OPTIMUM LEVEL OF PROTEIN IN CONCENTRATE MIXTURES OF KIDS FOR GROWTH

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "OPTIMUM LEVEL OF PROTEIN IN CONCENTRATE MIXTURES OF KIDS FOR GROWTH" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Mannuthy,
31-8-1981.

GANGA DEVI, P.

CERTIFICATE

Certified that this thesis entitled "OPTIMUM LEVEL OF PROTEIN IN CONCENTRATE MIXTURES OF KIDS FOR GROWTH" is a record of research work done independently by Kum. Ganga Devi, P. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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Dedicated To The Memory

of

MY BELOVED FATHER

CONTENTS

INTRODUCTION

INTRODUCTION

Archaeological evidence suggests that goat is probably the first animal to be domesticated after dog and brought to symbiotic relationship with man. In recent years goats are being increasingly recognized as important livestock in many parts of the tropics and subtropics. The recognition is born out of the fact that of the total world population of about 398 millions, approximately 79 per cent or 315 million goats are found in the tropical and subtropical regions.

Goat contributed 1.65 per cent of the total world's milk production in 1974 (FAO, 1974). In India, goat produced about 675 thousand tonnes of milk constituting about three per cent of the total milk produced in 1971 - '72 (National Commission on Agriculture, Report, Government of India, 1976).

According to the livestock census (1972), though there were only 68 million goats as compared to 40 million sheep in India, the contribution of goats to the country's agricultural economy was three times greater than that of sheep. The average milk production per lactation of desi goat is of the order of 58 kg as compared to 173 kg for the cow and 491 kg for the buffalo. Goats show higher feed efficiency for milk production than the cow (Verma and Mishra, 1978). The amount of feed required per pound of milk produced was reported to be

0.38 lb in goats and 0.8 lb in cows (Frederick, 1975). The milk producing capacity of goats and cows was also compared by MorandFehr and Sauvant (1978) who observed 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.

Given proper attention, goat can fetch a substantial income by way of a subsidiary vocation. Every part of this animal is a valuable commodity. The goat is the principal meat animal in India, contributing approximately 35 per cent to the total meat produced from livestock except poultry (Mudgal and Devendra, 1979). Out of the 355 million kg of meat obtained from sheep and goat 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 in the country (National Commission on Agriculture, Report, Government of India, 1976). Goat skin is an important raw material for the leather industry. Goats and goat products today contribute part of India's merchandise entering world markets. India having 68 million goats accounts for 17 per cent of world goat population and it produces around 40 - 45 million kg skins per year accounting for 22 per cent of the world production of goat skins. Its hair is used in the manufacture of rugs,

ropes, brushes, druggets etc. depending upon the variety. The hair obtained from goats differ in quality depending upon the breed. Mohair obtained from Angora goat is used for making blankets, pile fabrics, lining nets, shoelaces etc. Pashmina is the hairy undercoat obtained from the pashmina goat and is used for making robes, blankets, bags etc. On an average these goats produce 112 g of pashmina (Bhatnagar, 1977). The total quantity of hair obtained annually from goats in India is estimated to be 4,516 metric tonnes which include 40 tonnes of pashmina (Mudgal and Devendra, 1979). Goat's meat is delicious and its milk has curative properties for eczema, asthma, peptic ulcer and hay fever in children (Subbarama Naidu and Seshagiri Rao, 1979). On weight basis the solid excreta of the goat is several times richer in nitrogen and phosphorus content that that of cow or buffalo. The total quantity of manure obtained from goat in this country is estimated to be 34 million quintals per year. One hectare of land receives sufficient dressing of manure if 4,800 goats are folded there for a night (Bhatnagar, 1977). Goat's urine is equally rich in nitrogen and potash and is more valuable than that of any other species of animals.

The goat has certain inherent qualities of well known herbivorous feeding habits, high digestive efficiency of

crude fibre, high fertility, short generation interval and docility. Goats have higher capacity for digestion of organic nutrients of the diet (Jang and Majumdar, 1962 and Verma and Mishra, 1978).

Goats can thrive and maintain their body condition satisfactorily in such extremes and adverse circumstances as compared to cattle or sheep. One reason attributed to this is the superior capacity of the goat for digesting cellulosic material (Devendra, 1971). 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 ingesta along the alimentary tract.

The goat differs from other ruminants by its high feed intake and especially by its capacity of consuming large quantities of forage. Compared to cow or sheep, in terms of unit body size, they can consume dry matter, to the extent of 6.5 - 11.0 per cent of their body weight as against 2 - 3 per cent for cattle and sheep (Brannon, 1966). The dry matter capacity of goat averages 2.0 - 3.5 kg per day.

Surprisingly few research data are available on the animal's feeding habits and nutrient requirements, most

probably because this animal species has not been the subject of interest for scientists for many years as compared to other domestic animals. However, several workers in different parts of the world have earnestly started attempts to develop this species of animal for production purposes. Most of the nutritional principles applied to goats have been transposed from the data obtained from cattle and sheep without validation. The limited data available at present on the various aspects of goat feeding would stress the need to carry out more detailed investigations in this direction. The present investigation was taken up to assess the optimum level of protein required in concentrate mixtures of kids to achieve maximum daily gain and efficiency of feed conversion at least cost.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Among ruminants, cattle and sheep have received considerable attention all over the world but the situation regarding goat is one of total neglect (Devendra, 1979). However, it has now been well recognized that the goat has specific feeding habits and nutritional characteristics just like any other species of domestic animals.

Dry matter consumption.

Goats differ from other ruminants by their ability to consume more feed particularly forages. Rindsig (1977) reported that although goats could consume dry matter only about one sixth as that of cows, the dry matter consumption of goat in proportion to the body weight was more than that by cow or sheep. A higher dry matter intake has been reported for goats by many workers (Brannon, 1966; Mackenzie, 1967 and Maheswari and Talapatra, 1975). The apparent superiority of goats in digesting some feeds more efficiently has been confirmed by Mia et al. (1960a and 1960b), this being particularly true for certain nutrients like organic matter and crude fibre (Jang and Majumdar, 1962 and Devendra, 1978). On the other hand, studies carried out by several workers (Majumdar, 1960a; Devendra, 1967; Singh and Sengar, 1970 and

Saxena and Maheswari, 1971) tend to suggest that per unit body size almost similar quantities of dry matter are consumed by goats as that by cattle.

Nutrient requirements for maintenance.

Many workers both in India and abroad have carried out studies on the maintenance requirements of goats. Goats are found to have a lower basal metabolic rate in comparison to other farm animals (Kitzman et al. 1936). Investigations carried out on the energy requirement of goats by French (1944), Tasaki (1960), Devendra (1967), Mackenzie (1967), Lindahl (1972), Kentleach and Rayburn (1976), Rindsig (1977) and Haenlein (1978) indicate that adult goats require for maintenance about 0.90 kg starch equivalent per 100 kg body weight, the slight variations reported by the above workers being attributable chiefly to the differences in breed, sex and agro-climatic conditions of the area of study.

The quantity of protein required for maintenance of goats has also been a subject of interest for many workers (Majumdar, 1960a; Mackenzie, 1967; Devendra, 1967; Kentleach and Rayburn, 1976; Rindsig, 1977; Singh and Mudgal, 1977; Huston, 1978 and Haenlein, 1978). While lower figures ranging from 45 g - 90 g of digestible crude protein per 100 kg body weight have been reported for maintenance of

adult goats (Mackenzie, 1967 and Devendra, 1967) higher figures above 100 g per 100 kg body weight have also been suggested by many other workers (Kentleach and Rayburn, 1976; Rindsig, 1977; Singh and Mudgal, 1977 and Huston, 1978). The procedure employed for the determination is found to influence the figures arrived at for protein requirement, a very low figure of 65 g/100 kg being reported when the requirement was assessed from Endogenous Urinary Nitrogen values (Majumdar, 1960a) as compared to 114 g/ 100 kg when nitrogen balance technique was adopted (Majumdar, 1960b).

Nutrient Requirements for Production.

Literature on the requirements of nutrients for the various productive functions in goats seems to be rather scanty. The energy required by lactating goats for the production of each kg of milk reported by some of the workers has been found to vary from 300 - 325 g S.E. (Mackenzie, 1967; Devendra and Burns, 1970), while higher figures of about 0.64 kg are also reported by other workers (French, 1944; Tasaki, 1960; Kentleach and Rayburn, 1976; Rindsig, 1977 and Huston, 1978). The protein requirements for each kg of milk produced, reported by the above workers show almost uniform values of 50 g - 70 g except that reported by Huston (1978).

Requirements for Growth.

Very little information is available at present on the nutrient requirements of goat for optimum growth. The nutrients required by kids weighing from 9.0 kg have been reported by French (1964) in terms of S.E. and protein equivalent. Mackenzie (1967) has suggested a ration containing one part of digestible protein for every seven parts of S.E. for optimum growth in kids. The energy requirement for growth in kids has been recorded as 3.0 g of S.E. per g live weight gain by Devendra and Burns (1970). Haenlein (1978) has recommended the nutrient requirements of kids from first to eighth month of their growth period of males and females separately in terms of dry matter, digestible protein, fat, fibre, nitrogen-free-extract and European starch units. Mercy (1979) in her studies to determine the nutrient requirements of growing kids, found that per kg live weight gain, Alpine - Malabari crossbred kids require 7.01 - 7.9 kg of feed and 0.86 - 0.9 kg of D.C.P. and 4.84 - 5.31 kg of T.D.N. respectively in different groups of kids maintained on different planes of nutrition. Almost similar values have been reported by Singh (1980).

and found that all groups started to consume concentrate and roughage ad libitum from three weeks onwards. No significant difference in six months average daily gains between kids weaned gradually in 12 weeks after 87 or 124 kg of milk was also noted by Eker et al. (1959). On the other hand, kids fed milk replacer diets seemed to have a low rate of gain in studies carried out by Sashichandra and Arora (1979), possibly due to the lesser biological value of protein of milk replacer compared to that of whole milk.

The influence of type of concentrate fed and the quantity of concentrate fed on the growth of kids and the composition of tissue formed has also been studied. Growth studies conducted on weaned Japanese native kids by Haryu and Kameoka (1974) indicated that when yellow maize was used as the sole source of protein in the test feed, the kids showed insignificant gain in weight while inclusion of soyabean meal upto about 10 per cent of the D.C.P. brought about satisfactory gain. Dabadghao et al. (1976) in their studies with male Barbari kids maintained on either Cenchrus ciliaris alone and with concentrate supplement reported that the animals given supplement gave meat with more protein and fat. Feeding concentrates resulted in

greater live weight gain and efficiency of conversion in studies carried out on fattening lambs by Devendra (1967). Similar observations have been recorded in lambs by Sivish and Muddliar (1977) who also observed an increase in dressing percentage as the level of concentrate was increased in lamb ration. Studies carried out on lambs by Peter and Jordan (1973) indicated that the dietary protein level significantly influenced weight gain, energy and protein efficiency ratios and body protein levels. Mukherjee et al. (1980) reported that kids maintained on higher plane of nutrition had superior body weight gain and body measurements till they attained maturity.

Level of protein in the concentrate mixture is reported to influence the performance of growing kids by many workers. In a study conducted to evaluate the effect of dietary protein concentration on the growth of kids using four levels of protein, Tanabe, Haryu and Tam (1977) observed that the animals fed the highest level of 20.9 per cent protein gave maximum gain in weight. A similar observation has been recorded by Mc Donald et al. (1976) in lambs fed varying levels of protein in the ration. Akinsoyinu et al. (1976) reported an increase in the digestibility of crude protein and weight gain with increase in levels of protein in the

diet of West African Dwarf goats. In studies of Louca et al. (1975) where three groups of kids of Damascus breed were maintained on 10.9, 14.7 and 16.6 per cent crude protein in the diet, significant increase in weight gain, protain intake and concentrate intake occurred with progressive increase of protein in the diet. Increased daily gains and better feed conversion efficiency have also been noted by James (1978) in kids fed 15.4 per cent D.C.P. as against 7.3 per cent D.C.P. in the ration.

Similar observations of better performance of animals with increase in dietary protein level have been recorded in lambs by various workers. Sharma and Mittal (1977) using three levels of crude protein viz. 8, 12 and 16 per cent in concentrate mixtures of lambs reported that the animals maintained on 16 per cent protein attained maturity much earlier than those maintained on lower protein levels. Dalwani et al. (1975) in their studies with Mali lambs to study the effect of various levels of protein supplementation (20, 16 and 12 per cent) recorded that the animals fed 20 per cent crude protein in the diet had maximum average daily gains when compared to those fed lower levels of protein. On the other hand, Lakshminarayana and Raghavan (1979) could find an increase in growth rate of lambs with increase in protein intake only upto a certain level, the rate of growth declining when the protein level increased beyond 15 per cent.

MATERIALS AND METHODS

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Animals.

Twenty four crossbred kids (Saanen x Malabari and Alpine x Malabari) of approximately 3 - 4 months of age and weighing on an average 8.4 kg selected from the flock maintained at the All India Co-ordinated Research Project on Goats for Milk Production, Mannuthy, formed the experimental subjects for the study. The kids were divided into four groups (Group I, II, III and IV) of six animals (3 males and 3 females) each as uniformly as possible in regard to breed, age and weight. All the animals were dewormed and dipped against ectoparasites before the commencement of the experiment.

Diet.

The kids in the different groups were maintained on different concentrate mixtures with varying crude protein content viz. 16, 18, 20 and 22 per cent respectively. While kids in group I received concentrate mixture containing 16 per cent of crude protein, those in groups II, III and IV received concentrate mixtures containing 18, 20 and 22 per cent of crude protein respectively. All the concentrate mixtures were iso caloric. The percentage ingredient composition of the concentrate mixtures used are given below:

Ingredients	Concentrate mixtures I	II	III	IV
Coconut cake	10	27	17	10
Rice bran	12	10	10	10
Wheat	35	20	20	20
Horsegram	30	30	30	30
Dried unsalted fish	10	10	10	10
Deoiled ground-nut cake	--	--	10	17
Mineral mixture	2	2	2	2
Salt	1	1	1	1
Calculated crude protein (per cent)	16	18	20	22
Calculated total digestible nutrients (per cent)	70	70	70	70

Vitablend AB_2D_3* was incorporated at the rate of 25 g per 100 kg of each of the concentrate mixture so that each kg of the mixture had 10,000 i.u. of vitamin A, 6.25 mg of vitamin B_2 and 1,500 i.u. of vitamin D_3. Jack leaves formed the sole roughage for the experimental animals.

*Each gram of vitablend AB_2D_3 (Glaxo) contains 40,000 i.u.

of vitamin A; 25 mg of vitamin B_2 and 6,000 i.u. of vitamin D_3.

The percentage chemical composition of the concentrate mixtures and Jack leaves are shown below:

Nutritional moiety	Concentrate mixtures I	II	III	IV	Jack leaves
Dry matter	90.4	89.4	89.2	90.3	41.3
Crude protein	16.8	18.1	20.4	22.3	12.6
Ether extract	3.7	4.2	3.3	4.7	4.3
Crude fibre	4.3	4.2	4.6	5.0	19.6
Total ash	11.7	10.2	14.2	12.4	8.3
Nitrogen-free-extract	63.5	63.3	57.5	55.6	55.2

Methods.

The animals in all the experimental groups (group I, II, III and IV) were given initially 300 g of concentrate mixture daily along with jack leaves. After every six weeks the concentrate allowance for the experimental animals in all groups was increased by 50 g each taking into consideration the increased nutrient needs of the animals commensurate with

the growth increment. Jack leaves which formed the sole source of roughage, was given ad libitum to all the animals throughout the experimental period. The concentrate mixture was always given after moistening it in order to prevent dustiness and to stimulate feed consumption. All the kids were provided fresh water ad libitum. The animals were maintained on their respective feeding regimes for a period of $4\frac{1}{2}$ months. Records of daily feed and fodder consumption, weekly body weights and fortnightly body measurements including body length, heart girth, paunch girth and height at withers of animals were maintained throughout the experiment. Blood samples were collected from all the animals at the beginning, middle and at the end of the experiment, sodium citrate being used as the anticoagulant.

At the end of the experiment a digestion-cum-metabolism trial involving five days collection period was carried out. Only male animals from each group were used for the metabolism trial. During the collection period, the animals were kept in special metabolism cages with all facilities for feeding, watering and collection of dung and urine uncontaminated by any feed residue or dirt. Representative samples of concentrate mixture as well as jack leaves were collected daily for the determination of moisture content and to

calculate the dry matter intake. The dung was collected manually as and when it was 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 collected from each animal and preserved during the entire collection period were later 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 per cent 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.

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 haemophotometer. Buiret method (Gornall at 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 urine was estimated by the method described by Clark and Collip (1925) and inorganic phosphorus by Fiske and Subba Row method (1925). The data were statistically analysed by the method of Snedecor and Cochran (1967).

RESULTS

RESULTS

Data on weekly body weights of animals in groups I, II, III and IV maintained on the concentrate mixtures containing 16, 18, 20 and 22 per cent of crude protein respectively are set out in Tables 1a to 1d and represented in Fig. I.

The average daily gains of the experimental animals in the four groups are shown in Tables 2a to 2d and their statistical analysis in Table 3. Data on the body measurements of the animals viz. Body length (cm), Height at withers (cm), Heart girth (cm) and Paunch girth (cm) recorded fortnightly are presented in Tables 4a to 4d, 5a to 5d, 6a to 6d and 7a to 7d respectively and statistical analysis of these measurements in Tables 8 to 11.

The feed efficiency of the experimental animals maintained on the four dietary regimes are given in Tables 12a to 12d, represented in Fig. 2 and statistically analysed in Table 13.

The dry matter consumption of animals expressed in kg per 100 kg body weight recorded during the metabolism trial are detailed in Tables 14a to 14d and their statistical analysis in Table 15.

The percentage chemical composition of dung and the total volume and the nitrogen content of the urine voided by the animals during the metabolism trial are shown in Table 16 and 17 respectively.

The digestibility coefficients of nutrients in the ration calculated from the data obtained from the metabolism trial are detailed in Tables 18a to 18d and the statistical analysis of the results in Table 19 to 23.

Data on daily retention of nitrogen of the experimental animals are set out in Tables 24a to 24d with its statistical analysis in Table 25.

Haematological values of the animals in the different groups recorded at the beginning, middle and at the end of the feeding experiment are presented in Tables 26a to 26d, 27a to 27d and 28a to 28d respectively and the statistical analysis of the individual parameter in Tables 29 to 33.

Fig. 1 Average body weight of kids maintained on four experimental rations.

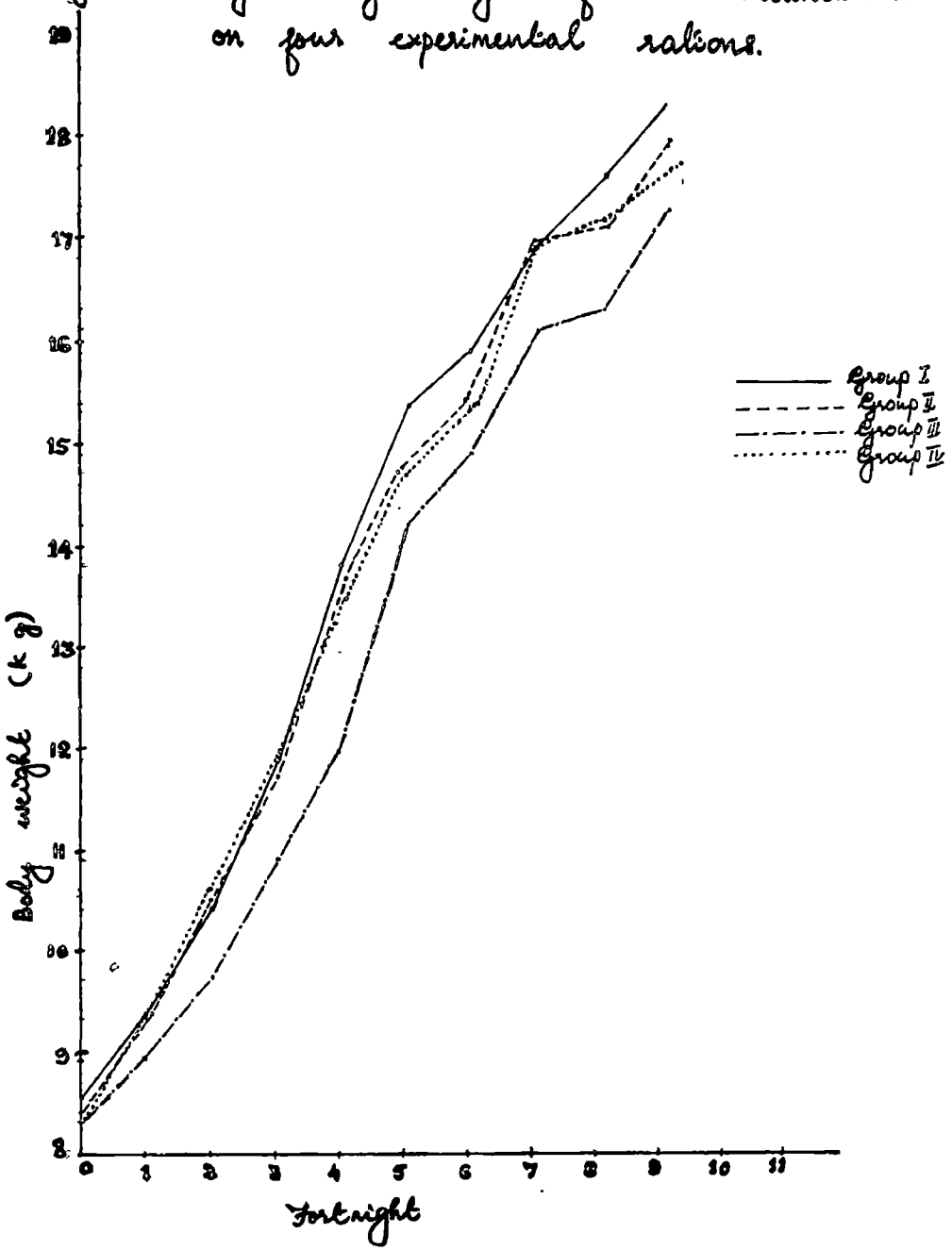

Table 2a. Average daily gain (in g) of animals maintained on the experimental rations for a period of 132 days.

Group I

Animal number	Initial body weight (kg)	Final body weight (kg)	Total body weight gain (kg)	Daily gain (g)
916	15.5	32.1	16.6	125.8
922	7.2	15.8	8.6	65.2
3243	6.0	13.8	7.8	59.1
AAM 86	8.2	18.0	9.8	74.2
3252	7.5	14.9	7.4	56.0
F_2A 27	6.3	16.7	10.4	78.8
Average	8.5	18.6	10.1	76.5
S.E.	±1.5	±2.8	±1.4	±10.5

Table 2b. Average daily gain (in g) of animals maintained on the experimental rations for a period of 132 days.

Group II				
Animal number	Initial body weight (kg)	Final body weight (kg)	Total body weight gain (kg)	Daily gain (g)
919	8.1	15.8	7.7	58.3
924	8.5	19.2	10.7	81.1
3235	10.3	18.5	8.2	62.1
SAH 9	7.1	21.0	13.9	105.3
F_2A 38	7.5	17.8	10.3	78.0
3242	8.6	17.0	8.4	63.6
Average	8.4	18.2	9.9	74.7
S.E.	±0.5	±0.7	±0.9	±7.2

Table 2c. Average daily gain (in g) of animals maintained on the experimental rations for a period of 132 days.

Group III

Animal number	Initial body weight (kg)	Final body weight (kg)	Total body weight gain (kg)	Daily gain (g)
923	9.5	18.8	9.3	70.5
918	9.0	20.1	11.1	84.1
3238	11.7	20.0	8.3	62.9
SAM 10	6.9	15.9	9.0	68.2
3237	7.6	17.3	9.7	73.5
F_2A 28	5.1	13.5	8.4	63.6
Average	8.3	17.6	9.3	70.5
S.E.	±0.9	±1.1	±0.4	±3.2

Table 2d. Average daily gain (in g) of animals maintained on the experimental rations for a period of 132 days.

Group IV

Animal number	Initial body weight (kg)	Final body weight (kg)	Total body weight gain (kg)	Daily gain (g)
921	9.4	17.0	7.6	57.6
3241	9.2	16.7	7.5	56.8
F_2A 23	6.7	14.1	7.4	56.1
925	9.2	22.4	13.2	100.0
3255	8.0	19.7	11.7	88.6
F_2S 107	7.8	22.1	14.3	108.3
Average	8.4	18.7	10.3	77.9
S.E.	±0.4	±1.3	±1.3	±9.8

Table 3. Analysis of variance - Average daily gain.

Source	df	SS	MSS	F
Groups	3	187.77	62.59	0.16 (N.S)
Error	20	7807.34	390.37	
Total	23	7995.11		

N.S. - Not Significant.

Table 4a. Fortnightly Body length (cm) of the experimental animals on the four dietary regimes.

Group I

Animal number	1	2	3	4	5	6	7	8
916	50	52	53	56	56	56	57	60
922	42	42	42	44	46	47	48	49
3243	36	37	39	41	43	44	45	47
AAM 86	42	43	44	47	49	50	52	53
3252	38	39	40	42	43	44	46	51
F_2A 27	39	40	41	42	43	44	47	52
Average	41.2	42.2	42.7	45.3	46.7	47.5	49.2	52.0
S.E.	±2.0	±2.2	±2.3	±2.3	±2.1	±2.0	±1.9	±1.8

Table 4b. Fortnightly Body length (cm) of the experimental animals on the four dietary regimes.

	Group II							
Animal number	1	2	3	4	5	6	7	8
919	38	39	40	43	44	47	48	54
924	41	43	45	47	49	51	53	56
3235	43	45	47	48	50	52	54	57
SAM 9	40	42	44	47	50	52	54	55
F_2A 38	38	40	42	44	46	48	50	51
3242	39	41	43	45	47	49	50	52
Average	39.8	41.8	43.5	45.7	47.7	49.8	51.5	54.2
S.E.	±0.8	±0.9	±1.0	±0.8	±1.0	±0.9	±1.0	±1.0

Table 4c. Fortnightly Body length (cm) of the experimental animals on the four dietary regimes.

	Group III							
Animal number	1	2	3	4	5	6	7	8
923	40	42	44	47	49	52	54	57
918	37	38	40	43	45	48	51	55
3238	42	43	44	47	49	53	56	59
SAM 10	38	39	41	43	45	46	47	48
3237	39	41	43	45	47	49	50	53
F_2A 28	35	36	38	40	42	43	45	46
Average	38.5	39.8	41.7	44.2	46.2	48.5	50.5	53.0
S.E.	±1.0	±1.1	±1.0	±1.1	±1.1	±1.5	±1.7	±2.1

Table 4d. Fortnightly Body length (cm) of the experimental animals on the four dietary regimes.

	Group IV							
Animal number	1	2	3	4	5	6	7	8
921	40	42	44	46	48	51	52	54
3241	38	40	43	46	48	50	52	54
F_2A 23	37	40	43	45	48	51	53	54
925	38	42	46	49	52	55	58	61
3255	38	42	44	47	49	50	52	55
F_2S 107	35	38	41	43	45	46	48	51
Average	37.7	40.7	43.5	46.0	48.3	50.5	52.5	54.8
S.E.	±0.7	±0.7	±0.7	±0.8	±0.9	±1.2	±1.3	±1.4

Table 5a. Fortnightly Height at withers (cm) of the experimental animals on the four dietary regimes.

Group I

Animal number	1	2	3	4	5	6	7	8
916	56	57	59	61	63	65	66	67
922	47	48	50	52	54	55	57	58
3243	48	48	50	52	53	54	55	56
AAM 86	52	54	56	58	60	61	61	62
3252	51	53	54	56	58	60	62	63
F_2^A 27	46	48	50	53	55	56	58	61
Average	50.0	51.3	53.2	55.3	57.2	58.5	59.8	61.2
S.E.	±1.5	±1.5	±1.6	±1.5	±1.5	±1.8	±1.6	±1.6

Table 5b. Fortnightly Height at withers (cm) of the experimental animals on the four dietary regimes.

	Group II							
Animal number	1	2	3	4	5	6	7	8
919	50	52	53	55	56	56	57	58
924	51	53	55	58	60	61	62	64
3235	55	56	57	59	61	62	63	65
SAM 9	49	51	53	55	57	59	62	65
F_2A 38	48	50	52	54	56	58	59	61
3242	49	51	53	54	55	57	58	59
Average	50.3	52.2	53.8	55.8	57.5	58.8	60.2	62.0
S.E.	±1.0	±0.9	±0.8	±0.9	±1.0	±1.0	±1.1	±1.3

Table 5c. Fortnightly Height at withers (cm) of the experimental animals on the four dietary regimes.

	Group III							
Animal number	1	2	3	4	5	6	7	8
923	55	57	59	61	62	63	64	65
918	53	54	56	58	59	60	61	62
3238	56	57	58	59	60	61	62	63
SAM 10	48	50	52	53	54	56	57	59
3237	48	49	50	52	54	56	57	59
F_2A 28	44	46	48	50	51	52	54	55
Average	50.7	52.2	53.8	55.5	56.7	58.0	59.1	60.5
S.E.	±1.9	±1.9	±1.8	±1.8	±1.7	±1.7	±1.5	±1.5

Table 5d. Fortnightly Height at withers (cm) of the experimental animals on the four dietary regimes.

	Group IV							
Animal number	1	2	3	4	5	6	7	8
921	53	54	55	57	58	59	60	61
3241	52	53	54	55	57	59	60	62
F_2A 23	47	48	50	52	54	56	57	59
925	46	48	50	52	54	56	59	62
3255	51	53	56	58	60	61	62	64
F_2S 107	49	51	53	56	59	61	63	65
Average	49.7	51.2	53.0	55.0	57.0	58.7	60.2	61.5
S.E.	±1.2	±1.1	±1.0	±1.0	±1.0	±1.0	±0.9	±0.7

Table 6a. Fortnightly Heart girth (cm) of the experimental animals on the four dietary regimes.

Group I

Animal number	1	2	3	4	5	6	7	8
916	64	64	65	65	66	67	69	71
922	47	48	52	53	53	54	56	57
3243	46	48	49	50	52	54	55	56
AAM 86	53	54	55	57	58	60	62	64
3252	49	50	50	53	55	56	57	58
F_2^A 27	46	47	50	52	53	55	57	59
Average	50.8	51.8	53.5	55.0	56.3	57.7	59.3	60.8
S.E.	±2.9	±2.6	±2.5	±2.2	±2.1	±2.1	±2.2	±2.3

Table 6b. Fortnightly Heart girth (cm) of the experimental animals on the four dietary regimes.

	Group II							
Animal number	1	2	3	4	5	6	7	8
919	51	52	53	53	54	55	56	59
924	52	53	55	57	60	61	62	63
3235	55	54	55	57	58	59	61	62
SAM 9	50	52	54	56	58	60	63	65
F_2^A 38	51	54	55	56	57	58	59	60
3242	51	54	55	56	58	57	59	60
Average	51.7	53.2	54.5	55.9	57.5	58.3	60.0	61.5
S.E.	±0.7	±0.4	±0.3	±0.5	±0.8	±0.9	±1.0	±1.0

Table 6c. Fortnightly Heart girth (cm) of the experimental animals on the four dietary regimes.

	Group III							
Animal number	1	2	3	4	5	6	7	8
923	53	54	55	57	58	61	60	62
918	53	54	55	57	58	59	60	62
3238	53	55	57	58	59	60	61	62
SAM 10	49	51	52	54	55	56	57	59
3237	47	50	51	52	54	56	57	59
F_2A 28	46	47	48	52	53	53	54	55
Average	50.2	51.8	53.0	55.0	56.2	57.5	58.2	59.8
S.E.	±1.3	±1.3	±1.3	±1.1	±1.0	±1.2	±1.1	±1.1

Table 6d. Fortnightly Heart girth (cm) of the experimental animals on the four dietary regimes.

	Group IV							
Animal number	1	2	3	4	5	6	7	8
921	54	55	55	56	57	59	60	61
3241	51	52	53	54	56	55	57	58
F_2A 23	49	50	53	54	55	56	57	57
925	52	55	56	57	61	62	64	66
3255	50	52	54	57	58	59	60	61
F_2S 107	52	55	56	57	58	59	61	63
Average	51.3	53.2	54.5	55.8	57.5	58.3	59.8	61.0
S.E.	±0.7	±0.9	±0.6	±0.6	±0.9	±1.0	±1.1	±1.3

Table 7a. Fortnightly Paunch girth (cm) of the experimental animals on the four dietary regimes.

Group I

Animal number	1	2	3	4	5	6	7	8
916	74	75	76	77	79	80	79	81
922	59	59	60	62	63	65	65	66
3243	57	55	56	58	60	61	62	63
AAM 86	63	64	65	66	66	65	66	66
3252	56	57	58	59	60	59	61	62
F_2A 27	56	57	58	59	60	61	62	62
Average	60.8	61.2	62.2	63.5	64.7	64.5	65.8	66.7
S.E.	±2.9	±3.0	±3.0	±3.0	±3.0	±3.2	±2.3	±3.0

Table 7b. Fortnightly Paunch girth (cm) of the experimental animals on the four dietary regimes.

	Group II							
Animal number	1	2	3	4	5	6	7	8
919	59	61	62	63	64	65	64	66
924	59	60	61	62	63	65	66	68
3235	62	61	63	63	64	64	65	66
SAM 9	57	58	59	60	62	64	66	68
F_2A 38	61	62	63	64	65	66	67	68
3242	60	60	61	62	63	64	65	66
Average	59.7	60.3	61.3	62.3	63.5	64.7	65.5	67.0
S.E.	±0.7	±0.6	±0.6	±0.6	±0.4	±0.3	±0.4	±0.5

Table 7c. Fortnightly Paunch girth (cm) of the experimental animals on the four dietary regimes.

Group III

Animal number	1	2	3	4	5	6	7	8
923	60	61	62	63	64	65	66	67
918	60	61	62	65	67	69	70	72
3238	63	64	66	68	69	70	71	71
SAM 9	59	60	62	63	65	66	67	68
3237	57	60	62	59	60	60	61	62
F_2A 28	55	56	58	59	60	61	62	63
Average	59.0	60.3	62.0	62.8	64.2	65.2	66.2	67.2
S.E.	±1.1	±1.1	±1.0	±1.4	±1.5	±1.7	±1.7	±1.7

Table 7d. Fortnightly Paunch girth (cm) of the experimental animals on the four dietary regimes.

	Group IV							
Animal number	1	2	3	4	5	6	7	8
921	62	63	64	64	63	63	65	66
3241	57	58	59	60	61	62	63	64
F_2A 23	53	53	54	55	57	58	59	60
925	58	59	60	62	61	63	65	66
3255	57	58	59	60	61	62	64	66
F_2S 107	62	63	64	66	67	68	70	71
Average	58.2	59.0	60.0	61.2	61.7	62.7	64.3	65.5
S.E.	±1.4	±1.5	±1.5	±1.6	±1.3	±1.3	±1.5	±1.5

Table 8. Analysis of variance - Body length.

Source	df	SS	MSS	F
Groups	3	121.464	40.486	5.93**
Error	20	136.496	6.825	
Total	23	257.960		

** Significant at 1% level.

Critical difference at 1% level = 4.291

Critical difference at 5% level = 3.1463

Pair wise comparison

Group means :	G_1	G_2	G_3	G_4
	10.83	14.33	14.50	17.70

$G_2 - G_1 = 3.5^*$

$G_3 - G_1 = 3.67^*$

$G_4 - G_1 = 6.34^{**}$

$G_3 - G_2 = 0.17$ (N.S)

$G_4 - G_2 = 2.84$ (N.S)

$G_4 - G_3 = 2.67$ (N.S)

Table 9. Analysis of variance - Height at withers.

Source	df	SS	MSS	F
Groups	3	22.46	7.487	0.79 (N.S)
Error	20	190.50	9.525	
Total	23	212.96		

N.S. - Not Significant.

Table 10. Analysis of variance - Heart girth.

Source	df	SS	MSS	F
Groups	3	0.46	0.15	0.03 (N.S)
Error	20	107.50	5.375	
Total	23	107.96		

N.S. - Not Significant.

Table 11. Analysis of variance - Paunch girth.

Source	df	SS	MSS	F
Groups	3	17.0	5.66	1.34 (N.S)
Error	20	84.33	4.22	
Total	23	101.33		

N.S. - Not Significant.

Table 12a. Feed efficiency (kg feed/kg weight gain) of animals maintained on the four dietary regimes.

Group I

Animal number	Dry matter intake from concentrates (kg)	Dry matter intake from jack leaves (kg)	Total dry matter intake (kg)	Total weight gain (kg)	Feed efficiency
916	47.0	58.6	105.6	16.6	6.4
922	30.5	37.7	68.2	8.6	7.9
3243	32.4	29.2	61.6	7.8	7.9
AAM 86	30.9	30.7	61 .6	9.8	6.3
3252	32.3	29.7	62.0	7.4	8.4
F_2A 27	33.4	32.1	65.5	10.4	6.3
Average	34.4	36.3	70.8	10.1	7.2
S.E.	±2.5	±4.6	± 7.1	±1.4	±0.4

Table 12b. Feed efficiency (kg feed/kg weight gain) of animals maintained on the four dietary regimes.

Group II

Animal number	Dry matter intake from concentrates (kg)	Dry matter intake from jack leaves (kg)	Total dry matter intake (kg)	Total weight gain (kg)	Feed efficiency
919	35.9	28.1	64.0	7.7	8.3
924	39.1	31.7	70.8	10.7	6.6
3235	36.4	29.7	66.1	8.2	8.1
SAM 9	37.7	30.1	67.8	13.9	4.9
F_2A 38	35.4	30.0	65.4	10.3	6.3
3242	36.8	28.1	64.9	8.4	7.7
Average	36.9	29.6	66.5	9.9	7.0
S.E.	±0.6	±0.6	±1.0	±0.9	±0.5

Table 12c. Feed efficiency (kg feed/kg weight gain) of animals maintained on the four dietary regimes.

Group III

Animal number	Dry matter intake from concentrates (kg)	Dry matter intake from jack leaves (kg)	Total dry matter intake (kg)	Total weight gain (kg)	Feed efficiency
923	37.4	32.1	69.5	9.3	7.5
918	37.2	30.4	67.6	11.1	6.1
3238	33.0	34.0	67.0	8.3	8.0
SAM 10	31.5	25.8	57.3	9.0	6.4
3237	33.6	26.2	59.8	9.7	6.2
F_2A 28	33.1	27.3	60.4	8.4	7.2
Average	34.3	29.3	63.6	9.3	6.9
S.E.	±1.0	±1.4	±2.1	±0.4	±0.3

Table 12d. Feed efficiency (kg feed/kg weight gain) of animals maintained on the four dietary regimes.

Group IV

Animal number	Dry matter intake from concentrates (kg)	Dry matter intake from jack leaves (kg)	Total dry matter intake (kg)	Total weight gain (kg)	Feed efficiency
921	33.7	25.3	59.0	7.6	7.8
3241	33.9	24.7	58.6	7.5	7.8
F_2A 23	29.7	22.6	52.3	7.4	7.1
925	33.6	31.3	64.9	13.2	4.9
3255	30.1	28.1	58.2	11.7	5.0
F_2S 107	34.5	34.6	69.0	14.3	4.8
Average	32.6	27.8	60.3	10.3	6.2
S.E.	±0.9	±1.8	±2.4	±1.3	±0.6

Fig: 2. Average Feed efficiency of kids maintained on four dietary regimes

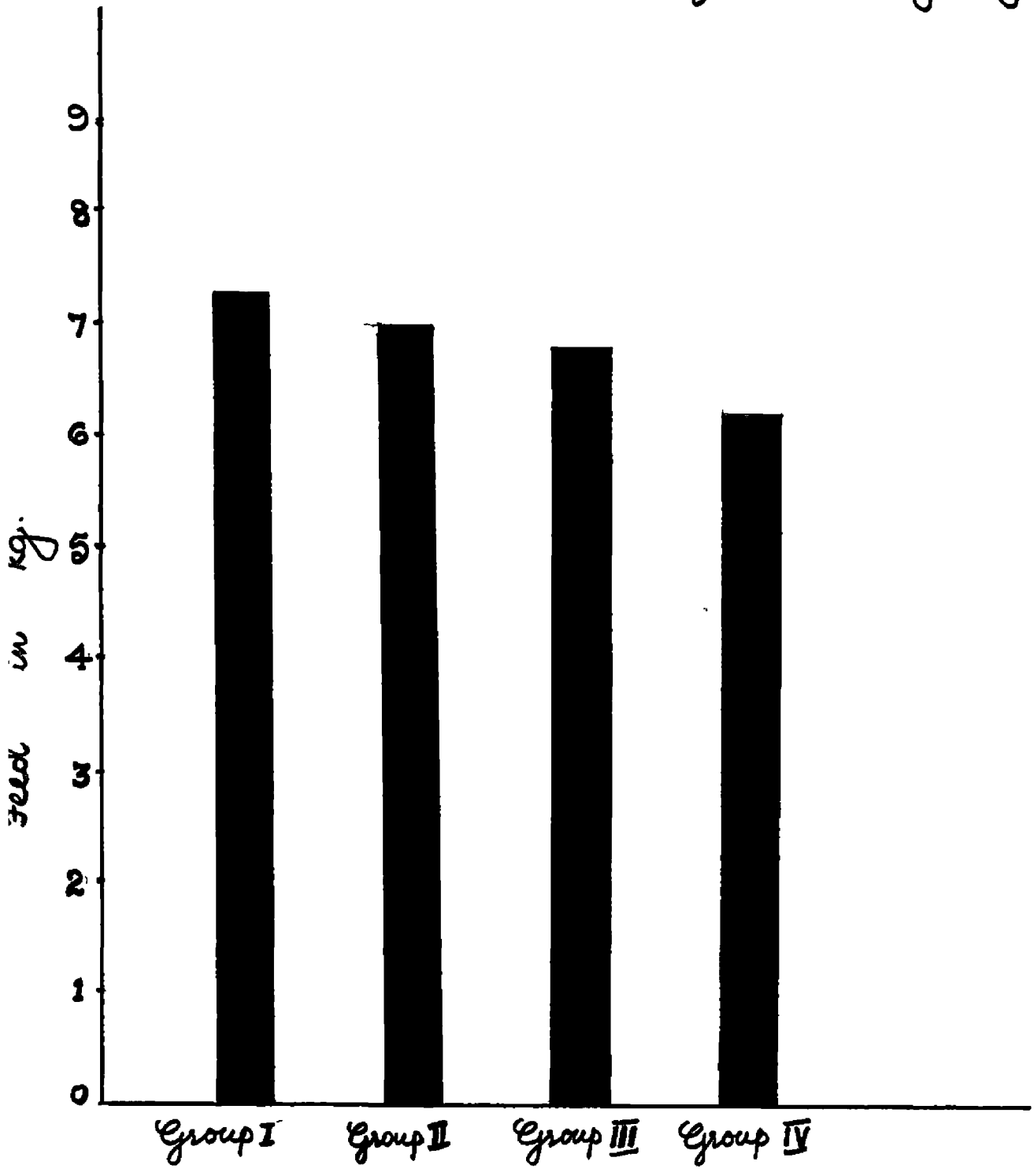

Table 13. Analysis of variance - Feed efficiency.

Source	df	SS	MSS	F
Groups	3	3.13	1.04	0.86 (N.S)
Error	20	24.05		
Total	23	27.18		

N.S. - Not Significant.

Table 14a. Dry matter consumption (in kg) of animals recorded during the metabolism trial.

Group I

Animal number	Daily dry matter intake from concentrates (g)	Daily dry matter intake from jack leaves (g)	Total dry matter intake per day (g)	Body weight (kg)	Dry matter intake per 100 kg body weight
AAH 86	355.0	292.8	647.8	18.3	3.5
3252	275.6	241.5	517.1	14.6	3.5
F_2A 27	360.0	370.4	730.4	16.4	4.5
Average	330.2	301.6	631.8	16.4	3.8
S.E.	±27.3	±37.5	±62.1	±1.1	±0.3

Table 14b. Dry matter consumption (in kg) of animals recorded during the metabolism trial.

Group II

Animal number	Daily dry matter intake from concentrates (g)	Daily dry matter intake from jack leaves (g)	Total dry matter intake per day (g)	Body weight (kg)	Dry matter intake per 100 kg body weight
3235	296.2	280.0	576.2	18.3	3.1
SAM 9	348.0	378.0	726.0	20.4	3.6
F_2A 38	356.0	378.0	734.0	17.7	4.2
Average	333.4	345.3	678.7	18.8	3.6
S.E.	±18.7	±32.7	±51.3	±0.8	±0.3

Table 14c. Dry matter consumption (in kg) of animals recorded during the metabolism trial.

Group III

Animal number	Daily dry matter intake from concentrates (g)	Daily dry matter intake from jack leaves (g)	Total dry matter intake per day (g)	Body weight (kg)	Dry matter intake per 100 kg body weight
3238	227.4	307.8	535.2	19.6	2.7
3237	266.9	223.3	490.2	17.2	2.9
918	227.0	300.2	527.2	20.1	2.6
Average	240.4	277.1	517.5	19.0	2.7
S.E.	±13.2	±27.0	±13.9	±0.9	±0.9

Table 14d. Dry matter consumption (in kg) of animals recorded during the metabolism trial.

Group IV

Animal number	Daily dry matter intake from concentrates (g)	Daily dry matter intake from jack leaves (g)	Total dry matter intake per day (g)	Body weight (kg)	Dry matter intake per 100 kg body weight
F_2S 107	360.0	364.8	724.8	19.9	3.6
925	360.0	380.0	740.0	20.5	3.6
3255	332.6	231.0	563.6	18.8	3.0
Average	350.9	325.3	676.1	19.7	3.4
S.E.	± 9.1	±47.3	±56.4	±0.5	±0.2

Table 15. Analysis of variance - Dry matter consumption.

Source	df	SS	MSS	F
Groups	3	2.06	0.69	3.54 (N.S)
Error	8	1.56	0.195	
Total	11	3.62		

N.S. - Not Significant.

Table 16a. Percentage chemical composition of dung (on dry matter basis) voided by the animals during the metabolism trial.

Group	Animal number	Total quantity of dung voided in five days (g)	Dry matter	Crude protein	Ether extract	Crude fibre	Total ash	Nitrogen free extract
I	AAM 86	1,890	50.9	21.4	4.2	14.6	20.2	39.6
	3252	2,255	40.4	19.9	4.6	13.4	18.9	42.2
	F_2A 27	1,912	51.2	18.8	3.9	10.7	20.3	46.3
II	3235	1,408	59.9	20.9	3.6	13.6	19.2	42.7
	SAM 9	2,380	46.6	18.4	3.8	12.0	23.0	42.8
	F_2A 38	2,365	50.3	20.5	3.6	15.4	22.6	37.9

Table 16b. Percentage chemical composition of dung (on dry matter basis) voided by the animals during the metabolism trial.

Group	Animal number	Total quantity of dung voided in five days (g)	Dry matter	Crude protein	Ether extract	Crude fibre	Total ash	Nitrogen free extract
	3238	1,420	38.1	17.6	4.6	10.6	21.2	46.0
III	3237	1,500	40.1	18.9	3.4	12.6	25.0	40.0
	918	1,800	45.3	18.9	2.9	13.2	21.1	43.9
	F_2S 107	2,590	42.2	20.0	4.2	12.2	22.2	41.4
IV	925	2,780	42.3	18.3	3.8	15.4	25.3	37.2
	3255	1,645	50.4	16.6	2.8	11.9	24.8	43.9

Table 17a. Total volume and Nitrogen content of urine voided by the animals during the metabolism trial.

Group Number	Animal Number	Total volume of urine voided in five days (ml)	Nitrogen percentage
	AAM 86	2,545	0.48
I.	3252	2,440	0.45
	F_2A 27	2,695	1.12
	3235	4,655	0.54
II	SAM 9	5,225	0.38
	F_2A 38	4,105	0.40

Table 17b. Total volume and Nitrogen content of urine voided by the animals during the metabolism trial.

Group Number	Animal Number	Total volume of urine voided in five days (ml)	Nitrogen percentage
	3238	4,505	0.29
III	3237	2,790	0.63
	918	1,300	0.72
	F_2S 107	5,225	0.40
IV	925	7,510	0.49
	3255	6,080	0.43

Table 18a. Digestibility coefficients of nutrients in the experimental rations obtained during the metabolism trial.

Group I

Animal number	Dry matter	Crude protein	Ether extract	Crude fibre	Nitrogen free extract
A&M 86	70.2	58.1	68.6	61.2	80.3
3252	64.7	52.7	59.3	58.7	74.6
F_2A 27	73.2	65.6	74.2	76.2	79.1
Average	69.4	58.8	67.4	65.4	78.0
S.E.	±2.5	±3.7	±4.3	±5.5	±1.7

Table 18b. Digestibility coefficients of nutrients in the experimental rations obtained during the metabolism trial.

Group II

Animal number	Dry matter	Crude protein	Ether extract	Crude fibre	Nitrogen free extract
3235	70.7	61.1	76.3	66.5	79.2
SAN 9	69.4	63.2	73.2	70.0	77.9
F_2A 38	67.8	56.8	73.2	59.0	79.2
Average	69.3	60.4	74.2	65.2	78.8
S.E.	±0.8	±1.9	±1.0	±3.2	±0.4

Table 18c. Digestibility coefficients of nutrients in the experimental rations obtained during the metabolism trial.

Group III

Animal number	Dry matter	Crude protein	Ether extract	Crude fibre	Nitrogen free extract
3238	69.2	66.7	64.3	75.9	74.6
3237	68.1	65.1	71.3	64.8	77.3
918	69.3	64.4	77.3	69.1	75.9
Average	68.9	65.4	71.0	69.9	75.9
S.E.	±0.4	±0.7	±3.8	±3.2	±0.8

Table 18d. Digestibility coefficients of nutrients in the experimental rations obtained during the metabolism trial.

Group IV

Animal number	Dry matter	Crude protein	Ether extract	Crude fibre	Nitrogen free extract
F_2S 107	69.9	66.1	72.0	71.2	77.6
925	68.2	67.3	74.5	60.9	78.9
3255	70.6	73.4	82.1	68.0	76.8
Average	69.6	68.9	76.2	66.7	77.8
S.E.	±0.7	±2.3	±3.0	±3.0	±0.6

Table 19. Analysis of variance - Digestibility coefficients of dry matter.

Source	df	SS	MSS	F
Groups	3	0.78	0.26	0.05 (N.S
Error	8	45.32	5.67	
Total	11	46.10		

N.S. - Not Significant.

Table 20. Analysis of variance - Digestibility coefficients of crude protein.

Source	df	SS	MSS	F
Groups	3	193.22	64.41	3.67 (N.S
Error	8	140.36	17.55	
Total	11	333.58		

N.S. - Not Significant.

Table 21. Analysis of variance - Digestibility coefficients of Ether extract.

Source	df	SS	MSS	F
Groups	3	135.05	45.02	1.39 (N.S)
Error	8	259.70	32.46	
Total	11	394.75		

N.S. - Not Significant.

Table 22. Analysis of variance - Digestibility coefficients of Crude fibre.

Source	df	SS	MSS	F
Groups	3	40.98	13.66	0.06 (N.S)
Error	8	1823.01	227.88	
Total	11	1863.99		

N.S. - Not Significant.

Table 23. Analysis of variance - Digestibility coefficients of Nitrogen-free-extract.

Source	df	SS	MSS	F
Groups	3	12.98	4.30	1.37 (N.S)
Error	8	35.08	3.14	
Total	11	48.06		

N.S. - Not Significant.

Table 24a. Nitrogen retention (g/day) of animals on the different dietary regimes.

Group I

Animal number	Nitrogen intake from concentrates (g)	Nitrogen intake from jack leaves (g)	Total intake of nitrogen (g)	Nitrogen outgo through dung (g)	Nitrogen outgo through urine (g)	Total outgo of nitrogen (g)	Nitrogen retention (g/day)
AAM 86	47.6	29.5	77.2	32.2	12.2	44.4	6.6
3252	37.0	24.4	61.4	29.0	11.0	40.1	4.3
F_2A 27	48.3	37.4	85.7	29.5	30.2	59.7	5.2
Average	44.3	30.4	74.8	30.2	17.8	48.1	5.4
S.E.	±3.7	±3.8	±7.1	±1.0	±6.2	±6.0	±0.7

Table 24b. Nitrogen retention (g/day) of animals on the different dietary regimes.

Group II

Animal number	Nitrogen intake from concentrates (g)	Nitrogen intake from jack leaves (g)	Total intake of nitrogen (g)	Nitrogen outgo through dung (g)	Nitrogen outgo through urine (g)	Total outgo of nitrogen (g)	Nitrogen retention (g/day)
3235	43.0	28.3	71.2	27.9	25.1	53.0	3.6
SAM 9	50.5	38.2	88.7	32.6	20.0	52.7	7.2
F_2 A 38	51.6	38.2	89.8	36.8	16.4	55.3	6.9
Average	48.4	34.9	83.2	33.0	20.5	53.7	5.9
S.E.	±2.72	±3.3	±6.0	±3.2	±2.5	±0.8	±1.2

Table 24c. Nitrogen retention (g/day) of animals on the different dietary regimes.

Group III

Animal number	Nitrogen intake from concentrates (g)	Nitrogen intake from jack leaves (g)	Total intake of nitrogen (g)	Nitrogen out go through dung (g)	Nitrogen out-go through urine (g)	Total outgo of nitrogen (g)	Nitrogen retention (g/day)
3238	38.1	31.1	69.2	23.1	13.1	36.4	6.6
3237	35.8	18.0	53.8	18.2	17.6	35.8	4.5
918	38.0	30.3	68.3	24.4	9.4	33.8	6.9
Average	37.3	26.5	63.8	21.9	13.4	35.3	6.0
S.E.	±0.8	±4.2	±5.0	±1.7	±2.4	±0.8	±0.8

Table 24d. Nitrogen retention (g/day) of animals on the different dietary regimes.

Group IV

Animal number	Nitrogen intake from concentrates (g)	Nitrogen intake from jack leaves (g)	Total intake of nitrogen (g)	Nitrogen outgo through dung (g)	Nitrogen outgo through urine (g)	Total outgo of nitrogen (g)	Nitrogen retention (g/day)
F_2S 107	64.3	38.4	102.7	34.8	20.9	55.7	9.4
925	64.3	38.4	102.7	33.6	36.8	70.4	6.5
3253	59.4	23.3	82.7	22.0	26.1	48.1	6.9
Average	62.7	33.4	96.0	30.1	28.0	58.1	7.6
S.E.	±1.6	±5.0	±6.7	±4.1	±4.7	±6.5	±0.9

Table 25. Analysis of variance - Nitrogen retention.

Source	df	SS	MSS	F
Groups	3	8.35	2.78	1.17 (N.S)
Error	8	19.03	2.378	
Total	11	27.38		

N.S. - Not Significant.

Table 26a. Haematological values of the experimental animals recorded at the beginning of the experiment.

Group I

Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100 ml)
916	33.0	11.4	7.7	10.2	4.5
922	37.0	11.8	7.1	8.0	4.8
3243	30.0	12.0	8.2	13.2	4.3
AAM 86	39.0	11.4	8.1	12.0	4.8
3252	42.0	10.0	8.8	12.6	4.6
F_2A 27	39.0	9.0	7.7	11.8	5.0
Average	36.7	10.9	7.9	11.2	4.7
S.E.	±1.8	±0.5	±0.2	±0.8	±0.1

Table 26b. Haematological values of the experimental animals recorded at the beginning of the experiment.

Group II					
Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)
919	34.6	11.6	7.1	12.0	6.4
924	27.0	11.2	7.1	14.0	5.4
3235	31.0	10.2	7.1	11.0	6.1
SAM 9	41.0	12.8	7.7	12.0	5.8
F_2A 38	44.0	11.0	6.2	11.8	5.4
3242	40.5	12.4	7.7	12.0	4.5
Average	36.4	11.5	7.1	12.1	5.6
S.E.	±2.7	±0.4	±0.2	±0.4	±0.3

Table 26c. Haematological values of the experimental animals recorded at the beginning of the experiment.

Group III

Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)
923	41.0	10.4	7.6	11.0	4.9
918	41.3	12.6	5.9	12.0	6.7
3238	30.0	12.2	7.6	12.0	5.6
SAM 10	39.0	10.0	7.6	13.4	4.6
3237	36.0	9.6	8.5	12.2	4.6
F_2A 28	30.0	11.6	7.1	13.0	6.2
Average	36.2	11.1	7.4	12.3	5.6
S.E.	±2.1	±0.5	±0.4	±0.3	±0.3

Table 26d. Haematological values of the experimental animals recorded at the beginning of the experiment.

Group IV

Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)
921	40.4	10.0	6.5	12.0	5.5
3241	36.0	9.2	7.6	13.2	5.9
F_2A 23	37.4	11.8	7.6	12.0	5.9
925	38.0	12.2	6.9	13.0	5.8
3255	33.0	12.6	6.2	12.0	6.9
F_2S 107	36.0	9.8	8.5	13.4	5.8
Average	36.8	10.9	7.2	12.6	5.9
S.E.	±1.0	±0.6	±0.4	±0.3	±0.2

Table 27a. Haematological values of the experimental animals recorded at the middle of the experiment.

Group I

Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)
916	35.0	8.6	7.1	11.0	5.2
922	36.0	12.8	6.5	12.4	5.6
3243	33.0	11.2	7.5	13.6	4.7
AAM 86	41.0	12.8	8.5	11.6	5.8
3252	37.0	12.4	6.5	13.2	5.2
F_2A 27	38.0	10.4	6.9	12.0	5.1
Average	36.6	11.4	7.1	12.3	5.3
S.E.	±1.1	±0.7	±0.3	±0.4	±0.2

Table 27b. Haematological values of the experimental animals recorded at the middle of the experiment.

Group II

Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)
919	38.0	10.8	8.5	12.4	4.6
924	41.0	14.0	7.1	14.0	4.7
3235	43.0	11.0	8.8	8.0	4.8
SAH 9	38.0	12.8	8.0	12.2	5.8
F_2A 38	47.0	13.8	7.7	11.4	4.8
3242	37.0	11.6	8.1	10.8	4.1
Average	40.7	12.3	8.0	11.5	4.8
S.E.	±1.6	±0.6	±0.2	±0.8	±0.2

Table 27c. Haematological values of the experimental animals recorded at the middle of the experiment.

Group III

Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)
923	38.0	14.2	8.5	12.0	5.7
918	33.0	12.2	8.6	10.0	4.3
3238	41.0	12.8	8.1	12.0	6.2
SAM 10	42.0	11.4	7.7	13.6	4.8
3237	26.0	9.0	8.8	12.6	5.3
F_2A 28	37.0	9.4	6.8	13.2	5.3
Average	36.2	11.5	8.1	12.1	5.3
S.E.	±2.4	±0.8	±0.3	±0.5	±0.3

Table 27d. Haematological values of the experimental animals recorded at the middle of the experiment.

Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)
		Group IV			
921	41.0	12.2	7.7	12.0	5.9
3241	42.0	10.2	8.1	12.6	7.4
F_2A 23	46.0	9.8	8.1	12.4	6.0
925	42.0	11.8	7.3	13.0	5.3
3255	37.0	10.2	8.1	13.2	5.3
F_2S 107	43.0	8.8	7.7	12.8	4.4
Average	41.8	10.8	7.8	12.6	5.7
S.D.	±1.2	±0.6	±0.1	±0.2	±0.4

Table 28a. Haematological values of the experimental animals recorded at the end of the experiment.

Group I

Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)
916	27.0	9.6	7.7	10.6	5.9
922	27.0	10.4	7.1	11.8	5.4
3243	34.0	9.2	7.1	12.0	6.0
AAM 86	42.0	11.2	7.6	12.0	5.5
3252	30.0	8.0	7.4	11.0	5.4
F_2A 27	27.0	9.6	6.5	10.8	5.3
Average	31.2	9.7	7.2	11.4	5.6
S.E.	±2.4	±0.4	±0.2	±0.3	±0.1

Table 28b. Haematological values of the experimental animals recorded at the end of the experiment.

Group II

Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)
919	28.0	11.4	7.7	12.0	6.0
924	37.0	10.6	7.1	13.0	6.4
3235	32.0	9.2	7.4	10.0	5.2
SAM 9	35.0	11.0	7.6	11.4	6.7
F_2A 38	35.0	10.6	6.5	12.0	5.8
3242	28.0	8.6	7.1	11.0	5.0
Average	32.5	10.2	7.2	11.5	5.8
S.E.	±1.6	±0.4	±0.2	±0.4	±0.3

Table 28c. Haematological values of the experimental animals recorded at the end of the experiment.

Group III

Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)
923	30.0	10.6	7.4	13.0	6.0
918	31.0	9.6	6.5	12.0	6.2
3238	28.0	9.6	6.8	12.4	5.8
SAH 10	26.0	9.4	7.1	13.0	6.4
3237	28.0	9.2	7.1	10.8	5.5
F_2A 28	31.0	9.6	7.1	12.0	5.9
Average	29.0	9.6	6.9	12.2	5.9
S.E.	±0.8	± 0.2	±0.1	±0.3	±0.1

Table 28d. Haematological values of the experimental animals recorded at the end of the experiment.

Group IV

Animal number	Packed cell volume	Haemoglobin (g/100ml)	Plasma protein (g/100ml)	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)
921	32.0	12.0	8.2	14.0	6.8
3241	31.0	9.6	7.1	13.0	6.2
F_2A 23	37.0	10.2	6.8	12.0	5.6
925	35.0	11.2	7.1	12.8	6.4
3255	33.0	9.8	7.6	13.0	6.0
F_2S 107	33.0	10.4	7.6	13.0	6.0
Average	33.5	10.5	7.4	13.0	6.2
S.E.	±0.9	±0.4	±0.2	±0.3	±0.2

Table 29. Analysis of variance - Packed cell volume.

Source	df	SS	MSS	F
Groups	3	141.662	47.221	2.65
Periods	2	662.225	331.1125	18.56**
Error	66	1177.332	17.8384	
Total	71	1981.219		

** Significant at 1% level.

Critical difference at 1% level = 3.235

Pair wise comparison

Period means :	P_1	P_2	P_3
	36.5	38.8	31.6

$P_2 - P_1 = 2.3$

$P_1 - P_3 = 4.9^{**}$

$P_2 - P_3 = 7.2^{**}$

Table 30. Analysis of variance - Haemoglobin.

Source	df	SS	MSS	F
Groups	3	5.3976	1.7992	1.48
Periods	2	28.7287	14.3643	11.84**
Error	66	80.0479	1.2130	
Total	71	114.17		

**Significant at 1% level.

Critical difference at 1% level = 0.843

Pair wise comparison

Period means :	P_1	P_2	P_3
	11.1	11.5	10.0

$P_2 - P_1 = 0.39$

$P_2 - P_3 = 1.5^{**}$

$P_1 - P_3 = 1.11^{**}$

Table 31. Analysis of variance - Plasma protein.

Source	df	SS	MSS	F
Groups	3	0.0357	0.0119	0.01 (N.S
Periods	2	4.0990	2.0496	1.04 (N.S
Error	66	130.1744	1.9723	
Total	71	134.3091		

N.S. - Not Significant.

Table 32. Analysis of variance - Calcium.

Source	df	SS	MSS	F
Groups	3	13.8818	4.6273	2.78 (N.S
Periods	2	0.1464	0.0732	0.04 (N.S
Error	66	109.9962	1.6666	
Total	71	124.0244		

N.S. - Not Significant.

Table 33. Analysis of variance - Inorganic phosphorus.

Source	df	SS	MSS	F
Groups	3	5.3083	1.769	5.34**
Periods	2	4.8250	2.413	7.29**
Error	66	21.8570		
Total	71	31.9903		

Pair wise comparison.

Group Comparison.

Critical difference at 1% level = 0.51

Critical difference at 5% level = 0.27

Period Comparison.

Critical difference at 1% level = 0.441

Critical difference at 5% level = 0.332

Group Means: G_1 G_2 G_3 G_4

5.19 5.4 5.59 5.93

$G_2 - G_1 = 0.21$

$G_3 - G_1 = 0.40^*$

$G_4 - G_1 = 0.74^{**}$

$G_3 - G_2 = 0.19$

$G_4 - G_2 = 0.53^{**}$

$G_4 - G_3 = 0.34^*$

Period means: P_1 P_2 P_3

5.45 5.26 5.8

$P_1 - P_2 = 0.19$

$P_3 - P_1 = 0.41^*$

$P_3 - P_2 = 0.61^{**}$

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 four dietary regimes for a period of 4½ months exhibit almost identical growth rates, the average daily weight gains of the animals in the four groups I, II, III and IV being 76.5 ± 10.5, 74.7 ± 7.2, 70.5 ± 3.2 and 77.9 ± 9.8 g respectively. Statistical analysis of the data (Table 3) reveal that there is no significant difference in growth rate of the animals maintained on the four dietary regimes.

Different workers have reported varying growth rates an daily gains in growing kids. For Barbari kids of 0-12 month of age, Singh and Sengar (1970) recorded an overall daily gai of only 20-40g. However, Singh and Sengar (1978) in a study to assess the growth rate of kids maintained under two dietary treatments reported an average daily gain of 79.0 g on a ration made up of concentrate mixture, gram bhusa and green arhar fed ad libitum. While studying the effects of various treatments on nutrient utilization by kids, Mudgal

and Sengar (1979) 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 rations containing control, formaldehyde treated, heat treated and tannic acid treated concentrate mixtures respectively. While Singh and Rekib (1979) could record daily gains of 33, 28 and 15 g in Barbari kids of 4-5 months of age maintained on three rations viz. Berseem hay alone and mixtures of Berseem hay and natural grass hay in two different proportions, 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 Johri and Talapatra (1971) recorded the rate of growth of Jamnapari kids from birth to 15th week of age. They observed that Jamnapari kids grow at the rate of 90 g/day, the males and females having hardly any difference in the growth rate upto the end of 15th week. The same authors recorded better growth rate in the kids of the same breed under browsing conditions (0.547 kg/week) as against stall fed conditions (0.333 kg/week). Mercy et al. (1981) in their studies to assess the nutrient requirements of Alpine-Malabari crossbred kids, observed average daily gains of 63.7 ± 5.3, 64.4 ± 5.0 and 67.6 ± 2.0 g in three groups of kids maintained on different planes of nutrition. While Dabadghao et al.(1976) observed an average daily gain of 43.0, 46.6 and 40.7 g in male Barbari kids fed different levels of concentrates,

Singh (1980) obtained an average daily gain of 80.0 ± 8.33 g for Sirohi kids maintained on a complete ration based on cow pea fodder.

In a study to evaluate the effect of dietary protein concentration on growth rate of kids using four levels of protein, Tamabo et al. (1977) observed maximum gain in weight in kids fed highest level (20.9%) of protein. Increased weight gain with increase in levels of protein in the diet is also reported by Akinsoyinu et al. (1976) in West African dwarf goats and Louca et al. (1975) in kids of Damascus breed. Better weight gains with increase in dietary protein level have also been reported in lambs by Peter and Jordan (1973); Grebing et al. (1973); Sharma and Mittal (1977), Balwani et al. (1975) and Lakshminarayana and Raghavan (1979), the observations of the latter indicating that increase in weight gain takes place with increase in protein only upto a certain level, the rate of growth declining when the protein level increased beyond 15 per cent.

From a perusal of the results obtained on growth, it can be seen that the overall daily gains of the animals observed in the present study are comparable to those reported by other workers for kids of similar age groups. The results further indicate that the levels of protein used

in the concentrate mixture in the present study have little influence on the average daily gain of kids in as much as no statistically significant difference in daily gains could be noticed between the four groups of kids fed 16, 18, 20 and 22 per cent crude protein respectively.

Body measurements.

Data presented in Tables 4a-4d on body length (cm) indicate that the average body length of the animals at the beginning and at the end of the experiment for group I, II, III and IV are 41.2 ± 2.0 and 52.0 ± 1.8, 39.8 ± 0.8 and 54.2 ± 1.0 and 38.5 ± 1.0 and 53.0 ± 2.1 and 37.7 ± 0.7 and 54.8 ± 1.4 respectively. The initial and final values for height at withers (cm) in animals of different groups are found to be 50.0 ± 1.5 and 61.2 ± 0.16, 50.3 ± 1.0 and 62.0 ± 1.3, 50.7 ± 1.9 and 60.5 ± 1.5 and 49.7 ± 1.2 and 61.5 ± 0.7 for kids of group I, II, III and IV (Table 5a-5d). It can be seen from Tables 6a-6d, that the initial and final values for heart girth (cm) for kids maintained on the four dietary regimes are 50.8 ± 2.9 and 60.8 ± 2.3, 51.7 ± 0.7 and 61.5 ± 1.0, 50.2 ± 1.3 and 59.8 ± 1.1 and 51.3 ± 0.7 and 61.0 ± 1.3 respectively. Data presented in Tables 7a-7d on Paunch girth (cm) show that while the average initial and final values for kids in group I are 60.8 ± 2.9 and 66.7 ± 3.0 respectively, that for group II are 59.7 ± 0.7 and 67.0 ± 0.5 respectively, that for group III are 59.0 ±1.1 and 67.2 ± 1.7

respectively and that for group IV are 58.2 ± 1.4 and 65.5 ± 1.5 respectively. On the whole, a linear increase in all body measurements is seen with increase in body weight. Statistical analysis of the data presented in Tables 8-11 on the various characters, taking into account the overall differences (cm) between the initial and final values indicate that there is significant difference between the various groups only in respect of body length ($P < 0.01$), the critical difference calculated for the same at 1% level being 0.68. A greater gain in body length is observed with each increase in protein level fed. With respect to the other parameters studied, no significant difference is noticed between the four groups. Literature on the influence of dietary protein level on the gain in body measurements in kids and lambs are rather scanty. Mukerjee et al. (1980) reported a greater gain in body measurements along with gain in weight in kids maintained on a high plane of nutrition. On the other hand, in studies carried out by Wilson (1958) and Devendra and Burns (1970), kids maintained on low plane of nutrition had larger measurements though their weight gain was lesser than those maintained on high plane of nutrition.

The data obtained on the various body measurements for kids maintained on four dietary regimes in the present study

are in agreement with those reported by Mukerjee et al. (1980) for Brown Bengal kids of the corresponding age group but the values are higher than those reported by Bhadula (1979) for Saanen x Assam crossbred kids of similar age.

Feed efficiency.

The overall efficiency of utilization of feed for growth in the case of kids belonging to group I, II, III and IV are found to be 7.2, 7.0, 6.9 and 6.2 respectively (Tables 12a-12d). Statistical analysis of the data presented in Table 13 indicate that no significant difference exists in the feed conversion efficiency of kids between the various groups. However, the conversion efficiency was found to be highest for kids of group IV receiving 22 per cent of protein in the concentrate mixture, followed by group III and II and least in group I receiving 16 per cent protein indicating there by that the feed conversion efficiency is directly proportional to protein level in the feed. This observation is in keeping with the results reported by Grobing et al. (1973) and Lakshminarayana and Raghavan (1979) who also could find increase in feed efficiency in lambs with increase in dietary protein level.

Almost similar feed efficiency values have been reported for kids of different breeds by many workers. Thomas et al. (1976) recorded values of 6.18, 6.4 and 7.1 for Jamnapari-Malabari crossbred kids in their feeding experiments with three rations viz. control, ration with 20 per cent rain tree fruit meal and that with 30 per cent ratin tree fruit meal respectively. For Saanen-Malabari cross kids fed three rations viz. control and experimental rations with either rubber seed cake or tea waste as one of the ingredients, James (1978) reported feed efficiency values of 5.5, 6.7 and 6.8 respectively. Mercy et al. (1981) during the course of their studies to determine the nutrient requirements of kids, obtained values of 7.0, 7.5 and 7.9 for Alpine-Malabari kids maintained on three planes of nutrition. Almost similar values have been reported by Singh (1980) for goats fed a complete ration based on cow pea fodder. A lower efficiency of conversion of feed has been observed by Mudgal and Sengar (1979) in Beetal kids in their studies to assess the effect of various treatments on the utilization of nutrients, the values being 11.76, 9.39, 10.53 and 10.38 respectively for kids fed control, formaldehyde treated, heat treated and tannic acid treated concentrate mixtures. The feed conversion efficiency of lambs for growth reported by Lakshminarayana and Raghavan (1979) are also comparable to those for kids, the values

given being 6.89, 6.58, 6.58, 6.23 and 6.36 respectively for five groups of Nellore lambs fed rations containing 12, 13, 14, 15 and 16 per cent of crude protein.

The values obtained in the present study for efficiency of conversion of feed by kids of the various groups receiving different protein levels in concentrate mixtures are in agreement with those reported by Thomas et al. (1976), James (1978), Mercy et al. (1981) and Singh (1980) in different breeds of kids.

Dry matter consumption.

The average dry matter consumption (kg) of growing kids expressed as percentage of body weight and presented in Tables 14a to 14d are found to be 3.8 ± 0.33, 3.6 ± 0.32, 2.7 0.88 and 3.4 ± 0.2 respectively for kids in group I, II, III and IV maintained on 16, 18, 20 and 22 per cent crude protein in the concentrate mixture. Statistical analysis of the data given in Table 15 indicate that there is no significant difference between the various groups in this regard. Similar values for dry matter consumption have been reported by many workers for kids of different breeds maintained on different dietary regimes.

Saxena and Maheswari (1971) stated that the dry matter consumption in kg per 100 kg of body weight of Jamnapari goats

at Chakkrangar ranged from 2.42 to 3.58 whereas at Mathura it varied from 1.47 to 2.65 kg. Singhal (1978) has reported average dry matter intakes of 3.41, 3.66 and 3.06 kg for Deetal kids maintained on three rations viz. control, urea based and biuret based rations respectively. The dry matter intake of growing Barbari kids have been calculated by Singh and Sengar (1978) the values given being 4.4 per cent on a ration made up of concentrate mixture, gram bhusa and green arhar, 4.1 per cent with a mixture of gram bhusa and green arhar and only 2.49 per cent on gram bhusa alone.

Singh and Rekib (1979) on the other hand have recorded in Barbari kids of 4-5 months of age, dry matter consumption of 3.49, 3.72 and 3.43 per cent of body weight when fed berseem hay, berseem hay plus natural grass hay 75:25 and berseem hay plus natural grass hay (50:50) respectively. James (1978) observed an average daily intake of 3.9 kg dry matter per 100 kg body weight in Saanen-Malabari crossbred kids. Mercy et al. (1981) in their studies to determine the nutrient requirements of Alpine-Malabari kids for growth reported an intake of 3.1, 3.5 and 3.6 kg of dry matter per 100 kg body weight for three groups of kids maintained on low, medium and high plane of nutrition respectively.

Widely varying values (2-11 per cent of body weight) have been given for dry matter consumption of adult goats for different breeds and maintained under different conditions of feeding and management (Brannon, 1966; Mackonzie, 1967; Singh and Sengar, 1970; Saxena and Maheswari, 1971; Maheswari and Talapatra, 1975 and Morand Fehr and Sauvant, 1978).

Digestibility of Nutrients.

The digestibility coefficients calculated for the various nutrients in the rations fed to the different groups of kids are detailed in Tables 18a to 18d and the data are statistically analysed in Tables 19 to 23. Statistical analysis of the data reveals that no significant difference in the digestibility of any of the nutrients is shown by kids of the various groups. However, the results indicate that there is an increase in digestibility of crude protein with an increase in dietary protein level. This finding is in agreement with those reported by Akinsoyinu et al. (1976) in West African dwarf goats, Dhabadgao et al. (1976) in Barbari goats and Lakshminarayana and Raghavan (1979) in lambs, who also observed higher digestibility of protein with increase in dietary protein level. While the values obtained in the present study for the various nutrients in the different ration are almost similar to those reported by Singh and Sengar (1970

for Jamnapari and Barbari kids, Prasad and Mudgal (1975) for Saanen-Beetal goats, Mudgal and Kaur (1976) for Alpino-Beetal kids, Singh and Sengar (1978) for Beetal kids, Mercy et al.(1981) for Alpine-Malabari crossbred kids, Singh and Rekib (1979) could find only lower values for Barbari kids. Kurar and Mudgal (1980) however, observed that the digestibility of crude protein decreased significantly in Beetal goats with increase in energy level.

Mudgal and Devendra (1979) stated that distinct differences exist in the digestibility of dietary constituents between goats and other ruminants maintained under identical conditions of feeding and management. Most of the reports available in this regard indicate that goats have better capacity to digest various nutrients particularly crude fibre when compared to other species of ruminants (Mia et al. 1960a and 1960b; Pant et al. 1962; Jang and Majumdar, 1962; Devendra and Burns, 1970; Jones et al. 1972; Gihad, 1976 and Mudgal and Kaur, 1976).

Nitrogen retention.

Data on nitrogen balance of the experimental animals maintained on different levels of protein and set out in Tables 24a to 24d reveal that the average daily retention of nitrogen by kids in group I, II, III and IV are 5.4 ± 0.67,

5.9 ± 1.2, 6.0 ± 0.75 and 7.6 ± 0.91 g respectively. Statistical analysis of the data presented in Table 25 indicate that no significant difference exists in the average amounts of nitrogen retained by the kids of different groups. However, it is evident from the Tables 24a to 24d that there is a linear increase in daily nitrogen retention of kids with the progressive increase in the dietary protein level, the highest retention being noticed in kids belonging to group IV fed 22 per cent protein and the lowest in kids of group I fed 16 per cent protein in the concentrate mixture. The increased nitrogen retention in animals fed highest levels of protein is also reflected in the higher feed efficiency shown by the animals in respective groups.

The observations recorded in the present study are in keeping with the findings of many workers. Grebing et al. (1973) in their study in sheep reported that animals fed a high dietary protein level (12 per cent) had a higher nitrogen retention compared to those fed on a low protein level (9 per cent). Campbell et al. (1969) also observed increased nitrogen retention in sheep with higher levels of supplemental protein. In studies on energy and protein metabolism in ewes as influenced by age and dietary protein-calorie ratio, Koening et al. (1980) recorded increase in

nitrogen retention with increase in either energy or protein intake. Lakshminarayana and Raghavan (1979) also reported better retention of nitrogen in lambs fed higher levels of protein in the diet. Work carried out by Dhabadgao et al. (1976) revealed that male Malabari kids given protein supplements gave meat with more crude protein and fat than those maintained on grazing alone.

The data on nitrogen balance obtained for the various groups of kids in the present study are essentially in agreement with the values reported by various other workers for kids and lambs maintained on almost similar rations. While Lakshminarayana and Raghavan (1979) observed a daily retention of 4.01 to 5.63 g for lambs fed ration with protein levels ranging from 12 to 16 per cent, Mudgal and Devendra (1979) recorded retention of nitrogen of 4.43, 3.57 and 2.84 g in kids fed either control, urea based or biuret based rations respectively. The latter authors also reported the daily nitrogen retention in kids maintained on poor, medium and high quality fodder as 0.27, 4.54 and 3.37 gorespectively.

Blood values.

Data collected on the haematological constituents of kids maintained on the different dietary protein levels,

presented in Tables 26 to 28 indicate that the blood values recorded during the course of the present study agree well with those reported by earlier workers.

The average values in respect of packed cell volume (PCV- per cent) for kids in the four groups are found to be 36.7, 36.4, 36.2 and 36.8 respectively for the first period, 36.6, 40.7, 36.2 and 41.8 respectively for the second period and 31.2, 32.5, 29.0 and 33.5 respectively for the third period. Statistical analysis of the data given in Table 29, reveal that though there is no significant difference between the four groups in respect of this haematological value, the difference between the various periods is highly significant ($P < 0.01$). A decrease of packed cell volume in the various species of bovines with advancing age has been observed by Schalm (1961).

However, the values obtained for the different groups during the various periods are essentially in keeping with those reported in literature for goats (24.0 to 48.0 per cent) by other workers (Mukherjee and Bhattacharya, 1952; Coffin, 1953; Dukes, 1955; Schalm, 1961; Varshney and Katiyar, 1963; Gautam, 1965; Bhalla *et al.* (1966) and Meroy *et al.* 1981).

The average values recorded for haemoglobin (g/100 ml) in the four groups of kids (Tables 26 to 28) during the

different periods of the experiment are essentially similar to those reported by earlier workers in this regard (Wirth, 1950; Kolmer et al. 1951; Coffin, 1953; Schalm, 1961; Wintrobe, 1961; Bhalla et al. 1966; Thomas et al. 1976; Castro et al. 1977 and Mercy et al. 1981). Statistical analysis of the data detailed in Table 30 shows that significant differences ($P < 0.01$) exist in the haemoglobin concentration between the various periods but not between the various groups. Schalm (1961) also reported a higher concentration of haemoglobin in young ones of bovines compared to adult animals.

Data presented for plasma protein (g/100 ml) indicate that the average values for kids of group I, II, III and IV are 7.9 ± 0.2, 7.1 ± 0.2, 7.4 ± 0.4 and 7.2 ± 0.4 respectively in the first period; 7.1 ± 0.3, 8.0 ± 0.2, 8.1 ± 0.3 and 7.8 ± 0.1 respectively in the second period and 7.2 ± 0.1, 7.2 ± 0.2, 6.9 ± 0.1 and 7.4 ± 0.2 in the third period, no statistically significant differences being noticed either between groups or between periods (Table 31). Almost similar values as observed in the present study have been reported by various workers (Dukes, 1955; Thomas et al. 1976; James, 1978 and Mercy et al. 1981).

Calcium contents (mg/100 ml) of the blood plasma of kids recorded at the beginning, middle and at the end of the

experiment are found to be 11.2 ± 0.8, 12.1 ± 0.4 and 11.4 ± 0.3 respectively for group I, 12.1 ± 0.4, 11.5 ± 0.8 and 11.5 ± 0.4 respectively for group II, 12.3 ± 0.3, 12.1 ± 0.5 and 12.2 ± 0.3 for group III and 12.6 ± 0.3, 12.6 ± 0.2 and 13.0 ± 0.3 for group IV respectively. No statistical difference either between groups or between periods is observed for this parameter (Table 32). The values recorded in the present study are found to agree well with those reported by other workers and lie within the normal range reported for the species (Gowda, 1954; Seshah, 1962; Cornelius and Kaneko, 1963; Thomas et al. 1976; James, 1976 and Mercy et al. 1981).

From the Tables 26 to 28, it can be seen that the inorganic phosphorus contents in the blood plasma of the kids of the various groups recorded in the different periods of the experiment are within the normal range reported for goats Statistical analysis of the data (Table 33) indicate that there is significant difference between the various groups ($P < 0.01$) as well as between the various periods ($P < 0.01$) in this regard. The level of inorganic phosphorus in the blood plasma is found to increase with increase in the dietar protein level. Literature on the influence of dietary protei level and the age of the animals on the inorganic phosphorus content of blood is rather scanty. However, the figures

obtained in the present study are almost similar to those reported by Seshiah (1962), Cornelius and Kaneko (1963), James (1978) and Mercy et al. (1981), though relatively higher concentrations are recorded by Gowda (1954) and Thomas et al. (1976).

From a perusal of the data on the various haematological values obtained in the present study, it is clear that the level of dietary protein in the concentrate mixture as used in the present study has no influence on the physiological well being of the animals as evidenced from the non significant differences obtained in the parameters studied for the purpose. Further the data reveal that all the animals were in good nutritional status since the values obtained for the various parameters are well within the range reported for the species by the various workers.

Cost per kg gain.

The total feed cost incurred by the animals of the four groups taking into account the quantity and cost of concentrates and jack leaves fed and the gain in body weight during the experimental period of 4½ months is given below:

	Groups			
	I	II	III	IV
Cost per kg of concentrate mixture (Rs)	2.11	2.14	2.12	2.11
Cost per kg of jack leaves (Rs)	0.15	0.15	0.15	0.15
Total quantity of concentrates consumed by the six animals (kg)	206.50	221.30	205.80	195.50
Total quantity of jack leaves consumed (kg) by six animals on dry matter (kg) basis	218.00	177.70	175.80	166.60
Total quantity (kg) of concentrates consumed on fresh basis	229.44	245.89	228.67	217.20
Total quantity (kg) of jack leaves consumed on fresh basis	527.85	430.27	425.67	403.39
Cost of concentrates fed (Rs)	484.12	526.20	484.78	458.29
Cost of jack leaves fed (Rs)	79.18	64.54	63.85	60.51
Total cost incurred (Rs)	563.30	590.74	548.63	518.80
Total gain in weight (kg) of six animals during the period of study	60.60	59.20	55.80	61.70
Cost per kg gain (Rs)	9.30	9.98	9.83	8.41

It can be seen from the figures presented above that the

maximum cost on feed during the entire period of the experiment was incurred on kids of group II fed on 18 per cent protein in the concentrate mixture followed by group I and III and the least by group IV. On the other hand, the total gain in body weight was maximum in kids belonging to group IV followed by group I and II and the least in group III. It is evident that at least cost, the kids in group IV had the highest gain. The cost per kg gain was Rs. 9.30, 9.98, 9.83 and 8.41 for groups I, II, III and IV respectively indicating that kids belonging to group IV had the most economic gain followed by the kids in group I, III and II respectively. The lower cost incurred per kg gain by kids of group I when compared to that of group II and III is mostly because of the higher dry matter intake of the animals of this group from jack leaves, the cheapest source of dry matter coupled with an equal body weight gain as that of group IV. The least difference in cost per kg gain as observed between the kids fed 16 per cent and 22 per cent crude protein in the concentrate mixture was Rs. 0.89 indicating that a 22 per cent protein in the concentrate mixture is economically the best for promoting growth in kids.

A critical evaluation of the overall results obtained in the present study on the performance of kids fed

different levels of dietary protein, reveals that among the protein levels tried viz. 16, 18, 20 and 22 per cent, 22 per cent is the optimum level to be recommended in concentrate mixtures for kids for growth since kids fed this dietary protein level were superior in terms of both biological and economical efficiency as they had the highest body weight gain, feed efficiency, digestibility of nutrients and nitrogen retention at least cost.

SUMMARY

SUMMARY

An investigation was undertaken using twenty four crossbred kids (Alpine x Malabari and Saanen x Malabari) of 3-4 months of age to establish the optimum level of protein in concentrate mixtures of kids for growth. The kids were divided into four groups (group I, II, III and IV) of six animals each as uniformly as possible in regard to sex, age, body weight and breed and were maintained on four isocaloric concentrate mixtures, that differed only in regard to the crude protein content. While kids in group I received concentrate mixture containing 16 per cent crude protein, those in group II, III and IV received concentrate mixtures with 18, 20 and 22 per cent crude protein respectively. Jack leaves offered ad libitum formed the sole source of roughage to the animals. The animals were maintained on their respective feeding regime for a period of 4½ months.

Records of daily feed and fodder intake, weekly body weight and fortnightly body measurements were kept throughout the experimental period. Haematological studies were carried out at the beginning, middle and at the end of the experiment. At the end of the feeding trial a digestion-cum-metabolism trial including a collection period of five days was carried out on male animals of all groups. The

criteria used for evaluation of the diets were the average daily gain, body measurements, feed conversion efficiency, digestibility of nutrients, nitrogen retention and the data on haematological values of the kids of the various groups.

The kids maintained on the four dietary protein levels showed almost similar growth rates, the average daily gains being 76.5 ± 10.5, 74.7 ± 7.2, 70.5 ± 3.2 and 77.9 ± 9.8 g respectively for kids of group I, II, III and IV. The average daily gain of kids was not seen influenced by the dietary protein level.

No significant differences could be observed in the body measurements of the kids of the various groups, except the body length which showed a significant difference ($P < 0.01$) between the groups, the highest value being seen in those fed the highest level of dietary protein.

The feed conversion efficiency of the kids were 7.2 ± 0.4, 7.0 ± 0.5, 6.9 ± 0.3 and 6.2 ± 0.6 respectively for group I, II, III and IV, the highest efficiency of conversion of feed being noticed in kids fed 22 per cent crude protein in the concentrate mixture.

The dry matter consumption in kg expressed as percentage of body weight of kids maintained on diets containing 16, 18,

20 and 22 per cent of crude protein were found to be 3.6 ± 0.3, 3.6 ± 0.3, 2.7 ± 0.9 and 3.4 ± 0.2 respectively.

Though the kids maintained on the four dietary regimes registered no significant differences in the digestibility coefficients of different nutrients, an increase in digestibility of crude protein was noticed with increase in dietary protein level.

The kids in all the four groups maintained a positive balance for nitrogen, the average daily retention of nitrogen (g/day) being 5.4 ± 0.7, 5.9 ± 1.2, 6.0 ± 0.8 and 7.6 ± 0.9 for groups I, II, III and IV respectively. Kids fed the highest level of protein had the highest nitrogen retention compared to the others.

The haematological values recorded for the kids of various groups at the beginning, middle and at the end of the feeding trial were all normal and well within the range reported for the species, indicating that all the animals were maintaining a sound nutritional status.

The cost per kg gain was calculated as Rs. 9.30, 9.98, 9.83 and 8.41 for group I, II, III and IV respectively, the lowest cost per kg gain being shown by the animals of group IV indicating that kids fed a dietary protein level of 22 per cent had the most economic gain at least cost.

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OPTIMUM LEVEL OF PROTEIN IN CONCENTRATE MIXTURES OF KIDS FOR GROWTH

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ABSTRACT OF A THESIS

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ABSTRACT

An investigation spread over a period of 4½ months was carried out to establish the optimum level of protein in concentrate mixtures of kids for growth. Twenty four crossbred kids (Saanen x Malabari and Alpine x Malabari) of 3-4 months of age, divided into four identical groups formed the experimental subjects. The kids in group I, II, III and IV was maintained on concentrate mixtures containing 16, 18, 20 and 22 per cent respectively of crude protein along with jack leaves fed ad libitum as the sole roughage. Increase in body weight and body measurements, feed conversion efficiency, digestibility of nutrients, nitrogen retention and haematological values of the kids were the criteria employed for the evaluation.

The average daily gain in body weight recorded for the kids of the four groups were almost similar and were not influenced by the level of dietary protein fed.

The body measurements did not reveal any significant differences between the groups except body length which showed increase with increase in level of dietary protein.

Highest feed efficiency was shown by kids of group IV followed by group III, II and I the values being 6.2, 6.9, 7.0 and 7.2 respectively for the four groups.

The digestibility of nutrients especially that of crude protein and the average daily nitrogen retention were directly proportional to the level of dietary protein fed.

All the animals maintained a sound nutritional status throughout the experimental period as evidenced from the normal haematological values recorded for them.

Kids fed 22 per cent crude protein in the concentrate mixture showed maximum economic gain.