	20	238.01	11.90	
Total	23	358.96		

* Significant at 5% level.

Table 18a. Data on retention of calcium and phosphorus (g per day) of animals during the first and second metabolism trials.

Group I.

Animal number	Calcium		Phosphorus	
	First trial	Second Trial	First trial	Second trial
6326	1.49	1.18	0.80	1.00
6338	0.24	1.98	0.90	1.30
6332	0.75	0.45	1.60	1.00
6349	0.22	1.59	0.70	1.50
Average	0.68	1.30	1.00	1.20
S.E.	±0.30	±0.40	±0.60	±0.70

Table 18b. Data on retention of calcium and phosphorus (g per day) of animals during the first and second metabolism trials.

Group II.

Animal number	Calcium		Phosphorus	
	First trial	Second trial	First trial	Second trial
6335	0.70	0.12	0.90	0.30
6328	1.50	0.30	1.40	0.30
6329	1.01	1.50	1.10	1.30
6363	1.30	1.90	0.60	1.40
Average	1.10	0.96	1.00	0.80
S.E.	±0.20	±0.40	±0.20	±0.30

Table 18c. Data on retention of calcium and phosphorus (g per day) of animals during the first and second metabolism trials.

Group III.

Animal number	Calcium		Phosphorus	
	First trial	Second trial	First trial	Second trial
6351	1.20	1.60	1.30	1.54
6325	0.80	1.60	0.95	1.50
6316	1.60	1.70	1.11	1.49
6341	0.90	1.80	0.78	1.30
Average	1.10	1.68	1.03	1.46
S.E.	±0.20	±0.05	±0.13	±0.05

Table 19. Analysis of variance - Calcium and Phosphorus retention in g per day

	Source	df	SS	MSS	F
Calcium	Between groups	2	1.7697	0.8849	2.22(N.S.)
	Between periods	1	1.4017	1.4017	3.52(N.S.)
	Error	20	7.969167	0.3985	
	Total	23	11.1405		
Phosphorus	Between groups	2	1.464	0.732	2.95(N.S.)
	Between periods	1	0.2017	0.2017	0.81(N.S.)
	Error	20	4.9626	0.2481	
	Total	23	6.6283		

Table 20a. Data on blood values of experimental animals recorded during the second week of the experiment.

Group I.

Animal number	Packed cell volume	Haemoglobin (g/100 ml)	Plasma protein (g/100 ml)	Calcium (mg/100 ml)	Inorganic phosphorus (mg/100 ml)
6326	38	9.4	7.3	14.0	6.7
6338	36	10.0	8.4	11.0	6.9
6332	33	9.2	8.4	11.0	6.9
6349	28	8.6	8.9	12.0	7.1
6313	40	11.8	7.9	14.0	7.2
6320	41	10.0	7.3	14.0	5.5
6327	36	10.4	7.3	11.0	5.0
6368	37	9.8	7.3	11.0	4.4
Average	36.1	9.9	7.9	12.3	6.2
S.E.	±7.0	±0.4	±0.3	±0.7	±0.7

Table 20b. Data on blood values of experimental animals recorded during the second week of the experiment.

Group II.

Animal number	Packed cell volume	Haemoglobin (g/100 ml)	Plasma protein (g/100 ml)	Calcium (mg/100 ml)	Inorganic phosphorus (mg/100 ml)
6335	37	9.0	8.9	11.0	5.3
6328	41	10.2	9.4	11.0	5.9
6329	32	10.6	7.9	14.0	7.4
6363	35	9.4	7.3	11.0	5.1
6315	36	11.0	7.3	13.0	5.1
6377	46	8.8	9.4	12.0	5.4
6376	38	10.4	5.8	9.0	6.0
6319	36	9.0	8.4	13.0	6.5
Average	37	9.8	8.1	11.8	5.9
S.E.	±1.3	±0.40	±0.3	±2.2	±0.40

Table 20c. Data on blood values of experimental animals recorded during the second week of the experiment.

Group III.

Animal number	Packed cell volume	Haemoglobin (g/100 ml)	Plasma protein (g/100 ml)	Calcium (mg/100 ml)	Inorganic phosphorus (mg/100 ml)
6351	39	10.4	7.9	11.0	8.0
6325	45	9.0	7.9	14.0	6.7
6316	40	9.0	8.4	11.0	6.0
6341	31	9.0	8.4	11.0	6.4
6323	32	9.4	7.9	11.0	5.8
6339	32	8.8	8.4	11.0	4.8
6355	26	8.2	7.9	11.0	6.4
6365	37	9.6	7.9	14.0	6.1
Average	35.3	9.2	7.1	11.8	6.3
S.E.	±2.7	±1.6	±0.1	±0.6	±0.7

Table 21a. Data on blood values of experimental animals recorded during the 12th week of the experiment.

Group I.

Animal number	Packed cell volume	Haemoglobin (g/100 ml)	Plasma protein (g/100 ml)	Calcium (mg/100 ml)	Inorganic phosphorus (mg/100 ml)
6326	35	10.4	7.6	10.6	5.9
6338	29	10.8	7.8	11.0	7.0
6332	26	10.0	6.7	11.8	5.1
6349	27	9.6	7.5	13.2	6.0
6313	47	10.6	6.4	11.4	7.3
6320	30	10.4	7.6	13.8	6.8
6327	35	10.2	6.4	11.8	6.4
6368	30	10.8	7.0	11.4	6.1
Average	32.4	10.4	7.1	11.9	6.3
S.E.	±2.9	±0.2	±0.3	±0.5	±0.3

Table 21b. Data on blood values of experimental animals recorded during the 12th week of the experiment.

Group II.

Animal number	Packed cell volume	Haemoglobin (g/100 ml)	Plasma protein (g/100 ml)	Calcium (mg/100 ml)	Inorganic phosphorus (mg/100 ml)
6335	33	9.4	6.8	11.8	5.0
6328	37	10.2	7.2	11.0	8.5
6329	33	10.0	7.5	11.8	6.3
6363	32	9.8	8.4	9.8	4.6
6315	43	9.4	9.5	11.0	4.4
6377	31	9.0	7.2	10.6	5.8
6376	40	10.0	8.3	11.4	5.8
6319	26	9.6	8.7	10.2	7.8
Average	34.4	9.7	7.9	11.0	6.0
S.E.	±2.3	±0.1	±0.3	±0.3	±0.6

Table 21c. Data on blood values of experimental animals recorded during the 12th week of the experiment.

Group III.

Animal number	Packed cell volume	Haemoglobin (g/100 ml)	Plasma protein (g/100 ml)	Calcium (mg/100 ml)	Inorganic phosphorus (mg/100 ml)
6351	41	9.0	8.8	13.8	5.8
6325	35	9.6	8.3	11.4	8.7
6316	35	9.6	8.3	9.8	6.1
6341	36	10.8	7.2	13.8	5.2
6323	29	10.0	8.0	10.2	6.1
6339	38	10.4	8.7	9.8	7.8
6355	27	9.2	7.9	11.4	6.2
6365	45	10.4	7.5	13.0	8.0
Average	35.8	9.9	8.1	11.7	6.7
S.E.	±2.6	±0.2	±0.3	±0.7	±0.6

Table 22a. Data on blood values of experimental animals recorded during the 18th week of the experiment.

Group I.

Animal number	Packed cell volume	Haemoglobin (g/100 ml)	Plasma protein (g/100 ml)	Calcium (mg/100 ml)	Inorganic phosphorus (mg/100 ml)
6326	33	9.0	7.2	12.0	6.6
6338	33	9.8	7.2	12.0	7.0
6332	34	8.8	8.3	12.0	6.4
6349	28	8.0	7.2	11.0	7.0
6313	45	9.6	7.8	11.0	6.6
6320	35	8.0	7.8	12.0	6.8
6327	37	9.4	7.8	14.0	7.3
6368	40	10.0	6.7	12.0	6.5
Average	35.6	9.1	7.5	12.0	6.8
S.E.	±2.4	±0.3	±1.5	±0.3	±0.5

Table 22b. Data on blood values of experimental animals recorded during the 18th week of the experiment.

Group II.

Animal number	Packed cell volume	Haemoglobin (g/100 ml)	Plasma protein (g/100 ml)	Calcium (mg/100 ml)	Inorganic phosphorus (mg/100 ml)
6335	30	9.2	7.2	14.0	8.0
6328	41	10.6	8.3	12.0	8.0
6329	38	11.8	7.5	11.0	6.8
6363	35	10.4	7.2	13.0	6.0
6315	41	8.0	7.8	14.0	4.8
6377	35	8.0	7.2	11.0	6.3
6376	36	11.0	6.7	12.0	6.7
6319	31	9.4	8.3	14.0	8.0
Average	35.9	9.8	7.5	11.1	6.8
S.E.	±1.4	±0.5	±0.2	±0.5	±0.4

Table 22c. Data on blood values of experimental animals recorded during the 18th week of the experiment.

Group III.

Animal number	Packed cell volume	Haemoglobin (g/100 ml)	Plasma protein (g/100 ml)	Calcium (mg/100 ml)	Inorganic phosphorus (mg/100 ml)
6351	36	10.8	9.4	10.0	7.5
6325	35	10.6	8.3	13.0	8.3
6316	39	12.0	6.9	14.0	5.2
6341	40	11.0	7.2	13.0	7.2
6323	34	8.0	7.8	11.0	5.0
6339	31	10.0	7.2	14.0	6.0
6355	30	9.6	7.8	14.0	7.5
6365	35	11.6	6.9	11.0	6.0
Average	34.5	10.5	7.7	12.5	6.6
S.E.	±1.2	±0.4	±0.3	±0.6	±0.4

Table 23. Analysis of variance - Packed cell volume.

Source	df	SS	MSS	F
Between groups	2	57.25	28.63	0.33 (N.S.)
Between periods	2	116.083	58.042	0.67 (N.S.)
Error	67	5779.17	86.26	
Total	71	5952.5		

N.S. - Not Significant

Table 24. Analysis of variance - Haemoglobin (g /100 ml).

Source	df	SS	MSS	F
Between groups	2	0.1154	0.0577	0.03 (N.S.)
Between periods	2	1.41	0.705	0.36 (N.S.)
Error	67	131.6946	1.97	
Total	71	133.22		

Table 25. Analysis of variance - Plasma protein (g /100 ml).

Source	df	SS	MSS	F
Between groups	2	1.4768	0.7384	0.30 (N.S.)
Between periods	2	0.258	0.129	0.05 (N.S.)
Error	67	163.3605	2.438	
Total	71	165.0953		

N.S. - Not Significant.

Table 26. Analysis of variance - Calcium (mg/100 ml).

Source	df	SS	MSS	F
Between groups	2	0.97	0.485	0.88 (N.S.)
Between periods	2	3.083	1.542	2.80 (N.S.)
Error	67	37.007	0.55	
Total	71	41.06		

N.S. - Not Significant.

Table 27. Analysis of variance - Inorganic phosphorus (mg/100 ml).

Source	df	SS	MSS	F
Between groups	2	1.0098	0.5049	0.52 (N.S.)
Between periods	2	4.8153	2.4077	2.46 (N.S.)
Error	67	65.51	0.978	
Total	71	71.3351		

N.S. - Not Significant.

Table 28a. D.C.P., T.D.N. and S.E. requirements per kg body weight gain of experimental animals calculated from the data on feeding trial.

Group I.

Animal number	Total D.C.P. intake (kg)	Total T.D.N. intake (kg)	Total S.E. intake (kg)	Totalbody weight gain (kg)	D.C.P.required per kg gain (kg)	T.D.N.required per kg gain (kg)	S.E. required per kg gain (kg)
6326	7.1	39.8	34.6	7.7	0.92	5.17	4.49
6338	7.1	39.8	34.6	9.5	0.75	4.19	3.64
6332	7.1	39.8	34.6	9.7	0.73	4.10	3.57
6349	7.1	39.8	34.6	10.5	0.68	3.79	3.30
6313	7.1	39.8	34.6	5.6	1.27	7.11	6.18
6320	7.1	39.8	34.6	6.7	1.06	5.94	5.16
6327	7.1	39.8	34.6	8.0	0.89	4.98	4.33
6368	7.1	39.8	34.6	11.0	0.65	3.43	2.98
Average	7.1	39.8	34.6	8.6	0.86	4.84	4.21
S.E.	±0.0	±0.0	±0.0	±0.8	±0.06	±0.40	±0.40

Table 28b. D.C.P., T.D.N. and S.E. requirements per kg body weight gain of experimental animals calculated from the data on feeding trial.

Group II.

Animal number	Total D.C.P. intake (kg)	Total T.D.N. intake (kg)	Total S.E. intake (kg)	Total body weight gain (kg)	D.C.P. required per kg gain (kg)	T.D.N. required per kg gain (kg)	S.E. required per kg gain (kg)
6335	8.1	46.3	40.2	10.1	0.80	4.58	3.98
6328	8.0	45.9	39.9	10.5	0.76	4.37	3.80
6329	7.5	45.9	39.8	11.1	0.72	4.12	3.59
6363	7.4	43.4	37.8	6.8	1.10	6.38	5.55
6315	7.4	42.7	37.1	7.0	1.06	6.10	5.30
6377	7.4	42.9	37.3	7.7	0.96	5.57	4.84
6376	7.4	42.8	37.2	8.1	0.91	5.28	4.59
Average	7.7	44.2	38.5	8.8	0.90	5.20	4.52
S.E.	±0.20	±0.6	±0.5	±0.7	±0.06	±0.30	±0.29

Table 28c. D.C.P., T.D.N. and S.E. requirements per kg body weight gain of experimental animals calculated from the data on feeding trial.

Group III.

Animal number	Total D.C.P. intake (kg)	Total T.D.N. intake (kg)	Total S.E. intake (kg)	Total body weight gain (kg)	D.C.P. required per kg gain (kg)	T.D.N. required per kg gain (kg)	S.E. required per kg gain (kg)
6351	8.6	50.7	44.1	10.4	0.83	4.88	4.24
6325	8.5	49.9	43.4	9.8	0.86	5.09	4.43
6316	8.3	49.9	43.4	7.8	1.06	6.40	5.56
6341	7.3	44.9	38.3	8.8	0.83	5.10	4.35
6323	8.5	50.4	43.8	10.0	0.85	5.04	4.38
6339	8.5	50.0	43.5	8.5	1.00	5.88	5.12
6355	7.8	46.2	40.2	9.3	0.83	4.97	4.32
6365	7.7	45.8	39.8	8.9	0.86	5.15	4.47
Average	8.1	48.5	42.1	9.2	0.89	5.31	4.60
S.E.	±0.3	±0.8	±0.8	±0.3	±0.03	±0.19	±0.17

Table 29a. Calcium and Phosphorus requirements (g/kg body weight gain) calculated from data on feeding trials.

Group I.

Animal number	Calcium retained/day (g)	Phosphorus retained/day (g)	Dailygain (g)	Requirement of calcium/kg gain (g)	Requirement of phosphorus/kg gain (g)
6326	1.2	1.0	56.6	20.8	17.6
6338	2.0	1.3	73.5	26.9	17.7
6332	0.5	1.0	71.3	6.3	14.0
6349	1.6	1.5	77.2	20.6	19.4
Average	1.3	1.2	69.7	18.7	17.2
S.E.	±0.3	±0.1	±4.5	±4.4	±1.1

Table 29b. Calcium and Phosphorus requirements (g/kg body weight gain) calculated from data on feeding trials.

Group II.

Animal number	Calcium retained/day (g)	Phosphorus retained/day (g)	Daily gain (g)	Requirement of calcium/kg gain (g)	Requirement of phosphorus/ kg gain (g)
6335	0.1	0.3	74.3	1.6	4.4
6328	0.3	0.3	77.2	4.0	3.9
6329	1.5	1.3	81.6	18.3	15.9
6363	1.9	1.4	50.0	38.2	27.6
Average	0.95	0.8	70.8	15.5	13.0
S.E.	±0.40	±0.3	±7.1	±8.4	±5.6

Table 29c. Calcium and Phosphorus requirements (g/kg body weight gain) calculated from data on feeding trials.

Group III.

Animal number	Calcium retained/day (g)	Phosphorus retained/day (g)	Daily gain (g)	Requirement of calcium/kg gain (g)	Requirement of phosphorus/kg gain (g)
6351	1.60	1.54	76.5	20.0	20.0
6325	1.60	1.50	72.1	20.0	20.0
6316	1.70	1.49	57.4	29.6	30.0
6341	1.80	1.30	64.7	30.0	20.0
Average	1.68	1.46	67.7	24.9	22.5
S.E.	±0.05	±0.05	±4.1	±2.8	±2.5

Table 30. Analysis of Covariance - D.C.P. requirement per kg daily gain.

Source	df	SS(x)	SP(xy)	SS(y)	Residual SS	df	MSS	F
Between groups	2	0.0757	0.01	0.01	0.01	2	0.005	0.03 (N.S.)
Error	20	85.6809	2.47	2.92	2.85	19	0.15	
Total	22	85.7566	2.48	2.93				

Regression coefficient β = 0.03 (N.S.)

N.S. - Not Significant

Table 31. Analysis of Covariance - S.E. requirement per kg body weight gain.

Source	df	SS(x)	SP(xy)	SS(y)	Residual SS	df	MSS	F
Between groups	2	0.0757	0.05	0.67	0.65	2	0.33	0.51 (N.S.)
Error	20	85.6809	9.99	13.43	12.27	19	0.65	
Total	22	85.7566	10.04	14.10				

Regression coefficient β = 0.12 (N.S.)

N.S. - Not Significant.

Summarised data on D.C.P., T.D.N., S.E., Calcium and Phosphorus requirements of growing kids calculated from the results of the present study. (Average values with S.E.).

.C.P. required			T.D.N. required			S.E. required			Calcium required			Phosphorus required		
r kg in g)	per W $kg^{0.73}$ (g)	per day (g)	per kg gain (kg)	per W $kg^{0.73}$ (g)	per day (g)	per kg gain (kg)	per W $kg^{0.73}$ (g)	per day (g)	per kg gain (g)	per W $kg^{0.73}$ (g)	per day (g)	per kg gain (g)	per W $kg^{0.73}$ (g)	per day (g)
36 06	6.38 ±0.13	54.78 ±0.32	4.84 ±0.40	37.82 ±0.73	308.31 ± 0.07	4.21 ±0.40	31.08 ±0.63	268.18 ±0.08	18.7 ±4.4	0.16 ±0.03	1.3 ±0.3	17.2 ±1.1	0.14 ±0.02	1.20 ±0.10
90 06	6.83 ±0.25	57.96 ±0.96	5.20 ±0.30	39.75 ±0.99	334.88 ±4.70	4.52 ±0.29	34.57 ±1.31	291.09 ±4.13	15.5 ±8.4	0.13 ±0.03	1.00 ±0.40	13.0 ±5.6	0.11 ±0.05	0.84 ±0.30
39 03	7.21 ±0.14	60.13 ±1.30	5.31 ±0.19	42.88 ±1.11	358.74 ±6.30	4.60 ±0.17	37.21 ±0.96	310.78 ±5.90	24.9 ±2.8	0.20 ±0.02	1.68 ±0.05	22.5 ±2.5	0.16 ±0.02	1.46 ±0.05

DISCUSSION

DISCUSSION

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

Growth.

The results presented in Tables 1-3 indicate that the kids maintained on the three dietary regimes over a period of 4½ months register almost identical growth rates, the average daily body weight gains of the animals in the three groups I, II and III being 63.7 ± 5.3, 64.4 ± 5.0 and 67.6 ± 2.0 g respectively. There is no significant difference in growth rate between the three groups. The results of covariance analysis of the data reveal that the differences in initial body weights of individual animals in the three groups show no positive influence on the rate of growth shown by the animals subsequently during the period of study.

Varying growth rates and daily gains in growing kids have been reported by different workers. Singh and Sengar (1970) recorded an overall daily gain of only 20-40 g for Barbari kids of 0-12 months of age. Singh and Sengar (1978) studied the growth rates of kids maintained under two dietary treatments and reported an average daily gain of 79.0 g on a ration made up of concentrate mixture, gram bhuse and green arhar and 90.0 g on a ration containing green bhuse and green arhar fed <u>ad libitum</u>. In a study to find out the effect of various treatments on the utilization of nutrients in kids, Mudgal and Sengar recorded daily gains of 49.1 ± 2.7, 71.9 ± 3.9, 52.2 ± 1.6 and 55.7 ± 2.3 g in kids fed control, formaldehyde treated, heat treated and tannic acid treated concentrate mixtures respectively. While Singh and Rekib (1979) could record daily gains of only 33, 28 and 15 g in Barbari kids of 4-5 months of age on three rations viz., Berseem hay alone, and two mixtures of Berseem hay and natural grass hay in different proportions respectively, Mittal and Panday (1978) reported higher daily gains of 58.0 g in kids of the same breed but within the age group of 3-9 months.

The growth rates of lambs reported by many workers are also quite comparable to those of kids. Mathur (1973) has recorded daily gains of 36.0, 48.0, 54.0 and 54.0 g in lambs fed on four rations providing protein levels of 7, 10, 13 and 16 per cent respectively. However, a higher growth rate in lambs has been reported by Arore *et al.* (1975). Rao and Raghavan (1978) recorded the average daily gains in lambs as 55.8, 56.7 and 50.8 g for animals on rations containing high, medium and low levels of protein respectively.

From a perusal of the results on growth, it can be seen that the overall daily gains of animals in the present study are quite comparable to those reported by other workers for animals of similar age group and initial body weights. Though data on growth rate of Alpine - Malabari crossbred kids are scanty in literature, the daily gains obtained in the present study are almost similar to those recorded for Alpine - Malabari crosses maintained at the University Goat Farm, Mannuthy (Kunjikutty, 1979). The overall pattern of growth in all the three groups of animals points to show that the three levels of nutrient intake satisfy the requirements for growth.

Feed efficiency.

The overall efficiency of utilisation of feed for growth in the case of kids belonging to groups I, II and III are found to be 7.0, 7.5 and 7.9 respectively (Tables 4 and 5). Though not statistically significant, the feed conversion efficiency is higher for Group I, lower in Group II and lowest in group III. The almost similar weight gains for animals in groups under lower planes of nutrition as well, can be attributed to the higher feed efficiency of these animals.

Though very few growth studies have been carried out on Alpine Malabari crossbred kids, the data obtained in the present study are almost in agreement with those reported for kids of other breeds. In feeding experiments using Jamnapari-Malabari crossbred kids, Thomas et al. (1976) have obtained feed conversion efficiency values of 6.18, 6.4 and 7.1 on three rations viz., control, ration with 20 per cent rain tree fruit meal and that with 30 per cent rain tree fruit meal respectively. James (1978) recorded feed efficiency values of 5.5, 6.7 and 6.8 for Saanen - Malabari cross kids and 5.9, 6.4 and 6.3 for Malabari kids on three rations viz., one control and two experimental rations with either rubber seed cake or tea waste as one of the ingredients, respectively. Mudgal and Sengar (1979) recorded the feed efficiency for growth of Beetal kids on four dietary treatments viz., control diet, formaldehyde treated, heat treated and tannic acid treated diets as 11.76, 9.39, 10.53 and 10.38 respectively. The feed conversion efficiency values for growth of lambs are also comparable to those for kids. The feed efficiency for growth of Nellore lambs as reported by Lakshminarayana and Raghavan (1979) are found to be 6.89, 6.58, 6.23 and 6.36 respectively for the five groups receiving rations containing 12, 13, 14, 15 and 16 per cent of crude protein.

Drymatter consumption.

The drymatter consumption expressed as percentage of body weight of growing kids in Groups I, II and III maintained on the three planes of nutrition are found to be 3.1 $\pm$ 0.2, 3.5 $\pm$ 0.3 and 3.6 $\pm$ 0.3 respectively (Tables 10a to c). The values of drymatter intake obtained in the present investigation are in agreement with many of the data gathered from similar studies with kids of different breeds and maintained under different dietary regimes. Singhal (1978) have reported drymatter consumption of 3.41 $\pm$ 0.21, 3.66 $\pm$ 0.16 and 3.06 $\pm$ 0.12 for Beetal kids on three rations, viz., control, urea based and biuret based rations respectively. Singh and Sengar (1978) have recorded drymatter intake of Barbari growing kids as 4.4 per cent on a ration made up of a concentrate mixture, gram bhuse and green arhar, 4.1 per cent with a mixture of gram bhuse and green arhar and only 2.49 per cent when fed on gram bhusa alone. Singh and Rekib (1979), on the other hand, have recorded the drymatter consumption in Barbari kids of 4-5 months of age as 3.49, 3.72 and 3.43 per cent of the body weight when fed Berseem hay, Berseem hay plus natural grass hay (75:25) and Berseem hay plus natural grass hay (50:50) respectively. Feeding experiments on adult Alpine-Malabari cross bred goats maintained at the University Goat Farm, Mannuthy, revealed drymatter consumption of 4.11 per cent in males and 3.6 - 4.2 per cent in milking goats (Annual Progress Report on A.I.C.R.P. on Goats, 1978).

Widely varying values for drymatter consumption have been recorded for adult goats of different breeds and maintained under different conditions of feeding and management (Mackenzie, 1967; Singh and Sengar, 1970; Saxena and Maheswari, 1971; Maheswari and Talapatra, 1975; Brannon, 1966 and Morand Fehr and Sauvant, 1978).

Water intake.

It can be seen from the data presented in Tables 6 and 7 that there is no significant difference in the water intake of animals maintained under the three different dietary regimes. The average daily water consumptions in the three groups were 1.2, 1.3 and 1.0 litres in the first metabolism trial and 1.5, 1.8 and 1.5 litres in the second metabolism trial respectively. The increase in water intake of animals of all the three groups recorded during the second period may be attributed to their higher requirement of water with advancing growth. Almost comparable water intakes of 1.6, 1.5 and 1.1 litres have been recorded by Singh and Rekib (1979) for Barbari kids of 4-5 months of age when maintained on three rations viz., Berseem hay, Berseem hay plus natural grass hay (75:25) and Berseem hay plus natural grass hay (50:50) respectively. Devendra (1967) has recorded a mean daily water intake of 1.5 lb (0.7 litres) in Katjang goats during the dry period of the year ie. from February to June. Devendra and Burns (1970) suggested that the average daily water requirements of goats would range from 450 ml to 680 ml under normal conditions of feeding and management. Asuncion (1939) has made a comparative study on the feed and water consumption of goats and sheep and observed that goats consumed less water than sheep under identical conditions. The ratio between dry-matter and water intakes of kids is found to be 1:3.6 in the present study. A ratio of 1:4 to 5 has been suggested by Mackenzie (1967) and 1:4.4 by Devendra and Burns (1970) in the case of dairy goats.

Since it is well known that the water intake will vary widely according to the magnitude of the various factors which govern the needs of the animals, determination of water requirements for a given species and in set conditions is of limited value for any general considerations.

Digestibility Coefficients.

It is clear from the data presented in Tables 12-18, that the animals under the first dietary regime (Group I) digested the different nutrients in the ration better when compared to those maintained on the higher planes of nutrition (Groups II and III) though the differences in the digestibility coefficients of nutrients in the rations were not significant except for nitrogen-free extract. Almost comparable values have been recorded by Singh and Sengar (1978) with Beetal kids, by James (1978) with Saanen-Malabari cross bred kids and by Thomas *et al*. (1976) with Jamnapari-Malabari crossbred kids. While Mudgal and Kaur (1976) have reported higher values with Alpine-Beetal crossbred kids, Singh and Rekib (1979) have shown lower values with

Barbari kids. However, it has to be noted that the variable data recorded on the digestibilities of nutrients may be attributed to the differences in breed, age and the type of rations employed.

There are reports that under identical conditions of feeding and management, distinct differences exist between goats and other ruminants as regards the digestibilities of nutrients in feeds. Mudgal and Devendra (1979) have presented a summary of these results indicating the species involved, location, type of diet and nature and magnitude of the responses in each case. Most of the reports indicate that goats have better capacity to digest various nutrients and in particular crude fibre when compared to other species of animals. (Mia et al. 1960a and b; Pant et al. 1962; Jang and Majumdar, 1962; Jones et al. 1972; Adeyanju et al. 1975; Mudgal and Kaur, 1976 and Gihad, 1976).

Blood values.

From a perusal of the haematological data (Tables 20-27) it is seen that the blood values recorded during the course of the present study agree with those reported by earlier workers. The statistical analysis of the results of haematological studies carried out during the three stages of the experiment indicates that there is no significant difference in any of the blood constituents studied either between groups or between periods. The values for packed cell volume recorded for animals in the three groups I, II and III are found to be 36.1 ± 7.0, 37.0 ± 1.3 and 35.3 ± 2.7 per cent during the first period, 32.4 ± 2.9, 34.4 ± 2.3 and 35.8 ± 2.6 per cent in the second period and 35.6 ± 2.4, 35.9 ± 1.4 and 34.5 ± 1.2 per cent for the third period respectively. Almost similar values have been reported by Coffin (1953), Dukes (1955), Schalm (1961) and Bhalla et al. (1966). An average PCV of 30.3 ± 0.3 has been recorded for sheep by Rajeshwar Rao et al. (1962).

The almost uniform values for haemoglobin concentrations recorded for the kids maintained under the three dietary regimes at all the stages of the experiment are essentially similar to those reported in the literature in this regard (Coffin, 1953; Sehalm, 1961; Bhalle et al. 1966; Thomas et al. 1976; and James, 1978). Rajeshwar Rao et al. (1962) have reported a similar value of 9.76 ± 0.15 in the case of sheep also.

The plasma protein values are found to be 7.9 ± 0.3, 8.1 ± 0.3 and 7.1 ± 0.1 g per 100 ml in the first period, 7.1 ± 0.3, 7.9 ± 0.3 and 8.1 ± 0.3 g per 100 ml in the second period and 7.5 ± 1.5, 7.5 ± 0.2 and 7.7 ± 0.3 g per 100 ml in the third period for the three groups I, II and III respectively and are similar to those reported by Dukes (1955); Thomas et al. (1976) and James (1978).

Calcium contents (mg/100 ml) in the blood plasma of all the experimental kids recorded at different stages of the experiment lie within the normal range and are found to agree well with the values reported by earlier workers (Gowda, 1954; Seshiah, 1962; Cornelius and Kaneko, 1963; Thomas et al. 1976 and James, 1978).

The inorganic phosphorus content in blood of kids belonging to the three groups I, II and III are found to be 6.2 ± 0.7, 5.9 ± 0.4 and 6.3 ± 0.7 mg per 100 ml in the first period, 6.3 ± 0.3, 6.0 ± 0.6 and 6.7 ± 0.6 mg per 100 ml in the second period and 6.8 ± 0.5, 6.8 ± 0.4 and 6.6 ± 0.4 mg per 100 ml in the third period respectively. Although similar values have been reported by Seshiah (1962), Cornelius and Kaneko (1963) and James (1978), relatively higher inorganic phosphorus concentrations have been observed by Gowda (1954) and Thomas et al. (1976).

A comparison of the values obtained for the blood constituents during the course of the present study with those reported earlier for the same in respect of other breeds indicates that there is hardly any breed difference in regards to the blood values. The results of the study also indicate that since all the blood constituents studied lie within the normal range for the species in question, the experimental animals of all the three dietary regimes are under normal and sound nutritional status.

Protein requirements.

From Tables 28 and 30 it can be seen that DCP requirements per kg gain in body weight of kids, arrived at from the results of metabolism trials using the experimental rations containing three levels of protein and energy, are almost identical, the values for the three groups I, II and III being 0.86, 0.90 and 0.89 kg respectively. The results also indicate that even with higher levels of protein and with *ad libitum*. feed intake no significant increase in growth rate is obtained suggesting that the low plane of feeding itself appears to be adequate for optimum growth in Alpine - Malabari kids.

Even though no such systematic studies have so far been carried out on Alpine - Malabari crossbred kids, the values obtained in the present study are quite in agreement with the available data reported in the case of kids though of other breeds and maintained under different conditions of feeding and management. The total DCP requirements expressed as g per kg metabolic live weight (W kg$^{0.73}$ ~~0.73~~, Brody, 1945) calculated from the results of the present study are found to be 6.67, 7.00 and 6.94 g for the three groups I, II and III respectively. This is in agreement with the results of Mudgal and Sengar (1979) who have reported the DCP requirements of Beetal kids as 6.78, 6.68, 5.85 and 6.15 g on four rations, viz., control, formaldehyde treated, heat treated and tannic acid treated rations respectively. Haenlein (1978) has stated the daily DCP allowance as 65-75 g in the rations of kids weighing 16-19 kg. The daily DCP requirements as calculated from the results of the present study are found to be 54.9, 58.0 and 60.13 g for the groups I, II and III respectively.

Almost comparable values for daily gains and DCP requirements have been reported in the case of lambs also. Raten et al. (1973) have given a daily DCP requirement of 60 g for crossbred lambs of 25 kg body weight and with an average daily gain of 70 g. Similar values have been recorded by Patnayak (1978) in the case of crossbred lambs. Maheshwari (1977)

From a critical evaluation of the results on the DCP requirements of kids, it can be inferred that the nutrients provided in the experimental diets seem adequate for optimum growth in Alpine - Malabari kids since all the experimental animals maintained normal health as evidenced by the recorded parameters used as criteria for the evaluation of the nutritional status and in view of almost comparable growth rates of kids reported in the literature, though of other breeds and maintained under different conditions.

Energy requirements.

Tables 28 and 31 indicate that the energy requirements of kids for unit gain in body weight are found to be 4.21 ± 0.40, 4.52 ± 0.29, 4.60 ± 0.17 in terms of S.E. and 4.84 ±0.40, 5.20 ± 0.30 and 5.31 ± 0.19 in terms of TDN for the three groups I, II and III respectively, the differences among the three groups being not significant. Devendra and Burns (1970) have reported a lower value of 3 g S.E. for every g daily gain in the case of kids. The total daily TDN requirements expressed in terms of metabolic live weight (W_{kg}0.73) arrived at from the results of the present study are found to be 37.82, 39.75 and 42.88 g for the groups I, II and III respectively. However, comparatively higher values have been reported by Mudgal and Sengar (1979) in their experiments to study the effects of various treatments on the utilization of nutrients in feeds using Beetal kids as experimental subjects. Haenlein (1978) has recorded the daily allowance of energy for kids weighing 16 - 19 kg as 320 - 375 g European starch units while the intakes of S.E. by the animals of the three groups I, II and III during the last phase of the experiment was only 270, 290 and 310 g respectively.

Comparatively higher values for the energy requirements of lambs have been reported in the literature. Raten _et al_. (1973) have reported the daily TDN requirement as 600 g for lambs weighing 25 kg and with an average daily gains of 70 g Patnayak (1978) has also reported almost similar value of 610 g TDN for lambs weighing 20 kg and gaining at the rate of 50 g per day. On the other hand, Maheshwari (1977) has reported a lower TDN requirement of 311 g in the case of lambs weighing 20 kg and having a daily gain of 70 g.

From a critical appraisal of the results obtained for the energy requirements of kids in the present study and in comparison with the data already available in the literature it can be presumed that the varying values reported for the energy requirements can be attributed to the differences in breeds and climatic conditions. In view of the uniform growth rates and daily gains obtained for the kids maintained on three planes of energy and protein, the requirements of energy arrived at from the results of present study can be considered to be optimum for normal growth of Alpine - Malabari crossbred kids.

Calcium and Phosphorus requirements.

Data presented in Tables 29a to 29c indicate that the calcium and phosphorus needs per kg gain in body weight, calculated from the results of metabolism trials conducted during the course of the present investigation, are found to be 18.7 g, 15.5 g and 24.9 g and 17.2 g, 13.0 g and 22.5 g for the groups I, II and III respectively. The total daily requirements of calcium and phosphorus for growth as arrived at from the above data are 1.3 g, 1.0 g and 1.7 g and 1.2 g, 0.8 g and 1.5 g for the groups I, II and III respectively.

Very few systematic studies have been carried out to establish the mineral requirements of kids.

Chaturvedi and Saxena (1971) have recorded the daily calcium and phosphorus intakes per kg body weight of Jamunapari kids of 0-3 months of age as 0.29 and 0.11 g and 0.44 and 0.13 g on two diets of whole milk and skim milk respectively. While Morrison standards of calcium and phosphorus requirements for lambs weighing 50 lb are higher, the NRC recommendations for lambs of 0-3 months of age are almost similar to those obtained for kids in the present study viz., 0.07, 0.09 and 0.09 g of calcium and 0.07, 0.05 and 0.08 g of phosphorus per kilogram body weight for the groups I, II and III respectively.

Since a normal rate of growth accompanied by normal levels of calcium and phosphorus in the blood is highly indicative of adequate skeletal development, it can be reasonably presumed that the levels of calcium and phosphorus present in the experimental diets are adequate for normal growth of Alpine - Malabari crossbred kids.

On a critical assessment of the results obtained during the course of the present investigation, it may be stated that since normal values are obtained for growth rate, feed efficiency and other physiological norms used as criteria for the evaluation of the nutritional status of animals, the nutrients provided in all the three dietary regimes appear to be adequate for noamal growth in Alpine - Malabari crossbred kids. Further, in as much as almost similar growth rates and daily gains are obtained for the animals under all the three dietary regimes, it can be reasonably presumed that even the lowest dietary regime (group I) is adequate for normal growth in kids. However, it may be pointed out that a feeding standard for growth must consist of a series of figures corresponding to the different ages and body weights representing the various phases of the growth period.

SUMMARY

SUMMARY

An investigation was carried out with twenty four Alpine - Malabari crossbred kids to find out their nutrient requirements for optimum growth. The kids were divided into three groups of eight each (groups I, II and III) and were maintained on three levels of nutrient intake for a total period of 4½ months in three stages of 1½ months each, the concentrate allowance being increased by 50 g in each stage. The average daily body weight gain, feed efficiency, drymatter intake, water intake, digestibility coefficients of nutrients, nitrogen balance, mineral balance and haematological values were taken as the criteria for assessing the optimum requirements of nutrients for the growth of kids.

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

(1). The kids maintained on the three levels of nutrient intake showed almost identical growth rates and daily gains during the period of study, the average daily gains for the groups I, II and III being 63.7 $\pm$ 5.3, 64.4 $\pm$ 5.0 and 67.6 $\pm$ 2.0 g respectively.

(2). Higher feed conversion efficiency was

shown by animals maintained on the lower dietary regimes.

(3). The drymatter consumption in kg per 100 kg body weight of kids maintained on the three dietary treatments (groups I, II and III) were found to be 3.1 ± 0.2, 3.5 ± 0.3 and 3.6 ± 0.3 respectively.

(4). The average daily water intake of animals recorded during the course of the experiment were 1.2 ± 0.2, 1.3 ± 0.4 and 1.0 ± 0.2 litres respectively for groups I, II and III ~~respectively~~ in the first metabolism trial and 1.5 ± 0.2, 1.8 ± 0.4 and 1.5 ± 0.3 litres respectively for the same groups of animals in the second metabolism trial.

(5). The kids maintained under the lower level of nutrient intake (group I) registered higher digestibility coefficients as compared with those on the higher levels of nutrient intake (groups II and III), though the differences in the digestibility coefficients of nutrients between groups were not significant except for nitrogen-free extract.

(6). The haematological values recorded for the animals maintained on the three levels of nutrient intake were all within the normal range for the species.

(7). The digestible crude protein requirements for each kg increase in body weight, were found to be 0.86 ± 0.06, 0.90 ± 0.06 and 0.89 ± 0.03 kg for the kids in groups I, II and III respectively, the corresponding values for the total daily D.C.P. requirements of the animals being 54.9 ±, 58.0± and 60.1 ± g.

(8). The energy requirements of the kids for unit increase in body weight for groups I, II and III respectively were shown to be 4.21 ± 0.40, 4.52 ± 0.29 and 4.60 ± 0.17 kg in terms of S.E. and 4.84 ± 0.40, 5.20 ± 0.30 and 5.31 ± 0.19 kg in terms of T.D.N., the total calculated daily needs for the animals in the three groups being 268.18 ± 0.08, 291.09 ± 4.13 and 310.98 ± 5.90 g S.E.

(9). The requirements of calcium of kids for kg increase in body weight were 18.7 ± 4.4, 15.5 ± 8.4 and 24.9 ± 2.8 g and those of phosphorus were 17.2 ± 1.1, 13.0 ± 5.6 and 22.5 ± 2.5 g for the animals in the groups I, II and III respectively. The daily requirements of calcium for growth as calculated from the above data were 1.3 ± 0.3, 1.0 ± 0.4 and 1.7 ± 0.05 g and of phosphorus were 1.2 ± 0.1, 0.8 ± 0.3 and 1.5 ± 0.05 g for kids in the groups I, II and III respectively.

REFERENCES

REFERENCES

Adeyanju, S.A., Obutuba, D.B.A., Ilora, J.O. and Adegbola, A.A. (1975). Cocoa husk in maintenance rations for sheep and goats in the tropics. Nutr. Repts. Inter. 11 (4): 351-357. (cited in Nutr. Abstr. Rev. 46 (7): 5493).

Annual Progress Report (1977-1978) on All India Co-ordinated Research Project on Goats for Milk Production, Kerala Agricultural University, Mannuthy, Trichur.

A.O.A.C. (1970). Official methods of analysis. Association of Agricultural Chemists, Washington, D.C.

Arora, C.L., Mahajan, J.M., Nivasarkar, A.E., Singh, B.N., Bohra, S.D.J. and Gurhochamlal, (1975). Cited by Patnayak, B.C. (1978). ,Recent trends in sheep nutrition research in India. Paper presented at the summer Institute on "Recent advances in ruminant nutrition" held at N.D.R.I. Karnal, India.

Asuncion, P.P. (1939). A comparative study on the forage and water consumption of sheep and goats. Philippine Agriculturist. 28: 576-582. (cited in Nutr. Abstr. Rev. 9 (4) 4980.

Bell, F.R. (1959). The sense of taste in domesticated animals. Vet. Rec. 71: 1071.

Benjamin, M.M. (1974). Outline of Veterinary Clinical Pathology. 2nd Ed. The Iowa State University Press, U.S.A. p. 56.

Bhalla, N.P., Bhalla, R.C. and Sharma, G.L. (1966). Haematological values of healthy hill goats. Indian Vet. J. 36(1): 33-39.

Bhatnagar, D.S. (1977). Goat Breeding cited in Hand Book of Animal Husbandry. Indian Council of Agricultural Research, New Delhi. pp. 71-107.

Brannon, W.F. (1966). Cited by Mudgal, V.D. and Devendra, C. (1979). Aspects of goat nutrition. FAO/APHCA/ICAR/GOI Seminar on "Goat Development in Asia" held at N.D.R.I. Karnal, India.

Brody, S. (1945). Bioenergetics and growth. Reinhold Publishing Corporation, New York.

Chaturvedi, M.L. and Saxena, J.S. (1971). Some salient features of kid rearing. Indian Vet. J. 48(1): 1034-1038.

Clark, E.P. and Collip, J.R. (1925). A study of Tisdall method for the determination of blood calcium with a suggested modification. J. Biol. Chem. 63: 461.

Coffin, D.L. (1953). Manual of Veterinary Clinical Pathology. 3rd Ed. Comstock Publishing Associates, Ithaca, New York. pp. 156-157.

Cornelius, C.E. and Kaneko, J.J. (1963). Clinical Biochemistry of domestic animals. Academic Press, New York. pp. 168-169, 448-449.

Devendra, C. (1967). Studies on the nutrition of the indegenous goat of Malaya. (2) Maintenance requirement of pen fed goats. (3) The requirement for liveweight gain. (4) The free water intake of penfed goats. (5) The food conversion efficiency, economic efficiency and feeding standards for goats. Malaysian Agric. J. 46: 80-97, 98-118, 191-203, 204-246. (cited in Nutr. Abstr. Rev. 38 (3): 60-80).

Devendra, C. (1976). Productivity of goats and sheep in Malaysia. 1. Contribution from goats. Bulletin, Ministry of Agriculture, Malaysia, 144. p. 19. (cited in Nutr. Abstr. Rev. 48 (9): 3970).

Devendra, C. (1978). The digestive efficiency of goats. World Review of Animal Production 14(1): 9-23.

Devendra, C. and Burns, M. (1970). Goat Production in tropics. Technical committee No. 19 of the Commonwealth Bureau of Animal Breeding and Genetics, Edinburgh.

Dukes, H.H. (1955). The physiology of domestic animals, 7th Ed. Bailliera, Tindall and Cox, London. pp. 18-66.

F.A.O. (1974). Cited by Sands, M. and Mc Dowell, R.E. (1978). The potential of goat for milk production in the tropics. Cornell International Agricultural Mimeograph - 60. Dept. of Animal Science, Ithaca, New York.

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

Frederick, H. (1975). A little about a lot. Dairy Goat J. 53 (6): 8.

French, M.H. (1944). Cited by Kurar, C.K. (1978). Feeding of goats. Paper presented at the Summer Institute on "Recent advances in Ruminant Nutrition" held at N.D.R.I. Karnal, India.

Gihad, E.A. (1976). Intake, digestibility and nutrient utilisation of tropical natural grss hay by goats and sheep. J. Anim. Sci. 43(4): 879-883.

Goatcher, W.D. and Church, D.C. (1970). Taste responses in ruminants. IV Reactions of Pygmy goats, normal goats, sheep and cattle to acetic acid and quinine hydrochloride. J. Anim. Sci. 31: 373-382.

Gornall, A.G., Bardawill, C.J. and David, M.M. (1949). Determination of serum protein by the biuret reaction. J. Biol. Chem. 177: 751-766.

Gowda, H.S. (1954). Seasonal variation of serum calcium, magnesium and inorganic phosphorus in sheep, goats and buffaloes. Indian Vet. J. 30(4): 366-371.

Haenlein, G.F.W. (1978). Dairy goat Management. J. Dairy Sci. 61(7): 1011-1022.

Huston, J.E. (1978). Forage utilisation and nutrient requirements of the goat. J. Dairy Sci. 61(7): 988-993.

James, C.S. (1978). Studies on goat nutrition. IV comparative evaluation of conventional and unconventional feed for evolving cheap and economic ration for goats. Kerala J. Vet. Sci. 9(2): 206-214.

Jang, S. and Majumdar, B.N. (1962). Ann. Biochem. Exp. Med. 22: 303-308 (cited by Verma, G.S. and Mishra, R.R. (1978). Goat-an emerging dairy animal. Indian Dairym. 30(12): 863-866.

Johri, C.B. and Talapatra, S.K. (1971). Growth studies with Jamnapari goats. III Goat as a meat producing animal. Indian Vet. J. 48(6): 602-605.

Jones, G.M., Larsen, R.E., Javed, A.H., Donefer, E and Gaudreau, J.M. (1972). Voluntary intake and nutrient digestibility of forages by goats and sheep. J. Anim. Sci. 34(5): 830-838.

Kentleach and Rayburn, S. (1976). Feeding your dairy goat. Dairy Goat J. 54(10): 9-13.

Kramer, B. and Tisdall, F.F. (1921). J. Biol. Chem. 47: 476. cited by Oser, B.L. (1965). Hawk's Physiological Chemistry, 14th Ed. Tata Mcgraw-Hill Publishing Company Ltd., Bombay - New Delhi.

Kunjikutty, N. (1979). Personal Communication.

Lakshminarayana, P. and Raghavan, G.V. (1979). Studies on the effect of level of intake of protein on growth rate, feed efficiency and digestibility of nutrients in Nellore lambs. Kerala J. Vet. Sci. 10(1): 29-38.

Lindahl, I.L. (1972). Cited by Kurar, G.K. (1978). Feeding of goats. Paper presented at the Summer Institute on "Recent advances in ruminant nutrition", held at N.D.R.I. Karnal, India.

Mackenzie, D. (1967). Goat Husbandry, 2nd Ed. Faber and Faber Publ. Co., London.

Maheshwari, S.R. (1977). Cited by Patnayak, R.C. (1978). Recent trends in sheep nutrition research in India. Paper presented at the Summer Institute on "Recent advances in ruminant nutrition", held at N.D.R.I. Karnal, India.

Maheshwari, M.L. and Talapatra, S.K. (1975). Stall feeding of Jamnapari goats with cowpea fodders. Indian Vet. J. 52(1): 30-32.

Majumdar, B.N. (1960a). Studies on goat nutrition, Part I. Minimum protein requirements of goats for maintenance endogenous urinary nitrogen and metabolic faecal nitrogen excretion studies. J. Agric. Sci. 54: 329.

Majumdar, B.N. (1960b). Studies on goat nutrition, Part II. Digestible protein requirements for maintenance from balance studies. J. Agric. Sci. 54: 335-340.

Mathur, C.S. (1973). Cited by Patnayak, B.C. (1978). Recent trends in sheep nutrition in India. Paper presented at the Summer Institute on "Recent advances in ruminant nutrition" held at N.D.R.I. Karnal, India.

Mia, W.H., Sahani, B., Majumdar, B.N. and Kehar, N.D. (1960a). Studies on tree leaves as cattle fodder, Part III. The nutritive value of Bargad leaves (Ficus bengalensis). Indian J. Dairy Sci. 13(1): 1-8.

Mia, W.H., Majumdar, B.N., Sahani, B. and Kehar, N.D. (1960b). Studies on tree leaves as cattle fodder, Part IV. The nutritive value of Pipal leaves (Ficus religiosa). Indian J. Dairy Sci. 13(1): 9-15.

Mittal, J.P. and Panday, M.D. (1978). A study on growth rate in Barbari kids. Indian Vet. J. 55(6): 470-474.

Morand-Fehr, P. and Sauvant, D. (1978). Nutrition Optimum Performance of dairy goats. Livest. Prod. Sci. 5(2): 203-213.

Morrison, F.B. (1954). Feeds and Feeding. The Morrison Publishing Company, Ithaca, New York, p. 1150.

Mudgal, V.D. and Devendra, C. (1979). Aspects of Goat Nutrition. F.A.O./A.P.H.C.A./I.C.A.R./G.O.I. Seminar on "Goat Development in Asia" held at N.D.R.I. Karnal, India.

Mudgal, V.D. and Kaur, D. (1976). Comparative utilisation of feed nutrients in growing goats and calves. Indian J. Anim. Sci. 29(3): 151.

Mudgal, V.D. and Senger, S.S. (1979). Cited by Mudgal, V.D. and Devendra, C. (1979). Aspects of Goat Nutrition. F.A.O./A.P.H.C.A./I.C.A.R./G.O.I. Seminar on "Goat Development in Asia", held at N.D.R.I. Karnal, India.

National Commission Report, Govt. of India (1976), Part VII, Animal Husbandry. Ministry of Agriculture and Irrigation, New Delhi. pp. 211-222.

Nawab Singh and Mudgal, V.D. (1977). Investigation on the protein requirements for maintenance and milk production in goats. Annual report from N.D.R.I. Karnal, India. p. 227.

Pant, H.C., Rawat, J.S. and Roy, A. (1962). Studies on rumen physiology. (1) Growth of fistulated animals and standardisation on methods. Indian J. Dairy Sci. 15: 167-185.

Patnayak, B.C. (1978). Recent trends in sheep nutrition research in India. Paper presented at the Summer Institute on "Recent advances in ruminant nutrition" held at N.D.R.I. Karnal, India.

Rajeshwar Rao, G., Narasimhalu, P.R., Reddy, V.K. and Hussain, M.A. (1962). Observations on some aspects of blood of sheep. Indian Vet. J. 39(8): 429-433.

Rao, A.V.M. and Raghavan, G.V. (1978). Effect of levels of protein intake on the growth rate, feed efficiency and digestibility of nutrients in Deccani lambs. Indian J. Anim. Res. 12(1): 8-12.

Raten, R., Patnayak, B.C., Singh, N.P. and Mohan, M. (1973). Cited by Ratnayak, B.C. (1978). Recent trends in sheep nutrition research in India. Paper presented at the Summer Institute on "Recent advances on ruminant nutrition" held at N.D.R.I. Karnal, India.

Rindsig, R.B. (1977). Practical dairy goat breeding. Dairy Goat J. 55(6): 12-19.

Ritzman, E.G., Washburn, L.E. and Benedict, F.G. (1936). The basal metabolism of the goat. New Hampshire Agric. Stat. Tech. Bull. No. 66 p. 23. (cited in Nutr. Abstr. Rev. 6 (4): 1937).

Sands, M. and Mc Dowell, R.E. (1978). The potential of the goat for milk production in the tropics. Cornell International Agriculture Mimeograph-60. Dept. of Animal Science, Ithaca, New York.

Saxena, J.S. and Maheswari, M.L. (1971). Studies on Jamnapari Goats. II Studies on comparative intake of nutrients by browsing goats. Indian Vet. J. 48 (1): 173-175.

Schalm, O.W. (1961). Veterinary haematology, Ist Ed. Lea and Febiger, Philadelpheia. pp. 174-176.

Seshiah, S. (1962). Studies on calcium, phosphorus and magnesium content in the blood of domestic animals of Madras State. Indian Vet. J. 39(3): 164-169.

Singhal, K.K. (1978). Ph.D. Thesis, Punjab University, Chandigarh. (Cited by Mudgal, V.D. and Devendra, C. (1979). Aspects of goat nutrition F.A.O./A.P.H.C.A./I.C.A.R./G.O.I. Seminar on "Goat development in Asia" held at N.D.R.I. Karnal, India).

Singh, S.H. and Sengar, O.P.S. (1970). Final Technical Report of the PL-480 Research Project "Investigation on milk and meat potentialities of Indian Goats", (1965-70) published by the Department of A.H. and Dairying, R.B.S. College, Agra.

Singh, S.N. and Sengar, O.P.S. (1978). Technical Progress Report of the PL-480 Research Project, "Studies on the combining ability of desirable characters of important goat breeds for meat and milk separately and in combination. Published by the Department of A.H. and Dairying, R.B.S. College, Bichpuri, Agra.

Singh, C. and Rekib, A. (1979). Effect of feeding natural grass and Berseem hay on the growth rate and nutrient utilisation of Barbari kids. Indian Vet. J. 56(9) 784-788.

Snedecor, G.W. and Cochran, W.G. (1967). Statistical methods, 6th Ed. Oxford and I.B.H. Publishing Co., Calcutta.

Tasaki, I. (1960). Studies on the energy metabolism of dairy goats. Mem. Lab. Anim. Nutr. Nagoya Univ. 75(1): 80 (Cited in Dairy Sci. Abstr. 25(II): 3215).

Thomas, C.T., Devasia, P.A., Kunjikutty, N. and Nandakumaran, N. (1976). Studies on feeding of goats III Evaluation of nutritive value of raintree. (Enterolobium saman or Samanae saman) fruit meal for growth. Kerala J. Vet. Sci. 7(1): 13-19.

Verma, G.S. and Mishra, R.R. (1978). Goat - An emerging dairy animal. Indian Dairym. 30 (12): 863-868.

STUDIES ON THE NUTRIENT REQUIREMENTS OF KIDS.

BY

MERCY A. D.

ABSTRACT OF A THESIS

Submitted in partial fulfilment of the

requirements for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences

Kerala Agricultural University

Department of Animal Nutrition

COLLEGE OF VETERINARY & ANIMAL SCIENCES

Mannuthy - Trichur.

1979

ABSTRACT

An investigation was carried out to find out the nutrient requirements for optimum growth in kids. Twenty four Alpine - Malabari crossbred kids of 3-4 months of age formed the experimental subjects for the study. The animals, divided into three identical groups (groups I, II and III), were maintained on three different levels of nutrient intake for over a total period of 4½ months, the parameters recorded during the course of the study being average daily body weight gain, drymatter intake, feed conversion efficiency, digestibility coefficients of nutrients, nitrogen balance, mineral balance and haematological constituents.

The average daily gain and feed conversion efficiency recorded for animals in the three groups I, II and III were found to be 63.7 $\pm$ 5.3, 64.4 $\pm$ 5.0 and 67.6 $\pm$ 2.0 g and 7.0 $\pm$ 0.7, 7.5 $\pm$ 0.5 and 7.9 $\pm$ 0.3 respectively. The average drymatter consumption of animals were 3.1 $\pm$ 0.2, 3.5 $\pm$ 0.3 and 3.6 $\pm$ 0.3 kg per 100 kg body weight respectively for the three groups I, II and III.

The data collected for the haematological constituents were found to lies within the normal range for the species indicating that all the animals

under the three dietary regimes were maintaining normal and sound nutritional status.

The requirements arrived at for protein and energy for unit gain in body weight were 0.86 ± 0.06 0.90 ± 0.06 and 0.89 ± 0.03 kg D.C.P. and 4.84 ± 0.4, 5.20 ± 0.30 and 5.31 ± 0.19 kg T.D.N. for the animals in groups I, II and III respectively. The requirements of D.C.P., T.D.N., calcium and Phosphorus arrived at from the results obtained during the course of the experiment are considered optimum for normal growth in Alpine - Malabari crossbred kids.