STUDIES ON THE PROTEIN REQUIREMENT FOR GROWTH IN GOATS

Thesis

Submitted to the Faculty of Veterinary Science,
AND ANIMAL HUSBANDRY
RAJENDRA AGRICULTURAL UNIVERSITY, BIHAR
in partial fulfilment of the requirement
for the degree of
MASTER OF SCIENCE (ANIMAL HUSBANDRY)
IN ANIMAL NUTRITION

By
Rabindra Bhakt
B. V. Sc. & A. H. (R. A. U.)
JUNIOR FELLOW (I. C. A. R.)
Post Graduate Department of Animal Nutrition
BIHAR VETERINARY COLLEGE,
PATNA

1975

STUDIES ON THE PROTEIN REQUIREMENT FOR GROWTH IN GOATS

Thesis

Submitted to the Faculty of Veterinary Science,
AND ANIMAL HUSBANDRY
RAJENDRA AGRICULTURAL UNIVERSITY, BIHAR
in partial fulfilment of the requirement
for the degree of

MASTER OF SCIENCE (ANIMAL HUSBANDRY)
IN ANIMAL NUTRITION

By
Rabindra Bhakt
B. V. Sc. & A. H. (R. A. U)
JUNIOR FELLOW (I. C. A. R.)
Post Graduate Department of Animal Nutrition
BIHAR VETERINARY COLLEGE,
PATNA

1975

Dr. P. Narayan,
Ex-Assistant Professor & Chairman
of Animal Nutrition Department,
Bihar Veterinary College, Patna
now Deputy Director (Headquarters),
Animal Husbandry Department,
Bihar, Patna.

PATNA,

Dated, the 19th December, 1975.

This is to certify that the work embodied in this Thesis entitled "STUDIES ON THE PROTEIN REQUIREMENT FOR GROWTH IN GOATS" is the bonafied work of Rabindra Bhakt and was carried out under my guidance and supervision.

Narayan

(P. NARAYAN).

C E R T I F I C A T E

Certified that the research work incorporated in this Thesis has not been published in part or in full in any other journal.

(RABINDRA BHAKT).

The author is highly indebted to the INDIAN COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI for awarding a Junior fellowship in Animal Nutrition in theshape of financial assistance for undergoing this course during 1973-75.

Bhakt
(RABINDRA BHAKT).

A C K N O W L E D G E M E N T

The author expresses his deep sense of gratitude to Dr. P.Narayan, Ex-Assistant Professor and Chairman of Animal Nutrition Department, Bihar Veterinary College, Patna now Deputy Director (Headquarters), Animal Husbandry Department, Bihar, Patna under whose guidance the present investigation was planned and conducted and whose invaluable suggestions and constant encouragement provided for completion of this piece of work.

The author is highly indebted to Dr. N.K. Prasad, B.V.Sc.& A.H., P.G.(A.H.), M.Sc.(A.H.), Diploma in Animal Science (R.V.A.U.,Copenhagen), Assistant Professor and Head of Animal Nutrition Department, Bihar Veterinary College,Patna for his valuable suggestion, constant encouragement and guidance in the preparation of this thesis, without which it might not have got the shape it has.

The author is also highly indebted to Dr.A.K.Tripathi, M.Sc.(A.H.), Gold Medalist, Research Officer (Animal Nutrition), Rajendra Agricultural University, Pusa, Bihar for his continuous help and valuable suggestions during the period of investigation.

Sincere thanks are also due to Dr. T. Prasad, B.Sc., M.V.Sc., P.G., Diploma in Physiology and Biochemistry(Copenhagen), Assistant Professor of Biochemistry, Bihar Veterinary College, Patna for his valuable suggestions from time to time during the period of this investigation.

A word of sincere gratitude is extended to Dr. K.N. Tiwary, Ex-Principal, and Dr. R.N.Singh, Principal,Bihar

C O N T E N T S

*****
***
*

INTRODUCTION

INTRODUCTION

The goat (Capra hircus) is one of the most useful animals among the domestic mammals. The contribution of goats in nation's economy for providing meat, milk, skin, mohair and manure is surprisingly high.

Goats seem to have been domesticated from very early times and it's mentions are found with dawn of civilization. It has been mentioned in "PURANS" of India that king Daksha, father of Sati was punished by transforming his head into a goat's head by the great god Shiva. Goat is regarded according to "VEDA" as a carrier of the god of fire (Agni). The ancient Greeks and Romans paid great attention to goat keeping and frequently references are found in the Greek pastoral poem. The Hindus and Jews have had been offering goats for their religious sacrifices from antiquity. Zeuner (1963) offers evidence from Jerico and Jarmo dating about 7000 B.C. that goat was the earliest of the ruminants to be domesticated by man.

According to the census of 1966 India possess 64.5 million goats which is about 20 per cent of the total world population. Thus, it is one of the largest goat owning countries. Production of goat's meat in our country is 36 per cent amounting 0.15 million tonnes. Besides meat, goat's milk provides befitting economy in these days of scarcity of milk and high cost of production. An average milk producing goat yields about 275 kg of milk in a lactation of 250 days. (The Times of India directory and year book, 1973).

Goats' meat is famous in India for its special taste and flavour, especially the meat of the tender aged one. It is nutritious, easily digestible and palatable. It supplies all essential amino acids, important minerals and vitamins. It has been liberally prescribed by "SUSHRUTI-SANHITA" an old book on Hindu medicine for regaining strength etc. Goat's liver is taken in anaemia. A neuter goat is used for making a kind of oil for curing nerve paralysis.

Linnaeus (1758) ranks the domestic goat Capra hircus as the most important dairy species after cow Bos-taurus/ Bos-indicus, and the water buffalo - Bubalus-bubalis. Likewise, goat's milk is very much valuable particularly for babies as it is nearest to mother's milk in composition. It is not only nutritious but easily digestible and palatable. The non-pathogenic qualities of goat's milk is its special feature. It is regarded completely immune from dangerous zoonotic disease like tuberculosis. Mahatma Gandhi, father of our nation liked goat's milk. He lived principally on goat's milk for more than 30 years, which was perhaps the chief secret of his sound health even at his old age.

Goat's skin has a great commercial value in earning foreign exchange to our country. It amounts to nearly Rs. 1,42,20,000 per year in the form of hides and skin alone. Singh and Singer (1970) It is largely used for manufacture of high class shoes and suitcase etc. Skin of Black Bengal breed is famous for this purpose.

The hair of goat has also good field in trade. Certain breeds in hilly regions in India produces "PASHMINA" or fine wool.

Goat's dung is a valuable source of manure. It is admirably used by small farmers. It is especially advantageous in garden and vegetable culture.

In addition to above mentioned qualities, goat's keeping do not produce any hard problem for feeding also. It can be very well maintained on tree leaves and small quantity of concentrate. This is why goat is called as poor man's cow.

Though, goat occupies an important place in our economy, it has not received much attention by the research workers so far. It is because of the fact that they have long been left to feed themselves on whatever green and leaves they can have access to and as such their feeding has not produced any problem. Moreover, people also have some prejudices against goat because of their destructive habits of the crops and had odour in the milk. As such goat husbandry in our country is still backward. But all these prejudices which have given goats bad name are baseless and happens only because of poor management. Moreover, in present situation of green revolution and perennial shortage of food grain in our country, all available lands are being cultivated. As a result of this there is progressive shortage of grazing lands and if goats are left for grazing in such condition they may destroy crops. So it is now being felt that goats must be stall fed like other farm animals.

Under such circumstances exact knowledge of their nutritional requirements is essential, the most important being the protein because proteinous feeds are much more expensive and its deficiency on the other hand causes retarded physical development and also brings many detrimental effects on health.

Proteins are indispensable constituents of the living protoplasm and participate as such in all vital processes. According to Geiger (1961) the specific structure of various body proteins imparts particular properties which are determinants of growth, neuromuscular and mental function of enzymatic and hormonal processes, immunological phenomena, physiological properties of tissue fluids of many other organs and indirectly of reproduction and heredity.

Since protein is the principal constituents of the organs and soft structures of animal body, a liberal and continuous supply is needed in food throughout the life for growth and repair and thus transformation of food protein into body protein is very important part of nutrition.

Therefore, protein must be fed in proper amount specially in growing one because growth is the foundation on which the other forms of production such as meat, milk etc. rests. It is the adequate growth of the young one that determines the possibilities of animals as producer in future though within the limits set up by the hereditary factors. Any retardation in growth will result in substantial and permanent loss of production by the animal and its progeny.

Goat's meat is an excellent source of protein in human nutrition which is predominantly used as human feed in our country. Being an over populated country there is derth of animal protein in India. Hence, in present situation, protein nutrition of goats requires much emphasis to have optimum growth with best efficiency of conversion for maximum turn over of meat.

In recent years some projects have been started by I.C.A.R. on goats. Works have been done on maintenance and production requirements for goats. (Majumdar (1960), Ranhotra and Jordan (1966), Devendra (1967), Singh and Sengar (1970).) But uptill now no nutritional requirements for goats has been formulated so far. Most of the work has been done keeping in view of the Morrison's and N.R.C. recommendations for lambs as the guide line. But these recommendations are not exactly applicable to Indian goats, because of the varying agro climatic condition and differences in the breed as well. Chaturvedi and Saxena (1971) have reported digestible protein, Ca and P intake in goats which are considerably higher than N.R.C. recommendations for lambs.

Keeping these facts into consideration the present experiment was under taken with a view to find out the optimum requirements of protein for growth in goats.

***
*

REVIEW OF LITERATURE

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Among livestocks, goats are the main source of meat in Asian and African countries. Although lot of work has been done on the nutritional requirements of sheep in India and abroad very little work has been done on the requirements of goats.

The following review, embodies some of the more recent reports related to this problem. These reviews have been prepared on the following headings : -

I. Dry matter consumption.
II. Growth rate.
III. Digestibility co-efficients of organic nutrients.
IV. Feed conversion efficiency.
V. Protein requirements for maintenance and nitrogen balance study.

I. Dry matter consumption :

On the basis of several feeding trials it has been observed that the dry matter intake of goat is higher in comparison to larger farm animals.

Hossain (1959) estimated dry matter intake of goats which was 1726 gm per 100 lbs body weight which comes to about 3.8 kg per 100 kg body weight.

Singh and Sengar (1970) observed average dry matter consumption per 100 kg body weight per day from 3.43 to 4.20 kg

in Barbari and 2.67 to 3.42 kg in Jamunapari does. Thus dry matter consumption of Barbari appears to be more than Jamunapari does. They also observed almost the same dry matter consumption in case of kids as mentioned for their respective dam in each group. In metabolic trials conducted on Barbari and Jamunapari bucks they estimated the dry matter consumption per 100 kg of live weight between 2.03 ± 0.02 to 2.82 ± 0.03 and 1.86 ± 0.09 to 2.65 ± 0.06 kg respectively.

Saxena and Maheshwari (1971) studied the performance of Jamunapari goats at Chakkar Nagar Range (Home Range of Jamunapari goats) and at Mathura. They observed that the dry matter consumption per 100 kg body weight at Chakkar Nagar Range was between 2.42 to 3.58 kg whereas at Mathura it varied from 1.47 to 2.65 kg.

Johri and Talpatra (1971) while comparing the growth rate of Jamunapari goats under browsing and stall fed condition recorded the average dry matter consumption to be 3.7 kg per 100 kg body weight under browsing and 3.5 kg per 100 body weight under stall fed condition.

Maheshwari and Talpatra (1975) studied the dry matter consumption and digestibility of two groups of Jamunapari goats, feeding them green cowpea and cowpea hay separately. They observed that under green cowpea fodder the dry matter consumption on an average per 100 kg body weight was 3.0 kg while under hay feeding the same was 4.04 kg. It appears that the legume hay is more palatable to goats as compared to roughage.

In another experiment Maheshwari and Talpatra (1975)

found average dry matter consumption to be 4.67 kg per 100 kg body weight in Jamunapari milch goats fed green Berseem ad lib.

II. Growth rate :

Growth is such a complex phenomenon which does not follow any rule. It varies with the variation of breeding, feeding and management. The following review embodies growth rate in kids in different conditions : -

Wilson (1958) observed that there was significant difference in growth rate between plane of Nutrition. On high plane (2½ to 3½ hours effective browsing and ½ lb concentrate daily) mature weight of 33 lbs was reached in 26 weeks and on low plane (1 to 2 hours effective browsing) in 48 weeks. When kids were changed from the low to high plane the subsequent growth was faster than in kids on high plane throughout. But he did not give any standard for feeding of nutrients.

Singh and Sengar (1970) recorded highest average birth weight of 2.119, 2.069 and 2.096 kg in Barbari and 4.115, 3.644 and 3.893 kg in Jamunapari for male, female and male + female in the group receiving medium energy and medium protein, which was significantly greater than other groups. They also recorded the mean body weight of kids at 6 months of age in Barbari and Jamunapari from 6.350 to 8.725 kg and 9.500 to 12.100 kg respectively in different groups which did not differ significantly. Thus, they calculated that Barbari and Jamunapari kids grow upto 6 months of age at the rate of 41 to 27 gm (average 31.7 gm) and 37 to 51 gm (average 45.2 gm) per

day respectively. In the course of their experiment they observed that both energy and protein and their interaction with protein have significantly affected the birth weight in different breeds. They also observed that, on an average, the male kids weighed heavier at birth than the female ones in both breeds and Jamunapari ones were almost 1½ to 2 times heavier than those of Barbari.

Johri and Talpatra (1971) attempted to determine the rate of growth of Jamunapari kids from birth to 15 weeks. On the basis of the experiment they observed that the Jamunapari kids grow at the rate of 0.63 kg per week on an average.

In another study Johri and Talpatra (1971) studied the performance of Jamunapari kids under browsing and stall-fed condition. They recorded an average gain of 547 gms in two weeks when fed by browsing and 333 gms under stall-fed condition.

Singh and Singh (1974) observed that growth in both sex of kids was remarkably better in Ist four months after birth. Thereafter during the period of 4 to 8 months the growth was lowest, again in the age group from 8th to 12th month the growth increased appreciably.

III. Digestibility co-efficients :

The actual nutritive value of feed depends upon its digestibility, which differs with differences in the digestive tract of various species and type of feed. The following review embodies some information regarding digestibility of various

nutrients in kids in different conditions.

Hossain (1959) conducted digestibility trials for 7 days in 4 goats. They were given pipal leaves (Ficus religiosa) to appetite and 20 gm rape cake with 5 gm salt. He observed digestibility co-efficient of organic matters 44, CP 53, EE 29, CF 23, NFE 56%.

Devendra (1967) conducted two digestibility trials with 7 and 6 nonlactating indigenous Katjang goats fed in pens. According to his trials the mean percentage of apparent digestibilities for the two trials were DM 76.5 and 66.2, organic matter 78.6 and 71.9, CP 80.6 and 72.2, CF 69.6 and 59.5, EE 69.2 and 58.6 and NFE 81.7 and 78.8% respectively.

Singh and Sengar (1970) conducted a metabolic trial on 8 bucks of Barbari and Jamunapari breed each with a view to determine adequacy of nine combinations of ration prepared by 3 levels (high, medium and low) Energy (TDN) and Protein (DCP). They found out digestibility co-efficients of DM 49.88 $\pm$ 1.10 to 62.63 $\pm$ 1.26, CP 53.32 $\pm$ 1.84 to 68.73 $\pm$ 0.60, EE 36.94 $\pm$ 1.85 to 68.53 $\pm$ 2.84, CF 35.17 $\pm$ 2.04 to 59.06 $\pm$ 1.29, NFE 56.44 $\pm$ 2.47 to 72.38 $\pm$ 1.17 in Barbari bucks and DM 48.37 $\pm$ 1.19 to 75.12 $\pm$ 1.50, CP 54.95 $\pm$ 1.37 to 77.70 $\pm$ 1.06, EE 28.49 $\pm$ 1.68 to 70.15 $\pm$ 1.24, CF 31.38 $\pm$ 2.69 to 61.81 $\pm$ 1.96, NFE 65.57 $\pm$ 0.74 to 83.89 $\pm$ 1.17 in Jamunapari bucks. It has been noticed that both energy and protein and also their interaction affect the digestibilities significantly in both the breeds.

Fonolla *et al.* (1972) compared digestibilities of

dried lucerne as meal and pellets. Two digestibility trials of latin square design were conducted on 4 lactating Granada goats after their second parturition. The composition of both type of products was almost same. Average apparent digestibilities for meal were DM 69.90, organic matter 72.46, CP 75.41, EE 63.72, CF 54.42 and NFE 77.13% and values for pellets were 72.30, 74.63, 74.79, 65.03, 56.27 and 81.04% respectively. They noticed that there was more waste and respiratory difficulty with meal and acceptibility was poor than with pellets.

Maheshwari and Talpatra (1975) compared digestibilities of green cowpea and cowpea hay in stall fed Jamunapari goats. The average digestibility co-efficient of dry matter and organic nutrients in green cowpea were DM 72.0 ± 1.36, CP 67 ± 1.79, EE 84.0 ± 0.55, CF 67.9 ± 1.62, NFE 80.9 ± 2.10 and in cowpea hay were 71.6 ± 1.74, 73.1 ± 2.44, 85.1 ± 1.25, 67.7 ± 2.42, 75.0 ± 1.20 respectively.

In another experiment Maheshwari and Talpatra (1975) tried to estimate digestibility co-efficients of Berseem fodder for milch goats. They estimated average digestibility co-efficients of CP, EE, CF and NFE as 79.4, 40.9, 70.9 and 91.3 respectively.

IV Feed conversion efficiency :

The efficiency of a ration for a unit gain in live weight is the means of its evaluation. It is also one of the measure to aggess the influence of growth rate on feed economy in the experiments of growth.

On the basis of the findings of Singh and Sengar

(1970) it is calculated that for one kg gain in live weight upto 6 months of age, Barbari goats require 8.69 to 10.5 kg dry matter, 0.273 to 0.923 kg DCP, 4.537 to 9.693 kg TDN and that of Jamunapari goats require 5.484 to 9.328 kg DM, 0.326 to 0.761 kg DCP and 3.507 to 9.597 TDN in different groups receiving ration of different combinations of high, medium and low energy and protein.

Chaturvedi and Saxena (1971) calculated DCP and TDN required to produce 100 gm weight gain to be 49.4 and 315.3 gm in the Jamunapari kids maintained on whole milk and 74.6 and 389.4 gm respectively in those maintained on skimmed milk.

V Protein requirement for maintenance and nitrogen balance study :

Mackenzie (1956) has recommended 0.9 lb SE and 0.09 lb DCP per gallon of milk. However, there is no recommendation for growing kids.

Majumdar (1960) estimated protein requirement for goats for maintenance by adopting the procedure of (a) Endogenous Urinary nitrogen and metabolic faecal nitrogen studies and (b) Balance studies. The daily requirements of DCP for maintenance of goats was calculated to be 0.65 lb per 1000 lb live weight by first method and 1.12 lb per 1000 lb live weight by second method, which is much higher value than the previous one.

Ranhotra and Jordan (1966) carried out studies on the protein and energy requirement of Hampshire and Hampshire x

Rambouillet lambs with pelleted diets containing a range of protein level from 10.4 to 16.7%. The concentrate roughage ratio was 75:25 and 55:45. Lambs were fed individually to appetite. Rate of gain and efficiency of feed conversion were not significantly affected by protein content. Lambs gained faster during first 28 days after weaning when given 12% protein or more. Gain during the whole trial was greater, but not significantly so with the higher than lower concentrate diet.

Devendra (1967) carried out exhaustive study on nutrition of indigenous adult goats of Malaya. On the basis of his work he has recommended daily maintenance requirement ranging between 0.5 lb SE and 0.029 lb protein equivalent per 100 lb live weight and production requirement was calculated to be 2.56 and 3.44 lb SE per lb live weight gain for goats of 40 and 60 lbs live weight respectively.

Singh and Sengar (1970) estimated maintenance requirement of protein for goats by the nitrogen balance studies. According to them DCP requirement varied from 0.12 to 0.14 kg per 100 kg body weight per day depending upon the level of dietary energy. On the basis of nitrogen balance they observed that with the minimum of 5.5 and 7.5 gm nitrogen intake per day in goats receiving high energy low protein of both Barbari and Jamunapari bucks respectively, the animal were in positive nitrogen balance of 1.7 and 0.4 gm respectively. They recorded balance of nitrogen from - 2.02 $\pm$ 0.16 to + 1.68 $\pm$ 0.09 in Barbari bucks and + 0.26 $\pm$ 0.39 to + 2.57 $\pm$ 0.35 in Jamunapari bucks receiving different combinations of high, medium and low

energy and protein, rations. Thus, it was concluded that with high energy the low level of protein intake may be adequate to meet protein requirement and bucks of Jamunapari breed can be maintained in positive nitrogen balance even on the low levels of both energy and protein. But bucks of Barbari breed showed negative nitrogen balance on the low level of energy and protein.

***
*

MATERIALS AND METHODS

MATERIALS AND METHODS

Experimental animals :

Twenty (20) nondescript locally available male kids of approximately three months age were selected out of a lot of 33. Immediately after that the kids were weighed and randomly divided into four groups (T_1, T_2, T_3, T_4), on the basis of their body weight. The details of their distribution are presented in Table below.

Table - 1.

The distribution of kids in groups

T_1		T_2		T_3		T_4	
Kid no.	Body weight (kg)	Kid no.	Body weight (kg)	Kid no.	Body weight (kg)	Kid no.	Body weight (kg)
1	7.0	2	7.5	7	6.5	4	7.0
21	7.0	10	6.5	3	7.5	8	6.5
25	7.0	14	7.5	11	7.0	20	6.5
29	6.5	22	7.0	15	7.0	24	7.0
33	8.0	30	6.5	23	7.0	32	8.0

The experiment was started on Ist February 1975 and concluded on 3rd May 1975. A 10 days preliminary feeding period was allowed before the start of the experiment, during which the kids were believed to have been accustomed to the new environment as well as individual stall feeding. During

this period the kids were also drenched with proper dose of parasiticidal drugs such as Phenovis, Sulphamezathin and Kerenol.

Feeds and their analysis :

Green Paragrass only was given as the source of roughage. The concentrate mixture consists of linseed cake, wheat bran and Arhar chuni in different proportions for the four groups.

Proximate analysis of all the feed ingredients were done by the A.O.A.C. method (1970).

For calculating TDN value of the different rations the digestibility co-efficients of the paragrass, linseed cake and wheat bran with respect to CP, EE, CF and NFE were taken from Sen and Ray Bulletin (No. 25, 1967) and the digestibility co-efficient of Arhar chuni with respect to CP, EE, CF and NFE was taken from the review of the work done at Animal Nutrition Centre, Haringhata (1954-1969) for cattle because the digestibility co-efficients value of the feeds in goats were not available.

For the analysis of feeds, 10 samples of individual feed were separately collected from different places of the bag. The samples of the individual feed were then pooled together and powdered with mortar and pestle.

For the analysis of paragrass, 10 samples were collected from different parts of the grass. They were finely chaffed, mixed and dried upto constant weight in hot air oven.

The dried sample was finally powdered and then it was analysed for different proximate principles.

All analysis were done in duplicate. The result of analysis of feed has been furnished in chapter of "Results".

Computation of ration :

The proportion of roughage and concentrate mixture in the ration of all the four treatments were kept 50:50. The concentrate mixtures consisting of lineseed cake, wheat bran and Arhar chuni were prepared in such a way that prepared ration (including 50 parts paragrass) had 8, 10, 12 and 14% crude protein in group T_1, T_2, T_3, T_4, respectively. The details of the four different rations are presented in Table-2.

Table - 2.

Proportions of different ingredients in the ration of four treatment groups.

Feed ingredients	Group no.			
	T_1	T_2	T_3	T_4
Paragrass	50 parts	50 parts	50 parts	50 parts
Linseed cake	5 parts	19 parts	32 parts	46 parts
Wheat bran	40 parts	28 parts	15 parts	1 part
Arhar chuni	5 parts	3 parts	3 parts	3 parts
Dry matter	62.049	62.310	62.572	62.844
Crude protein.	8.264	10.236	12.073	14.050
TDN.	42.681	43.722	44.511	45.361

In addition, a mineral mixture with the brand name of Milkmin (Squibb) was mixed in the concentrate mixture of all groups. Mineral mixture was mixed in proportion to 1 kg in 100 kg of concentrate mixture.

The composition of the mineral mixture is as follows:

Calcium (%)	Phosphorus (%)	Manganese (%)	Iodine (%)	Iron (%)	Copper (%)	Cobalt (%)	Sodium chloride (%)	Fluorine (%)
24	9	0.12	0.1	0.6	0.1	0.02	30	Not more than 0.03

Feeding practice :

Kids of group T_1, T_2, T_3 and T_4 were fed the ration containing 8, 10, 12 and 14 per cent crude protein respectively. They were fed individually in clay troughs prepared for this purpose.

Kids were fed to appetite. Feeding was done twice in a day i.e. from 8 A.M. to 10 A.M. and 3.30 P.M. to 5.30 P.M. concentrate mixture and roughage were offered to kids in equal quantity turn by turn twice in the morning and twice in the evening. Weighed amount of concentrate and roughage were offered to the kids and left overs were also weighed. Thus, the actual daily consumption of concentrate and roughage were observed.

Watering of animal was done thrice daily i.e. morning, afternoon and evening.

Weighing of kids :

On the day of starting the experiment kids were weighed and thereafter body weight was recorded every week. Weighing of kids was done in the morning before offering feed and water to them.

The growth rate has been expressed as average growth rate by the formula $\frac{W_2-W_1}{T_2-T_1}$, where W_1 is the initial body weight, W_2 is the final body weight and T_2-T_1 is the time interval. The growth rate of the four groups has been given in chapter of "Result".

Nitrogen balance study :

Two nitrogen balance studies were conducted during the experiment, one in the middle and the other at the end of the experiment. For this purpose two kids from each group were randomly selected and shifted to the locally prepared metabolic cage. Faeces and urine collection bags were attached to the animal. Two days preliminary period was allowed to accustom the animals in the metabolic cage and the collection bags. Necessity of further preliminary period was not felt because kids were fed the original ration during trial and they were already accustomed to stall feeding. After preliminary period actual collection of faeces and urine was done. The faeces collection was done in a rectangular bag whose inner covering was made of plastic sheet and the outer of thick cotton cloth. Urine was collected in a conical funnel shaped bag whose inner covering was of plastic and the outer of thick cotton. This

conical bag was connected with a plastic funnel and that from a rubber tube. The rubber tube came down into a bottle through a hole in the cage. Faeces was collected twice daily and stored in a separate container. 24 hours collection of faeces of individual animal was weighed and recorded. Then a representative sample of 10 gm faeces was weighed in an aluminium moisture cup and kept in hot air oven for moisture estimation. Moisture was estimated every day. Seven days dried faeces was pooled together and powdered. From this pooled dried sample further analysis was done.

Likewise, 24 hours' collection of urine was measured by means of a measuring cylinder and recorded. Every day 50 ml of urine was collected in a bottle containing 7.7 ml concentrated sulphuric acid as a preservative for a week. The pooled sample was levelled and kept for analysis of urinary nitrogen. Analysis of faeces and urine was done according to the method as mentioned before for feeds. Outgo of nitrogen through faeces and urine was thus obtained. The value was deducted from the total nitrogen intake so as to know the nitrogen retained.

Digestion trial study :

A digestion trial involves a record of nutrients consumed and of the amounts of them voided in the faeces.

Along with 'nitrogen balance' digestion trial was also done at the end of the experiment to determine the difference in digestibility co-efficient in the four groups. Analysis of faeces for various components was used for finding out digestibility co-efficients. Digestibility co-efficient for dry

matter, crude protein, crude fibre, ether extract and nitrogen free extract was obtained in each group.

Like other estimates, all analysis were done in duplicate and mean of the two readings were used for calculation. The results of these analysis have been shown in chapter of "Result".

Body measurement :

Along with body weight, certain body measurements such as height, length and girth were also measured so as to assess the type of growth in all the experimental animals. The measurements were taken every week.

Mortality :

Altogether 6 kids died during the experimental period. Kid no.11 of group T_3 died just after a day of commencement of experiment. Kid no. 8 of group T_4, Kid no. 30 and 14 of group T_2 died on 5th, 6th and 8th day of experiment respectively. Kid No. 24 died on 24th day of experiment. Kid no. 29 of group T_1 became debilitated gradually and died after 2 months of commencement of experiment. The cause of the deaths of the kids as per the P.M. report was pneumonia. Now group T_1 and T_3 contained 4 kids each and T_2 and T_4 3 kids each.

Statistical analysis :

The usual procedures of mean of standard error from ungrouped data were calculated as per method described by Snedecor (1957). Besides this analysis of variance was run with test effects of different groups on body weight and also effects of different weeks on body weight were calculated.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

With objectives outlined earlier, the results of the experiment conducted on the protein requirement for growth in goats at 4 protein levels are presented and discussed. The parameters studied in this study were dry matter consumption, weight gain of kids, feed efficiency, digestibility co-efficient and nitrogen balance. The data are presented and described below :

Chemical composition and nutritive values of feed :

Before starting the actual experiment the chemical composition of each feed ingredient was estimated. It is being given in Table - 3.

Table - 3.

Chemical composition of feed ingredients in percentage (on air dry basis)

Feed ingredient	Moisture	Crude protein	Crude fibre	Ether extract	Total ash	NFE
Linseed cake	8.83	28.13	7.96	8.98	6.60	39.51
Wheat bran	10.84	14.00	10.09	5.15	5.44	54.48
Arhar chuni	9.85	14.25	24.01	1.75	11.85	38.29
Paragrass	65.36	1.09	11.32	1.01	4.50	16.72

Table - 4

Chemical composition of feed in percentage (on dry matter basis).

Name of the feed	Crude protein	Crude fibre	Ether extract	Total ash	NFE
Linseed cake	30.08	8.73	9.84	7.24	44.11
Wheat bran	15.70	11.31	5.78	6.10	61.11
Arhar chuni	15.81	26.63	1.94	13.14	42.78
Paragrass	3.16	32.67	2.92	12.99	48.27

In order to provide optimum amount of energy in all the four groups of animals, it was essential to know the TDN value of all feeds. As the digestibility co-efficients of different nutrients of the feeds used in this experiment for goats were not available, digestibility co-efficients for cattle was taken as guide line.

Table - 5

Digestibility co-efficients of the nutrients of the different ingredients of experimental feed (in percentage).

Feed ingredients	Digestibility co-efficients			
	Crude Protein	Crude fibre	Ether extract	NFE
*Linseed cake	85	27	96	67
*Wheat bran	77	20	63	84
*Paragrass	68	66	63	63
**Arhar chuni	52.83	45.18	57.67	80.05

* Data for linseed cake, wheat bran and paragrass has been taken from I.C.A.R. bulletin No.25, 1967 (Sen and Ray).

** Data for Arhar chuni has been taken from the review of work carried out at Animal Nutrition Centre, Haringhata (Kalyani) (1954-1969).

The amount of digestible nutrients present in each feed and the TDN value of the feeds were calculated from the data of Table 3 and 5. In computing the TDN value of feeds the digestible ether extract was multiplied by 2.25 in each case. The digestible nutrient contents and TDN value of the feeds have been shown in Table - 6.

Table - 6

Digestible nutrient contents and the TDN value of different feeds (in percentage).

Feed ingredients	DCP	DCF	DEE	DNFE	TDN
Linseed cake	23.91	2.15	8.62	26.47	71.91
Wheat bran	10.78	2.02	3.24	45.76	65.86
Arhar chuni	7.53	10.85	1.01	30.65	51.29
Paragrass	0.74	7.47	0.64	10.53	20.17

Dry matter consumption :

DM intake of the different experimental groups of animals were calculated from the feed intake and has been presented in Table - 7.

Table - 7

Mean dry matter consumption (kg) per 100 kg body weight per day from 1st (3 months age) to 13th week (6 months age) in deshi male kids under different feed treatment groups.

Weeks	Treatment groups			
	T_1	T_2	T_3	T_4
	Mean ± S.E.	Mean ± S.E.	Mean ± S.E.	Mean ± S.E.
I	2.4 ± 0.19	2.4 ± 0.42	2.6 ± 0.39	1.9 ± 0.19
II	3.4 ± 0.19	3.1 ± 0.48	2.8 ± 0.47	2.2 ± 0.32
III	3.6 ± 0.29	4.1 ± 0.39	4.2 ± 0.63	3.5 ± 0.52
IV	3.8 ± 0.31	4.2 ± 0.58	4.6 ± 0.58	3.4 ± 0.29
V	3.8 ± 0.41	4.2 ± 0.46	4.5 ± 0.51	3.6 ± 0.43
VI	4.5 ± 0.38	4.5 ± 0.47	5.0 ± 0.42	4.8 ± 0.39
VII	4.6 ± 0.12	4.1 ± 0.32	4.9 ± 0.56	4.8 ± 0.56
VIII	4.7 ± 0.18	4.1 ± 0.38	5.0 ± 0.37	4.5 ± 0.29
IX	4.9 ± 0.24	4.1 ± 0.27	5.3 ± 0.19	5.1 ± 0.41
X	5.3 ± 0.25	5.0 ± 0.48	5.6 ± 0.22	5.5 ± 0.23
XI	5.6 ± 0.42	5.1 ± 0.41	5.5 ± 0.33	5.3 ± 0.46
XII	5.6 ± 0.13	5.0 ± 0.43	4.9 ± 0.25	5.4 ± 0.43
XIII	5.1 ± 0.26	4.9 ± 0.25	4.6 ± 0.44	4.5 ± 0.38
Average	4.32± 0.30	4.24± 0.21	4.53± 0.13	4.30± 0.19
Overall average -		4.34 ± 0.21		

From the above table, the DM intake in group T_1 ranged from 2.4 ± 0.19 to 5.6 ± 0.42, in T_2 2.4 ± 0.42 to 5.1 ± 0.41, in T_3 2.6 ± 0.39 to 5.6 ± 0.22 and in T_4 1.9 ± 0.19 to

5.5 ± 0.23 kg per 100 kg body weight per day. The average DM consumption of all the 4 groups during experimental period ranged from 4.24 ± 0.21 to 4.53 ± 0.13 kg per 100 kg body weight per day; indicating that protein level did not affect the DM consumption. The overall DM intake was 4.34 ± 0.21 kg per 100 kg body weight per day during experimental period which is in agreement with the observations made by Maheshwari and Talpatra (1975) in Jamunapari goats fed cowpea hay and Maheshwari and Talpatra (1975) in Jamunapari milch goats fed green Berseem ad lib; who observed 4.04 and 4.67 kg dry matter intake per 100 kg body weight respectively.

The present findings differ from those of Singh and Sengar (1970), Saxena and Maheshwari (1971) and Johri and Talpatra (1971) who observed average dry matter consumption per 100 kg body weight per day from 3.43 to 4.20 kg in Barbari, 2.67 to 3.42 kg in Jamunapari; 2.42 to 3.58 kg at Chakharnagar range, 1.47 to 2.65 kg at Mathura and 3.7 kg under browsing and 3.5 kg under stall fed condition respectively. However, the highest figure obtained for Barbari is slightly at variance with the average DM intake per 100 kg body weight per day obtained in this experiment. The difference might be due to difference in breed, composition and palatability of the diet and different agro-climatic conditions.

Live weight gain of kids :

The mean live weight in different weeks of kids of all four different treatment groups are given in Table - 8.

Table - 8

Mean body weight (kg) of Deshi male kids at different weeks under different feeding treatment groups with S.E.

Weeks	Treatment groups			
	T_1	T_2	T_3	T_4
	Mean ± S.E.	Mean ± S.E.	Mean ± S.E.	Mean ± S.E.
Initial.	7.1 ± 0.45	7.1 ± 0.23	7.0 ± 0.15	7.3 ± 0.57
I	7.2 ± 0.43	7.3 ± 0.25	7.5 ± 0.27	7.3 ± 0.68
II	7.5 ± 0.63	7.3 ± 0.67	7.5 ± 0.38	7.3 ± 0.73
III	7.7 ± 0.83	7.5 ± 0.82	7.8 ± 0.58	7.4 ± 0.28
IV	7.8 ± 0.68	8.0 ± 0.64	8.0 ± 0.83	7.4 ± 0.32
V	7.9 ± 0.45	8.5 ± 0.89	8.7 ± 0.23	7.8 ± 0.78
VI	8.0 ± 0.73	8.6 ± 0.65	8.8 ± 0.43	7.9 ± 0.39
VII	8.1 ± 0.23	9.3 ± 0.75	8.9 ± 0.12	7.9 ± 0.47
VIII	8.1 ± 0.38	9.3 ± 0.67	9.6 ± 0.67	8.1 ± 0.66
IX	8.2 ± 0.48	9.4 ± 0.86	10.6 ± 0.76	8.5 ± 0.62
X	8.3 ± 0.53	10.2 ± 0.74	11.1 ± 0.86	9.3 ± 0.36
XI	8.3 ± 0.81	10.6 ± 0.73	11.3 ± 0.21	9.9 ± 0.51
XII	9.0 ± 0.74	10.5 ± 0.48	11.8 ± 0.63	10.2 ± 0.45
XIII	9.2 ± 0.23	10.8 ± 0.82	11.9 ± 0.68	10.6 ± 0.64
Growth rate per week.	0.185	0.276	0.376	0.269
Growth rate per day.	26.4 gm	39.4 gm	53.7 gm	38.4 gm

Table - 9

Analysis of variance table showing effect of different ages and treatments on the body weight of Deshi (nondescript) goats.

Sources of variation	df	M. S.
Between treatment	3	798.53**
Within treatment	208	132.85
Between weeks	12	873.54**
Within weeks	199	98.22

** denotes significance at 1% level.

From the perusal of Table - 8 it will appear that the highest body weight at 13th week was observed in T_3 group which was 11.9 $\pm$ 0.68 kg while the lowest was observed in group T_1 (9.2 $\pm$ 0.23). Although T_4 group obtained the maximum percentage (14% CP) of crude protein in the diets the body weight was lower as compared to T_3 group.

As was to be expcted the mean body weight increased with the increase in age and the difference in growth between different weeks were found to be statistically significant.The initial body weight among the different groups did not seem to differ. Similarly no significant difference in body weight was observed upto the 9th week of the experiment. But from the 10th week onward upto 13th week the mean weekly body weight among the different groups was found to differ significantly. The statistical analysis also revealed significant difference between the

group T_1 and T_2, T_1 and T_3, T_1 and T_4, T_2 and T_3, T_3 and T_4 ; but no significant difference in 13th week of body weight was observed between T_2 and T_4 group. These findings reveal that in the present investigation T_3 group feed had best performance indicating the optimum level of dietary CP to be 12%.

The average body weight at 6 months of age i.e.13th week of the experiment was on an average 10.6 kg for all the 4 groups (9.2 to 11.9 kg). Similar body weight were also recorded by Singh and Sengar (1970) in Jamunapari goats at 6 months of age which ranges from 9.5 to 12.1 kg. But they differed from those recorded for Barbari goats (6.350 to 8.725 kg at 6 months age) which might be due to difference in breed.

As regards the growth rate it was found that the kids of group T_1, T_2, T_3 and T_4 grew at the rate of 0.185, 0.276, 0.376 and 0.269 kg per week or 26.4 gm, 39.4 gm, 53.7 gm and 38.4 gm per day on an average respectively. Thus it was noticed that the kids of group T_3 had the maximum growth while the T_1 had the least. Like, 13th week body weight, the growth rate was also highest in T_3 group indicating that 12% crude protein is the optimum requirement for growth in goats.

The growth rates recorded for group T_1, T_2 and T_4 in the present study are quite similar from those of Singh and Sengar (1970) for Barbari (27 to 41 gm per day) and growth rate of group T_3 is also in close agreement from their findings for Jamunapari kids (37 to 51 gm per day) maintained on different combinations of energy and protein.

The results of the present experiment differ from

those of Johri and Talpatra (1971) who recorded growth rate of Jamunapari kids to be 333 gm in two weeks or 22.2 gm per day under stall fed condition. This difference may be due to the fact that animals in their experiment comprise of varying age ranging between 3 to 12 months, whereas in present work animals were 3 months old. These results also widely differ from the another study of Johri and Talpatra (1971) in which they observed that Jamunapari kids grow at the rate of 0.63 kg per week or 90 gm per day on an average. The difference in growth rate from this experiment appears possibly due to the fact that in this experiment the growth study was carried on goats between 3 to 6 months of age while Johri and Talpatra (loc. cit.) carried out the experiment from birth to 15 weeks. It also might be due to the reason observed by Singh and Singh (1974) that during the period of 4 to 8 months the growth is lowest in both the sex of kids.

Body measurement :

The details of the body measurements of kids at the beginning and end of the experiment has been presented in Table - 10.

Table - 10

Body measurement of kids.

Group no.	Animal no.	Length (cm)			Girth (cm)			Height (cm)		
		Initial	Final	Difference	Initial	Final	Difference	Initial	Final	Difference
T_1	1	34	35	1	44	48	4	38	48	10
	21	33	40	7	46	49	3	41	50	9
	25	39	39	0	43	50	7	39	50	11
	33	36	42	6	46	49	3	38	48	10
Average		35.5	39	3.5	44.75	49	4.25	39	49	10
T_2	2	33	42	9	42	51	9	43	52	9
	10	32	36	4	46	46	0	38	42	4
	22	34	43	9	46	54	8	45	53	8
Average		33	40.3	7.3	44.6	50.3	5.7	42	49	7
T_3	7	31	41	10	46	49	3	36	47	11
	3	36	40	4	45	52	7	38	49	11
	15	32	41	9	45	51	6	39	49	10
	23	33	42	9	45	53	8	38	53	15
Average		33	41	8	45.25	51.25	6	37.75	49.5	11.75
T_4	4	36	41	5	44	51	7	41	51	10
	20	32	36	4	42	46	4	37	47	10
	32	34	43	9	45	51	6	43	51	8
Average		34	40	6	43.6	49.3	5.7	40.3	49.6	9.3

From the above table it appears that group T_3 (12% CP) has the maximum length, girth and height as compared to the other groups, thereby indicating the best performance of the kids in this group; which was expected according to the rate of growth and body weight development as observed earlier in this experiment.

Digestibility co-efficient :

In order to find out the extent of digestion of different nutrients, digestibility trial was conducted. The average digestibility co-efficient of different nutrients in kids of different groups have been presented in Table - 11.

Table - 11

Mean digestibility co-efficient of different nutrients in different groups of kids

Group no.	Dry matter	Crude protein	Crude fibre	Ether extract	NFE
	Mean ± S.E.	Mean ± S.E.	Mean ± S.E.	Mean ± S.E.	Mean ± S.E.
T_1	70.90±1.05	71.08±1.50	68.73±1.56	80.09±1.43	73.76±1.11
T_2	78.20±1.83	83.02±1.78	72.74±2.51	92.09±0.76	81.24±1.52
T_3	76.10±2.83	82.37±3.45	69.04±2.64	92.59±0.95	80.69±1.51
T_4	76.64±2.15	80.58±3.82	69.29±2.65	94.24±1.54	77.87±1.70
Overall	75.46±1.95	79.26±2.07	69.95±2.68	89.75±1.17	78.39±1.46

Table - 12

Analysis of variance table of digestibility.

Sources of variation	df	DM		CP		CF		EE		NFE	
		M.S.	F	M.S.	F	M.S.	F	M.S.	F	M.S.	F
Between groups.	3	137.45	9.27**	450.79	2.57	43.50	0.59	593.86	31.23**	163.77	4.71**
Within group.	52	14.83		175.11		77.39		19.01		33.74	
C.D.		1.933		NS		NS		2.214		2.932	

** denotes significant at 1% level.
NS denotes non-significant.

Digestibility of dry matter :

From the table of digestibility co-efficient it was observed that the DM digestibility was highest in T_2 group (78.20 ± 1.83%) which was closely followed by T_4 (76.64 ± 2.15%) and T_3 (76.10 ± 2.83%) whereas the T_1 group showed the least value (70.90 ± 1.05%). Highly significant differences were observed in the digestibility co-efficient of DM between T_1 group and other groups. Significant differences were also observed between T_2 and T_3 whereas no difference was observed between T_3 and T_4. The overall average digestibility co-efficient of DM was found to be 75.46 ± 1.95.

The results with regards to the digestibility co-efficient of DM seemed to agree with the findings of Maheshwari and Talpatra (1975) who found the digestibility co-efficient of DM of green cowpea to be 72.0 ± 1.36 whereas in cowpea hay they

reported the digestibility co-efficient of DM to be 71.6 ± 1.74. The present study was on paragrass, linseed cake,wheat bran and Arhar chuni, a composite feed. The findings therefore seemed to be closely agreeing with the observation of Devendra (1967) who found digestibility co-efficient for DM in stall fed nonlactating Katjang goats to be 76.5 in one trial, which is very close to the overall mean digestibility co-efficient for DM obtained in the present investigation (75.46 ± 1.95). But the result differs widely from the findings of Singh and Sengar (1970) who found digestibility co-efficient of DM to be 49.88 ± 1.10 to 62.63 ± 1.26 in Barbari bucks and 48.37 ± 1.19 to 75.12 ± 1.50 in the case of Jamunapari bucks. However, the highest figure obtained by them (75.12 ± 1.50) is in agreement with the overall digestibility for DM obtained in the present work. These variations in the DM digestibility apart from being due to well established interaction between energy and protein and may be also due to the differences in ration, breed variation, differences in the managemental practices and possibly varying agro-climatic conditions. Moreover, in the present study paragrass was incorporated with concentrate mixture as mentioned above whereas in the literature obtained so far, no such comparable work with this ration could be traced. The work so far done were mostly on female goats with lone exception of Singh and Sengar (loc. cit.) who conducted digestibility trial with bucks as well and were also of the view that protein and energy interaction affects digestibility.

Crude protein :

The overall average digestibility for crude protein was 79.26 ± 2.07. The maximum digestibility co-efficient was observed in T_2 group (83.02 ± 1.78) followed closely by T_3 (82.37 ± 3.45) and T_4 group (80.58 ± 3.82) whereas the least value was obtained in T_1 group (71.08 ± 1.50), although this variation was not significant.

The results of the present investigation are in agreement with the findings of Devendra (loc. cit.) and Fonolla et al. (1972) who reported the value to be 80.6 and 75.41 and 74.79 in dried lucern as meal and pellets respectively. Maheshwari and Talpatra (1975) also reported the digestibility co-efficient of crude protein to be 79.4 in the case of Berseem fodder for milch goat, which was very close to the overall mean crude protein digestibility in the present case. However, the present findings differs with those of Singh and Sengar (loc. cit.) who reported the digestibility co-efficient of crude protein for Barbari and Jamunapari bucks to be 53.32 ± 1.84 to 68.73 ± 0.60 and 54.95 ± 1.37 to 77.70 ± 1.06 respectively, and also with Maheshwari and Talpatra (1975) who observed digestibility co-efficient of crude protein to be 67.0 ± 1.79 in Jamunapari goats by feeding them green cowpea.

The difference observed might be due to sources of feed, influence of nutrient relationship of the ration as well as difference of age and breed of the animal.

Crude fibre :

Though the overall crude fibre digestibility was

found to be 69.95 ± 2.68, there was considerable variation in different treatment groups. The maximum value being obtained in case of group T_2 (72.74 ± 2.51) followed by 69.29 ± 2.65 in T_4 and 69.04 ± 2.64 in T_3 group and the least value 68.73 ± 1.56 was in T_1 group. However, these variations between groups were not significant.

There is close conformity of the present finding with those of Devendra (loc. cit.) who reported the digestibility co-efficient of crude fibre to be 69.6 and with those of Maheshwari and Talpatra (loc. cit.) who reported 67.9 ± 1.62, 67.7 ± 2.42 and 70.9 in Jamunapari goats by feeding them green cowpea, cowpea hay and green Berseem respectively. From their observations it appears that the average digestibility co-efficient of crude fibre is around 69 to 70%. Although Singh and Sengar (loc. cit.) have observed a very wide range of digestibility co-efficient of crude fibre which was 35.17 ± 2.04 to 59.06 ± 1.29 in Barbari bucks and 31.38 ± 2.69 to 61.81 ± 1.96 in Jamunapari bucks.

Ether extract :

In the case of ether extract the mean digestibility co-efficient was found to be 89.75 ± 1.17, though the highest value for digestibility was recorded in the T_4 group (94.24 ± 1.54) followed by T_3 group (92.59 ± 0.95) and 92.09 ± 0.76 in T_2 group. In this case also falling in line like the other constituents (DM, CP, CF) the lowest value of EE digestibility was recorded (80.09 ± 1.43) in T_1 group which is obviously due

to lower protein content of its ration. Group T_1 significantly varied with other three groups while rest three groups do not vary among themselves.

The present result obtained for digestibility of ether extract was close to the findings of Maheshwari and Talpatra (loc. cit.) who reported the value to be 84.0 ± 0.55 and 85.1 ± 1.25 in Jamunapari goats fed green cowpea and cowpea hay respectively. The value of digestibility co-efficient for this nutrient was reported to be 69.2 and 58.6 by Devendra (loc. cit.), 36.94 ± 1.85 to 68.53 ± 2.84 for Barbari and 28.49 ± 1.68 to 70.15 ± 1.24 for Jamunapari bucks by Singh and Sengar (loc. cit.), 63.72 and 65.03 by Fonolla et al. (loc. cit.) and 40.9 by Maheshwari and Talpatra (loc. cit.) which widely differ from the result of the present experiment. Moreover, what has been found in literature it seemed that the digestibility co-efficient value of this nutrient had the widest variation recorded so far than in other constituent of feed stuff. The causes of differences might be due to difference in age of the animal, variation in feed sources as attributed by Maynard and Loosli (1969). "In seeds and their by-products ether extract consists almost entirely of readily digestible esters of fatty acids while the extract of roughages contains a high proportion of non-saponifiable constituents as well as nonlipid substances".

Nitrogen free extract :

The overall mean digestibility co-efficient of NFE was worked out to be 78.39 ± 1.46 although values as low as

73.76 ± 1.11 in group T_1 and as high as 81.24 ± 1.52 in treatment T_2 were observed. The highest value of group T_2 was closely followed by that of T_3 (80.69 ± 1.51) and T_4 (77.87 ± 1.70). Significant differences were observed in the digestibility co-efficient of NFE between T_1 group and others. Significant difference was also observed between T_4, T_2 and T_3 whereas there was no significant difference between T_2 and T_3.

The overall digestibility co-efficient of NFE in the present study is in agreement with Maheshwari and Talpatra (loc. cit.), Devendra (loc. cit.) and Fonolla et al.(loc.cit.) who reported the value to be 80.9 ± 2.10; 81.7 and 78.8; 77.13 and 81.04 respectively. The findings of Singh and Sengar (loc. cit.) and Maheshwari and Talpatra (loc. cit.) did not seem to agree with those find in the present study, They observed the value to be 56.44 ± 2.47 to 72.38 ± 1.17 in Barbari, 65.57± 0.75 to 83.89 ± 1.17 in Jamunapari and 91.3 in Jamunapari milch goat fed Berseem ad lib. The differences observed might be due to the variation in feed sources and also due to associative effect of feed constituent of the ration.

Feed conversion efficiency :

Feed efficiency was calculated to find out the influence of different rations on growth. At first the average total DM, DCP and TDN consumed by a kid in different treatment groups during the whole experimental period was calculated with the help of digestibility co-efficients obtained in this experiment. The details are presented in Table-13.

Table - 13

Total average DM, DCP and TDN consumed by a kid of different groups during experimental period.

Group no.	Dry matter (kg)	DCP (kg)	TDN (kg)	Average weight gain during experimental period (kg)
T_1	24.296	2.972	23.454	2.1
T_2	25.217	4.715	27.831	3.7
T_3	26.363	5.883	29.697	4.9
T_4	27.316	5.466	26.265	3.3

The dry matter, DCP and TDN consumption by kids in different groups required to produce 1 kg body weight has been calculated with the help of data contained in Table-13 and relevant details are presented in Table - 14.

Table - 14

Average DM, DCP and TDN consumed by a kid of different group for 1 kg increase in live weight.

Group no.	Dry matter (kg)	DCP (kg)	TDN (kg)
T_1	11.569	1.415	11.168
T_2	6.815	1.274	7.521
T_3	5.380	1.200	6.060
T_4	8.277	1.656	7.959

The figures in Table - 14 reveal that the mininum dry matter intake per unit live weight gain was in group T_3

(5.38 kg) followed by group T_2 (6.815 kg) and T_4 (8.277 kg) and the maximum value was observed in group T_1 (11.569 kg). Similar pattern was seen for TDN intake (6.060, 7.521, 7.959 and 11.168 kg for group T_3, T_2, T_4 and T_1 respectively). But DCP utility per kg gain in live weight was minimum in group T_3 (1.200 kg) followed by T_2 (1.274 kg) and T_1 (1.415 kg) and maximum value was recorded in T_4 group (1.656 kg). However, DM, DCP and TDN consumption was minimum in group T_3 indicating that the ration containing 12% CP was more efficient than others. Though there was very slight difference between group T_2 and T_3.

The results obtained in this investigation for dry matter and TDN fall within the range given by Singh and Sengar (1970) for Barbari and Jamunapari goats with only exception in group T_1. They reported that Barbari goats require 8.69 to 10.5 kg dry matter and 4.532 to 9.693 kg TDN and Jamunapari require 5.484 to 9.328 kg dry matter and 3.507 to 9.597 kg TDN for unit gain in the live weight. But the present study widely differs from that of Singh and Sengar (loc. cit.) and Chaturvedi and Saxena (1971) who reported 0.273 to 0.923 kg DCP intake in Barbari; 0.326 to 0.761 kg DCP in Jamunapari and 3.153 to 3.894 gm TDN; 0.494 to 0.746 gm DCP in Jamunapari respectively for per unit gain in live weight.

This difference may be due to breed variation.

Nitrogen balance study :

Nitrogen balance study was conducted for the purpose

of determining the nitrogen status of the animals under different treatment. The details of balance study are present in Table - 15.

Table - 15

Average nitrogen intake, excretion and retention obtained in both trials

Group no.	Intake (gm) Roughage + concentrate	Excretion (gm) Urine + faeces	Retention (gm)
	Mean ± S.E.	Mean ± S.E.	Mean ± S.E.
T_1	7.73 ± 0.26	6.24 ± 0.27	1.48 ± 0.36
T_2	11.23 ± 0.75	7.23 ± 0.43	4.23 ± 0.74
T_3	14.64 ± 0.80	9.22 ± 0.82	5.47 ± 0.63
T_4	12.59 ± 1.00	7.54 ± 0.76	5.05 ± 0.89

Table - 16

Analysis of variance of nitrogen retention

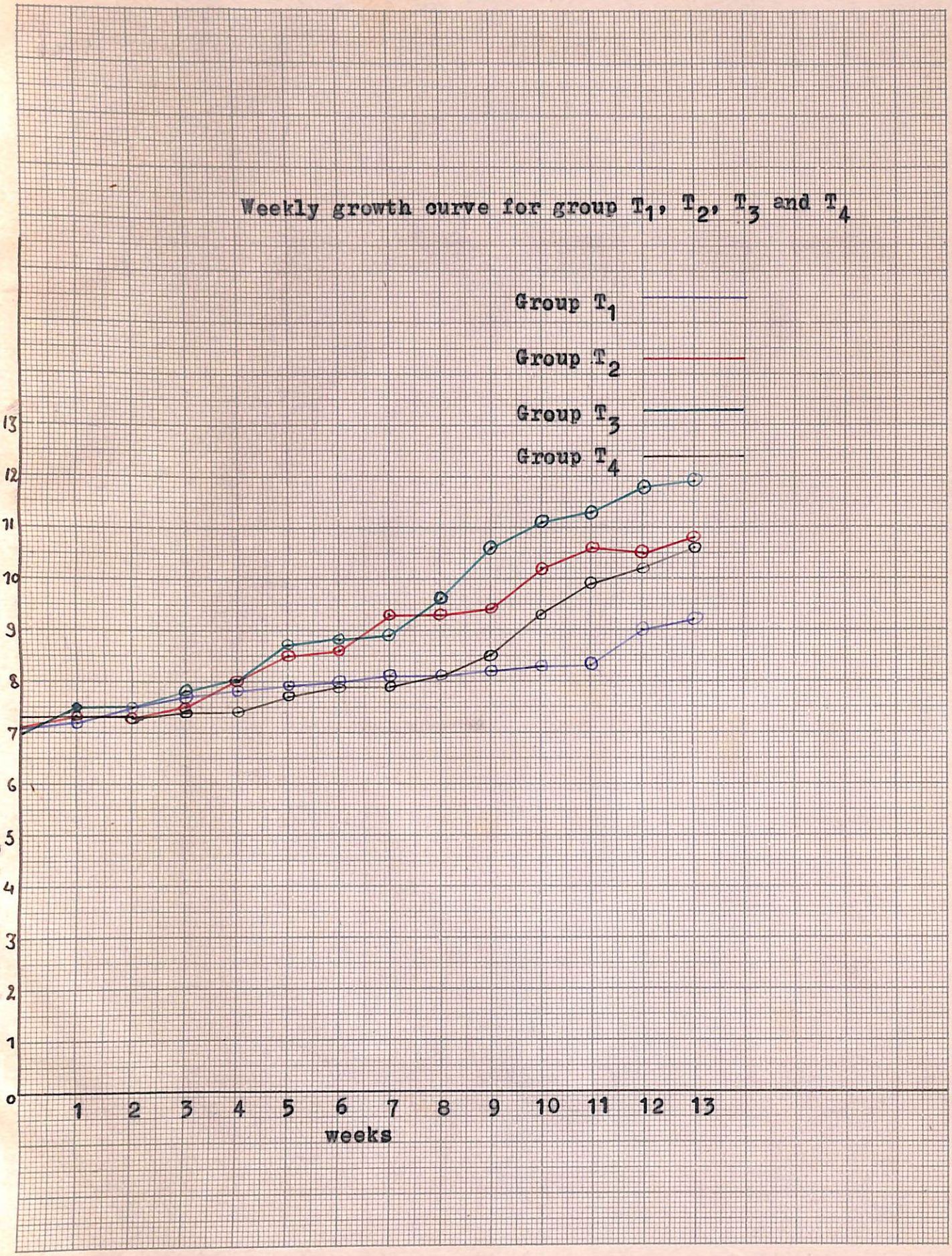
Sources of variation	df	M.S.	F
Between groups	3	109.91	8.05**
Within group	105	13.52	
C.D. with group T_1, T_2 and T_4	2.53		
C.D. with group T_3	2.61		

** denotes significant at 1% level.

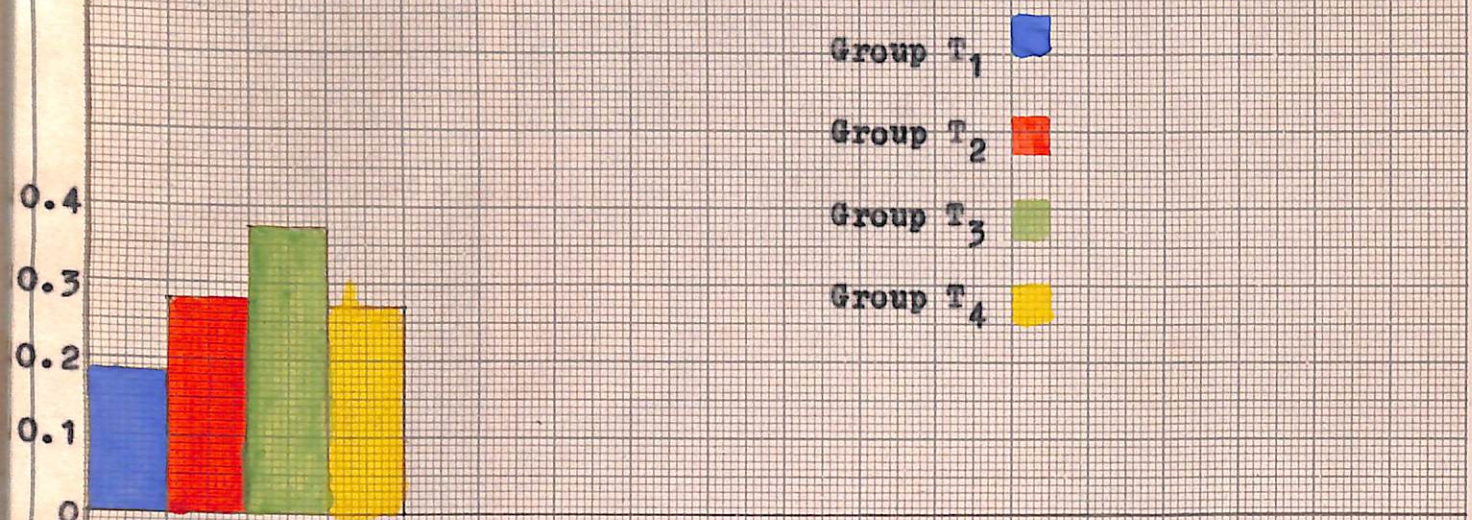
From perusal of Table - 15 it will appear that although the animals of all the groups were in positive nitrogen balance, the maximum nitrogen retention was found in group T_3 (5.47±0.63) followed by group T_4 (5.05±0.89) and T_2 (4.23± 0.74) and the least nitrogen retention was recorded in group T_1 (1.48±0.36) which is obviously due to the least nitrogen content in its diet. The group T_1 significantly varies with other three groups. But there is no significant variation between group T_2, T_3 and T_4. The maximum retention per unit nitrogen intake was in group T_4 (0.401 gm) closely followed by group T_2 (0.378 gm) and group T_3 (0.373 gm). But there is no significant variation between these three groups indicating that ration containing 10% CP was better. However, the best performance as regards growth rate, body size development and feed conversion efficiency was observed in group T_3. Thus it is concluded that optimum protein requirement for growth in deshi male kids (7 to 12 kg body weight) is about 10 to 12% crude protein corresponding to 8.3 to 9.9 % DCP in the air dry feed.

The findings of nitrogen balance of the present study appreciably varied with those of Singh and Sengar (loc. cit.) who recorded balance of nitrogen from -2.02 ± 0.16 to 1.68 ± 0.09 in Barbari bucks and +0.26 ± 0.39 to +2.57 ± 0.35 in Jamunapari bucks receiving different combinations of high, medium and low energy and protein rations. A probable explanation for this variation may be that they carried the nitrogen balance on adult goats (bucks) but the present trial was carried on growing kids.

***

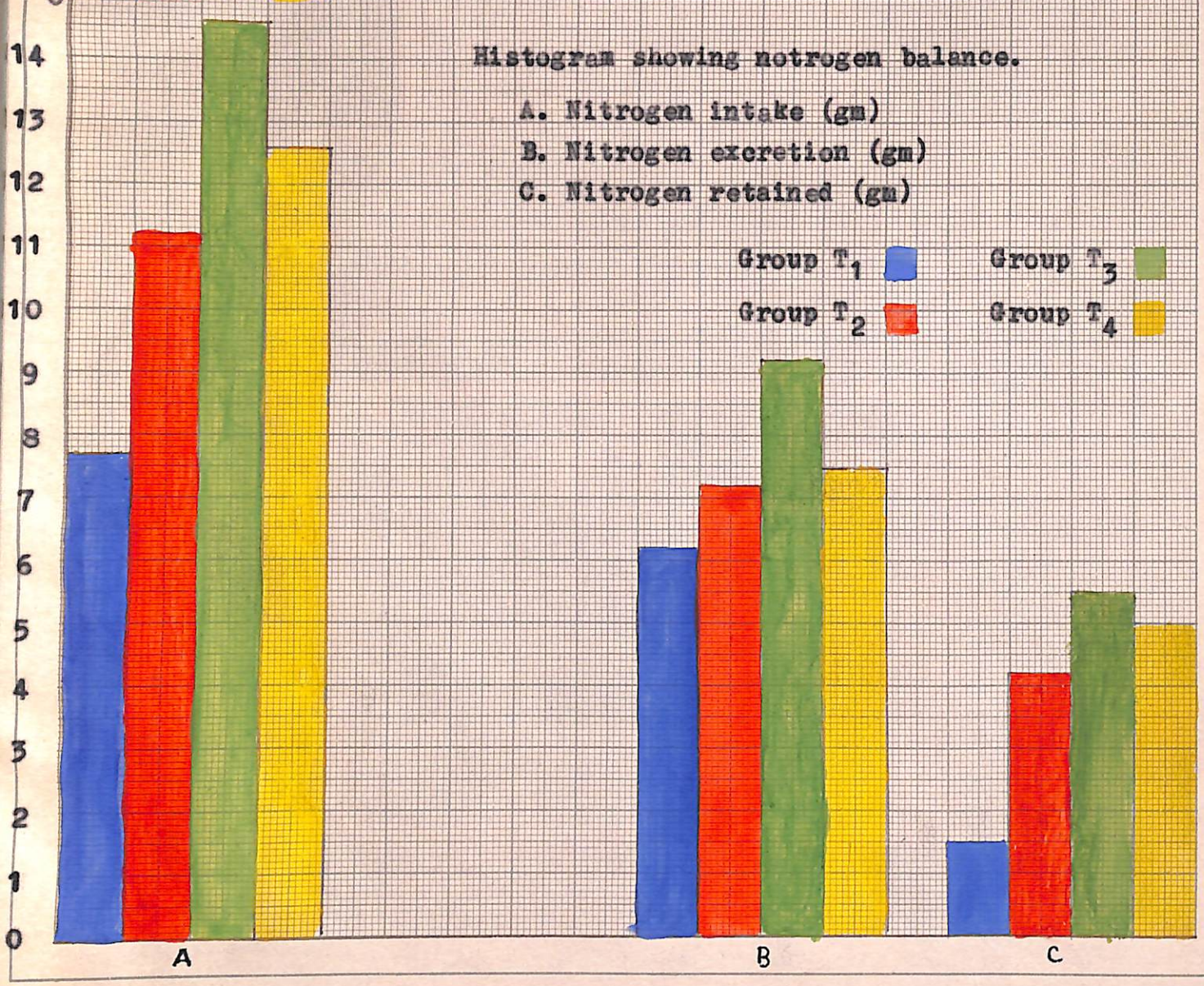

Weekly growth curve for group T_1, T_2, T_3 and T_4
Group T_1
Group T_2
Group T_3
Group T_4
Body weight (kg)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
1 2 3 4 5 6 7 8 9 10 11 12 13
weeks

Histogram showing rate of body weight gain (kg) per week in different treatment g groups.

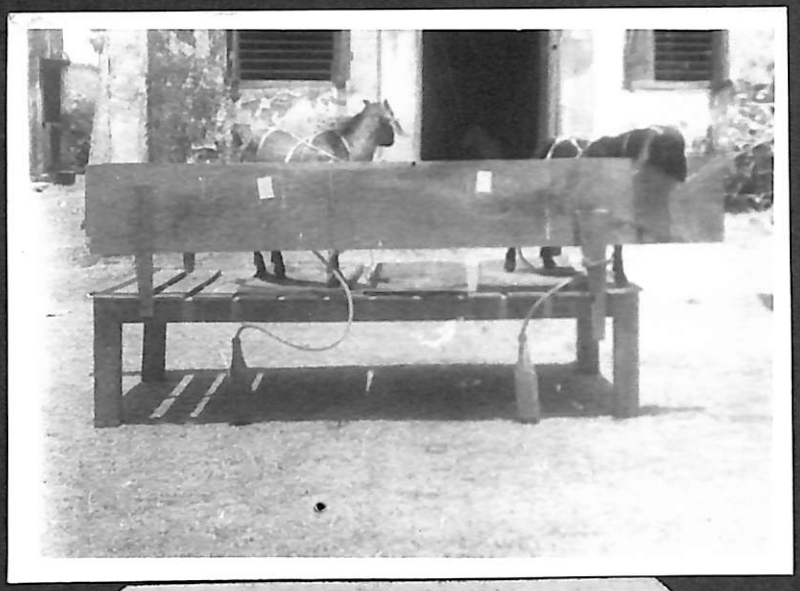


Histogram showing notrogen balance.

A. Nitrogen intake (gm)
B. Nitrogen exeretion (gm)
C. Nitrogen retained (gm)



The kid attached with urine and faeces collection bags, before shifting into the metabolic cage.



Kids, in metabolic cage.

S U M M A R Y

S U M M A R Y

1. Twenty (20) locally available nondescript male kids of about 3 months age were randomly divided into 4 groups (T_1, T_2, T_3 and T_4). They were kept on rations (concentrate mixture + paragrass) of optimum energy but different levels (8, 10, 12 and 14%) of crude protein respectively. Concentrate mixtures consisted of linseed cake, wheat bran and Arhar chuni.

2. The overall average dry matter consumption was recorded to be 4.34 ± 0.21 (4.24 ± 0.21 to 4.53 ± 0.13) kg per 100 kg body weight per day which increased with increase of age and body weight and did not varied with the level of protein in the diet.

3. Weekly body weight was recorded and it was found that protein level significantly affected the growth rate. The average growth rate of 26.4, 39.4, 53.7 and 38.4 gm per day were observed in group T_1, T_2, T_3 and T_4 respectively, indicating that the growth rate of group T_3 was maximum in the present experiment.

4. Length, girth and height of each animal were measured at the beginning and end of the experiment and thus, body development was observed. The average increase in length in group T_1, T_2, T_3 and T_4 was 3.5, 7.3, 8 and 6 cm, girth 4.25, 5.7, 6 and 5.7 cm, length 10, 7, 11.75 and 9.3 cm respectively. Thus, the group T_3 showed the best performance ~~than others~~.

5. Digestibility co-efficient of different nutrients of the composite feed was estimated in all the 4 groups. The overall

digestibility co-efficient of DM, CP, CF, EE and NFE was observed to be 75.46 ± 1.95, 79.26 ± 2.07, 69.95 ± 2.68, 89.75 ± 1.17 and 78.39 ± 1.46 respectively. The digestibility co-efficient of all nutrients in group T_1 significantly varied with other groups while the rest three did not vary significantly among themselves.

6. Feed efficiency was calculated to find out the influence of different rations on growth. Average DM, DCP and TDN consumed per kg gain in live weight were recorded to be 11.569, 1.415, 11.168 in group T_1, 6.815, 1.274, 7.521 in group T_2, 5.380, 1.200, 6.060 in group T_3 and 8.277, 1.656, 7.959 kg in group T_4 respectively. Thus, the minimum intake of DM, DCP and TDN per unit gain in weight was observed in group T_3.

7. Nitrogen balance study was carried on twice, one in the middle and the other at the end of the experiment. The balance of nitrogen was 1.48 ± 0.36, 4.23 ± 0.74, 5.47 ± 0.63 and 5.05 ± 0.89 in group T_1, T_2, T_3 and T_4 respectively.

The maximum retention per unit of intake was recorded in group T_4 (0.401 gm), closely followed by group T_2 (0.378 gm) and T_3 (0.373 gm). There was no significant difference between these three groups indicating that ration of 10% CP was better.

The overall performance, with respect to growth rate, body size development and feed conversion efficiency was observed in group T_3. Thus it can be concluded that optimum requirement of crude protein for growth in deshi male kids (7 to 12 kg body weight) is 10 to 12% corresponding to 8.3 to 9.9% DCP in the air dry feed.

...

BIBLIOGRAPHY

B I B L I O G R A P H Y

A.O.A.C. (1970). Official method of analysis of the Association of official analytical chemists. 11th Edition, Washington, DC, 20044.

Becker, D.E. and Co-worker (1954). Level of protein in practical rations for the pig. J.Ani.Sci., 13:611-621.

Chaturvedi,M.L. and Saxena, J.S. (1971). Some salient features of kid rearing. Ind. vet. J., 48: 10, 1034-1038.

Devendra, C. (1967). Studies in nutrition of the indigenous goat of Malaya; The maintenance requirement of pen fed goats; The requirement of live weight gain; The free water intake of pen fed goats; Feed conversion efficiency, Economic efficiency and feeding standards for goats. Malaysian Agri.J., 46: 80-97, 98-118, 191-203, 204-216. Cited by in Nutri.Abs. and Rev. (1968), 38: 3, 1022-1023.

Dalai, R.K. (1966). Growth studies of Tharparkar calves on three levels of Nutrition, M.Sc. Thesis submitted to the Magadh University.

Devegowda, G. (1973). The protein requirement of pure bred broiler chicks,. M.V.Sc. Thesis submitted to Agra University.

Fonolla, J., Sanz, R., Gonzalez, M.A. (1972). Effect of pelleting on digestibility and feeding value of dried lucern meal for Granda goats. Mejora Animal. 13: 6, 343-349. Cited in Nutri.Abst.Rev., 43; 7(1973).

Geiger, E. (1961). "Modern nutrition in health and disease" Ed.by Wohl,G.M.,Goodhart,R.S. Lea and Febigar.

Hossain, W. (1959). Goat rising in Pakistan. Agriculture Pakistan, 16: 509-534. Cited in Nutri. Abst. and Rev., (1967), 37: 3, 5522.

Johri, C.B. and Talpatra, S.K. (1971). Early growth of Jamunapari goats. Ind. vet. J., 48: 4,389-393.

Johri, C.B. and Talpatra, S.K. (1971). Jaminapari kids under browsing and stall fed condition. Ind.vet.J., 48: 5, 495-503.

Linnaeus (1758). Cited in Dairy Sci. Abst. 1968, 30(2):67-87.

Lofgreen,G.P., Loosli, J.K. and Maynard, L.A. (1951).Comparative study of the conventional protein allowances and theoretical requirement. J. Ani.Sci., 10: 171-183.

Maheshwari, M.L. and Talpatra, S.K. (1975). Stall feeding of Jamunapari goats with cowpea fodder. Ind. vet. J., 52: 1, 30-33.

Maheshwari, M.L. and Talpatra, S.K. (1975). Berseem as a fodder for milch goats. Ind. vet. J.,52:2, 113-114.

Majumdar, B.N. (1960). Studies on goat nutrition, minimum protein requirement of goats for maintenance, endogenous urinary nitrogen and metabolic faecal nitrogen excretion studies Part I and II. J.Agric. Sci., 54: 329-340.

Maynard, L.A. and Loosli, J.K. (1969). Animal Nutrition, 6th Edi., pp. 356.

Meckenzie (1956). Goat husbandry, Faber and Faber Ltd.,London.

Ranhotra, G.S. and Jordan, P.M. (1966). Protein and energy requirement of lambs weaned at 6 to 8 weeks of age as determined by growth and digestion study. J. Ani. Sci., 25: 630-635.

Saxena, J.S. and Maheshwari, M.L. (1971). Studies on comparative intake of nutrient by browsing goats. Ind. vet. J., 48: 2, 173-175.

Sen, K.C. and Roy, S.N. (1967). The nutritive value of Indian cattle foods and feeding of farm animals. I.C.A.R. Bull. 25.

Sharma, G.N. (1962). Studies on growth rate and chemical composition of calves on two levels of protein feeding. M.V.Sc. Thesis submitted to Magadh University.

Singh, S.N. and Sengar, O.P.S. (1970). Final technical report of the P.L. 480 Research Project No. A7. AH18. pp. 3,4,5,18,146,147,155, 233.

Singh, B.B. and Singh, B.P. (1974). Performance of Jamunapari goats. Ind. vet. J., 51: 5, 326-332.

Snedecor, G.W. (1957). Statistical methods; The Iowa State College Press Ames Iowa.

The review of work done at animal Nutrition Centre, Haringhata (1954-1969).

The Times of India Directory and Year Book including Who's who (1973).

Tigga, J.J. (1969). The amino acid composition of muscle tissue of buffalo, goat and poultry, with reference to Lysine, Erginine, Leucine, Isoleucine and Phenylalanine. M.Sc. Thesis submitted to Magadh Univ.

Wilson, P.N. (1958). The effect of plane of nutrition on the growth and development of East African dwarf goats, Effect of plane of nutrition on live weight gains and external measurement. J. Agri. Sci., (1960), 19: 44-53.

Zeuner, F.E. (1963). A history of domesticated animals. New York and Evanston, Hasper and Row, Publishers. p. 560. Cited by Singh and Sengar (1970).

***
*