NUTRITIVE EVALUATION OF COMPLETE RATION FOR GROWTH IN KIDS

By
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THESIS

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DECLARATION

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

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CERTIFICATE

Certified that the thesis entitled "NUTRITIVE EVALUATION OF COMPLETE RATION FOR GROWTH IN KIDS" is a record of research work done independently by Miss.Deepa Ananth under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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Dedicated To My Beloved

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Introduction

INTRODUCTION

Indian agriculture is an economic symbiosis of crop and animal production. Seventy per cent of Indian population live in rural areas and of these, thirty per cent are progressive farmers holding about eighty per cent of land and the rest are poor farmers or labourers holding less than 1 acre of land (Malik, 1990). Inorder to achieve social justice between the two groups, we have to modify our existing system to generate income and employment potential for small holdings through diversification of farm production, at the same time increasing the productivity of crop as well as livestock. To bridge this wide gap, it has to increase net return of the small income group by promoting subsidiary enterprise like livestock farming. For the landless and marginal farmers, goat farming is ideal, as this not only need small investment but also, provide rural employment and absorb family labour as it is well said as poor man's cow.

India is blessed with largest population of goat accounting to 118 million in 1993 (FAO, 1993). Of these, 13 per cent are slaughtered per annum yielding about 3,500 crore rupees from meat, 1000 crore rupees from milk and rupees 5,500 crore from skin, hair , manure etc. Mutton Industry is fast progressing as it is well accepted by all religions. Nutritionally, it provides low fat, lean, easily digestible meat. About 44.2 per cent of total meat produced in India comes from small ruminants. As per 1984 Figures, India is third in fresh mutton export and the export potential comes to about 1000 tonnes per year.

Management of goats is also easier when compared to cattle, as they are more sturdy, accept wide variety of feeds and thrive well in harsh environmental conditions. They are better adapted to coarse roughage in comparison with other ruminants (Krishna and Prasad, 1990). Goat manure is rich in nitrogen and fetches more price. This animal is highly prolific, having good kidding percentage and better feed conversion efficiency.

Still, goat and sheep production in India is very low due to acute shortage of grazing and browsing resources, as more and more marginal and submarginal lands are brought under cultivation. Further, the quality and quantity of forage available from natural grazing lands are progressively diminishing due to excessive grazing pressure and also neglect of grazing lands for lack of proper maintenance and development. In the present situation, 44 per cent of the country's cultivated area is under fodder crops and there is hardly any scope for expansion because of pressure on agricultural land for food and cash crops (Reddy and Raghavan, 1992). It is reported that in India, there is a deficiency of 44 per cent and 11 per cent respectively for concentrates and dry fodder and 38 per cent for green fodder (National Commission of Agriculture, 1976). The feed deficit in terms of metabolizable energy and digestible protein for the year 1984 were 32 per cent and 54 per cent respectively (Reddy, 1990).

In India, 95 per cent of feed stuff utilization is from locally available sources which include crop residues and agroindustrial byproducts, the availability of which was abstracted to the extent of 409.7 metric tonnes annually (FAO, 1986). Optimum level of incorporation of fibrous resources in the ration of small ruminants is an essential step in enhancing livestock productivity. But majority of crop residues are generally low in nitrogen and mineral content along with high lignin and silica, which influence their digestibility adversely, so much so these items cannot meet even the maintenance requirements of the animal. They are also deficient in fermentable energy as reflected by relatively low organic matter digestibility.

The concentrates that are available include various agroindustrial byproducts which are either the end products of production and consumption, that have not been used, recycled or salvaged. The byproducts obtained from grain processing (bran), oil seed processing (oil meals) and pulses processing are the major feed ingredients covering over 70 per cent of total concentrates produced and utilized as livestock feed in the country (Reddy, 1990).

The major drawbacks of using nonconventional feed ingredients are, their scattered nature, non competitive cost, high cost of collection and processing, limited knowledge about their composition such as the proximate principles, nutritive value and presence of deleterious principles as well as the marketability of end products. In view of inadequate supply and exorbitant cost of conventional feed ingredients, there is an urgent need to procure unconventional feed ingredients and to develop suitable and appropriate processing methods to enhance their bioavailability for increased and improved use as animal feed. This aspect has to be considered on priority basis and long range comprehensive studies have to be undertaken to standardize the methods for utilizing agroindustrial byproducts as animal feed to the maximum extent.

Investigations have been carried out in different parts of the world in utilizing locally available unconventional feed ingredients with special reference to their analysis and processing to improve their nutritive value.

Studies on standardization of various agroindustrial waste materials which are available in plenty in Kerala were carried out for the last twenty years in the College of Veterinary Sciences, Kerala Agricultural University, Mannuthy under the All India Coordinated Research Project (ICAR) on utilization of agricultural by products and industrial waste material for evolving economic ration for livestock, with the objective of exploring the possibility of utilizing agroindustrial waste materials as livestock feed and to evolve unconventional, economic and balanced ration for livestock. Significant achievements have been made in the project and on scrutiny of the work carried out under the project, it has been shown that several new unconventional feed materials have been identified, their nutritive value have been assessed and rations have been formulated by incorporating those unconventional feed with beneficial effect. Among these, Rubber seed cake, Tapioca starch waste, Tapioca leaf meal, and Tea waste are of special importance to Kerala (Sankunny et al., 1964).

Effective utilization of the fibrous, low nutritive feed involving an appropriate feeding system is the most important avenue that can ensure high performance in small ruminant. The concept of complete ration utilizing locally available agroindustrial byproducts may be a feasible feeding system, for stall feeding small ruminants for commercial production and at the same time converting poor quality non edible products into highly nutritious animal feed (Reddy and Reddy, 1983).

Considerable opportunities exist for evolving various methods of processing and developing complete feed for goats and sheep in India. Processing of chosen feeds have several advantages, that prompted the development of complete feed for small ruminants. Both aspects are relatively new but are gaining increasing attention in India (Krishna and Prasad, 1990). They have particular relevance and considerable future potential when viewed in the context of a shift towards more intensive system of production.

In the present study, attempts have been made to develop complete ration for goats, using unconventional feed ingredients as the major part such as tapioca leaves, gliricidia leaves, and tea waste and to assess their effect on nutrient utilization in growing kids.

Review of Literature

REVIEW OF LITERATURE

Major constraints in utilizing crop residues and agroindustrial byproducts are, their low nutritive value in terms of low digestible crude protein and energy, poor palatability, and presence of antinutritional factors, along with their scattered availability, rapid spoilage and also lack of preservation facility (Devendra, 1981). Most of them are characterised by low content of nitrogen in general and total nutrients in particular, with carbohydrate content of either high solubility or of highly insoluble structural nature.

Supplementation with protein, minerals and vitamins alone does not overcome the problems of low intake and low metabolisable energy content. Methods to improve the nutritive value of crop residues and agroindustrial byproducts are by the use of cheap and viable technologies that include chemical, mechanical and biological treatments.

Effective utilization of unconventional feed stuffs includes their nutritive evaluation, economics of feeding in relation to conventional raw materials and added cost for detoxification and increasing palatability (Devendra, 1981).

The works done in the Department of Nutrition, College of Veterinary and Animal Sciences under the All India Coordinated Research Project on agroindustrial byproducts (ICAR) to evolve non conventional economic balanced ration for livestock, Kunjikutty (1981) reported that tapioca leaves could be utilized for feeding cattle successfully at the level of 25 per cent. Similar work was also done by Onwuka and Akinsoyinu (1989) with tapioca leaf incorporated ration in West African Dwarf goats for maintenance.

There are also reports that gliricidia leaves could be incorporated in the ration of goats as substantiated by Murugan et al. (1985), Van Eys (1986), Dharia et al. (1987), Rao (1987) and Veereswara Rao et al. (1993).

Combination of unconventional feed resources will tackle the problems of their reduced availability, low level of incorporation in the diet, palatability and also improve the nutritive value due to associative effect. The concept of complete feeding system can be advantageously used for improving utilization of poor quality crop residues by increasing their intake, nutritive value and palatability (Reddy, 1989).

2.1 Complete Feed - Definition

Owen (1979) has defined the complete feed as a uniform mixture of feed ingredients processed in such a way as to avoid differential selection by the animal which include roughages and concentrates given as a sole source of nutrients except water and sometimes certain minerals. The diet is freely offered during most of the 24 hours so that, the animals consume little and often but as much as they like according to the yield per lactation basis, and thus provides a reason for the high yielders to realise their potential, without wasting feed on a low yielder.

2.1.1 Advantages of complete feed

Rakes (1969) reported that the complete mixed rations have the potential advantage of providing a uniform feed at all times for all animals in a pen minimizing labour requirement and maximizing automation.

Works done by Fontenot and Hopkins (1965) showed that pelleting of concentrate portion of the ration did not increase feed consumption; however, pelleting of forage or forage-concentrate combination did.

Bartley (1973) stated that the complete diet, when consumed by all animals could be defined more exactly and a better balance of nutrient and intake could be achieved, by avoiding individual preferences for forage and concentrate.

To minimize feed cost and labour and to maximise production, is the need of the time and could be achieved by blending concentrate, which include locally available byproducts and roughage portions, containing crop residues in the ration to form complete feed (Reddy, 1989).

2.2.1. Effect on feed characteristics

Ross and Pavey (1959) had stated that pelleting allows incorporation of more total forage into lamb rations while improving both average daily gain and feed efficiency.

Brent et al. (1961) showed that digestibilities of energy and dry matter in pelleted rations containing known amounts of concentrate and roughage, decreased as the roughage portion increased from 40 to 90 per cent and protein digestibility decreased with increase in roughage level from 60 to 90 per cent. Horton et al. (1982) stated that pelleting of low quality roughages has been shown to increase the intake and daily gain in steers.

Newland et al. (1962) showed that pelleting of corn portion of corn-alfalfa ration decreased total feed consumption when compared to a ground corn-alfalfa ration, while the average daily gain remained the same. It was suggested that a change in relative amounts of acetate and propionate was responsible for improved feed efficiency in pelleted feeds.

Butchner and Raleigh (1962) in their study to find out the effect of stilbestrol and oxytetracycline and pelleted feed on fattening of White face and Black face crossbred wether lambs showed that, increased daily feed consumption and feed efficiency could be achieved by feeding pelleted rations.

Reddy and Narasa Reddy (1990) studied certain characteristics of eight crop residues and forest grasses by subjecting them to physical processing where they found that there was an increase in density, to the extent of 32 per cent by crushing the cotton seed, and by pelleting to the extent of 236 per cent in maize straw depending upon the particle size, shape, fibre character and compactness of molecule. The cost of transportation of low density light fibrous crop residues from area of production to area of scarcity can thus be reduced. Pelleting also markedly increased the digestibility of N.D.F., A.D.F., hemicellulose, cellulose and lignin in sorghum straw, maize straw, Heteropogon contortus and Sahima nervosa grasses, cotton seed hulls, ground nut hulls and maize cobs but not in cotton straw, sunflower straw and sugarcane bagasse in small ruminants.

2.2.2 Effect on Nitrogen Utilization

A more even intake of feed into the rumen is associated with less fluctuation in the release of ammonia, better utilization of nonprotein nitrogen and may lead to an increase in general utilization of protein.

Tarakanov et al. (1979) conducted studies on the effect of complete feed containing urea and different amounts of straw on rumen microflora and productivity of young fattening bulls and showed that the intensity of biosynthesis and enzyme activity in the forestomach changed in relation to composition and duration of intake of pellets and ensured efficient utilization of nonprotein nitrogen in the synthesis of microbial protein and increased formation of acetate in the rumen.

Reddy and Reddy (1985) from their studies on the effect and rumen characteristics of ammoniated processed cotton straw, fed as a sole source of roughage in the complete ration for Murrah buffaloes disclosed that, the concentration of total nitrogen, trichloroacetic acid insoluble nitrogen, residual nitrogen, food and protozoan nitrogen were increased with ammonia treatment.

Reddy and Reddy (1990) also reported that pelleting of cotton seed hull-based complete feed increased the organic matter, crude protein, and ether extract digestibility and significantly improved nitrogen balance.

2.2.3 Effect on physiology and rumen characteristics

It has been demonstrated by Warner (1966) that the amount of bulky material a ruminant can consume could be limited by the space available in the digestive tract.

Magnar Ronning and Laben (1966) fed four milled diets having hay to concentrate ratio 90:10, 60:40, 30:70 and 0:100 to lactating cows and observed that milk yield was found to be depressed on 90:10 diet and over conditioning was noted in the two high concentrate groups. These workers have concluded that diets containing 60 per cent hay resulted in best overall performance.

Burt and Dunton (1967) suggested that dry matter and nitrogen digestibility could be increased by frequent feeding , particularly when offered low quality feed, to non-lactating cattle and other species. Their experiment also revealed that, frequent feeding could reduce the fluctuation in rumen pH values, the concentration of volatile fatty acid and ammonia in the rumen liquor and increased the proportion of propionic acid.

Mehta and Singhal (1983) showed that pelleting had no effect on release of ammonia nitrogen, digestibility of cellulose, nutrient utilization or microbial protein synthesis. Utilization of nitrogen was better with experimental diet when pelleted, than when unpelleted and was comparable with that of control diet. Pelleted complete feed decreased heat production and gas formation in the rumen (Prokudin and Tashenov, 1983).

Nadal-Yak and Ptashkin (1983) observed a decreased heat production and gas formation in the rumen, reduced urinary nitrogen excretion and improved utilization of metabolizable energy and nitrogen for growth in lambs reared for meat maintained on a complete feed mixture.

Reddy and Reddy (1985) pelleted a complete ration incorporating ground cotton straw, when offered to Murrah buffaloes, showed an increase in total volatile fatty acid concentration, the rate of fermentation and better utilization of crude fibre and also a reduction in the rumen pH in comparison with the corresponding mash feed.

2.2.4 Effect on rearing and fattening animals

Bartely (1973) observed that feeding 25 per cent sun cured alfalfa hay in pelleted form to calves significantly increased feed consumption and more weight gain than calves maintained on milk starter and hay separately.

Borland and Kesler (1979) reported considerable weight gain and chest circumference when Holstein calves were maintained on commercial pelleted complete feed than that of hay-based pellets or corn silage or hay-based rations. They have also shown that the efficiency of conversion of drymatter or digestible energy was greatest in pelleted diets.

Ananthasubramaniam et al. (1983) have reported that inclusion of coconut pith-based complete ration for growth in crossbred calves did increase the total weight gain and daily body weight gain, though there was a reduction in the crude fibre and drymatter digestibility.

Agaev (1984) maintained young cattle with complete pelleted feed as supplements to concentrate and silage, helped to spare grain concentrate without adversely affecting meat yield, meat quality and financial returns and also facilitated part replacement of grain by grass meal, straw and other roughages.

Khokhar et al. (1985) stated that alkali treated wheat straw significantly increased the drymatter consumption, digestibilities of drymatter, crude fibre and decreased cost per kilogram live weight gain when fed as complete feed for growing calves. Better carcase quality was reported by Palenik (1988) in Czechslovak Red spotted young bulls and their crossbreds with Black and White low land given complete feed containing 20 per cent haylage and maize given both in pelleted or loose form showed similar proportions of lean in the forequarter and an increase in fat compared to same feed given as roughage and concentrate separately. Narayanaswamy et al. (1990) found that 50 per cent inclusion of red gram straw and groundnut having crude protein value of 9.3 per cent and 11.45 per cent respectively in complete rations of growing sheep produced satisfactory growth with feed efficiency of 1:10.57 and 1:9.53 respectively and drymatter intake ranged from 80-98 Kg $W^{0.75}$ per day with digestible crude protein and total digestible nutrient value of 10.78, 10.8 and 50.29, 57.58 percent respectively.

Reddy and Raghavan (1992) had concluded that complete feeds containing 60 per cent mixed grass hay supported growth rate upto 500-600 g/day where as feed containing 35 per cent wheat straw and 15 per cent berseem hay supported a growth rate of only 450 g/day in crossbred calves.

2.2.5 Effect on milk production

Thurmon et al. (1964) fed a complete ration containing 30 per cent hay ad libitum to lactating cows produced significantly more 4 per cent fat corrected milk (4 per cent FCM) than either the cows fed both hay and concentrate ad libitum or concentrate ad libitum or those fed hay ad libitum and concentrate at the rate of 1 Kg to each 2.5 Kg of 4 per cent fat corrected milk produced daily. The intake by the group consuming the complete ration was significantly lower than those receiving both hay and concentrate ad libitum.

Lactating cows fed the hay-based complete feed were found to be more efficient in their use of TDN for milk production than those fed either the corn cobs or cotton seed hull containing rations (Mc.Coy, 1966).

Leighton and Helm (1967) compared the feeding of alfalfa hay and sorghum green chop ad libitum along with concentrate at the rate of 1 Kg to 2.5 Kg of milk with two complete rations containing 30 per cent chopped alfalfa hay and ground alfalfa hay respectively. Similar feed intakes and milk production levels were reported for all the three groups. The depression of fat percentage (Rakes, 1969) in cow's milk by feeding rations having high proportion of concentrate had been observed repeatedly. Complete feed were found to be notorious for their adverse effect on fat percentage

Owen (1979) observed reduced chances of low milk fat syndrome, in crossbred cows and buffaloes when fed a complete feed containing either 54 per cent cotton straw, 47 per cent mixed grass hay or 35 per cent sunflower straw as roughage sources, maintained 6-8 litres of milk with normal butter fat in comparison with conventional type of feed containing concentrates, green fodder and roughage separately. He also reported that, in farms that adopted complete diet for their dairy herds showed an increase in average percentage of total solids in milk by about 0.2 units per annum, with butter fat per cent showing annual improvement of 0.14 units and SNF per cent by 0.06 units, which accounts for 10 per cent increase in the value of milk.

Reddy and Reddy (1983) studied the effect of feeding complete feeds containing dried grass, maize and other conventional ingredients on nutrient utilization and milk production, in cross bred cows fed both as mash and pellet form in comparison with conventional feeding system including feeding of napier grass and concentrate at the rate of 1 Kg per 2.5 Kg of milk as control, showed that daily drymatter intake and milk yield was higher with complete ration, both in mash and pellets, milk composition, feed efficiency, feed cost per Kg of milk did not differ significantly but feed intake per Kg of milk tended to be lowest with control diet and feed cost per Kg of milk was lowest with complete mash diet.

Increased milk yield, reduced weight loss and shorter calving interval was reported by Tvrznik et al. (1992) in dairy cows fed commercial complete diet during first stage of lactation.

2.3.1 Disadvantages of Complete Feeding System

Major disadvantages of complete feeding system are high processing cost and labour. Most of the adverse effect caused by complete feeding is due to disparity in concentrate-roughage ratio. Jensen et al. (1958) had demonstrated that, in sheep fed finely ground pelleted diets required long forages to prevent rumen parakeratosis.

Pelleted complete feed had shown to decrease the digestibility of crude fibre but had no effect on protein digestibility (Weir et al., 1959) and produced a decrease in energy digestibility as reported by Heany et al. (1963).

Newland et al. (1962) showed that pelleting of corn portion of a corn-alfalfa ration decreased the total feed consumption when compared with ground corn-alfalfa ration, while average daily gain remains the same.

Laszezka et al. (1980) from their investigation on the effect of changes in qualitative composition of the diet on freezing ability of bull semen found a significant reduction in sperm motility of first ejaculate in fresh as well as post thawing.

Increase in length by 2.31 m and increase in weight of intestine and thickness of rumen wall in lambs fed complete feed was reported by Slesarev et al. (1980) from their work on effect of roughages on growth and rumen digestion in lambs fed complete mixed diets.

Palfi et al. (1981) pointed out some physiological changes in the digestive tract of sheep fed on complete feed in the form of mash or pellets compared with traditional diet, induced an increase in length of small intestine and mass of liver, kidney, spleen, internal fat and also temporary parakeratosis in the rumen, which could be rectified by long term feeding.

Levchenko (1983) reported neutrophilia and increased serum aminotransferase and abnormal blood protein pattern in beef cattle fed grannulated complete feed of high density concentrates.

Increased calcium aspartate, amino transferase, bilirubin and cholesterol concentration in the serum of sheep fed with complete ration were reported by Markiewicz et al. (1988) and Serra et al. (1992).

The value of crop residues and tree forages are associated with number of advantages like, they provide variety of feed and a valuable source of protein, energy, sulphur for rumen microorganisms, rich in minerals and they have a laxative effect on the alimentary system as well as reduce the cost for purchased concentrates (Devendra, 1992).

Optimum inclusion of fibre together with improved performance with concentrates demand attention as this system would increase the utilization of more coarse ingredients and better intake.

Many unconventional feed ingredients have been utilized for making complete feed such as bagasse (Bhosrekar et al., 1981), ammoniated cotton plant, cotton straw (Reddy and Reddy, 1983), citruspeeling (Kroll, 1986), ground nut hulls (Reddy and Narasa Reddy, 1990), reed (Aagel-Din, 1990), cotton seed hull (Reddy and Reddy, 1991), *Sesbania grandifolia* leaves (Balapeeraiah et al., 1993), legume based complete feeds (Reddy et al., 1994), alkali treated wheat straw (Sihag et al., 1994) maize husk (Dayal et al., 1996), sunflower heads (Rao et al., 1997) and some unconventional items on different rations at 25 per cent level as reported by Bala Nageswara Rao (1989) are some of them.

On scrutiny of the foregoing paragraphs explicitly explained on various aspects of complete feeding system and its effect on feed characteristics, nitrogen utilization, rumen physiology, rearing and fattening animals and on milk production, informations on the feasibility of incorporation of agroindustrial byproducts in the complete ration and a definite recommendation of its utilization especially the agroindustrial byproducts prevailing in Kerala are rather scanty. An attempt has been made to evolve a complete pelleted ration for goats utilizing unconventional feed ingredients for the Malabari goats, the native breed of Kerala, which are highly prolific and has an average weight gain of 50 - 80 grams per day as reported by James and Chandran (1975), Gangadevi (1981), Mercy et al. (1981), James (1990) and Shyama (1994).

Materials and Methods

MATERIALS AND METHODS

3.1. Experimental animals

Eigtheen Malabari kids, four to five months of age and weighing on an average 9.27, Kg after being dewormed and sprayed against ectoparasites, were used in the present investigation. The animals selected from the herd of goats maintained by the University Goat and Sheep Farm, Mannuthy, formed the experimental subjects for study. The kids were distributed randomly to three experimental groups of six animals each as uniformly as possible, with regard to age, sex and weight. All the kids were maintained on identical conditions of management and were fed individually as per I.C.A.R (1985) standards. Wholesome water was made available at all time. The experimental duration lasted for 120 days including a preliminary period of one week.

3.2. Experimental Rations

Three rations were prepared, Complete ration I (CR-I) consisting of guinea grass and bran, Complete ration II (CR-II) consisting of tapioca leaves and tea waste and Complete ration III (CR-III) consisting of gliricidia leaves and tea waste as major parts. Grass and gliricidia leaves were procured from University Livestock Farm and Fodder Research Station, Mannuthy, tea waste from Mattupetty Tea Estate and tapioca leaves were procured locally. Leaves were removed with petioles from the main stem and were chopped manually for about one and half inches in length, and dried in hot air oven for 3 days at 60° C. Materials were ground separately in a hammer mill and sieved manually to have a particle size less than 0.4 cm^2. The resultant materials were mixed with other ingredients as per their percentage composition in their respective ration as shown in the table A in a horizontal mixer for 10 minutes. The mash was taken out, mixed with one-fifth the weight with water and cold pelleted in a pelleting machine supplied by M/s. Cremach Designs, Baroda with die size of 12 mm diameter. The pellets were sieved again to remove the dust and placed in the oven at 60° C overnight to remove excess moisture.

Table A- The percentage composition of rations CR I, CR II and CR III

CR-I		CR-II		CR-III	
Grass meal	45	Tapioca leaves	45	Gliricidia leaves	45
Black gram bran	15	Tea waste	15	Tea waste	15
Gingelly oil cake	10	Gingelly oil cake	14	Gingelly oil cake	14
Bengal gram	12	Bengal gram	12	Bengal gram	12
Groundnut cake	10	--	--	--	--
Wheat	6	Wheat	12	Wheat	12
Mineral mixture	1.5	Mineral mixture	1.5	Mineral mixture	1.5
Salt	0.5	Salt	0.5	Salt	0.5
	100		100		100

Supplevit-M at the rate of 25 grams per 100 Kg feed was added which provides vitamin A 5 lakhs i.u., vitamin D3 1 lakh i.u., vitamin E 75 i.u., vitamin K 0.1 g, vitamin B2 0.2 g, nicotinamide 1 mg, vitamin B12 0.6 mg.

The chemical composition of rations are shown in table B.

Pellets are shown in plate I.

Plate I **Complete feed pellets**

CR II

CR III

CR I

3.3 Methods

The kids were weighed at weekly intervals and record of daily feed intake both morning and evening were maintained throughout the course of the study. A digestibility cum metabolism trial was carried out towards the terminal period of the feeding trial wherein, quantitative and separate collection of urine and faeces were carried out for five consecutive days, using metabolism cages specially fabricated for the purpose (Plate II). Urine from male kids were collected through urine collection device attached to the collection bottle. Every day at 9.30 AM and 3.30 PM the animals were given measured quantities of respective ration . At the same time residue from previous meal was removed and quantified.

3.3.1 Sampling of rations

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

3.3.2 Collection and sampling of faeces and urine

All precautions were taken to ensure the collection of dung and urine quantitatively uncontaminated with any feed residue or dirt. The dung was collected manually as and when it was voided. The urine was collected in bottles kept under the funnel of metabolism cages with frequent rinsing with distilled water in case of females and with collection device in case of males.

Plate II Metabolism trial - Male

Concentrated Sulphuric acid (25 per cent) at the rate of 20 ml was added in each bottle before the collection of urine. At 11 AM every day , the dung and urine voided during the previous 24 hours were measured accurately. Representative samples of both dung and urine at the rate of 10 per cent of the total voided quantity were taken and stored in refrigerator. The samples collected from each animal were preserved during the entire collection period and later pooled and used for further analysis.

3.3.3. Digestibility Coefficients

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

3.3.4 Proximate Analysis

The feed and dung samples collected during the metabolism trial were subjected to proximate analysis as per standard procedures (A.O.A.C, 1990) Protein was analysed using Kjeltec 2000 digestion and distillation unit. Fibre fractions were analysed as per the method described by Goering and Vansoest (1970). Calcium and magnesium content of feed and dung samples were estimated by using Atomic Absorption Spectrophotometer (Perkin Elmer model 3110) and Phosphorus by colorimetric procedure using spectronic 20 (Milton Roy Co. USA).

The urine samples collected during the metabolism trial were analysed for nitrogen (Kjeltec 2000 digestion and distillation unit) calcium and magnesium were estimated using Atomic Absorption Spectrophotometer and phosphorus by modified metol method using phosphorus kit supplied by Stangen Immunodiagnostics.

3.3.5. Hematological Studies

Blood samples for the analysis were collected from the jugular vein of the animal into sterile citrated tubes. Red cell counts were made using improved Neubauer counting chamber with 1:200 dilution of blood using Hayems fluid. White blood cell counts were made by using Thomas fluid as the diluent with 1:20 dilution. Haemoglobin content of the samples were determined by Cyanmethaemoglobin method (Benjamin, 1974). Plasma protein values were determined by Biuret method (Gornall et al., 1949) using total protein and albumin kit supplied by Stangen Immunodiagnostics. Serum calcium and magnesium were determined by Atomic Absorption Spectrophotometer (Perkin Elmer model 3110). Serum inorganic phosphorus was determined by modified metol method using phosphorus kit supplied by Stangen Immunodiagnostics.

Table B Percentage chemical composition of the experimental rations on drymatter basis

	CR I	CR II	CR III
Crude Protein	18.26	18.41	19.03
Ether Extract	4.70	3.46	5.78
Crude Fibre	17.40	19.07	15.50
Total Ash	9.00	10.70	8.25
Nitrogen Free Extract	50.64	48.36	51.44
Acid Insoluble Ash	3.15	3.42	1.09
Neutral Detergent Fibre	44.12	45.13	51.26
Acid Detergent Fibre	30.81	32.55	35.50
Acid Detergent Lignin	9.66	7.68	8.12

Results

RESULT

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

4.1 Body weight gain

The body weight gain of animals recorded during the entire period of study and their average daily gain are presented in Tables 1 to 3 represented by Fig. 1 and summarised data on average initial body weight, final body weight, cumulative weight gain and daily gain of kids maintained on three dietary treatments are presented in Table 4.

4.2 Dry matter intake

The average daily dry matter consumption during the period of 16 weeks of study are summarised in Table 7 and dry matter intake per Kg $W^{0.75}$ summarised in Table 8.

4.3 Feed efficiency

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

4.4 Protein efficiency

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

4.5 Cost per unit gain

Data on cost per unit gain are shown in Table 11 and represented by Fig. 4.

Consolidated data on weight gain, dry matter intake, feed efficiency, protein efficiency and cost per unit gain of animals are detailed in Table 12, and the statistical analyses of these parameters are set out in Tables 5 and 6 and Tables 13 to 16 respectively.

4.6 Hematological parameters

Data on hematological parameters such as T.E.C., T.L.C., haemoglobin and plasma protein concentrations are set out in Table 17 and serum calcium, phosphorus and magnesium are presented in Table 18 and statistical analyses of these parameters are detailed in Tables 19 to 25.

4.7 Digestibilities of nutrients

Results of the digestibility trial are set out in Tables 26 to 32 and consolidated data in table 33 and data on statistical analyses are detailed in Tables 34 to 40.

4.8 Nitrogen and mineral balances

Results of nitrogen and mineral balances are shown Tables 41 to 44 and represented by Figs. 5 to 8. Consolidated data on per cent retention of nitrogen, calcium, phosphorus and magnesium are presented in table 44 and corresponding statistical analyses in Tables 46 to 49.

Table 1 : Weekly body weights (Kilogram) of kids maintained on complete ration (CR I - Control), containing conventional feed ingredients.

Week	Animal Number						Average with S.E.
0	1	2	3	4	5	6	
0	7.0	7.5	7.6	12.8	10.7	10.2	9.30±0.939
1	7.2	8.0	8.2	13.7	11.3	11.6	10.00±1.049
2	7.4	8.3	8.6	15.6	11.6	11.9	10.57±1.255
3	7.6	8.4	9.0	16.0	12.5	12.0	10.92±1.298
4	7.8	8.5	9.5	16.5	13.1	12.3	11.28±1.349
5	8.0	8.8	9.9	17.0	13.7	12.6	11.67±1.393
6	8.3	9.1	10.2	17.4	14.4	13.0	12.07±1.429
7	8.6	9.6	10.5	17.9	15.0	13.3	12.48±1.457
8	9.1	9.9	10.9	18.3	15.5	13.7	12.91±1.461
9	9.5	10.4	11.3	18.7	16.0	14.0	13.32±1.458
10	9.8	10.8	11.8	19.2	16.5	14.4	13.75±1.481
11	10.2	11.2	12.4	19.5	17.0	14.7	14.17±1.463
12	10.4	11.8	12.8	20.2	17.3	15.2	14.62±1.503
13	10.7	12.2	13.3	20.7	17.8	15.7	15.01±1.528
14	11.2	12.5	13.8	21.1	18.2	16.1	15.48±1.521
15	11.7	12.9	14.2	21.6	18.6	16.5	15.92±1.524
16	12.1	13.3	14.6	22.1	19.0	16.9	16.33±1.536

Table 2 : Weekly body weights (Kilogram) of kids maintained on complete ration (Ration CR II), containing Tapioca leaves plus Tea waste as the major parts.

Week	Animal Number						Average with S.E.
	7	8	9	10	11	12	
0	8.1	7.4	7.6	12.4	10.3	9.1	9.15±0.784
1	8.5	7.7	8.4	13.0	10.9	9.5	9.67±0.806
2	9.0	8.0	9.0	13.5	11.4	10.1	10.16±0.818
3	9.4	8.4	9.4	13.9	11.8	10.4	10.55±0.818
4	9.7	8.7	9.8	14.3	12.2	10.8	10.92±0.832
5	10.1	8.9	10.2	14.9	12.6	11.3	11.33±0.877
6	10.4	9.2	10.5	15.5	13.2	11.7	11.74±0.925
7	10.8	9.5	10.9	15.9	13.7	12.2	12.17±0.946
8	11.1	9.8	11.3	16.4	14.3	12.5	12.57±0.985
9	11.5	10.2	11.6	16.9	14.8	12.9	12.98±1.008
10	11.9	10.5	11.9	17.3	15.3	13.4	13.38±1.028
11	12.3	10.9	12.3	17.9	15.8	13.7	13.82±1.060
12	12.8	11.3	12.5	18.3	16.3	14.2	14.23±1.072
13	13.2	11.6	12.9	18.8	16.7	14.6	14.63±1.094
14	13.6	12.1	13.3	19.2	17.0	15.0	15.03±1.078
15	14.0	12.5	13.6	19.6	17.4	15.4	15.42±1.084
16	14.4	12.8	14.0	20.0	17.8	15.8	15.80±1.093

Table 3 : Weekly body weights (Kilogram) of kids maintained on complete ration (Ration CR III), containing unconvetional feed ingredients like Gliricidia leaves plus Tea waste as major parts

Week	Animal Number						Average with S.E.
	13	14	15	16	17	18	
0	8.0	7.6	10.8	11.5	10.4	7.9	9.37±0.703
1	8.5	8.0	11.3	12.0	10.7	8.4	9.82±0.702
2	8.7	8.3	11.7	12.6	11.1	8.9	10.22±0.739
3	8.9	8.6	12.0	13.2	11.5	9.3	10.58±0.777
4	9.2	8.9	12.3	13.6	11.9	9.7	10.93±0.787
5	9.6	9.2	12.5	13.9	12.4	10.2	11.30±0.773
6	9.9	9.6	12.8	14.3	12.8	10.6	11.67±0.775
7	10.3	10.0	13.1	14.7	13.1	11.0	12.03±0.766
8	10.5	10.3	13.4	15.0	13.7	11.5	12.40±0.781
9	10.9	10.6	13.8	15.4	14.1	11.9	12.78±0.790
10	11.3	11.0	14.2	15.8	14.4	12.3	13.17±0.784
11	11.6	11.4	14.6	16.2	14.8	12.6	13.53±0.796
12	12.0	11.7	15.1	16.5	15.1	13.0	13.90±0.794
13	12.4	12.0	15.5	16.8	15.4	13.4	14.25±0.787
14	12.7	12.3	15.9	17.2	15.8	13.7	14.60±0.808
15	13.0	12.6	16.3	17.6	16.2	14.0	14.95±0.829
16	13.4	13.0	16.6	18.0	16.5	14.3	15.33±0.834

Fig1. Body weight of kids maintained on three complete rations

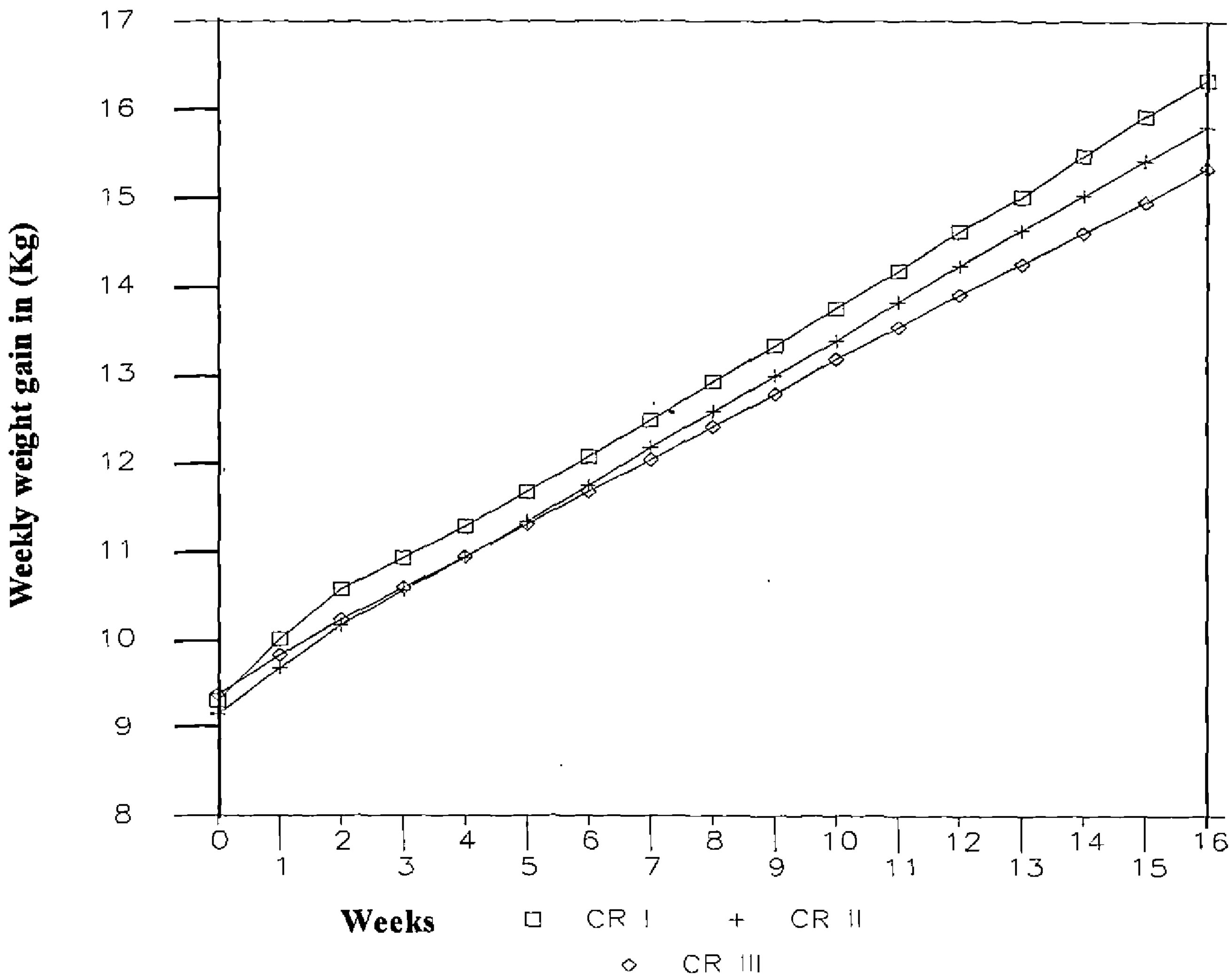

Table 4 : Summarised data on average initial body weight, average final body weight, average cumulative weight gain and average daily gain of kids maintained on three dietary treatments (Rations CR I, CR II and CR III)

Treatments	Ration CR I control containing conventional feed ingredients	Ration CR II Experimental containing unconventional feed ingredients like Tapioca leaves plus Tea Waste	Ration CR III Experimental containing unconventional feed ingredients like Gliricidia leaves plus Tea Waste
Number of Kids	6	6	6
Initial body weight (Kg)	9.30±0.939	9.15±0.784	9.37±0.703
Final body weight (Kg)	16.33±1.536	15.80±1.093	15.33±0.834
Cumulative weight gain (Kg)	7.03±0.637	6.65±0.335	5.96±2.422
Average daily gain (g)	62.77±0.004	59.38±0.004	53.21±0.000

Table 5 : Analysis of variance - Cumulative weight gain

Source	df	SS	MSS	F
Rations	2	3.741	1.871	1.686 NS
Error	15	16.642	1.109	
Total	17	20.383		

Table 6 : Analysis of variance - Average daily gain

Source	df	SS	MSS	F
Rations	2	0.000	0.000	1.696 NS
Error	15	0.002	0.000	
Total	17	0.002		

NS Not significant

Table 7 : Average daily dry matter intake (g) of the animals maintained on the experimental rations (CR I, CR II and CR III)

Treatments	Ration CR I	Ration CR II	Ration CR III
Number of Kids	6	6	6
0-7 days	337.38	322.80	299.50
7-14	385.23	378.80	313.60
14-21	401.66	389.95	336.60
21-28	412.16	392.13	363.37
28-35	427.63	438.09	393.36
35-42	455.42	454.06	430.88
42-49	481.98	479.23	445.28
49-56	508.95	497.70	480.55
56-63	555.56	560.91	525.90
63-70	616.80	590.24	555.50
70-77	653.58	648.28	590.08
77-84	717.31	698.19	634.58
84-91	756.38	715.39	656.10
91-98	766.50	739.60	677.00
98-105	811.40	760.61	701.10
105-112	817.30	798.00	765.00

Table 8 : Average daily feed intake (g) per Kg $W^{0.75}$ on drymatter basis of the animals maintained on the experimental rations (CR I, CR II and CR III)

	Treatments	Ration CR I	Ration CRII	Ration CR III
	No. of kids	6	6	6
1	0-7 days	63.35	57.94	55.97
2	7-14	68.35	58.09	56.62
3	14-21	68.52	60.56	58.97
4	21-28	68.75	67.32	60.24
5	28-35	69.61	67.93	63.64
6	35-42	70.59	68.22	66.05
7	42-49	73.55	68.41	66.82
8	49-56	79.38	74.11	68.87
9	56-63	83.41	85.66	73.49
10	63-70	85.40	86.11	79.37
11	70-77	89.49	86.63	82.77
12	77-84	93.38	86.88	84.50
13	84-91	93.27	86.99	87.22
14	91-98	95.17	87.91	87.93
15	98-105	96.56	89.52	89.04
16	105-112	100.84	92.97	90.27

Table 9 : Average weekly feed efficiency of animals maintained on the three dietary regimes. [kg DMI/kg gain]

Treatments	Ration CR I	Ration CR II	Ration CR III
Number of kids	6	6	6
0-7 days	3.52	4.35	4.66
7-14	5.39	5.41	5.49
14-21	3.40	6.99	6.37
21-28	7.59	7.42	7.27
28-35	7.87	7.48	7.41
35-42	7.97	7.75	8.16
42-49	8.03	8.18	8.66
49-56	8.48	8.50	9.09
56-63	9.26	9.35	9.69
63-70	10.04	10.08	10.23
70-77	10.89	11.07	11.16
77-84	11.41	11.64	12.05
84-91	11.76	12.21	13.12
91-98	12.78	13.28	13.54
98-105	13.21	13.65	14.02
105-112	14.30	14.70	15.75

Fig.2. Feed efficiency of kids maintained on three complete rations

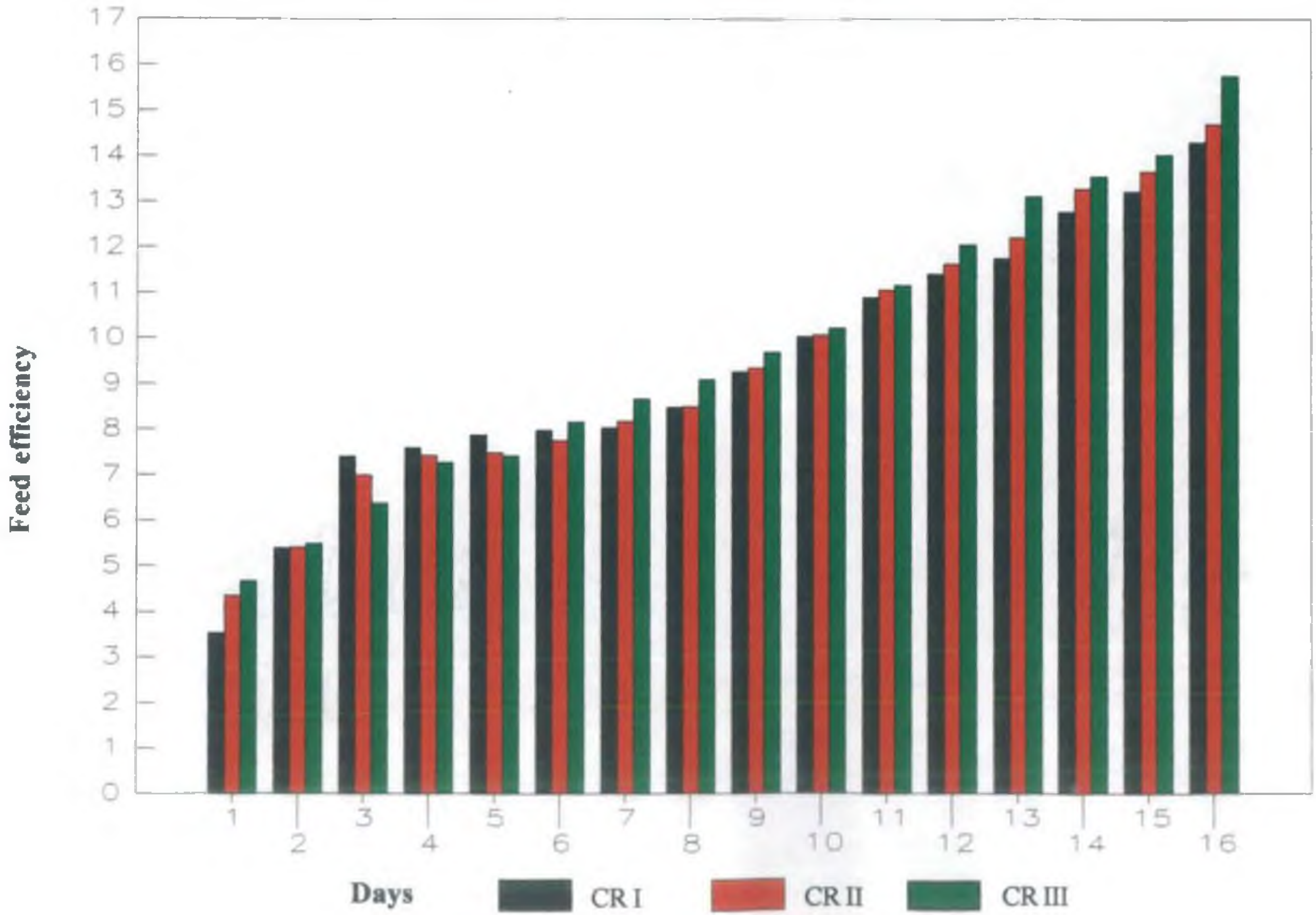

Table 10 : Average weekly protein efficiency of animals maintained on the three dietary regimes.

(Amount of protein consumed per kilogram gain)

Treatments	Ration CR I	Ration CR II	Ration CR III
Number of Kids	6	6	6
0-7 days	0.5718	0.7299	0.8783
7-14	0.8769	0.9091	1.0343
14-21	1.2030	1.1745	1.2006
21-28	1.2339	1.2462	1.3697
28-35	1.2788	1.2566	1.3974
35-42	1.2960	1.3023	1.5376
42-49	1.3060	1.3746	1.6319
49-56	1.3790	1.4275	1.7136
56-63	1.5055	1.5704	1.8260
63-70	1.6320	1.6929	1.9287
70-77	1.7710	1.8596	2.1042
77-84	1.8550	1.9548	2.2711
84-91	1.9120	2.0519	2.4728
91-98	2.0770	2.2302	2.5520
98-105	2.1480	2.2935	2.6425
105-112	2.3256	2.4696	2.9686

Fig.3. Protein efficiency of kids maintained on three complete rations

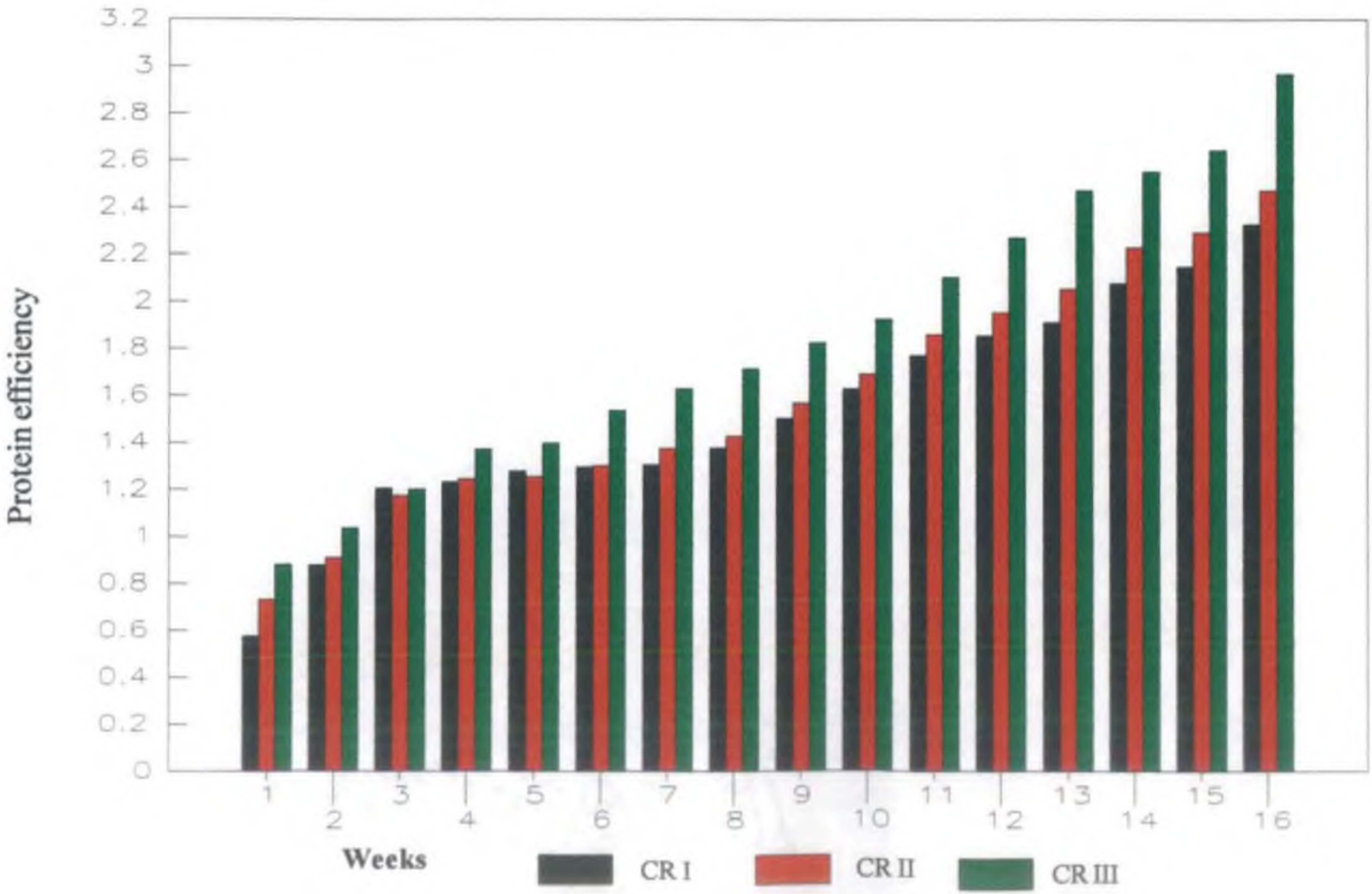

Table 11 : Data on cost of production per kg gain (Rs.) of the animals maintained on the three dietary regimes.

Treatments	Ration CR I	Ration CR II	Ration CR III
Number of kids	6	6	6
Average total weight gain (kg)	7.03	6.65	5.96
Total feed consumption (kg)	63.74	62.05	57.18
Total feed cost (Rs.)	488.88	393.40	360.17
Cost of production per kg gain (Rs.)	69.54	59.16	60.43

Cost of ration CR I	Rs. 7670.00/tonne
Cost of ration CR II	Rs. 6340.00/tonne
Cost of ration CR III	Rs. 6300.00/tonne

Fig.4. **Cost of production per Kg gain of kids maintained on three complete rations**

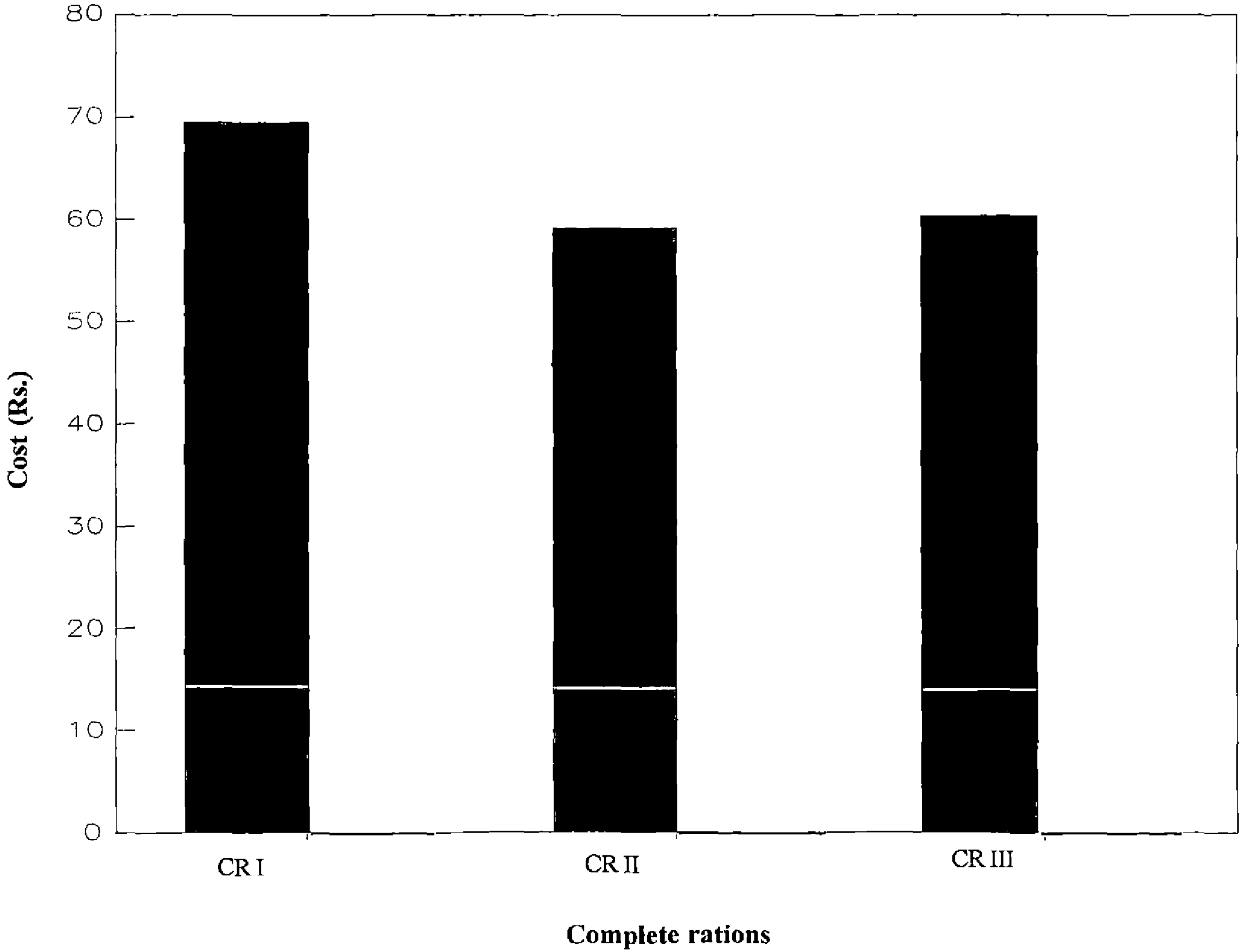

Table 12 : Consolidated data on dry matter intake, weight gain, feed efficiency, protein efficiency and cost per unit gain recorded for kids maintained on the three rations for a period of 112 days.

Treatments	Ration CR I	Ration CRII	Ration CR III
Number of kids	6	6	6
Average daily dry matter consumption(g)	569.07±67.510	554.00±63.530	510.53±60.960
Average daily gain(g)	62.77±0.004	59.38±0.004	53.21±0.000
Average cumulative gain 112 days (Kg)	7.03±0.637	6.65±0.335	5.96±2.422
Average cumulative feed efficiency	9.09±1.190	9.33±1.230	9.63±1.330
Average cumulative protein efficiency	1.5232±0.192	1.5965±0.208	1.8456±0.249
Cost per unit gain(Rs.)	69.54±2.00	59.16±4.04	60.43±2.22

Table 13 : Analysis of variance - Average daily drymatter intake

Source	df	SS	MSS	F
Ration	2	29577.236	14788.618	0.601 NS
Error	45	1107834.753	24618.550	
Total	47	1137411.989		

Table 14 : Analysis of variance - Feed efficiency

Source	df	SS	MSS	F
Ration	2	1.497	0.748	0.080 NS
Error	45	423.019	9.400	
Total	47	424.515		

Table 15 : Analysis of Variance - Protein Efficiency

Source	df	SS	MSS	F
Ration	2	0.914	0.457	1.597 NS
Error	45	12.872	0.286	
Total	47	13.786		

Table 16 : Analysis of Variance - Cost efficiency

Source	df	SS	MSS	F
Ration	2	1279.771	639.886	1.493 NS
Error	45	19288.178	428.626	
Total	47	20567.949		

Table 17 : Data on average T.L.C, Haemoglobin and Plasma protein concentrations of kids maintained on experimental rations.

Treatments	Ration CR I	Ration CR II	Ration CR III
Number of Kids	6	6	6
T.E.C. (10^6/cumm)	12.4±2.43	11.83±0.73	10.19±0.99
T.L.C. (10^3/Cumm)	13.0±2.32	12.54±0.70	10.80±0.95
Haemoglobin (g/dl)	9.27±0.67	8.42±0.19	8.17±0.13
Plasma Protein (g/dl)	11.91±0.85	11.58±0.96	11.74±0.95

Table 18 : Data on average serum calcium, inorganic phosphorus and magnesium concentration of kids maintained on experimental rations.

Treatments	CR I	CR II	CR III
Number of Kids	6	6	6
Calcium mg/dl	9.03±0.280	9.58±0.470	9.46±0.612
Phosphorus mg/dl	3.65±0.289	3.73±0.126	3.69±0.543
Magnesium mg/dl	2.08±0.127	2.19±0.135	1.81±0.143

Table 19 : Analysis of variance - Total Erythrocyte Count

Source	df	SS	MSS	F
Ration	2	11.746	5.873	0.991^{NS}
Error	15	88.937	5.929	
Total	17	100.683		

NS Not significant

Table 20 : Analysis of variance - Total Leucocyte Count

Source	df	SS	MSS	F
Ration	2	12.80	6.40	1.187 NS
Error	15	80.86	5.39	
Total	17	93.66		

Table 21 : Analysis of Variance - Hemoglobin

Source	df	SS	MSS	F
Ration	2	3.99	1.995	1.967 NS
Error	15	15.215	1.014	
Total	17	19.205		

Table 22 : Analysis of variance - Plasma protein

Source	df	SS	MSS	F
Ration	2	4.313	2.157	0.425 NS
Error	15	76.060	5.071	

NS Not significant

Table 23 : Analysis of variance - serum calcium

Source	df	SS	MSS	F
Ration	2	1.008	0.504	0.37 NS
Error	15	20.405	1.36	

Table 24 : Analysis of variance - serum inorganic phosphorus

Source	df	SS	MSS	F
Ration	2	0.02	0.010	0.013 NS
Error	15	11.868	0.791	

Table 25 : Analysis of variance - serum magnesium

Source	df	SS	MSS	F
Ration	2	0.469	0.234	2.12 NS
Error	15	1.659	0.111	

NS Not significant

Table 26 : Digestibility coefficients of dry matter intake of the animals maintained on the three dietary regimes.

Treatment	CR I	CR II	CR III
Number of kids	6	6	6
Drymatter intake (g/day)	630.06	534.61	511.56
Outgo (g/day)	207.25	210.81	223.49
Difference (g/day)	422.81	323.80	288.07
Digestibility Coefficient	67.04	60.72	56.37

Table 27 : Digestibility coefficients of crude protein consumed by the animals maintained on the three dietary regimes.

Treatments	CR I	CR II	CR III
Number of kids	6	6	6
Protein intake (g/day)	115.05	98.39	97.34
Protein outgo(g/day)	39.97	39.45	44.24
Difference (g/day)	72.08	58.94	53.10
Digestibility coefficient	65.26	59.79	54.46

Table 28 : Digestibility coefficients of ether extract consumed by the animals maintained on the three dietary regimes.

Treatments	CR I	CR II	CR III
Number of kids	6	6	6
Intake of ether extract (g/day)	29.61	18.50	27.12
Outgo (g/day)	4.08	4.17	8.64
Difference (g/day)	25.53	14.33	18.48
Digestibility Coefficient	86.48	77.53	68.30

Table 29 : Digestibility coefficients of crude fibre consumed by the animals maintained on the three dietary regimes.

Treatments	CR I	CR II	CR III
Number of kids	6	6	6
Intake of crude fibre (g/day)	109.63	101.95	79.29
Outgo (g/day)	69.09	58.10	40.13
Difference (g/day)	39.86	43.65	39.16
Digestibility coefficient	36.36	43.01	49.45

Table 30 : Digestibility coefficients of nitrogen free extract consumed by the animals maintained on the three dietary regimes.

Treatments	CR I	CR II	CR III
Number of kids	6	6	6
Intake of nitrogen free extract (g/day)	322.72	269.53	253.58
Outgo (g/day)	59.94	69.57	91.72
retained (g/day)	262.78	199.96	161.86
Digestibility coefficient	81.43	74.19	63.83

Table 31 : Digestibility Coefficient of neutral detergent fibre consumed by the animals maintained on the three dietary regimes.

Treatments	CR I	CR II	CR III
Number of kids	6	6	6
Intake of NDF (g/day)	278.61	187.81	264.79
Outgo (g/day)	124.47	142.29	132.25
Balance (g/day)	154.10	45.52	132.54
Digestibility Coefficient	55.31	24.24	50.06

Table 32 : Digestibility coefficient of acid detergent fibre consumed by the animals maintained on the three dietary regimes.

Treatments	CR I	CR II	CR III
Number of kids	6	6	6
Intake of ADF (g/day)	137.42	104.52	115.76
Outgo (g/day)	73.48	65.20	67.68
Balance (g/day)	63.94	39.32	48.08
Digestibility Coefficient	46.53	37.62	41.53

Table 33 : Consolidated table on digestibility coefficients of nutrients consumed by the animals maintained on the experimental rations (vide Tables 26 - 32).

Digestibility Coefficients of nutrients	CR I	CR II	CR III
Number of kids	6	6	6
Drymatter	67.04±0.588	60.72±0.498	56.37±0.628
Crude Protein	65.26±1.502	59.90±0.784	54.55±1.796
Ether Extract	86.48±0.445	77.53±0.278	68.30±1.240
Crude Fibre	36.36±1.710	43.01±2.490	49.45±1.176
Nitrogen Free Extract	81.15±1.074	74.19±0.861	63.90±0.890
Neutral Detergent Fibre	55.31±1.853	24.24±1.184	50.06±2.964
Acid Detergent Fibre	46.53±3.630	37.62±2.150	41.53±3.364

Table 34 : Analysis of variance - digestibility coefficient of dry matter

Source	df	SS	MSS	F
Ration	2	345.441	172.72	87.298**
Error	15	29.678	1.979	
Total	17	375.118		

Table 35 : Analysis of variance - digestibility coefficient of crude protein

Source	df	SS	MSS	F
Ration	2	393.607	198.803	16.131**
Error	15	183.008	12.201	
Total	17	576.615		

Table 36 : Analysis of variance - digestibility coefficient of ether extract

Source	df	SS	MSS	F
Ration	2	990.887	495.443	136.031**
Error	15	54.632	3.642	
Total	17	1045.519		

** $P > 0.01$

Table 37 : Analysis of variance - digestibility coefficient of crude fibre

Source	df	SS	MSS	F
Ration	2	514.224	257.112	12.225**
Error	15	315.462	21.031	
Total	17	829.687		

Table 38 : Analysis of variance - digestibility coefficient of nitrogen free extract

Source	df	SS	MSS	F
Ration	2	903.732	451.866	84.192**
Error	15	80.507	5.367	
Total	17	984.239		

Table 39 : Analysis of variance - digestibility coefficient of neutral detergent fibre

Source	df	SS	MSS	F
Ration	2	8271.845	4135.922	151.952**
Error	15	408.280	27.219	
Total	17	8680.125		

Table 40 : Analysis of variance - digestibility coefficient of acid detergent fibre

Source	df	SS	MSS	F
Ration	2	239.538	119.769	2.055 NS
Error	15	874.025	58.268	
Total	17	1113.563		

** P > 0.01
NS Not significant

Table 41 : Data on nitrogen balance and per cent retention of the animals during metabolism trial.

Treatments	CR I	CR II	CR III
Number of kids	6	6	6
Nitrogen intake (g/day)	18.41	15.75	15.58
Nitrogen outgo			
Faecal (g/day)	6.21	6.31	7.07
Urinary (g/day)	2.47	2.00	1.33
Total (g/day)	8.68	8.31	8.40
Nitrogen balance (g/day)	9.73	7.44	7.18
Per cent retention of Nitrogen	53.03	47.26	46.12

Fig.5. Per cent retention of Nitrogen of kids maintained on three complete rations

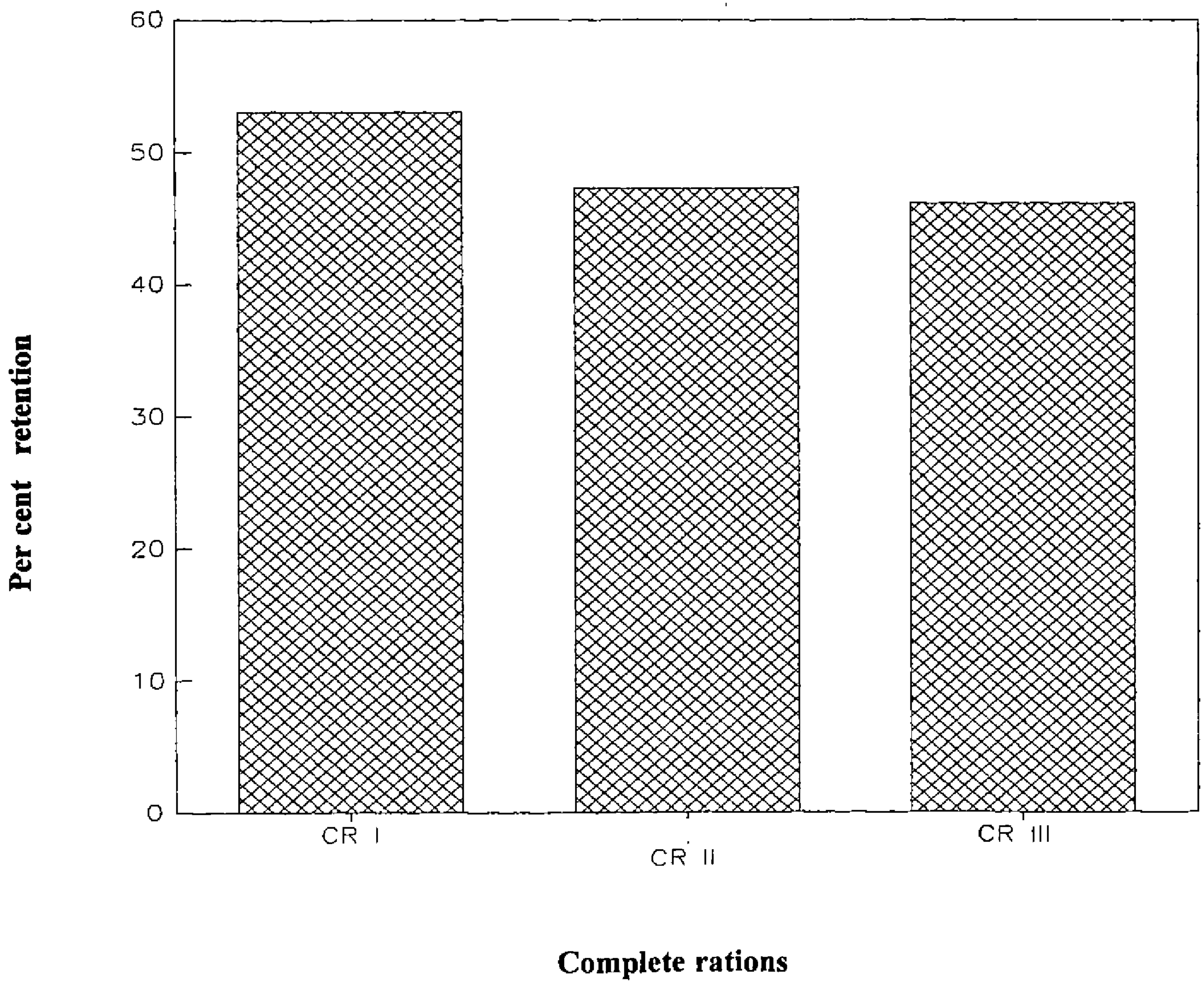

Table 42 : Data on calcium balance and per cent retention of the animals maintained during metabolism trial.

Treatments	CR I	CR II	CR III
Number of kids	6	6	6
Calcium intake (g/day)	7.31	9.30	11.87
Calcium outgo			
Faecal (g/day)	3.27	4.25	4.56
Urinary (g/day)	0.08	0.12	0.14
Total (g/day)	3.35	4.41	4.70
Balance (g/day)	3.96	4.89	7.17
Per cent retention of Calcium	54.17	52.57	60.40

Fig.6. Per cent retention of Calcium of kids maintained on three complete ration

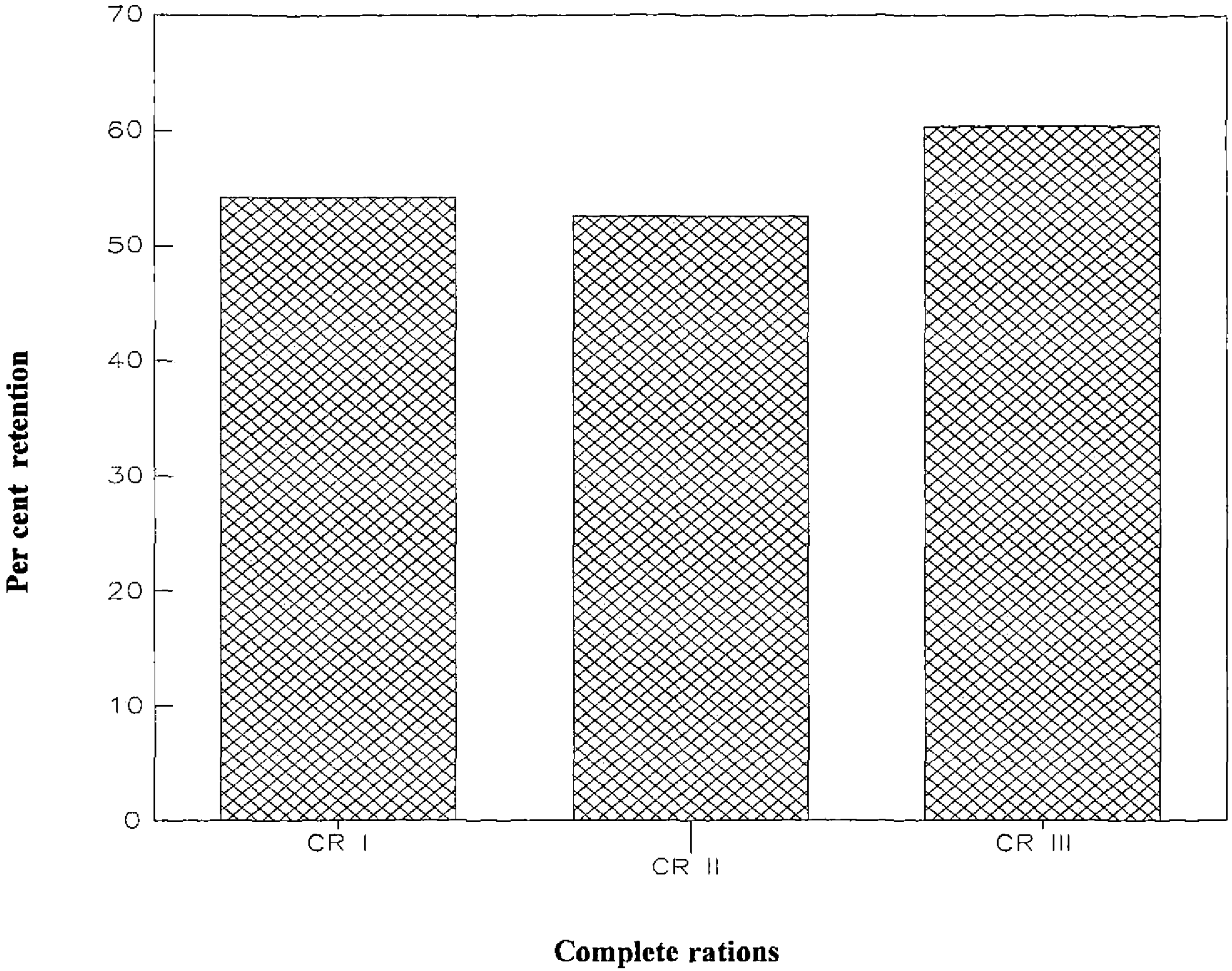

Table 43 : Data on phosphorus balance and per cent retention of the animals during metabolism trial.

Treatment	CR I	CR II	CR III
Number of kids	6	6	6
Phosphorus Intake (g/day)	4.85	3.73	3.27
Phosphorus Outgo			
Faecal (g/day)	2.54	2.01	1.86
Urinary (g/day)	0.07	0.08	0.10
Total (g/day)	2.61	2.09	1.96
Balance (g/day)	2.24	1.64	1.31
Per cent retention of Phosphorus	46.65	44.00	40.35

Fig.7. Per cent retention of Phosphorus of kids maintained on three complete ration

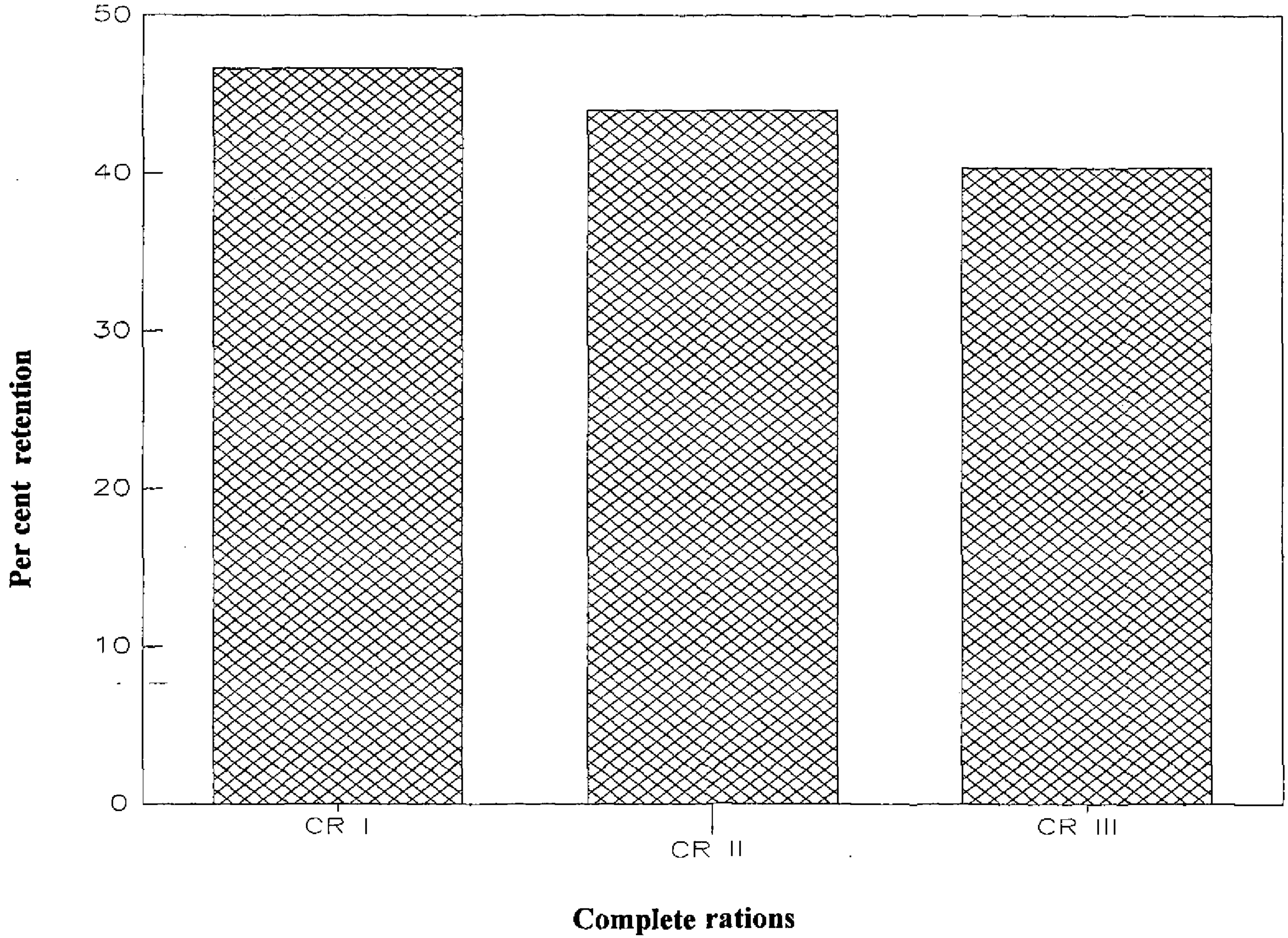

Table 44 : Data on magnesium balance and per cent retention of the animals during metabolism trial.

Treatment	CR I	CR II	CR III
Number of kids	6	6	6
Magnesium Intake (g/day)	2.90	2.28	2.02
Magnesium outgo			
Faecal (g/day)	1.25	1.10	1.07
Urinary (g/day)	0.27	0.17	0.11
Total (g/day)	1.52	1.27	1.18
Balance (g/day)	1.38	1.01	0.84
Per cent retention of Magnesium	47.59	44.30	41.58

Fig.8. Per cent retention of Magnesium of kids maintained on three complete rations

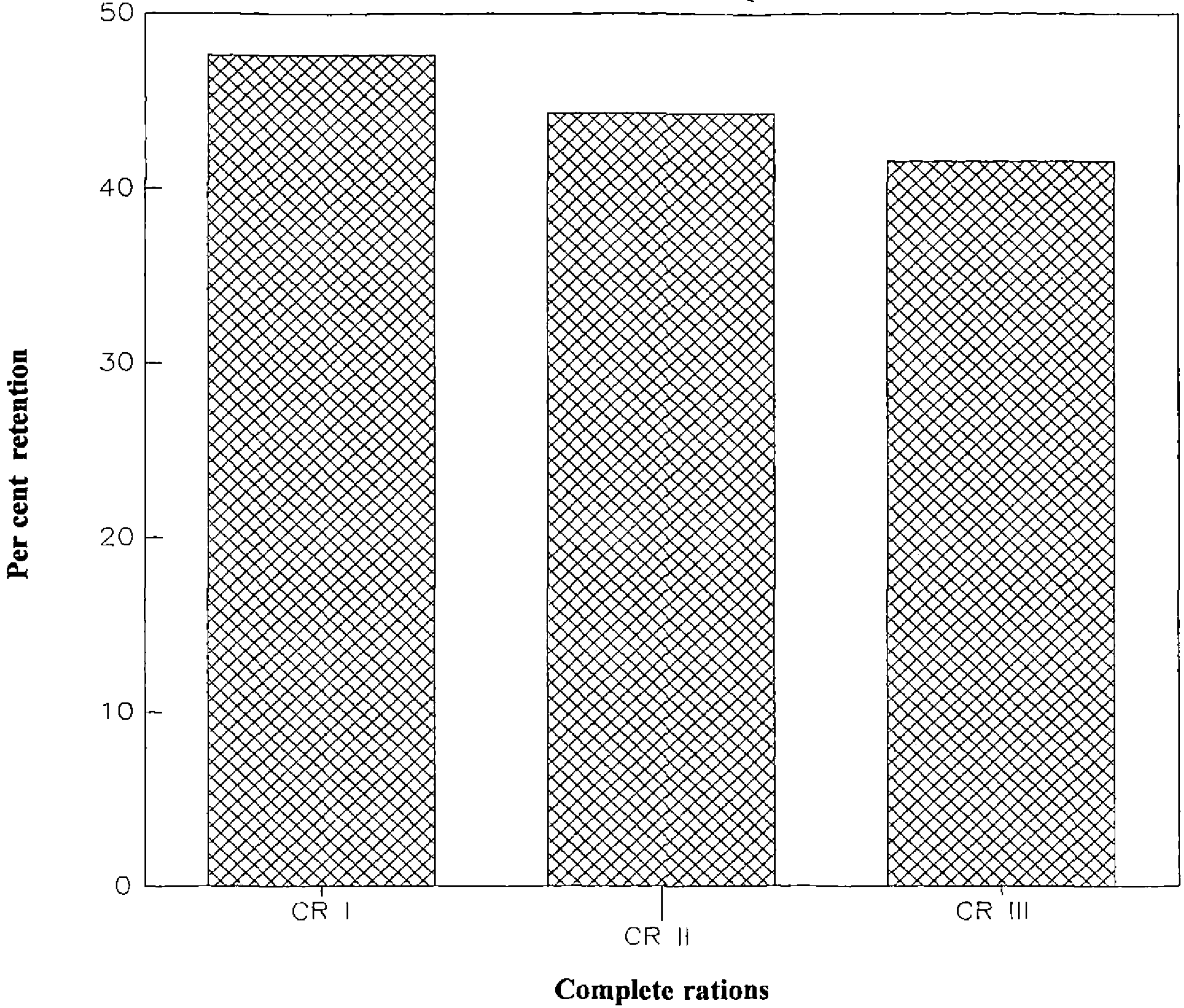

Table 45 : Consolidated data on per cent retention of nitrogen, calcium, phosphorus and magnesium of the animals maintained on experimental rations (vide Tables 41 - 44).

Treatments	CR I	CR II	CR III
No. of kids	6	6	6
Per cent retention of :			
Nitrogen	53.03±0.665	47.26±0.187	46.12±0.167
Calcium	54.17±4.650	52.57±4.360	60.40±1.796
Phosphorus	46.65±0.000	44.00±1.760	40.35±1.837
Magnesium	47.59±5.005	44.30±2.372	41.58±1.049

Table 46 : Analysis of variance - nitrogen balance

Source	df	SS	MSS	F
Ration	2	178.350	89.175	3.329 NS
Error	15	401.858	26.791	
Total	17	580.208		

Table 47 : Analysis of variance - calcium balance

Source	df	SS	MSS	F
Ration	2	200.254	100.127	1.140 NS
Error	15	1316.963	87.798	
Total	17	1517.217		

Table 48 : Analysis of variance - phosphorus balance

Source	df	SS	MSS	F
Ration	2	120.895	60.447	3.622 NS
Error	15	250.335	16.689	
Total	17	371.230		

Table 49 : Analysis of variance - magnesium balance

Source	df	SS	MSS	F
Ration	2	29.270	14.635	0.230 NS
Error	15	953.084	63.539	
Total	17	982.354		

NS Not significant

Discussion

DISCUSSION

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

5.1 Growth

It can be seen from the data on growth rate presented in Tables 1 to 3, represented by fig. I, consolidated in table 4, and the result of statistical analysis set out in Table 5, that the kids maintained on complete ration I, (CR I - Control) containing guinea grass as the major roughage, complete ration II (CR II) containing tapioca leaves as the major roughage and complete ration III (CR III) containing gliricidia leaves as the major roughage, exhibited an appreciable increase in body weight during the experimental period of 120 days, the average daily gain recorded for the kids being 62.77, 59.37, and 53.21 grams per day respectively wherein difference in weight gain between the groups being not statistically significant ($P<0.05$). It is to be noted that the highest rate of gain was noticed in kids maintained on conventional feed items like guinea grass, while lowest gain was noticed in kids maintained on ration containing gliricidia leaves as roughage part.

Various authors have reported different rate of growth in kids. James and Chandran (1975) reported average daily gain of 64.9, 59.8 and 71.7 grams respectively for growing crossbred Malabari kids in the age group of 3 - 9 months, maintained on different rations fortified with either calcium or magnesium. From a study on comparative evaluation of conventional and unconventional feed for evolving cheap and economic ration for goats, James (1978) observed an average daily gain of 96.4, 80.95, and 78.57 grams in Sannen-Malabari crossbreds and 90.5, 82.2 and 81.5 grams in Malabari kids of 4 - 5 months of age fed with three different rations namely farm ration, experimental conventional ration and experimental unconventional ration respectively.

James (1978) reported an average daily gain of 26.2 grams in Sannen-Malabari crossbred goats in the age group of 7 - 8 months maintained on Leucaena leucocephala fodder alone.

James and Mukundan (1978) reported an average daily gain of 58.3, 59.5, 58.3 grams in Malabari kids in the age group of 6-9 months fed with three rations with varying concentrate-jack leaf ratio.

Mercy et al. (1981) observed a weight gain of 63.7, 64.4 and 57.6 grams per day for Alpine - Malabari crossbred kids maintained on three nutritional planes.

Murugan et al. (1985) studied the nutritive value of gliricidia leaves in Tellicheri goats and observed a weight gain of 59.7 to 74.62 grams per day.

Ademosun et al. (1988) showed that west African Dwarf goats maintained on a basal ration containing Gliricidia sepium and Leucaena leucocephala to produce a weight gain up to 35-40 grams per day. Chalal and Sharma (1992) in their study with complete pelleted rations, namely, the control ration, Mahua seed cake incorporated ration, ammonia treated Mahua seed cake incorporated ration and a low protein diet, produced a weight gain of 92.8, 64.8, 72.0 and 54.0 grams per day in Alpine-Beetal kids in the age group of 5 - 6 months.

The observations made during the present investigation is essentially in accordance with the findings of the above authors (James and Chandran,1975; James and Mukundan, 1978 and Mercy et al., 1981) except in the case of observations made by Murugan et al. (1985), who obtained a better gain in weight at the rate of 59.7 to 74.62 grams per day in Tellichery goats on a gliricidia ration. A slight reduction in weight gain, which was not statistically significant, observed in kids maintained on ration CR III fortified with gliricidia leaves could be due to low palatability and erratic feeding behaviour of the kids.

5.2 Dry matter consumption

Data presented in table 7, that consolidated in table 12 and the statistical analysis of the data set out in table 13, on drymatter consumption of the kids maintained on three rations for evaluation, revealed no significant difference between the groups ($P<0.05$), the average drymatter intake in grams recorded for the kids maintained on three dietary regimes (CR I, CR II and CR III) being 569.07, 554, 510.52 grams respectively. When it is expressed on average feed intake (g) per kg $W^{0.75}$ the values being 81.47, 76.58 and 73.23 respectively, showing that the highest intake of drymatter was seen with ration I (control), followed by ration CR II and ration CR III, which may be attributed to the higher palatability of the control ration when compared to ration CR II and ration CR III.

From an investigation on evaluation of complete mixed block using wheat straw, Ram et al.(1990) observed a drymatter intake of 817, 829 and 1095 grams per day in adult goats.

Chalal and Sharma (1992) from an evaluation of complete rations fortified with ammonia treated Mahua seed cake reported a drymatter intake of 686.81 grams per day for Alpine - Beetal kids in comparison with control ration, ration fortified with untreated Mahua seed cake and a low protein ration whose drymatter consumptions being 756, 746.63, and 694.14 grams per day respectively.

Shyama [illegible] (1994) observed a drymatter intake of 562.92, 574.59, 572.3, and 564 grams per day for kids maintained on rations containing 12 per cent and 16 per cent crude protein with or without supplementation of dried spleen at 0.1 per cent level.

Drymatter consumption of kids maintained on the three rations in the present investigation is essentialy in agreement with that reported by Shyama [illegible] (1994) but slightly lower rate of consumption when compared to that reported by Chalal and Sharma (1992). The data presented in tables (Table 7 and 8), tends to suggest that fortification with unconventional feed in complete rations do not produce any significant reduction in drymatter intake in comparison with that of complete ration fortified with conventional feed ingredients though lower intakes could be observed with unconventional rations under the same plane of nutrition.

5.3 Feed efficiency

Feed efficiency values registered for kids maintained on three rations are presented in table 9, represented by fig.2, consolidated data in table 12, and their statistical analysis in table 14, reveal no significant difference between the three groups ($P<0.05$), the cumulative feed efficiency values recorded for the kids maintained on three dietary treatments being 9.091, 9.331 and 9.630 for the rations CR I, CR II and CR III respectively. On further scrutiny of the data it can be perceived that the feed intake per kilogram weight gain was found to be slightly more in complete ration fortified with gliricidia leaves in comparison with other rations. Better feed efficiency could be obtained in the present study in comparison with the reports of Reddy (1989), Narayanaswamy et al.(1990) and Reddy and Reddy[1] (1990) except for ration containing cotton seed hull.

5.4 Protein efficiency

Protein efficiency ratio registered with regard to respective rations presented in table 10, represented by fig.3, summarised in table 12, and the statistical analysis in table 15, reveal that maximum efficiency was obtained with the control ration containing guinea grass as roughage, the animals maintained on rations CR I, CR II and CR III exhibiting efficiency of protein utilization in that descending order, the values recorded being 1.523, 1.596, 1.846 respectively. The data revealed no significant difference ($P<0.05$) between the groups maintained on the three complete rations, as can be seen from statistical analysis between the three dietary treatments. The values of experimental rations in comparison to the control ration did not show any significant difference between the groups indicating that incorporation of agroindustrial byproducts as a major roughage in the complete ration have not much altered the efficiency of protein utilization in growing kids as can be seen from essentially similar values obtained for the control ration containing conventional items. The protein efficiency values are comparatively lower than that obtained by Reddy and Prasad (1983), and Shyama [illegible] (1994), probably due to higher percentage of unconventional items in the ration under study.

5.5 Cost efficiency

Comparative data on economics and cost per unit kilogram gain due to three rations for a period of 120 days presented in table 11, represented by fig. 4, consolidated data in table 12 and statistical analysis in table 16, reveal that the cost efficiency in terms of cost per unit gain recorded for the three groups in the descending order being Rs.69.54, 60.44, and 59.16 for the kids maintained on rations CR I, CR III and CR II respectively. The highest economic efficiency was recorded with ration CR II containing tapioca leaves as the major part, though feed cost was lowest for ration containing gliricidia leaves, indicating that incorporation of tapioca leaves in the complete ration exhibited comparatively better biological efficiency than that of gliricidia leaves. The result also indicate that the incorporation of unconventional feed resources in the complete ration for goats seems to be beneficial and reduce the cost of production to the extent of 15.17 per cent and 13.13 per cent for rations CR II and CR III respectively over the control ration CR I.

Reddy and Reddy[1] (1991) observed a cost efficiency of 20.6 per cent and 28.63 per cent respectively for complete diets containing cotton seed hulls in the form of mash or pellet in comparison with conventional ration. Higher cost efficiency obtained for Reddy and Reddy (1991) may be due to low material cost.

5.6 Hematological Parameters

5.6.1. Total Erythrocyte Count, Total Leucocyte Count, Haemoglobin and Plasma protein concentrations

Data on Hematological parameters like Total Erythrocyte Count, Total Leucocyte Count, Haemoglobin and Plasma protein concentrations of kids maintained on three dietary regimes presented in table 17, and their statistical analysis in tables 19 to 22 clearly indicates that all the kids showing the values within the normal range irrespective of the rations. The statistical analysis also indicate that replacing conventional ration with agroindustrial byproducts to the extent of 60 per cent in complete rations do not have any significant influence on hematological parameters. However, there is a tendency for decrease in hematological values with the experimental rations, CR II and CR III in comparison with control ration CR I. The values fall in accordance with that reported by James (1978), Gangadevi (1981) and Mercy et al. (1981) showing that animals are maintaining normal nutritional status.

5.6.2. Serum Calcium, Phosphorus and Magnesium concentrations.

The average values obtained (Table 18) for serum calcium phosphorus and magnesium of kids maintained under three dietary treatments and their statistical analysis set out in tables 23, 24 and 25 respectively, did not disclose any significant difference in these parameters ($P<0.01$).

The values recorded in the present study are found to agree well with the reports of other workers and lie within the normal range reported for the species (Shyama, 1994, Ghosh et al.,1997 and Mahanta et al., 1997). The result indicate that supplementing unconventional feed ingredients up to a level of 60 per cent did not seem to influence the nutritional status and thus the mineral concentration in the blood.

5.7 **Metabolism Trial Data**

5.7.1 Digestibility of nutrients

5.7.1.1 *Dry matter*

Data gathered on the drymatter digestibility of experimental rations are presented in table 26, and the consolidated data set out in table 33 and their statistical analysis given in table 34. On statistical analysis it could be seen that, there existed a significant difference ($P>0.01$) in drymatter digestibility between the groups and the digestibility values being 67.04, 60.72 and 56.37 per cent for rations CR I, CR II and CR III respectively which clearly showed that digestibility was better with the control ration in comparison with the experimental rations. It is discernible that blending of unconventional feed ingredients in the complete ration would influence the drymatter digestibility. Among the experimental rations, the ration containing tapioca leaves plus tea waste (CR II) exhibited significantly higher (P>0.01) drymatter digestibility than the ration containing gliricidia leaves plus tea waste (CR III) indicating that fortification with tapioca leaves have better digestibility than with gliricidia leaves in the complete ration for goats.

Kunjikutty (1981) reported a digestibility of 49.4 per cent in cattle fed with tapioca leaves at 27.5 per cent level. Kondal Reddy et al. (1983) had obtained digestibility figures of 60.92, 60.43 and 62.77 per cent for complete rations containing cotton seed hulls, bagasse and sorghum straw respectively. Van Eys et al. (1986) had reported the digestibility coefficient of 57.3 per cent for gliricidia supplemented rations at 12.3 per cent level in comparison to 58.1 per cent for the control ration containing napier grass when fed to Kacang goats. Ademosun et al. (1987) had reported a drymatter digestibility of 55.1, 56.82 and 57.51 per cent with rations containing 45, 100 and 80 per cent gliricidia leaves when fed to West African Dwarf goats although the drymatter intake was variable.

Bala Nageswara Rao (1989) from his studies on in vitro evaluation of complete ration containing crop residues such as Sehima nervosa hay, Heteropogon contortus hay, sorghum straw maize stover, bagasse, sunflower, cotton straw and ground nut hulls at 25 per cent level had recorded a drymatter digestibility of 70.8, 68.8, 67.9, 76.1, 72.5, 70.6, 73.1 and 67.9 per cent respectively. James (1990) had reported drymatter digestibility of 60.4, 65.1, 58.9 and 61.4 per cent with respective rations containing tapioca leaves or gliricidia leaves with molasses alone or in combination with paddy straw.

Narayanaswamy et al. (1990) reported a digestibility coefficient of 57.43, 43.47, 52.14 per cent for drymatter of complete rations containing 50 per cent groundnut haulms or Banyan tree leaves or red gram straw respectively.

The result obtained in the present study is comparable with the works of Kondal Reddy et al.(1983), Van Eys et al. (1986), Ademosun et al. (1986) and James (1990). Comparatively lower values were obtained with the result of Bala Nageswara Rao (1989) and higher results were obtained than that obtained by Narayanaswamy et al. (1990). The lower digestibility of control ration during the present investigation in comparison with the investigations of the above authors may be attributed to the effect of pelleting, as it would increase the rate of passage of the digesta through the tract. Appreciably lower digestibility noticed with the experimental diet ($p>0.01$) in comparison with the control may be due to their innate incremінating factors. Higher digestibility could be obtained for individual rations, when compared with the digestibility obtained by various authors on respective rations. For tapioca leaf incorporated ration, higher digestibility was obtained in comparison with the value reported by Kunjikutty (1981) in cattle, may be due to the effect of pelleting or due to better capacity of the goats to digest coarse nutrients. Better digestibility obtained for ration CR II than ration CR III might be due to inconsistant level of feeding seen with gliricidia leaves perhaps, on the palatability reasons as well as due to the deleterious factors present in the legume which affects its digestibility.

5.7.1.2 *Crude protein*

Data on digestion coefficient of protein set out in table 27, consolidated in table 33 and statistical analysis in table 35, revealed a significantly better digestibility of protein in the animals maintained on ration CR I, the values recorded being 65.26, 59.79 and 54.46 per cent arranged in the descending order for the rations CR I , CR II and CR III respectively. As between the experimental rations CR II and CR III, kids maintained on ration CR II exhibited significantly ($P>0.01$) better digestibility of protein in comparison with ration CR III. The data clearly implicit that the inclusion of agroindustrial byproducts up to a level of 60 per cent bringforth a significant reduction in the digestibility of protein to the extent 9.27 per cent and 17.35 per cent respectively for rations CR II and CR III.

Kunjikutty (1981) had reported 61.9 per cent as the protein digestibility coefficient for tapioca leaves when fed along with paddy straw to cattle. Van Eys et al.(1986) from their study with tree legumes as supplement at 15 per cent level to napier grass in the diets of growing goats obtained a protein digestibility of 69.2 per cent with gliricidia leaves. Dharia et al. (1987) observed a protein digestibility of 74.65, 72.72, and 70.37 per cent for feeds replacing 0, 25 and 50 per cent with gliricidia leaves respectively in growing cross bred heifers, showing a reduction in digestibility of protein with increasing gliricidia supplementation. The digestibility coefficient for the diets obtained in the present investigation show a similar trend with gliricidia supplementation.

Onwuka and Akinsoyinu (1989) in their study to estimate the protein and energy requirement for maintenance and gain in West African Dwarf goat fed cassava peels with cassava leaves as supplement at 0, 25, 50, 75 and 100 per cent cassava leaf meal, showed apparent protein digestibility coefficient of -12.06, 52.77, 63.22, 63.38 and 64.02 per cent respectively. Values at 25 per cent and 50 per cent are comparable with the value obtained for ration CR II in the present investigation.

Protein digestibility coefficients observed in the present study are also comparable with the observations made by Ram et al. (1990) and Gupta et al. (1994) with their respective complete rations in the form of block or pellet, incorporating crop residues or subabul leaf meal as protein sources in ruminants suggesting that the values are comparable with the complete feed standards. But lower digestibilities obtained, when compared to Onwuka and Akinsoyinu (1989) may be due to the difference in the plane of nutrition, or may be due to increased presence of tannin in the complete ration due to incorporation of tea waste.

5.7.1.3 *Ether extract*

Data on digestibility coefficient of ether extract presented in table 28, summarised in table 33, and statistical analysis of the data presented in table 36, showed a significant difference ($P>0.01$) between the groups. A highest digestibility value of 86.48 per cent was recorded for the control ration. Of the experimental rations CR II and CR III, ration containing tapioca leaves plus tea waste (CR II) showed significantly better digestibility in comparison with the ration containing gliricidia leaves plus tea waste (CR III), the values being 77.53 and 68.3 per cent for rations CR II and CR III respectively.

Kunjikutty (1981) had reported a value of 41.9 per cent as digestibility of crude fat for tapioca leaves in cattle. Murugan et al. (1985) reported a digestibility of 36.2 per cent for gliricidia leaves in Tellicheri goats. Dharia et al. (1987) evaluated the ether extract digestibility of rations containing 0, 25 and 50 per cent gliricidia leaves when fed to goats as 59.49, 61.63, 60.55 per cent respectively.

Narayanaswamy et al. (1990) reported the digestibility of crude fat as 74.35, 65.44 and 66.62 per cent for complete rations containing ground nut haulms, Banyan tree leaves, and red gram straw respectively in growing sheep. Reddy and Reddy[2] (1991) reported a digestibility of 58.52 per cent with control ration containing forest grass and 65.2 per cent and 68.42 per cent with rations containing cotton seed hull either fed in mash or in pelleted form Reddy et al. (1994) reported a digestibility of 79.43, 81.36, 82.19 and 83.9 per cent for complete rations containing sorghum straw or dried mixed grass alone or supplemented with subabul meal at 10 per cent level.

The results obtained in the present study is comparable with the work of Reddy et al. (1994). The values obtained in the present study in comparison with other reports are higher. As between the complete rations, the values for rations CR II and CR III are found to be lower which may be attributed to the type of ingredients such as tapioca and gliricidia leaves, which formed the major constituent whose individual digestibilities were low as substantiated by Kunjikutty (1981), Murugan et al. (1985) and Dharia et al. (1987) from their study.

5.7.1.4 *Crude fibre*

Data on digestion coefficient of crude fibre of the three rations presented in table 29 summarised in table 33 and their statistical analysis given in table 37 revealed a significant difference (P>0.01) between the groups. The highest digestibility was seen with ration CR III and the digestibility values when arranged in the descending order being 49.44, 43.01, and 36.36 per cent for rations CR III, CR II and CR I respectively.

Kunjikutty (1981) had reported the digestibility of crude fibre to be 43.1 per cent for tapioca leaves in the ration of cattle. James et al. (1990) had reported a value of 45.1 and 47.9 per cent for ensiled tapioca leaves with or without supplementation of paddy straw. The result obtained in the present study is comparable for tapioca leaves incorporated ration (CR II).

Murugan et al. (1985) reported a digestibility of 36.2 per cent for gliricidia leaves in Tellicheri goats. Dharia et al.(1987) obtained 57.16, 58.88, 57.96 per cent for rations containing 0, 25, and 50 per cent gliricidia leaves. James et al. (1990) had evaluated the crude fibre digestibility as 63.2 and 60.1 per cent for ensiled gliricidia leaves alone or with supplementation of paddy straw. Veereswara Rao et al. (1993) reported a digestibility of 49.2 per cent in goats on napier based diet supplemented with gliricidia leaves at 40 per cent level.

The results obtained on incorporation of unconventional feed on crude fibre digestibility is essentially in agreement with the reports of Kunjikutty (1981), James . . (1990) and Veereswara Rao et al. (1993). Better digestibility for experimental rations than the control ration for crude fibre may be due to higher Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) level and lower Acid Detergent Lignin (ADL) in the experimental rations in comparison to the control ration. As between rations CR II and CR III significantly (P>0.01) better digestibility was noticed with ration CR III which may be attributed to low total fibre level in the gliricidia containing ration as well as low ADL value when compared with ration CR II.

5.7.1.5 *Nitrogen free extract*

Digestion coefficient values for nitrogen free extract are presented in table 30, summarised in table 33, and their statistical analysis set out in table 38. The analysis revealed a significant difference (P>0.01) between the three groups. The control ration has shown the highest NFE digestibility than the experimental rations, the values being 81.43, 74.19 and 63.83 per cent for rations CR I, CR II and CR III respectively. As between the rations CR II and CR III, ration CR II recorded a significantly higher (P>0.01) digestibility over ration CR III.

On scrutiny of the data on digestibility of NFE, it can be seen that lower digestibility obtained for experimental rations CR II and CR III when compared to ration CR I may be attributed to the incorporation of unconventional feed items to the extent of 60 per cent in the complete ration for kids.

Reddy and Murthy (1972) reported a digestibility value of 79.1 per cent for complete ration containing sunhemp hay in sheep. Dharia et al. (1987) reported digestibility coefficient for nitrogen free extract to the extent of 74.34, 74.19 and 71 per cent with rations containing 0, 25 and 50 per cent gliricidia leaf meal, indicating a lowering of digestibility with higher levels of fortification. The results obtained in the present study are in agreement with the above findings.

Better results for NFE digestibility could be obtained for ration CR II than that obtained for Kunjikutty (1981), Murugan et al. (1985) and James (1990). Higher digestibility values may be due to the effect of pelleting as it would increase the gelatinisation of starch causing better digestibility.

Narayanaswamy et al. (1990) reported digestibility coefficient of 74.35, 56.92, 64.9 per cent for complete ration containing ground nut hulls, banyan tree leaves and red gram straw respectively when fed to sheep.

The results obtained in the present investigation is comparable with that obtained for Reddy and Murthy, (1972) and Narayanaswamy et al. (1990).

The significantly low NFE digestibility associated with the experimental rations in the present investigation might be due to low energy content of the leaves, along with fortification of tea waste which is having a low soluble fraction and also due to higher NPN source especially seen with the legumes.

The digestibility values obtained during the course of the present study for various nutrients in kids maintained on three complete rations is in agreement with those reported by Narayanaswamy et al. (1990), Ram et al. (1990), Reddy and Reddy[1] (1991), Gupta et al. (1994), Reddy et al. (1994) for the control ration (CR I) and Kunjikutty (1981), and James (1990) for the complete ration containing tapioca leaves and for the gliricidia leaves based complete ration (CR III) the values concur with the reports of Dharia et al. (1987), James (1990) and Veereswara Rao et al.(1993).

5.7.1.6 *Neutral detergent fibre*

The digestibility of neutral detergent fibre for the three rations are given in table 31 and the consolidated data given in table 33 and the statistical analysis given in table 39 showed significant difference (P>0.01) among the three groups, the values being 55.3,24.24,50.06 for rations CR I,CR II and CR III respectively. The lower value for NDF digestibility could not be explained as similar works were not available with tapioca leaves.

Van Eys et al. (1986) reported NDF digestibility of 60.0 per cent in goats fed napier grass based rations supplemented with gliricidia leaves. Bala Nageswara Rao (1989) reported digestibility values of 66.4, 58.6, 65.2, 74.4, 70.41, 41.9, 66.7, 64.3 per cent for complete rations containing Sehima nervosa hay, Heteropogon contortus hay, sorghum straw, maize stover, bagasse, sunflower, cotton straw and ground nut hulls respectively, when fed to goats. The results are comparable with the works of the above authors.

5.7.1.7 *Acid detergent fibre*

The Values for ADF digestibility are given in table 32 and the consolidated data given in table 35 and their statistical analysis given in table 40 indicate no significant difference among the groups (P<0.01), the digestibilities being 46.53, 37.62 and 41.53 per cent respectively for complete rations CR I, CR II and CR III. Van Eys et al. (1986) reported ADF digestibility of 43.7 per cent for gliricidia leaves in goats and the value is comparable with the result obtained during the course of present investigation. Rao et al. (1994) reported ADF digestibility of 46.8, 56.7, 29,56.43 per cent respectively for complete rations containing spear grass, nendra grass, cotton straw, ground nut hulls containing ration having similar ADF percentage and comparable with present investigation.

5.7.2 Nitrogen and Mineral Balances

5.7.2.1 *Nitrogen balance*

Nitrogen balance data presented in table 41 represented by fig. 5, the consolidated data in table 45 and statistical analysis set out in table 46, revealed that a positive nitrogen balance was seen with all the three rations and the data did not differ significantly (P<0.05) between the groups.

However, the values showed a decreasing trend in nitrogen retention on incorporation of agroindustrial byproducts. The control ration showed the highest percentage retention of nitrogen. As between experimental rations, CR II and CR III, the ration fortified with tapioca leaves showed better nitrogen retention than the ration fortified with gliricidia leaves (CR III) and the percentage retention of nitrogen in rations CR I, CR II and CR III being 53.03, 47.26, 46.12 respectively. On further scrutiny of the data it can be perceived that there was a significant difference in the faecal nitrogen loss between kids maintained on rations CR I and CR III, showing that the incorporation of gliricidia leaves in the ration influence the faecal nitrogen loss. Higher urinary nitrogen loss was seen with ration CRI, when compared to rations CR II and CR III which on statistical analysis was not found to be significant.

Reddy and Reddy (1983) have reported a nitrogen balance of 46.4, 24.7, and 59.1 per cent with complete pelleted ration containing cotton seed hull, bagasse, sorghum straw with cassava waste when fed to sheep.

Rao et al. (1987) reported 70.56 per cent retention of nitrogen in rabbits fed gliricidia leaves. Yadav et al. (1990) reported a balance of nitrogen to be 45.8 per cent for goats fed subabul hay. Nageswara Rao et al. (1996) reported a nitrogen balance of 24.0 and 33.8 per cent respectively for neem leaves based and mulberry leaves based pelleted feeds fed to goats.

The results obtained is in accordance with Reddy and Reddy (1983) and Yadav et al. (1990). Higher retention observed in the work of Rao et al. (1987) might be due to species difference. The higher loss through faeces in the experimental rations may be due to the tannins present in the ration which lower the digestibility as well as higher non protein nitrogen source in these rations.

5.7.2.2. *Calcium balance*

Data on calcium balance and per cent retention of calcium in animals maintained on the three complete rations CR I, CR II and CR III presented in table 42 represented by fig.6, and consolidated data in table 45 and their statistical analysis in table 47, revealed a positive calcium balance in animals maintained on all the three rations and the per cent retention was not significant ($P<0.05$) between the groups showing that the incorporation of unconventional items did not affect the status of calcium metabolism in the body. However, on critical evaluation of the data higher content of calcium was seen with the legume ration as well as the tapioca leaf containing ration over the control ration, and it can also be seen from the data, that there is a proportionate increase in the quantity of calcium excreted through the faeces as well as through urine with CR III and CR II in comparison with the control ration, CR I.

The percentage retention values obtained in the present study is comparable with the works of Narayanaswamy et al. (1990) and Shyama [illegible] (1994).

5.7.2.3 *Phosphorus balance*

Data set out in table 36 depicted by fig.7, consolidated data in table 45, and statistical analysis set out in table 48, showed no significant difference ($P<0.05$) among the groups in per cent retention of phosphorus and all the animals maintained a positive phosphorus balance.

On further scrutiny of the data, it can be seen that higher intake of phosphorus was seen with the control ration which accounts for proportionate increase in the loss of phosphorus through faeces as seen with the control and higher urinary loss was seen with the complete ration CR III though there is no significant difference between the groups. The highest percentage retention was seen with the control ration (CR I) followed by CR II and CR III and the values being 46.65, 44.00, 40.35 per cent respectively.

Similar phosphorus balance could be observed with the work of Reddy and Reddy (1990) for the complete diets containing grass or cotton seed hulls fed to sheep and also with Reddy and Reddy (1983) for complete pelleted rations containing cotton seed hulls or bagasse or sorghum straw fed to sheep and Narayanaswamy _et al_. (1990) for complete rations containing groundnut hulls, banyan tree leaves and red gram straw when fed to sheep.

The result, indicating an increased retention of phosphorus in the control over the experimental ration, may be due to increased inorganic phosphorus present in the control ration. Generally, the tree leaves are rich in calcium and low in phosphorus, which cause poor intake of phosphorus and comparatively higher calcium to phosphorus ratio accounts for higher excreation and lower retention of phosphorus.

5.7.2.4 *Magnesium balance*

Data on magnesium balance in the table 44, represented by fig. 8, and summarised in table 45, and statistical analysis in table 49 showed that there was no significant difference in magnesium retention among the rations, however an apparently higher percentage retention was observed with the control ration. On further evaluation of the excreatory pattern of magnesium in animals, it can be perceived that there is a trend towards higher excreation of magnesium in the control ration both in faeces and in urine followed by ration CR II and ration CR III which is proportionate to the intake. But as far as per cent utilization of magnesium is concerned better retention was seen with the control ration CR I.

Information regarding the per cent utilization of magnesium are scanty with regard to magnesium for complete ration incorporating agroindustrial byproducts and hence comparable data is not available on magnesium retention.

5.8 Economic implications

Small ruminants play an important role in the economy of the country. As far as meat production is concerned, the meat of these animals fetch more price and call for intensive method of rearing, slaughtering, processing and marketing of the product. Economic rearing includes economic feeding of the animal. As the cost of livestock feed is augmenting day by day, it is pertinent to find alternate feed resources. Agroindustrial byproducts like tapioca leaves, gliricidia leaves and tea waste which are available in Kerala are found to replace the conventional ingredients to the extent of 60 per cent without affecting the performance of the animal.

On recapitulating the data on feed efficiency and nutrient utilization it can be construed that cost per kilo gram weight gain in experimental kids were highest in ration containing conventional ingredients as the major part (Ration CR I). As on examination of the production cost for the three complete rations, it has been found that inclusion of tapioca leaves plus tea waste (75:25) in the ration upto 60 per cent level in the complete ration for goat, would accrue an amount of Rs.1330/tonne (17.34 %) of feed as profit and if gliricidia leaves plus tea waste (75:25) when incorporated upto the level of 60 per cent would accrue an amount of Rs.1370/tonne (17.86 %) of feed over the control ration containing conventional feed items.

Hence it is reasonably concluded that agroindustrial byproducts could be economically made available and effectively utilized by simple processing methods which can be practised by small and marginal farmers with beneficial effect.

Summary

SUMMARY

An investigation spread over a period of 120 days was carried out using Malabari kids to evaluate complete rations fortified with agroindustrial byproducts like tapioca leaves, tea waste and gliricidia leaves as major roughage part. Eighteen Malabari kids with an average body weight of 9.27 Kg were distributed randomly and as uniformly as possible with respect to weight and sex into three groups (Group I, II and III) with six animals each. The Group I kids were assigned complete ration (CR I) containing conventional ingredients like guinea grass plus bran as major part (75:25) and group II kids were assigned complete ration (CR II) containing tapioca leaves plus tea waste (75:25) at 60 per cent level and group III kids were assigned complete ration (CR III) containing gliricidia leaves plus tea waste (75:25) at 60 per cent level.

The animals were maintained on their respective feeding regimes and their requirements being periodically determined on the basis of their body weights as per standards. Records of daily feed intake and weekly body weight were maintained throughout the experimental period. A digestion cum metabolism trial including a collection period of five consecutive days was carried out towards the terminal period of the feeding trial. Blood samples were collected towards the end of the trial for hematological studies.

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

The kids maintained on rations CR I, CR II and CR III exhibited marked increase in body weights during the experimental period of 120 days and gain in weight of kids maintained on CR I, CR II and CR III were in a descending order, the cumulative and average daily gain registered during the period being 7.03 Kg and 62.77 g, 6.65 Kg and 59.38 g and 5.96 Kg and 53.21 g respectively. The kids maintained on CR II and CR III did not produce any significant difference on growth rate and also the kids maintained on the three dietary regimes registered no significant difference between the groups with regard to drymatter consumption.

The efficiency of feed utilization was decreased in animals maintained on rations CR I, CR II and CR III in that descending order, the feed efficiency values recorded for the animals maintained on the three rations being 9.09, 9.33 and 9.63 respectively. The protein efficiency of kids also exhibited the same trend as that of feed efficiency. Economic efficiency in terms of cost per kg gain of kids maintained on tapioca leaf plus tea waste incorporated rations being Rs.59.16 and gliricidia leaf plus tea waste incorporated ration registered an amount of Rs.60.43, and the same arrived at for the control group being Rs.69.54, indicating better economic efficiency in CR II and CR III.

The hematological parameters studied (T.E.C., T.L.C., haemoglobin, plasma protein, serum calcium, phosphorus and magnesium) were within the normal range. There was no significant difference between the groups with regard to these parameters.

Data on digestibility studies revealed a significant difference in the digestibility of drymatter, protein, crude fibre, ether extract and nitrogen free extract between the groups. Significantly (P>0.01) higher digestibility for drymatter, crude protein, ether extract and NFE were observed with the control ration (CR I) followed by ratons CR II and CR III in that descending order. Significant difference (P>0.01) was noticed with regard crude fibre digestibility between the groups, where the ration CR III recorded the highest digestibility followed by CR II, and CR I being the lowest. Significant difference (P>0.01) was noticed with regard to the digestibility of fibre fractions, the NDF digestibility being highest with ration CR I followed by ration CR III and lowest value recorded was with ration CR II. There was not much difference in ADF digestibility between the groups.

Data on nitrogen balance revealed that all the animals maintained a positive nitrogen balance and there was no significant difference in the balance of nitrogen between the three groups. It can also be seen that higher per cent retention of nitrogen was with the control ration CR I followed by CR II and CR III. There was a significant difference between CR I and CR III in faecal loss of nitrogen. However the balance study also emphasised that the agroindustrial byproduct incorporated ration did not influence much on the per cent nitrogen retention.

In the calcium balance study, apparently higher retention was seen in ration CR III followed by ration CR II and ration CR I in that descending order. On critical evaluation there was proportionately higher excreation depending on intake in all the rations and the per cent retention was not significant showing that incorporation of tree leaves and legumes could produce a better balance of calcium.

Phosphorus balance studies showed an appreciably better retention with ration CR I followed by ration CR II and ration CR III as seen from proportionate reduction in per cent retention of phosphorus.

Magnesium balance studies showed similar trend in the retention of magnesium among rations, the difference between rations being not significant. The result revealed that animals maintained a positive magnesium balance without significant effect on retention among kids maintained on conventional or unconventional rations.

From an overall assessment of the data gathered during the course of present investigation, it can be reasonably concluded that incorporation of unconventional ingredients in the complete ration of goats to the extent of 60 per cent do not affect the nutrient utilization, the growth and feed conversion efficiency which showed that the unconventional feed items could be incorporated in the ration without deleterious effect, and better economic efficiency as seen with ration CR II containing tapioca leaves and tea waste over the control ration and to a lesser extent ration CR III containing gliricidia leaves and tea waste, with slightly lower biological efficiency, could successfully replace the conventional items in the ration of growing kids.

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NUTRITIVE EVALUATION OF COMPLETE RATION FOR GROWTH IN KIDS

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ABSTRACT OF A THESIS

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Abstract

An attempt has been made to evaluate the effect of complete ration containing unconventional ingredients on growth and nutrient utilization in kids.

Three complete pelleted rations were prepared consisting of a control ration (CR I) containing guinea grass and conventional ingredients, experimental rations CR II and CR III containing crop residues and agroindustrial byproducts such as tapioca leaves plus tea waste and gliricidia leaves plus tea waste respectively (75:25) at 60 per cent level.

Eighteen Malabari kids of 4 - 5 months of age with an average body weight of 9.27 Kg distributed into three groups of six animals each as uniformly as possible with regard to age, sex and weight and were fed individually with three complete rations over a period of 120 days.

The results indicated that the incorporation of unconventional feed ingredients even to the extent of 60 per cent did not affect the growth performance of animals as the total weight gain and average daily gain recorded as 7.03 Kg and 62.6 g/day for the control and 6.65 Kg and 59.37 g/day for experimental ration CR II and 5.96 Kg and 53.21 g/day for ration CR III.

The efficiency of feed and protein utilization also exhibited the same trend. Cost efficiency for ration CR II containing tapioca leaves plus tea waste as major

part as well as for ration CR III containing gliricidia leaves plus tea waste as major part comes to around Rs.59.16 per Kg gain and Rs.60.43 per Kg gain respectively, as against Rs.69.54 per Kg gain for control ration CR I.

The hematological studies revealed that T.E.C., T.L.C., Haemoglobin, Plasma protein, serum calcium, phosphorus and magnesium were within normal range prescribed for the species. The animals maintained on the three rations did not show any significant difference between groups for these parameters.

Digestibility studies revealed a significant difference ($P>0.01$) in all the parameters between groups, while the kids maintained on control ration CR I recorded highest digestibility of drymatter, crude protein, ether extract and nitrogen free extract, the kids maintained on ration CR III recorded maximum fibre digestibility. On fibre fractions, ration CR II recorded the lowest digestibility ($P>0.01$) in neutral detergent fibre and there was no difference in acid detergent fibre digestibilty. The results show that incorporation of agroindustrial byproducts in the complete ration for kids influenced the digestibility of nutrients.

The results on balance experiment showed no significant difference ($P<0.01$) between the groups with regard to per cent retention of nitrogen, calcium, phosphorus and magnesium.

Overall assessment of the results showed that incorporation of agroindustrial byproducts even upto the extent of 60 per cent in the complete ration of goats did not have any significant effect on production parameters and animals maintained on ration CR II containing tapioca leaves plus tea waste as major part did show similar performance and efficiency compared to that of control ration and though not significant, slightly lower biological efficiency was exhibited by ration CR III on performance of the animals.