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EFFECT OF RESTRICTED MILK FEEDING ON GROWTH PERFORMANCE IN CROSS BRED CALVES

JASMINE RANI. K.

Thesis submitted in partial fulfilment of the requirement for the degree of

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Department of Animal Nutrition
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR-680651
KERALA, INDIA

DECLARATION

I hereby declare that this thesis, entitled **"EFFECT OF RESTRICTED MILK FEEDING ON GROWTH PERFORMANCE IN CROSS BRED CALVES"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Rani K.

Mannuthy,
16.10.2006.

JASMINE RANI K.

CERTIFICATE

Certified that this thesis, entitled **"EFFECT OF RESTRICTED MILK FEEDING ON GROWTH PERFORMANCE IN CROSS BRED CALVES"** is a record of research work done independently by **Jasmine Rani K.,** under my guidance and supervision and it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

Dr. P. Gangadevi
(Chairperson, Advisory Committee)
Associate Professor
Department of Animal Nutrition
College of Veterinary and Animal Sciences
Mannuthy, Thrissur

Mannuthy
16.10.2006

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Jasmine Rani K.**, a candidate for the degree of Master of Veterinary Science in Animal Nutrition, agree that this thesis entitled **"EFFECT OF RESTRICTED MILK FEEDING ON GROWTH PERFORMANCE IN CROSS BRED CALVES"** may be submitted by **Jasmine Rani K.** in partial fulfilment of the requirement for the degree.

Dr. P. Gangadevi
(Chairperson, Advisory Committee)
Associate Professor
Department of Animal Nutrition
College of Veterinary and Animal Sciences
Mannuthy

Dr. A.D. Mercy
Associate Professor and Head
Department of Animal Nutrition
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

Dr. Shyama K.
Assistant Professor
Department of Animal Nutrition
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

Smt. K.S. Sujatha
Assistant Professor,(Sln Gr)
Department of Statistics,
College of Veterinary and
Animal Sciences
Mannuthy,
(Member)

External Examiner 30/10/2006

PROFESSOR & HEAD
Department of Animal Nutrition
Veterinary College, KVAFSU
Hebbal, Bangalore-560 024.

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Jasmine Rani K.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

1. INTRODUCTION

In India about 60 per cent of the population depends on income from agriculture. Animal husbandry in India is closely interwoven with agriculture and plays an important role in rural economy. Livestock particularly cattle have a strong role in poverty alleviation. The estimated milk production of India, in the year 2005-2006 is about 95 million metric tonnes. The total projected demand of milk for 150 crore population by the year 2020 will be about 170 million metric tonnes. The current rate of increase in milk production is about four to five per cent per annum leaving a deficit of 30 million metric tonnes by the year 2020. Hence innovative methods are to be adopted for enhancing the milk production to the required levels.

Success of dairy industry mainly depends on the economic rearing of calves. In the traditional calf rearing method of Indian farmers, whole milk is fed up to three to four months of age. Even though this system has lot of attractive points, in a developing country like India where the protein intake of man is below the required level, it is necessary to save milk for human consumption. Milk substitute and skim milk based calf rearing could not be adopted by most of the organized farms and by the farmers due to difficulty in procuring the various ingredients. The quantity as well as duration of milk feeding can be reduced by increasing the intake of calf starter and introducing green fodder in their feeding schedule at an early stage to meet their nutrient requirements. The performance of young cross bred calves that were fed different levels of milk with calf starter and green fodder were studied by earlier workers. (Ranjhan *et al.*, 1972 ; Winter, 1985 and Krishnamohan *et al.*, 1987). An important effect of early weaning of calves by feeding high energy concentrate mixture is the early development of rumen permitting earlier consumption and utilization of large quantities of roughage.

Pre-ruminant calves are like monogastric animals and in their early life digestion and metabolism are in a transition state from a monogastric to that of ruminant. During this transition state there is a rapid increase in size and capacity of fore stomach relative to the other organs of the digestive tract. The development of the reticulo-rumen mainly depends on the eating habits of young calves. Restricting the calves to whole milk diet prevents the development of mature levels of rumen acids until such time as pasture or roughage became available (Godfrey, 1961). Acceleration of weaning age of calves appeared to increase their ruminal activity. If calves are offered dry feed from about six weeks of age, the total ruminal volatile fatty acids concentration will reach to that of adult by six to eight weeks of age (Agabawi *et al.*, 1968). Thus early weaning of calves will reduce the cost of production and spare whole milk for human consumption, there by increases the financial returns to the farmer. Hence this work was done with the following objectives.

1. To study the effect of restricted milk feeding on growth performance in cross bred calves.

2. To assess the effect of restricted milk feeding on the cost of production of cross bred calves.

Review of literature

2. REVIEW OF LITERATURE

2.1 DIETARY FACTORS AFFECTING RUMEN DEVELOPMENT

The development of rumen is critical for successful weaning and good growth rate after weaning. At birth the digestive system of pre-ruminant calf is under developed and abomasum is the only stomach compartment actively involved in digestion. As the calf begins to eat dry feed, particularly grains containing readily fermentable carbohydrates, the rumen starts to develop. Preston *et al.* (1957) reported that the calf acquires ability to ruminate and digest roughage gradually and adult type rumen function is attained when calf is six months of age. Weaning of new born calf on solid food resulted in faster development of reticulo-rumen and reduced rumen ammonia production from casein hydrolysis in calves fed solemnly on milk (Godfrey, 1961). Huber (1969) observed that the growth and elongation of rumen papillae have been associated with the functional development of rumen. Williams and Dinusson (1973) observed that the total volatile fatty acid (TVFA) approached to that of mature ruminant as early as third week of age, when calves were consuming high roughage pelleted starter ration at 1.5 per cent of body weight.

Quigley *et al.* (1985) opined that the mature ruminal function tends to be reached at an earlier age in calves weaned at fourth week than those weaned at eighth or twelfth week. Anderson *et al.* (1987) reported that acceleration of weaning of calves appears to increase their ruminal activity. Luchini *et al.* (1993) observed that the consumption of dry feed from first week of age is important to promote rumen development and to maintain acceptable growth rate in calves weaned at an early age. A calf consuming both calf starter and water at an early age develops rumen faster than those fed only milk (Franklin *et al.*, 2003).

2.2 EFFECT OF RESTRICTED MILK FEEDING

2.2.1 Growth

Borhami *et al.* (1967) reported that early weaned (45 days) buffalo calves grew at slightly faster rate than the late weaned (120 days) calves. Khoury *et al.* (1967) studied the effect of early weaning in calves and found that the live weight gain of early weaned calves (31 and 45 days) was not significantly different from the calves weaned at 120 days of age. The calves reared by either system were almost identical in live weight gain, health and general appearance. Ranjhan *et al.* (1972) reported that there is no significant difference in body weight gain in calves weaned at 45, 60 and 90 days of age. Winter (1985) studied the comparative growth performance in Airshire and Holstein bull calves weaned at three, five and seven weeks of age and found that the calf growth was not significantly affected by weaning at different ages.

Feeding milk at different levels of low (80kg), medium (100kg) and high (120kg) up to 60 days, did not produce any significant effect on the growth rate from birth to three months of age in cross bred calves (Krishnamohan *et al.*, 1987). Khalili *et al.* (1992) studied the effect of feeding different levels of whole milk and weaning at different ages in cross bred calves and reported average daily gain of 422 and 464 g for calves fed 134 litre milk for eight weeks and 252 litre for a period of 12 weeks respectively.

On studying the growth performance in Holstein calves, fed on calf starters with varying levels of crude protein (CP) ranging from five to twenty two per cent Akayezu *et al.* (1994) obtained maximum growth on 19.6 per cent CP diet. Bar-peled *et al.* (1997) compared the effect of production parameters of Holstein calves that were allowed to suckle from birth to six weeks of age with that of milk replacer fed

calves and found that heifer calves that suckled milk had higher average daily gain, higher height at the wither, earlier age at calving and a tendency for greater milk production than did calves fed milk replacer. Hopkins (1997) studied the effect of weaning age on starter intake and growth of Holstein calves fed milk once daily and observed that at 90 days of age, calves that have been weaned at 28th day had similar body weight and wither height as did calves that had been weaned at 56th day.

Raut *et al.* (1998) from their studies on the performance of restricted milk fed cross bred calves observed that the cross bred calves can be weaned as early as six weeks of age without any adverse effect on their growth by giving calf starter and green fodder *ad libitum.* Babu *et al.* (2003) observed better performance in calves that fed whole milk up to four weeks, then milk and skim milk at 50 per cent level followed by complete removal after sixth week of age than the late weaned calves (eighth week). The effect of different milk feeding schedule on the growth and feed conversion efficiency in Holstein and Brown Swiss calves was studied by Guler *et al.* (2003) and observed better growth in calves fed milk at higher level (approximately 10 per cent of body weight) as compared to the lower level of eight per cent of the body weight.

2.2.2 Feed intake

Quigly *et al.* (1985) studied the effect of weaning age (four and eight weeks) and the type of ration on the development of rumen function and found that the intake of dry matter from dry feeds tended to be higher from four to seven weeks of age when calves were weaned at four weeks of age. Winter (1985) studied the effect of weaning at three, five and seven weeks of age and found that the early weaned calves consumed more dry feed to compensate for the loss of milk nutrients. Dry feed consumption increased rapidly and relatively stable rumen fermentation developed as quickly in calves weaned at third week as in those weaned at fifth and seventh week

of age. In the week after weaning, dry matter and energy were digested as effectively in the early weaned calves as in those weaned at fifth and seventh week. Anderson *et al.* (1987) reported that average daily feed intake of calves weaned at four and six weeks increased with age and the total feed intake was higher for the early weaned calves. Misra *et al.* (1994) studied the effect of weaning of calves at 63 and 90 days of age and found that there was no significant difference in the intake of calf starter between the groups. Hopkins (1997) reported that the calves weaned at 28th day consumed more starter from 28 to 56 days than those weaned at 56 days of age.

Raut *et al.* (1998) studied the performance of restricted milk fed cross bred calves. No significant difference was observed in green fodder intake and total dry matter intake per 100 kg body weight, among the groups which received whole milk up to thirteen, eight, seven and six weeks of age. It was reported that the calves received less milk tried to compensate their dry matter requirement from calf starter successfully.

2. 2. 3 Feed efficiency

Khoury *et al.* (1967) studied the effect of weaning the buffalo calves at 120 and 61 days of age and found no significant difference in feed efficiency of calves reared by either of the two systems. The calves weaned at three, five and seven weeks of age did not produce any significant difference in feed efficiency from nine to fourteen weeks of age, the feed efficiency of the three weeks weaned calves being slightly better than that of the five weeks weaned calves (Winter, 1985). Krishnamohan *et al.* (1987) observed that feeding milk at different levels of low, medium and high up to 60 days did not produce any significant effect on the feed efficiency from birth to three months of age. Misra *et al.* (1994) studied the effect of weaning of calves at 63 and 90 days of age and found that there was no significant

difference in total dry matter intake as well as dry matter intake per kg gain in bodyweight.

The effect of various levels of forage and form of diet on rumen development and growth in Holstein bull calves weaned at 52 days of age was studied by Coverdale *et al.* (2004) and found that the addition of controlled particle size hay to diets of young calves appears to alter favorably the rumen environment resulting in increased intake and improved feed efficiency.

2.2.4 Digestibility

Ranjhan *et al.* (1972) studied the nutrient digestibility in calves weaned at 45, 60 and 90 days of age and reported no significant difference among the treatments in the digestibility of dry matter (DM) and CP. From the digestibility trial conducted in calves weaned at three, five and seven weeks of age, Winter (1985) observed that the dry matter digestibility of the earliest weaned calves (three weeks) was similar to that of the calves weaned at five and seven weeks of age. He further reported that there was no increase in DM digestibility in any of these calves at later collection period of 8^{th} , 14^{th} and 20^{th} week of age. Krishnamohan *et al.* (1987) observed dry matter digestibility ranging from 68.6 to 74.4 percent in cross bred calves fed different levels of milk and skim milk and different calf starters at three months of age.

Asitha (2002) reported an average digestibility coefficient ranging from 72 to 77, 76 to 80, 42 to 56 and 55 to 65 for DM, CP, neutral detergent fibre (NDF) and acid detergent fibre (ADF) respectively when digestion trial conducted at third and fifth month of age in cross bred calves maintained on standard calf starter with and without supplementation of yeast. She also observed increased CP, NDF and ADF digestibility with advancing age. From the digestion trial conducted at fourth month

of age in calves weaned at four and eight weeks of age, Babu *et al.* (2003) also did not observe any significant difference between groups in nutrient digestibility of DM, CP, ether extract (EE), NDF and ADF. Raja (2005) studied the effect of utilization of urea at different stages of development of rumen in weaned calves and a digestion trial conducted at fifth month of experiment and recorded digestibility coefficients of nutrients in the range of 59 to 62, 64 to 65, 70 to 73, 58 to 63 and 47 to 52 for DM, CP, EE, NDF and ADF, respectively.

2.2.5 Haematology

Ratcliff *et al.* (1958) studied the effect of age and dietary regime on haemoglobin and reducing sugar levels in the blood of dairy calves and found that haemoglobin level declined from birth to five weeks in the female and up to nine weeks in male and increased thereafter. Haemoglobin levels of calf fed milk replacer with distillers dried solubles were significantly higher than those fed whole milk. Whole blood reducing sugar declined from birth to eight weeks in all the groups. Hibbs *et al.* (1961) studied the changes in blood glucose level up to 12 weeks of age in calves maintained on high roughage diet along with whole milk at the rate of $1/10^{th}$ of their body weight for six weeks with complete stoppage at seventh week by gradual reduction and found a marked decline in blood glucose level after milk intake was reduced. Bhosrekar *et al.* (1967) conducted a study on the blood and serum composition of cross bred calves from birth to six months of age and found that the values of haemoglobin, plasma protein, calcium and phosphorus were in the range of 9.6 to 10, 6.1 to 6.83, 11.16 to 11.67 and 8.25 to 9.52 mg/dl respectively.

Head and Ventura (1967) conducted four glucose turn over studies on dairy calves after a 16-hour fast, using the constant rate infusion of uniformly labeled ^{14}C glucose and recorded an average glucose turn over rate of 7.33, 7.88, 6.17 and 6.58

mg/min/kg body weight at two, five, eight and twelve weeks of age. Glucose pool and glucose space declined with advancing age. Nangia *et al.* (1970) studied the effect of ration and rumen inoculation on the growth performance of calves reared on milk substitutes and reported higher haemoglobin values in calf starter fed group as compared to milk fed one, which may partly be due to greater intake of iron in case of concentrate fed animals. Studies of blood glucose level at fortnightly interval in calves weaned at 8, 10, 12 and 24weeks by Garg *et al.* (1974) revealed maximum glucose concentration at sixth week and thereafter declined gradually and the glucose level remained significantly higher in control group than treatment groups.

Little *et al.* (1977) studied the effect of age, live weight gain and feed intake on the blood composition of young calves weaned at six weeks of age. They found that the glucose concentration decreased until six weeks of age. At two to five weeks period haemoglobin concentration showed statistically significant correlation with subsequent growth. Puri *et al.* (1983) reported that the rate of reduction of glucose level is higher in early weaned calves than in normal weaned calves and change in blood glucose is due to change in the metabolic pattern as a result of early development of rumen function. Gupta *et al.* (1997) studied the normal haematological parameters of Sahiwal calves and found that the haemoglobin level from birth to 30 days differed significantly and the values being 17, 16.54, 15.36 and 15.08 at 1, 10, 20 and 30 days of age.

2.2.5 Economics

Khoury *et al.* (1967) reported that the cost of rearing was less for early weaned calves than late weaned calves. Nangia *et al.* (1970) studied the effect of ration and rumen inoculation on the growth performance of calves reared on milk

substitutes and reported that the cost of feeding was almost half in the case of calves reared on mixture of concentrate and hay in the ratio of 50:50 and 30:70 over a period of six months when compared to calves fed on either milk with limited amount of concentrate or higher level of concentrate with limited amount of milk. Krishnamohan *et al.* (1987) observed that the cost of feeding was minimum with lowest level of milk feeding when calves were fed milk at different levels up to 60 days of age. Misra *et al.* (1994) reported that feed cost reduced considerably in calves weaned at 63 days than those weaned at 90 days. Raut *et al.* (1998) studied the performance of restricted milk fed cross bred calves and found that calves can be successfully weaned at six weeks of age.

Materials and methods

3. MATERIALS AND METHODS

3.1 EXPERIMENTAL ANIMALS

Eighteen healthy cross bred calves selected from University Livestock Farm and Fodder Research and Development Scheme (ULF&FRDS), College of Veterinary and Animal Sciences, Mannuthy, formed the experimental subjects for the study. After four days of suckling of colostrum, calves were weaned and housed individually in well ventilated, clean and dry pens with separate feeding and watering facility. The calves were divided into three groups (group I, II and III) as uniformly as possible with regard to age, sex and body weight and were allotted randomly to three dietary treatments. All the calves were dewormed at first week of the feeding trial followed by once in every month during the experimental period of five months. All the experimental calves were maintained under identical conditions of feeding and management through out the experimental period.

3.2 RATION

Calves of group I, II and III were fed with whole milk up to twelve, eight and four weeks of age respectively. Along with whole milk all the calves were given calf starter prepared as per BIS specification (IS: 5560:1970) and good quality green grass *ad libitum*. Ingredient composition of calf starter is given in Table 1 and the chemical composition of calf starter and green grass is given in Table 2. The calf starter used for the study had 26 per cent crude protein (CP) and 71 per cent total digestible nutrients (TDN).

3.3 METHODS

All the experimental calves were fed required quantity of whole milk daily at 8 am and 3.30 pm in two equal proportions. The quantity of whole milk fed was at the rate of $1/10^{th}$ of their body weight from first to six weeks, $1/15^{th}$ of body weight from seven to eight weeks and $1/20^{th}$ of body weight from nine to twelve weeks of age.

Calf starter was slowly introduced from seventh day onwards and green grass was introduced by 15^{th} day of age. Weighed quantity of calf starter was given moistened with water to all the calves once daily in the morning after milk feeding during the first month. From second month onwards the feeding frequency of calf starter was increased twice daily and was offered just prior to milk feeding in the morning and evening. Weighed quantity of fresh green grass was fed once daily in the afternoon through out the experimental period. Individual data of daily offered quantity of calf starter, milk and green grass were recorded. The left over portion of the calf starter and green grass were weighed daily and their moisture content was analyzed. Daily dry matter intakes from whole milk, calf starter and green grass with respect to each calf were calculated through out the experimental period. Body weight of all the calves was recorded before feeding at weekly interval. The concentrate allowance and green grass offered were increased weekly based on body weight and intake taking into consideration the increased nutrient requirement commensurate with the growth increment. Fresh drinking water was provided *ad libitum* to all the calves through out the course of experiment.

All the experimental calves were maintained on their respective feeding regime for a period of 150 days. Blood samples were collected from all animals at monthly intervals. A digestion trial involving five days collection period was carried

out at the fourth month of age. Representative samples of calf starter and green grass offered were taken daily during the digestion trial for chemical analysis. The balance feed and grass samples were collected from individual pens and their moisture content was determined daily. At the end of the collection period feed samples collected daily were pooled and subjected to chemical analysis.

The dung was collected manually as and when it was voided. All precautions were taken to collect the dung quantitatively, uncontaminated by urine, feed residue and dirt. The dung collected each day was weighed accurately, mixed thoroughly and representative samples at the rate of 10 per cent of the total quantity was stored in airtight plastic bags under refrigeration. At the end of the collection period the dung samples taken from each animal and preserved during the entire collection period were pooled and used for chemical analysis.

3.4 ANALYSIS OF FEED AND DUNG

Proximate analysis of the calf starter, green grass and dung was done as per the standard procedure (AOAC, 1990). Crude protein in dung was estimated using fresh samples. The acid detergent fiber (ADF) was estimated by the method suggested by Van Soest (1963) and neutral detergent fiber (NDF) by the method suggested by Van Soest and Whine (1967). The calcium content in feed and dung was estimated using Atomic Absorption Spectrophotometer (PERKIN ELMER 3110, U.S. instrument division, Norwalk, U.S.A.). Phosphorus content in the feed and dung was determined by Vanado-Molybdate method (AOAC, 1990).

From the data obtained on the intake and out go of dry matter and different nutrients during digestion trail, digestibility coefficient of nutrients was calculated.

3.5 HAEMATOLOGICAL STUDIES

Haematological studies included the estimation of haemoglobin, plasma protein, plasma glucose, serum calcium and phosphorus. Haemoglobin was estimated by cyanmethaemoglobin method using kit supplied by Beacon Diagnostics PVT.LTD.Navsari, India. Plasma glucose (GOD-PAP method), plasma protein (Biuret method), and serum phosphorus (Phosphomolybdate method) were determined using the kits supplied by Agappe diagnostics, Maharastra, India. Serum calcium was determined by Atomic Absorption Spectrophotometer.

3.6 STATISTICAL ANALYSIS

Data obtained on different parameters during the course of experiment were subjected to statistical analysis using Analysis of Variance (ANOVA) (Snedecor and Cochran, 1994).

Table 1. Ingredient composition of calf starter, %

Ingredient	Percentage composition
Yellow Maize	30
Wheat bran	10
Soya bean meal	20
Unsalted dried fish	8
Black gram husk	10
Gingelly oil cake	20
Mineral mixture	2

To every 100 kg calf starter, 0.5kg of common salt and 10grams of Indomix-AB_2D_3K (Nicholas Piramal India Ltd, 100, Centre point, Dr. Ambedkar road, Parel, Mumbai-400012) having in every gram, Vitamin A-82500 I.U, Vitamin B_2-50 mg, Vitamin D_3-12000 I.U, Vitamin K-10 mg were added.

Table 2. Percentage chemical composition of calf starter and green grass fed to experimental calves on dry matter basis

Item	Calf starter	Grass
Dry matter	91.66	22.73
Crude protein	25.78	10.49
Ether extract	3.98	1.92
Crude fibre	7.12	34.13
Total ash	11.34	10.73
Nitrogen Free Extract	51.78	42.73
Acid insoluble ash	3.74	3.21
Neutral Detergent Fibre	22.67	70.28
Acid Detergent Fibre	11.44	41.68
Calcium	1.59	0.36
Phosphorus	0.98	0.48

Results

4. RESULTS

The results obtained during the course of the present study are documented here under the following headings.

4.1 BODY WEIGHT

The average body weight of experimental calves maintained on three different milk feeding schedule, recorded at fortnightly intervals are documented in Table 3 and depicted in Fig. 1.

4.2 AVERAGE DAILY GAIN

Summarized data on initial body weight, final body weight, total weight gain and average daily gain obtained for the calves maintained on the three different milk feeding schedule are listed in Table 4. Average daily gain was 300 g, 307.78 g and 321.67 g for group I, II and III respectively and is graphically illustrated in Fig. 2.

4.3 DRY MATTER INTAKE

Data on fortnightly average of daily dry matter intake of experimental calves of group I, II and III are presented in Table 5a to 5c respectively and are consolidated in Table 6 and graphically depicted in Fig. 3. The fortnightly averages of daily dry matter intake (DMI)/ 100 kg body weight and on metabolic body size are shown in Table 7.

4.4 FEED CONVERSION EFFICIENCY

The mean cumulative feed conversion efficiency (kg feed/ kg gain) was 4.14, 3.59 and 4.23 for group I, II and III respectively and are presented in Table 8. Cumulative feed conversion efficiency of the calves is also illustrated in Fig. 4.

4.5 DIGESTIBILITY COEFFICIENT

Data on the digestion trial of calves conducted during fourth month of age are presented in Table 9. Percentage chemical composition of dung collected during the digestion trial of the calves of group I, II and III respectively are presented in Table 10a to 10c. The digestibility coefficients of nutrients estimated are presented in Table 11a to 11 c and consolidated in Table 12 and graphically depicted in Fig. 5.

4.6 HAEMATOLOGICAL PARAMETERS

Haematological parameters of the experimental calves such as haemoglobin, plasma protein, plasma glucose, serum calcium and serum phosphorus recorded at monthly interval are listed in Table 13 to 17, consolidated in Table 18 and graphically represented in Fig. 6 to 10 respectively.

4.7 ECONOMICS OF PRODUCTION

The economics of production as obtained in the present study are detailed in Table 19. The feed cost per kg weight gain of experimental calves for group I, II and III were Rs. 88.14, Rs. 65.62 and Rs. 53.95 respectively.

Table 3. Fortnightly average body weight of experimental calves, * kg

Weeks	Groups			P value
	I	II	III	
0	23.67±2.32	21.83±1.14	23.00±1.39	N.S
2	25.58±1.61	23.92±1.27	26.33±1.30	"
4	28.58±1.71	25.08±1.61	28.50±1.63	"
6	30.33±2.35	28.50±2.25	31.17±2.09	"
8	33.50±2.71	32.58±2.71	35.00±2.60	"
10	37.67±3.21	36.58±3.10	38.92±2.31	"
12	42.92±3.39	40.58±3.63	42.75±3.00	"
14	48.00±3.66	44.67±3.93	47.50±4.36	"
16	52.33±3.61	50.08±4.03	53.83±5.17	"
18	57.08±3.27	56.75±4.61	59.67±5.84	"
20	64.58±4.40	64.25±5.26	67.67±6.05	"
21	68.67±4.48	68.00±5.37	71.25±5.80	"

* Average of six values
N.S : Non Significant

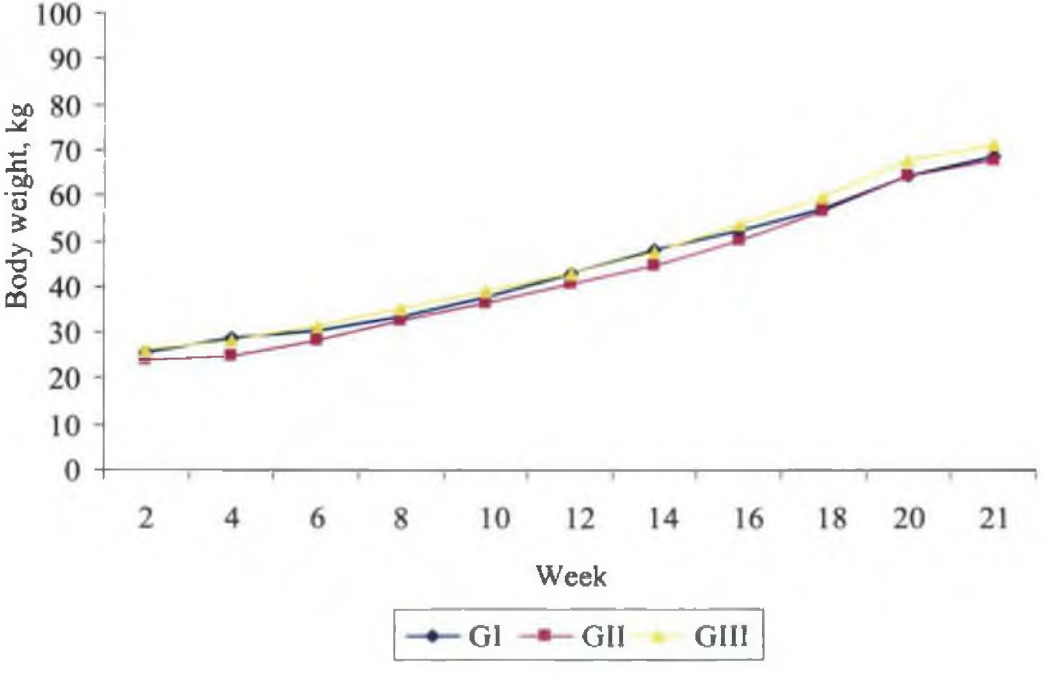

Fig.1. Fortnightly average body weight of experimental calves, kg

Table 4. Summarized data on body weight, total gain and average daily gain of experimental calves* for a period of 150 days

Parameters	Groups			P value
	I	II	III	
Initial body weight (kg)	23.67 ± 2.32	21.83 ± 1.14	23.00 ± 1.39	N.S
Final body weight (kg)	68.67 ± 4.48	68.00 ± 5.37	71.25 ± 5.80	"
Total gain (kg)	45.00 ± 5.44	46.17± 5.07	48.25 ± 6.21	"
Average daily gain (g)	300.00 ± 36.27	307.78 ± 33.79	321.67 ± 41.38	"

* Average of six values.

N.S : Non Significant

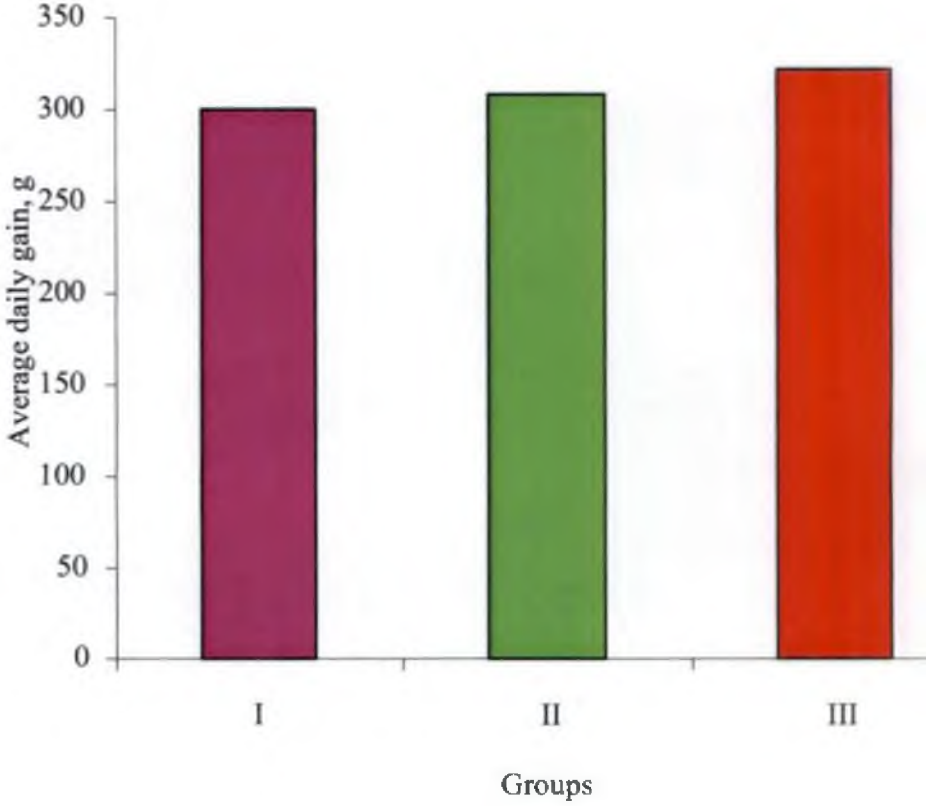

Fig.2. Average daily gain of experimental calves, g

Table 5 a. Fortnightly average of daily dry matter intake of experimental calves*, kg

Group I

Week	Milk	Concentrate	Grass	Total
2	0.30 ± 0.03	0.02 ± 0.003	0.00	0.31 ± 0.05
4	0.32 ± 0.02	0.08 ± 0.02	0.002±0.01	0.40 ± 0.07
6	0.35 ± 0.02	0.12 ± 0.03	0.033±0.01	0.50 ± 0.09
8	0.27 ± 0.02	0.24 ± 0.04	0.069±0.01	0.58 ± 0.1
10	0.22 ± 0.02	0.41 ± 0.06	0.126±0.01	0.76 ± 0.14
12	0.24 ± 0.02	0.64 ± 0.07	0.175±0.02	1.05 ± 0.18
14		0.88 ± 0 .07	0.249±0.03	1.13 ± 0.19
16		1.14 ± 0.08	0.368±0.05	1.51 ± 0.25
18		1.38 ± 0.08	0.612±0.06	1.99 ± 0.32
20		1.64 ± 0.12	0.866±0.13	2.51 ± 0.42
21		1.82 ± 0.20	1.053±0.19	2.87 ± 0.49

* Average of six values

Table 5 b. Fortnightly average of daily dry matter intake of experimental calves*, kg

Group II

Week	Milk	Concentrate	Grass	Total
2	0.28 ± 0.01	0.02 ± 0.01	0.00	0.29 ± 0.05
4	0.30 ± 0.02	0.07 ± 0.01	0.01 ± 0.01	0.38 ± 0.06
6	0.33 ± 0.02	0.18 ± 0.03	0.04 ± 0.01	0.55 ± 0.09
8	0.27 ± 0.02	0.30 ± 0.05	0.07 ± 0.01	0.64 ± 0.11
10		0.45 ± 0.07	0.12 ± 0.02	0.57 ± 0.11
12		0.63 ± 0.09	0.22 ± 0.04	0.85 ± 0.16
14		0.90 ± 0.11	0.32 ± 0.06	1.21 ± 0.23
16		1.23 ± 0.14	0.45 ± 0.08	1.68 ± 0.30
18		1.54 ± 0.15	0.60 ± 0.10	2.13 ± 0.37
20		1.77 ± 0.16	0.81 ± 0.13	2.58 ± 0.45
21		1.94 ± 0.17	0.95 ± 0.13	2.89 ± 0.49

* Average of six values

Table 5 c. Fortnightly average of daily dry matter intake of experimental calves*, kg

Group III

Week	Milk	Concentrate	Grass	Total
2	0.29 ± 0.02	0.02 ± 0.01	0.002 ± 0.01	0.31 ± 0.05
4	0.33 ± 0.02	0.08 ± 0.01	0.03 ± 0.01	0.44 ± 0.07
6		0.28 ± 0.02	0.16 ± 0.12	0.44 ± 0.06
8		0.39 ± 0.04	0.17 ± 0.04	0.56 ± 0.10
10		0.65 ± 0.07	0.27 ± 0.08	0.93 ± 0.17
12		0.90 ± 0.08	0.39 ± 0.11	1.26 ± 0.24
14		1.17 ± 0.12	0.57 ± 0.15	1.74 ± 0.34
16		1.52 ± 0.13	0.77 ± 0.20	2.28 ± 0.45
18		1.79 ± 0.14	0.98 ± 0.24	2.77 ± 0.55
20		2.05 ± 0.13	1.19 ± 0.24	3.23 ± 0.55
21		2.16 ± 0.12	1.35 ± 0.25	3.51 ± 0.59

* Average of six values

Table 6. Consolidated data on fortnightly average of daily dry matter intake of experimental calves*, kg

Weeks	Groups			P value
	I	II	III	
2	0.31 ± 0.05	0.29 ± 0.05	0.31 ± 0.05	N.S
4	0.40 ± 0.07	0.38 ± 0.06	0.44 ± 0.07	"
6	0.50 ± 0.09[a]	0.55 ± 0.09[a]	0.44 ± 0.06[b]	0.02
8	0.58 ± 0.10	0.64 ± 0.11	0.56 ± 0.10	N.S
10	0.76 ± 0.14	0.57 ± 0.11	0.93 ± 0.17	"
12	1.05 ± 0.18	0.85 ± 0.16	1.26 ± 0.24	"
14	1.13 ± 0.19	1.21 ± 0.23	1.74 ± 0.34	"
16	1.51 ± 0.25	1.68 ± 0.30	2.28 ± 0.45	"
18	1.99 ± 0.32	2.13 ± 0.37	2.77 ± 0.55	"
20	2.51 ± 0.42	2.58 ± 0.45	3.23 ± 0.55	"
21	2.87 ± 0.49	2.89 ± 0.49	3.51 ± 0.59	"

* Average of six values
a, b-Means with different superscripts in the same row differ significantly at five per cent level.
N.S : Non Significant

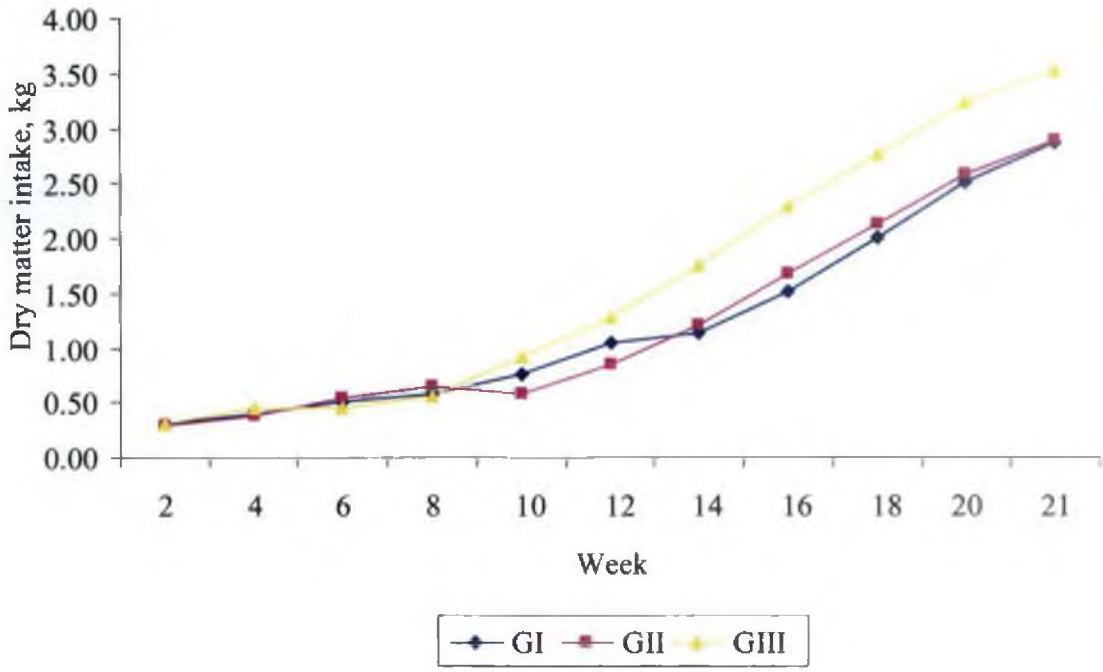

Fig.3. Fortnightly average of daily dry matter intake of experimental calves, kg

Table 7. Fortnightly average of daily dry matter intake per 100 kg body weight and on metabolic body size of experimental calves*, kg

Weeks	Fortnightly average of daily dry matter intake per 100 kg body weight			P value	Fortnightly average of daily dry matter intake per metabolic body size, ($Wkg^{0.75}$)			P value
	Group I	Group II	Group III		Group I	Group II	Group III	
2	1.27 ± 0.04	1.27 ± 0.04	1.25 ± 0.03	N.S	0.028±0.002	0.03 ± 0.001	0.03 ± 0.001	N.S
4	1.48 ± 0.05	1.55 ± 0.05	1.61 ± 0.04	"	0.034±0.0013	0.03 ± 0.001	0.04 ± 0.001	"
6	1.69 ± 0.09[a]	2.04 ± 0.06[a]	1.48 ± 0.11[b]	0.002	0.040±0.004[a]	0.05 ± 0.002[a]	0.03 ± 0.003[b]	0.001
8	1.82 ± 0.09	2.10 ± 0.12	1.70 ± 0.19	N.S	0.043±0.002	0.05 ± 0.004	0.04 ± 0.004	N.S
10	2.14 ± 0.11[a]	1.65 ± 0.18[b]	2.51 ± 0.26[a]	0.041	0.052±0.003	0.04 ± 0.005	0.06 ± 0.007	"
12	2.60 ± 0.12	2.21 ± 0.20	3.15 ± 0.37	"	0.066±0.003	0.05 ± 0.006	0.08 ± 0.010	"
14	2.48 ± 0.12	2.85 ± 0.22	3.86 ± 0.46	"	0.070±0.003	0.07 ± 0.007	0.10 ± 0.012	"
16	3.01 ± 0.16	3.54 ± 0.24	4.51 ± 0.62	"	0.080±0.004	0.09 ± 0.007	0.12 ± 0.017	"
18	3.64 ± 0.17	3.99 ± 0.19	4.87 ± 0.68	"	0.099±0.004	0.12 ± 0.007	0.13 ± 0.020	"
20	4.13 ± 0.17	4.27 ± 0.19	5.08 ± 0.31	"	0.115±0.292	0.12 ± 0.007	0.14 ± 0.010	"
21	4.31 ± 0.21	4.37 ± 0.15	5.05 ± 0.29	"	0.123±0.006	0.12 ± 0.006	0.15 ± 0.009	"

*Average of six values

a, b-Means with different superscripts in same row differ significantly at five per cent level

N.S : Non Significant.

Table 8. Cumulative feed efficiency of experimental calves for a period of 150 days*

Parameters	Groups			P value
	I	II	III	
Total dry matter consumed (kg/animal)	178.98 ± 13.34	165.64 ± 19.07	196.42 ± 19.91	N.S
Average daily dry matter consumed (kg/animal)	1.19 ± 0.09	1.10 ± 0.13	1.31 ± 0.13	"
Total body weight gain (kg)	45.00 ± 5.44	46.17± 5.07	48.25 ± 6.21	"
Feed to gain ratio	4.14 ± 0.36	3.59 ± 0.14	4.23 ± 0.29	"

* Average of six values
N.S : Non Significant

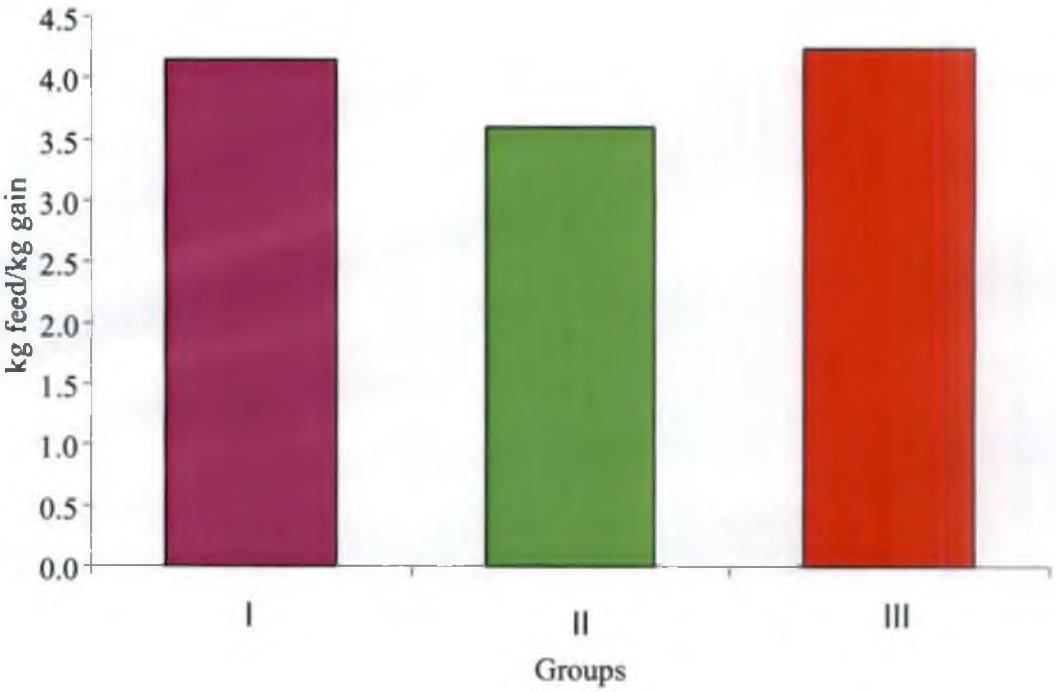

Fig. 4. Cumulative feed efficiency of experimental calves

Table 9. Data on digestion trial conducted in experimental calves at fourth month of age

	Animal Number	Total DMI from concentrate	Total DMI from grass	DM out go through dung
	kg			
Group I	1	5.04	1.16	1.49
	2	5.04	1.95	1.64
	3	8.25	4.01	2.67
	4	8.25	5.15	3.17
	5	5.96	2.06	1.65
	6	5.50	2.46	1.60
Group II	1	5.04	1.29	1.55
	2	5.96	2.37	2.64
	3	5.98	2.10	2.36
	4	4.58	1.16	1.61
	5	5.50	1.77	1.43
	6	6.42	4.19	2.30
Group III	1	7.33	2.90	2.48
	2	4.12	0.79	1.39
	3	5.96	2.14	2.12
	4	11.00	4.53	3.32
	5	7.79	3.39	3.50
	6	5.50	2.52	2.09

Table 10 a. Percentage chemical composition of dung of experimental calves collected during digestion trial on dry matter basis

Group I

Animal Number	Dry matter	Crude protein	Crude fibre	Ether extract	Total ash	Acid insoluble ash	N F E	Calcium	Phosphorus	NDF	ADF
1	23.70	17.55	22.40	2.15	23.12	13.11	34.78	1.27	0.97	56.72	40.86
2	22.67	18.57	23.55	2.45	20.22	11.96	35.21	1.31	0.93	57.76	41.03
3	24.21	16.74	22.31	2.34	24.56	13.10	34.06	1.15	0.73	56.27	39.85
4	22.25	17.42	22.96	2.16	23.42	12.25	34.03	1.31	0.89	55.62	40.86
5	19.71	18.50	23.25	2.55	22.96	13.24	32.74	1.31	1.06	57.50	42.58
6	23.39	17.54	23.30	2.53	22.88	12.91	33.75	1.41	0.91	57.25	41.23

Table 10 b. Percentage chemical composition of dung of experimental calves collected during digestion trial on dry matter basis

Group II

Animal Number	Dry matter	Crude protein	Crude fibre	Ether extract	Total ash	Acid insoluble ash	N F E	Calcium	Phosphorus	NDF	ADF
1	24.59	17.56	22.50	2.42	23.68	12.05	33.85	1.31	0.92	56.78	41.66
2	23.59	17.50	22.66	2.28	23.33	12.22	34.24	1.35	0.94	54.80	38.66
3	24.85	16.89	22.51	2.26	23.93	13.12	34.41	1.30	0.87	54.68	38.66
4	24.04	17.19	22.64	2.27	23.14	13.50	34.75	1.38	0.95	55.81	38.92
5	24.68	16.70	23.38	2.28	23.94	13.32	33.70	1.31	0.92	56.77	40.66
6	24.47	16.69	22.60	2.21	22.42	13.45	36.08	1.36	0.91	54.89	38.38

Table 10 c. Percentage chemical composition of dung of experimental calves collected during digestion trial on dry matter basis

Group III

Animal Number	Dry matter	Crude protein	Crude fibre	Ether extract	Total ash	Acid insoluble ash	N F E	Calcium	Phosphorus	NDF	ADF
1	24.81	16.51	22.67	1.90	22.47	11.97	36.46	1.25	0.78	54.78	38.88
2	23.98	17.21	23.33	2.26	23.85	12.25	33.36	1.34	0.91	56.98	41.01
3	23.80	16.93	23.51	2.42	23.22	12.30	33.93	1.35	0.90	55.85	40.14
4	23.08	17.51	21.22	2.28	22.30	12.31	36.70	1.30	0.88	55.85	39.95
5	22.87	17.42	21.22	2.18	22.87	11.26	36.31	1.28	0.86	56.91	40.57
6	21.15	17.55	21.60	2.43	22.87	11.66	35.55	1.34	0.91	55.96	40.11

Table 11 a. Digestibility coefficient of nutrients of experimental ration

Group I

Animal Number	Dry matter	Crude protein	Crude fibre	Ether extract	N F E	NDF	ADF
1	75.93	81.56	53.59	85.60	83.29	56.79	42.51
2	78.18	80.50	65.67	83.83	84.26	67.04	58.02
3	76.32	80.09	67.69	82.60	83.31	67.48	59.08
4	79.47	83.64	64.53	87.13	85.88	67.29	56.34
5	79.94	82.37	67.93	84.69	86.59	69.14	58.90
6	76.59	80.91	60.52	82.60	83.96	62.72	51.44
Average with SE	77.74±0.70	81.51±0.54	63.32±2.23	84.41±0.72	84.55±0.56	65.08±1.87	54.38±2.64

Table 11 b. Digestibility coefficient of nutrients of experimental ration

Group II

Animal No.	Dry matter	Crude protein	Crude fibre	Ether extract	N F E	NDF	ADF
1	75.52	81.04	54.13	83.35	83.41	57.05	42.04
2	68.25	74.08	48.40	78.70	77.91	51.94	38.74
3	70.77	77.36	50.74	80.85	79.65	54.38	41.43
4	71.94	78.75	46.89	82.13	80.48	51.47	37.73
5	80.32	85.10	64.52	87.08	86.62	67.40	57.46
6	78.31	81.66	70.48	84.89	83.77	71.30	64.41
Average with SE	74.14±1.90	79.66±1.56	55.86±3.89	82.83±1.21	81.97±1.30	58.92±3.43	46.97±4.55

Table 11 c. Digestibility coefficient of nutrients of experimental ration.

Group III

Animal Number	Dry matter	Crude protein	Crude fibre	Ether extract	N F E	NDF	ADF
1	75.76	81.34	60.51	86.51	82.04	63.26	52.88
2	71.71	79.13	39.88	82.48	81.25	46.84	28.83
3	73.85	79.64	54.32	81.60	82.03	58.56	45.97
4	78.60	82.42	67.84	85.57	84.02	67.30	57.79
5	68.70	74.21	53.87	79.64	76.82	51.98	38.36
6	73.92	78.18	61.57	81.00	81.05	61.20	50.02
Average with SE	73.75±1.38	79.15±1.17	56.33±3.91	82.80±1.10	81.20±0.98	58.19±3.08	45.64±4.30

Table 12. Consolidated data on digestibility coefficient of nutrients of experimental rations*

Item	Groups			P value
	I	II	III	
Dry matter	77.74 ± 0.70	74.14 ± 1.90	73.75 ± 1.38	N.S
Crude protein	81.51 ± 0.54	79.66 ± 1.56	79.15 ± 1.17	"
Crude fibre	63.32 ± 2.23	55.86 ± 3.89	56.33 ± 3.91	"
Ether extract	84.41 ± 0.72	82.83 ± 1.21	82.80 ± 1.09	"
N F E	84.55 ± 0.56	81.97 ± 1.30	81.20 ± 0.97	"
NDF	65.08 ± 1.87	58.92 ± 3.43	58.19 ± 3.08	"
ADF	54.38 ± 2.64	46.97 ± 4.56	45.64 ± 4.30	"

N.S : Non Significant
* Average of six values

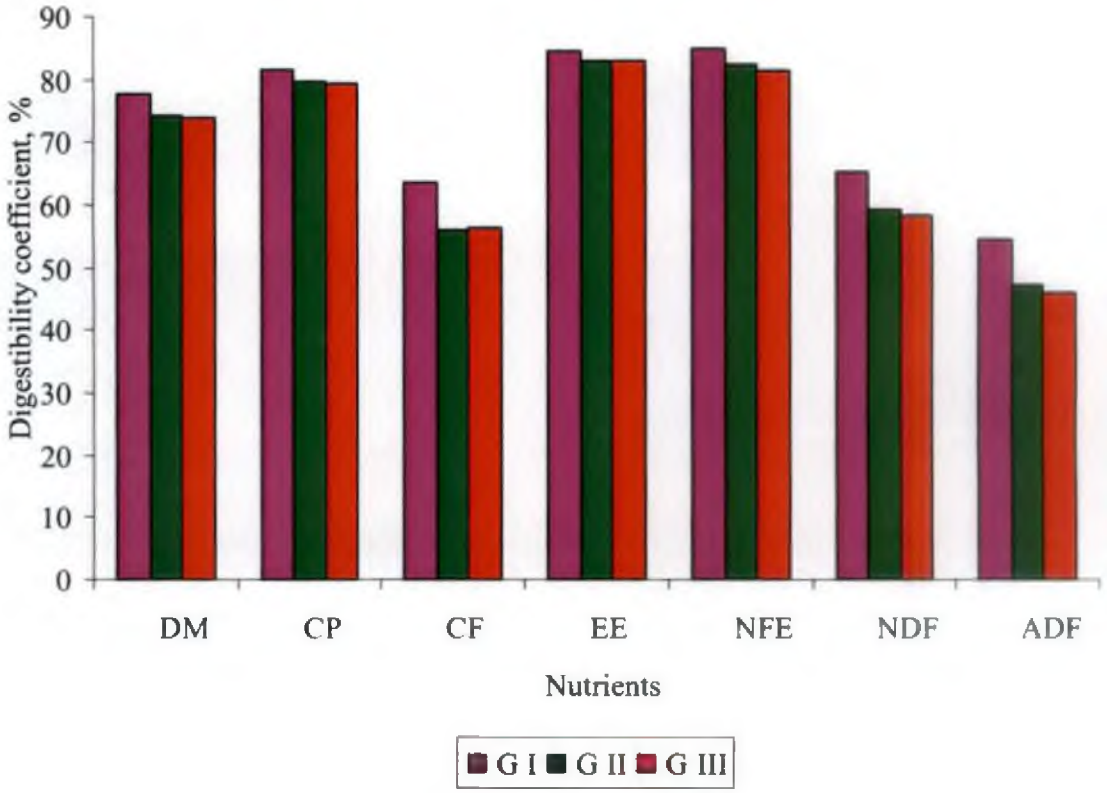

Fig.5. Digestibility coefficient of nutrients of experimental ration

Table 13. Blood haemoglobin concentration of experimental calves recorded at monthly interval, mg/dl

Group I

Animal Number	1st month	2nd month	3rd month	4th month	5th month
1	13.22	12.82	12.42	12.18	12.02
2	12.16	11.83	11.84	10.86	10.92
3	12.81	12.42	12.84	12.82	12.36
4	11.9	11.08	11.62	11.73	11.36
5	11.87	12.02	12.12	12.06	12.76
6	11.62	11.02	10.98	10.62	10.12
Average with SE	12.26±0.25	11.87±0.29	11.97±0.26	11.71±0.34	11.59±0.40

Group II

Animal Number	1st month	2nd month	3rd month	4th month	5th month
1	8.13	8.34	7.81	7.98	8.21
2	12.82	12.63	12.26	12.14	12.12
3	11.72	11.91	13.17	12.84	12.61
4	12.23	11.74	12.32	12.16	12.29
5	12.37	12.27	12.12	12.13	12.39
6	12.76	13.13	13.27	13.6	12.82
Average with SE	11.67±0.73	11.67±0.70	11.83±0.83	11.81±0.80	11.74±0.71

Group III

Animal Number	1st month	2nd month	3rd month	4th month	5th month
1	13.81	13.62	13.41	13.24	12.98
2	10.92	10.35	10.26	10.84	10.86
3	13.43	12.81	13.12	12.48	11.6
4	12.46	12.23	13.14	10.17	12.1
5	11.84	11.42	11.32	11.01	10.2
6	11.62	11.64	11.34	10.62	11.36
Average with SE	12.35±0.45	12.01±0.47	12.10±0.53	11.39±0.49	11.52±0.39

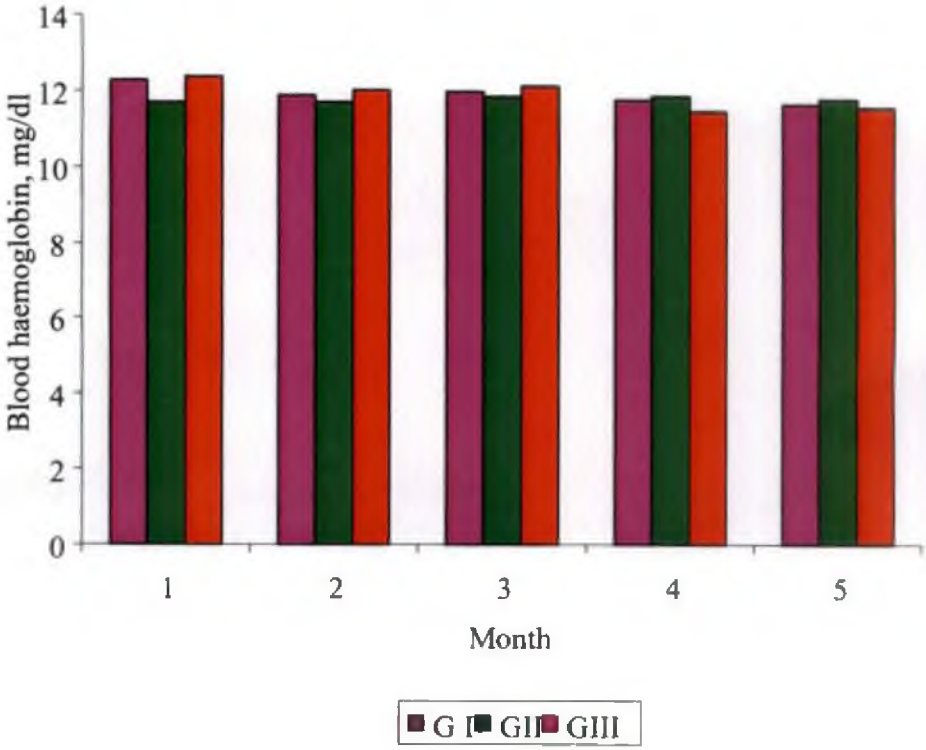

Fig.6. Blood haemoglobin concentration of experimental calves, mg/dl

Table 14. Plasma protein concentration of experimental calves recorded at monthly interval, mg/dl

Group I

Animal Number	1st month	2nd month	3rdmonth	4th month	5th month
1	6.21	6.43	6.62	6.94	6.93
2	6.10	6.70	6.90	6.89	7.02
3	6.12	6.36	6.43	6.60	6.78
4	6.01	6.33	6.41	6.52	6.56
5	6.48	6.42	6.59	6.67	7.12
6	6.50	6.69	6.81	6.79	6.86
Average with SE	6.24±0.08	6.49±0.07	6.63±0.08	6.74±0.07	6.87±0.08

Group II

Animal Number	1st month	2nd month	3rdmonth	4th month	5th month
1	5.30	5.41	5.42	5.49	5.56
2	6.40	6.52	6.63	6.71	6.90
3	6.30	6.42	6.59	6.80	7.20
4	6.21	6.36	6.43	6.60	6.78
5	6.32	6.42	6.53	6.54	6.60
6	6.80	6.93	6.97	7.08	7.01
Average with SE	6.22±0.20	6.34±0.20	6.43±0.22	6.54±0.22	6.68±0.24

Group III

Animal Number	1st month	2nd month	3rdmonth	4th month	5th month
1	6.12	6.32	6.51	6.79	7.22
2	6.26	6.32	6.35	6.38	6.68
3	6.12	6.40	6.42	6.82	7.08
4	6.30	6.41	6.52	6.70	6.90
5	6.12	6.16	6.23	6.42	6.80
6	6.60	6.62	6.71	6.73	6.78
Average with SE	6.25±0.08	6.37±0.06	6.46±0.07	6.64±0.08	6.91±0.08

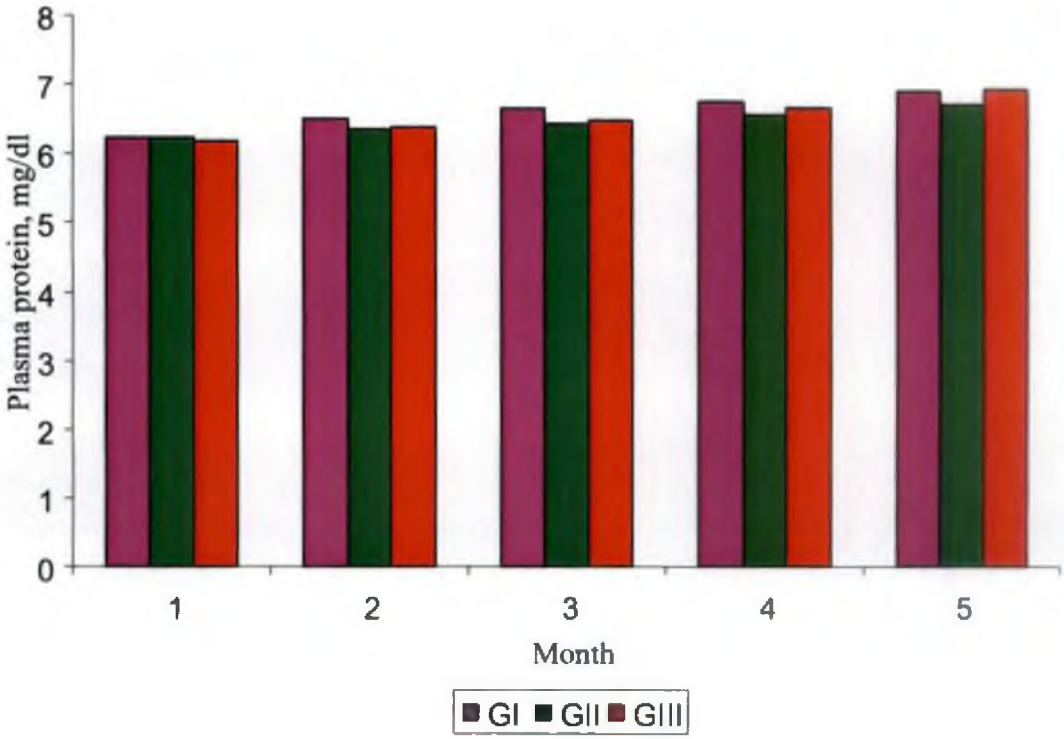

Fig.7. Plasma protein concentration of experimental calves, mg/dl

Table 15. Plasma glucose concentration of experimental calves recorded at monthly interval, mg/dl

Group I

Animal Number	1st month	2nd month	3rd month	4th month	5th month
1	96.82	90.18	79.80	75.20	61.20
2	92.34	89.90	78.20	73.20	60.40
3	94.16	90.80	79.60	72.60	62.20
4	99.76	87.80	80.40	68.20	62.40
5	98.89	89.20	80.60	72.40	60.60
6	99.96	89.70	78.40	73.20	61.80
Average with SE	96.99±1.29	89.60±0.42[a]	79.50±0.41[a]	72.47±0.94[a]	61.43±0.34

Group II

Animal Number	1st month	2nd month	3rd month	4th month	5th month
1	99.28	90.20	74.60	70.20	60.20
2	98.62	90.10	75.60	71.40	60.50
3	96.78	89.80	74.80	70.20	61.20
4	95.89	89.70	73.20	69.20	60.80
5	94.18	90.60	76.40	68.40	60.70
6	97.52	88.90	70.90	69.40	61.40
Average with SE	97.05±0.76	89.89±0.24[a]	74.25±0.80[b]	69.80±0.42[b]	60.80±0.18

Group III

Animal Number	1st month	2nd month	3rd month	4th month	5th month
1	98.63	86.20	69.30	65.82	60.22
2	95.41	87.20	68.90	65.30	61.20
3	97.84	86.92	69.23	65.71	60.44
4	93.88	87.42	69.87	64.81	61.42
5	99.80	87.62	69.86	66.22	60.53
6	98.21	88.23	64.44	65.46	61.87
Average with SE	97.30±0.90	87.30±0.28[b]	68.6±0.85[c]	65.55±0.20[c]	60.95±0.26

a, b, c-Means with different superscripts in the same column differ significantly at one per cent level.

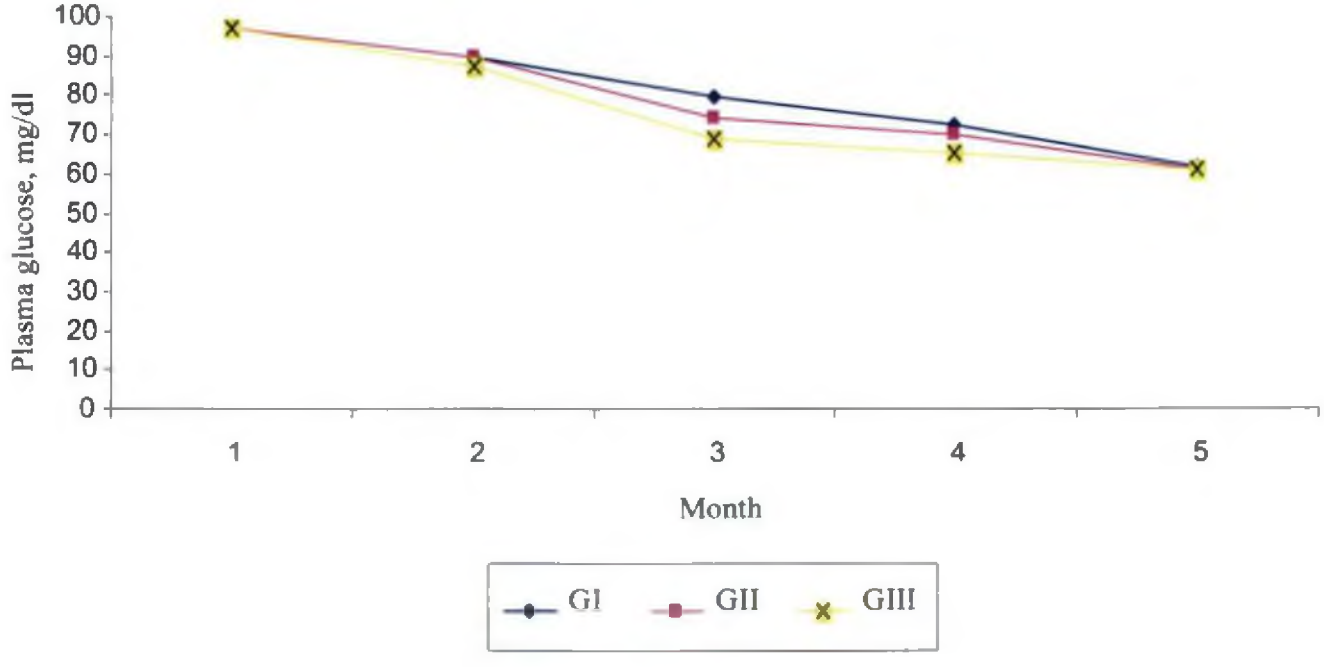

Fig.8. Plasma glucose concentration of experimental calves, mg/dl

Table 16. Serum calcium concentration of experimental calves recorded at monthly interval, mg/dl

Group I

Animal Number	1st month	2nd month	3rd month	4th month	5th month
1	10.96	11.36	10.98	10.89	11.12
2	11.42	10.41	10.62	10.87	11.32
3	11.34	11.26	10.43	11.09	11.41
4	10.86	10.72	10.88	11.02	11.06
5	11.21	11.16	11.02	11.06	11.12
6	11.47	10.89	11.01	10.92	11.23
Average with SE	11.21±0.12	10.97±0.15	10.82±0.10	10.98±0.04	11.21±0.06

Group II

Animal Number	1st month	2nd month	3rd month	4th month	5th month
1	11.22	10.76	11.15	11.68	11.70
2	10.98	11.08	11.11	10.88	10.94
3	11.26	11.06	11.12	10.97	11.16
4	11.34	11.68	10.94	10.98	11.23
5	11.50	11.78	10.92	10.97	11.12
6	11.41	11.68	11.01	10.89	11.13
Average with SE	11.29±0.07	11.34±0.17	11.04±0.04	11.06±0.12	11.21±0.10

Group III

Animal Number	1st month	2nd month	3rd month	4th month	5th month
1	10.98	11.42	11.02	10.98	11.06
2	11.25	11.42	10.89	10.87	11.16
3	11.56	10.82	11.04	10.88	11.62
4	11.56	10.47	10.81	10.86	10.92
5	10.46	10.36	10.43	10.85	11.01
6	11.21	11.43	11.16	11.07	11.15
Average with SE	11.17±0.17	10.99±0.20	10.89±0.10	10.92±0.04	11.15±0.10

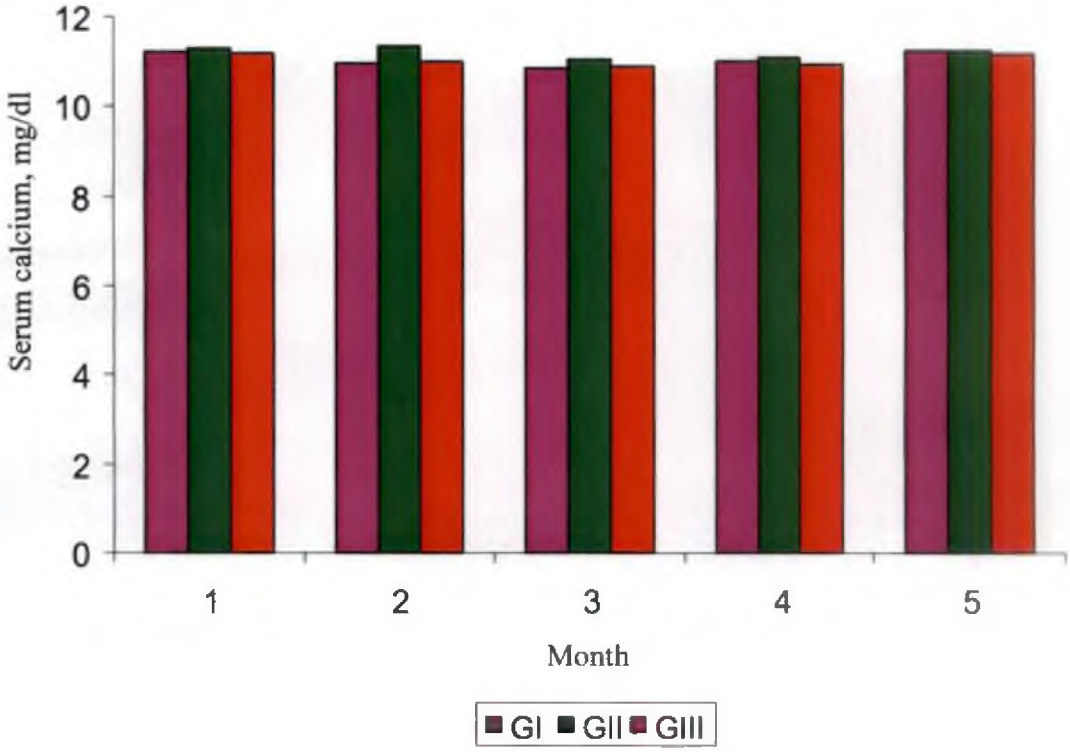

Fig.9. Serum calcium concentration of experimental calves, mg/dl

Table 17. Serum phosphorus concentration of experimental calves recorded at monthly interval , mg/dl

Group I

Animal Number	1st month	2nd month	3rd month	4thmonth	5th month
1	6.82	6.84	6.21	6.18	6.93
2	6.88	6.67	6.19	5.89	6.92
3	6.12	6.24	5.68	6.81	6.48
4	6.76	6.13	6.19	7.16	6.93
5	6.08	6.42	5.82	6.92	6.89
6	6.23	5.98	6.43	6.56	6.62
Average with SE	6.48±0.15	6.38±0.13	6.09±0.11	6.59±0.20	6.80±0.80

Group II

Animal Number	1st month	2nd month	3rd month	4thmonth	5th month
1	5.98	6.32	5.62	5.18	6.82
2	6.98	6.83	5.98	5.91	6.93
3	6.74	6.89	6.82	5.48	6.83
4	6.43	6.61	6.22	6.24	6.43
5	6.23	6.28	6.82	7.02	6.89
6	5.99	5.62	5.81	6.01	6.82
Average with SE	6.39±0.17	6.43±0.19	6.21±0.21	5.97±0.26	6.79±0.07

Group III

Animal Number	1st month	2nd month	3rd month	4thmonth	5th month
1	6.86	6.91	6.62	6.12	6.08
2	6.51	6.82	6.84	6.28	6.12
3	6.67	6.69	6.12	5.96	6.63
4	6.83	6.28	6.18	6.68	7.90
5	5.62	5.68	5.64	6.93	6.92
6	6.12	6.73	7.03	7.40	7.03
Average with SE	6.44±0.20	6.52±0.20	6.41±0.21	6.56±0.22	6.78±0.28

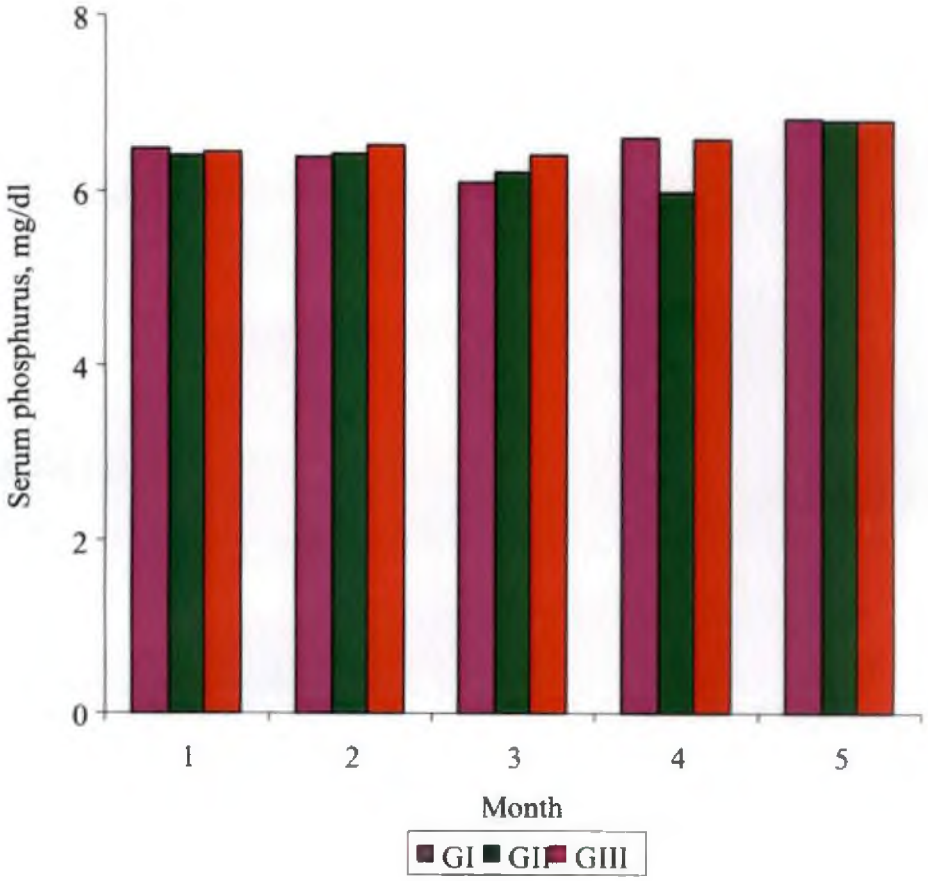

Fig.10. Serum phosphorus concentration of experimental calves, mg/dl

Table 18. Consolidated data on haematological parameters of experimental calves *, mg/dl

	Month					
	Group	1	2	3	4	5
Haemoglobin	I	12.26±0.25	11.87±0.29	11.97±0.26	11.71±0.34	11.59±0.40
	II	11.67±0.73	11.67±0.70	11.83±0.83	11.81±0.80	11.74±0.71
	III	12.35±0.45	12.01±0.47	12.10±0.53	11.39±0.49	11.52±0.39
	P value	N.S	N.S	N.S	N.S	N.S

	Month					
	Group	1	2	3	4	5
Plasma protein	I	6.24±0.08	6.49±0.07	6.63±0.08	6.74±0.07	6.87±0.08
	II	6.22±0.20	6.34±0.20	6.43±0.22	6.54±0.22	6.68±0.24
	III	6.25 ±0.04	6.37±0.06	6.46±0.07	6.64±0.08	6.91±0.08
	P value	N.S	N.S	N.S	N.S	N.S

	Month					
	Group	1	2	3	4	5
Plasma glucose	I	96.99±1.29	89.60±0.42[a]	79.50±0.41[a]	72.47±0.94[a]	61.43±0.34
	II	97.05±0.76	89.89±0.24[a]	74.25±0.80[b]	69.80±0.42[b]	60.80±0.18
	III	97.30±0.90	87.30±0.28[b]	68.6±0.85[c]	65.55±0.20[c]	60.95±0.26
	P value	N.S	0.0001	0.0000	0.0000	N.S

	Month					
	Group	1	2	3	4	5
Serum calcium	I	11.21±0.12	10.97±0.15	10.82±0.10	10.98±0.04	11.21±0.06
	II	11.29±0.07	11.34±0.17	11.04±0.04	11.06±0.12	11.21±0.10
	III	11.17±0.17	10.99±0.20	10.89±0.10	10.92±0.04	11.15±0.10
	P value	N.S	N.S	N.S	N.S	N.S

	Month					
	Group	1	2	3	4	5
Serum phosphorus	I	6.48±0.15	6.38±0.13	6.09±0.11	6.59±0.20	6.80±0.80
	II	6.39±0.17	6.43±0.19	6.21±0.21	5.97±0.26	6.79±0.07
	III	6.44±0.20	6.52±0.20	6.41±0.21	6.56±0.22	6.78±0.28
	P value	N.S	N.S	N.S	N.S	N.S

* Average of six values

a, b, c-Means with different superscripts in the same column differ significantly at one per cent level.

N.S : Non Significant

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Table 19. Economics of production of experimental calves for a period of 150 days*

Parameter	Groups		
	I	II	III
Total milk intake (kg/calf)	208.52 ± 11.98	140.08 ± 8.67	84.59 ± 4.00
Total calf starter intake, on fresh basis (kg/calf)	118.81 ± 7.70	114.80 ± 11.42	143.20 ± 13.27
Total grass intake on fresh basis (kg/calf)	188.34 ± 5.14	175.21 ± 7.31	229.12 ± 7.11
Total cost of feed (Rs./calf)**	3966.50 ± 211.90	3029.33±215.12	2603.32 ± 129.79
Total weight gain(kg/calf)	45.00 ± 5.44	46.17±5.07	48.25 ± 6.21
Cost per kg gain(Rs.)	88.14 ± 10.52	65.62 ± 4.48	53.95 ± 7.59

* Average of six values

** Cost of milk –Rs.13/ kg
calf starter- Rs.9.38/kg
grass – Rs.0.75/kg

Discussion

5. DISCUSSION

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

5.1 GROWTH

Data on the average fortnightly body weight of calves in group I, II and III fed on whole milk up to twelve, eight and four weeks of age respectively with *ad libitum* calf starter, and green grass for a period of 150 days are presented in Table 3 and depicted in Fig. 1. The results on fortnightly body weight revealed that the calves of all the three groups recorded normal pattern of growth without any significant difference ($P > 0.05$). Data presented in Table 4 further revealed that calves in group I, II and III had an average daily body weight gain of 300, 307.78 and 321.67g respectively, and the respective cumulative total gain was 45, 46.17 and 48.25 kg. Statistical analysis of the data on average daily gain and total gain also did not reveal any significant difference ($P > 0.05$) between the three dietary treatments. From the results on growth performance it is evident that calves of restricted milk fed groups and control group exhibited similar pattern of growth. This indicates that replacement of milk with calf starter, did not limit the growth of calves, which might be due to the compensatory intake of solid feed by the calves that received less milk.

Present results on the growth performance of experimental calves are in agreement with various authors. Quigley *et al.* (1985) reported no significant difference in growth of calves that were weaned at 28 and 56 days of age. Similarly, Ranjhan *et al.* (1972) also observed no significant difference in body weight of calves weaned at 45, 60 and 90 days of age.

While Winter (1985) reported no significant difference in growth performance in calves weaned at three, five and seven weeks of age, Borhami *et al.* (1967) reported higher growth rate for early weaned calves (45 days) than late weaned (120 days) calves.

Jasper and Weary (2002) reported that calves fed *ad libitum* milk remained more healthy and gained weight much more rapidly than the calves fed milk conventionally at the rate of $1/10^{th}$ of their body weight. Bar-peled *et al.* (1997) and Guler *et al.* (2003) also reported better growth performance in calves fed higher levels of milk compared to restricted milk/ milk replacer fed calves.

Similar values on average daily gain and total gain of calves as observed in the present study are also reported by Jith (2004) and Raja (2005) for cross bred calves below six months of age.

5.2 DRY MATTER CONSUMPTION

The average daily dry matter consumption of calves of three dietary treatments, recorded at fortnightly intervals are presented in Table 5a to 5c and consolidated with statistical analysis in Table 6 and graphically depicted in Fig. 3.

The average daily dry matter consumption at fortnightly intervals ranges from 0.31 to 2.87 kg for group I, 0.29 to 2.89 kg for group II and 0.31 to 3.51 kg for group III animals. Statistical analysis of the data on fortnightly average of daily dry matter consumption recorded no significant difference ($P>0.05$) between the various groups, except for the sixth week. In the week soon after weaning there is significant drop in dry matter intake in early weaned calves due to milk stoppage. But it increased rapidly in the subsequent weeks and dry matter intake reached comparable level to

that of milk fed calves during next fortnight. Though the values are statistically non significant, animals of early weaned group consumed more calf starter to compensate for the loss of milk nutrients.

The average daily dry matter consumption as percentage of the body weight and per metabolic body size of the experimental calves is presented in Table 7. Dry matter consumption per 100 kg body weight ranges from 1.27 to 4.31 kg, 1.27 to 4.37 kg and 1.25 to 5.05 kg ($P > 0.05$) for the calves of group I, II and III respectively. The dry matter consumption per metabolic body size of experimental calves was in the range of 0.028 to 0.123 kg, 0.03 to 0.12 kg, 0.03 to 0.15 kg ($P>0.05$) for group I, II and III respectively.

Significant drop ($P < 0.005$) in average daily dry matter consumption for group III calves, observed in the week soon after weaning (sixth week) was also reflected in dry matter consumption when expressed as percentage of body weight and per metabolic body size. As observed in restricted milk fed group III calves, group II calves also recorded a significant drop in percentage dry matter consumption in the week soon after milk stoppage (10^{th} week) and in subsequent weeks it reached comparable level to that of other groups.

Present results are in agreement with Misra *et al.* (1994) who observed no significant difference in dry matter intake of calves that were weaned at 63 and 90 days of age. Better dry matter intake in early weaned calves (28 days) as observed in present study was also reported by Quigley *et al.* (1985) and Hopkins (1997). Data on the dry matter consumption of the present study were in agreement with values reported by Asitha (2002); Jith (2004) and Raja (2005) in cross bred calves of similar age group.

5.3 FEED EFFICIENCY

Cumulative feed efficiency of experimental calves presented in Table 8 and Fig.4 was 4.14, 3.59 and 4.23 for group I, II and III respectively. Statistical analysis of the data on feed efficiency did not reveal any significant difference ($P>0.05$) among the groups. The data further revealed that Group III calves which received milk up to 28 days recorded similar feed efficiency as that of group I and group II calves which received milk up to 84 and 56 days, respectively. On comparing the feed efficiency of restricted milk fed groups, calves of group II that received whole milk up to eight weeks of age showed numerically better feed efficiency than the calves weaned at four weeks of age. In agreement with present results, Guler *et al.* (2003) reported better feed efficiency in calves weaned at eight weeks of age than calves weaned at five weeks of age. Winter (1985) reported no significant difference in feed efficiency among the calves that were weaned at three, five and seven weeks of age. In line with present results Misra *et al.* (1994) and Raut *et al.* (1998) also observed no significant difference in feed efficiency in early and late weaned calves.

In contrary to this Winter (1978) observed poor feed efficiency in calves weaned at third week of age. Data on the feed efficiency of cross bred calves recorded in the present study were comparable to that reported by several authors (Asitha, 2002; Jith, 2004 and Raja 2005).

5.4 NUTRIENT DIGESTIBILITY

The digestibility coefficient of different nutrients recorded from digestion trial conducted at fourth month of age in calves of three dietary treatments are

presented in Table 11 a to 11 c with consolidated data in Table 12 and depicted in Fig.5.

5.4.1 Dry Matter

Digestibility coefficient of dry matter observed in the present study was 77.74, 74.14 and 73.75 for the calves in group I, II and III respectively and statistical analysis did not reveal any significant difference between the groups ($P>0.05$) (Table 11a to 11 c and 12). Winter (1985) also observed no significant difference in dry matter digestibility of calves weaned at three, five and seven weeks of age.

In agreement with the present study Ranjhan *et al.* (1972) reported no significant difference in dry matter digestibility of calves weaned at 45, 60 and 90 days of age. Krishnamohan *et al.* (1987) and Babu *et al.* (2003) also observed similar dry matter digestibility ($P<0.05$) in calves fed different levels of milk.

5.4.2 Crude Protein

Digestibility coefficient of crude protein as presented in Table 11 a to 11 c and 12 was 81.51, 79.66 and 79.15 for the group I, II and III respectively. There was no significant difference ($P>0.05$) between the groups. This indicates that early weaning of calves did not influence the crude protein digestibility. Ranjhan *et al.* (1972) reported no significant difference in crude protein digestibility in calves weaned at 45, 60 and 90 days of age. Similar values of crude protein digestibility as observed in present study are also reported by Asitha (2002) and Babu *et al.* (2003) in cross bred calves of similar age group.

5.4.3 Ether Extract

Ether extract digestibility recorded in the present study was 84.41, 82.83 and 82.80 for group I, II and III respectively (Table 11a to11c and Table 12) and there was no significant difference (P>0.05) between the groups. In agreement with the present study, Babu *et al.* (2003) observed no significant difference in ether extract digestibility among the calves which received milk up to four and eight weeks of age. Jith (2004) and Raja (2005) reported slightly lower digestibility coefficient for ether extract in the range of 61 to 73 per cent in cross bred calves at fifth month of age.

5.4.4 Nitrogen Free Extract

Digestibility coefficient of NFE observed in the present study was 84.55, 81.97 and 81.20 per cent for group I, II and III respectively (Table 11a to 11 c and 12). Statistical analysis did not reveal any significant difference (P>0.05) between the groups.

5.4.5 Neutral Detergent Fibre

Digestibility coefficient of neutral detergent fibre observed in the present study was 65.08, 58.92 and 58.19 per cent for group I, II and III respectively (Table 11a to 11 c and 12). Statistical analysis did not reveal any significant difference (P> 0.05) between the groups. As observed in the present study Babu *et al.* (2003) also reported comparable NDF digestibility for calves fed milk up to four and eight weeks of age. In line with present findings Asitha (2002), Jith (2004) and Raja (2005)

reported similar NDF digestibility in the range of 58 to 62 per cent in cross bred calves below six months of age.

5.4.6 Acid Detergent Fibre

Average digestibility coefficient for ADF observed in the present study was 54.38, 46.97 and 45.64 per cent, respectively, for group I, II and III and there was no significant difference (P>0.05) between the groups (Table 11 a to 11 c and 12). Babu *et al.* (2003) observed similar ADF digestibility at fourth month of age in cross bred calves fed milk up to four and eight weeks of age. Asitha (2002) and Raja (2005) also observed similar ADF digestibility in the range of 42 to 55 and 47 to 52 per cent, respectively, in cross bred calves below six month of age.

5.5 HAEMATOLOGICAL PARAMETERS

The haematological parameters estimated at monthly intervals during the experimental period of 150 days are given in Table 13 to Table 18 and represented in Fig. 6 to 10.

5.5.1 Blood Haemoglobin

The blood haemoglobin concentration of experimental calves as presented in Table 13 and 18 and Fig. 6 was in the rage of 11.59 to 12.26, 11.67 to 11.83 and 11.39 to 12.35mg/100ml for group I, II and III respectively and there was no significant difference (P>0.05) between the groups. The values of haemoglobin recorded in the present study was within the normal range reported for the species and animals were in good nutritional status. Ratcliff *et al.* (1958) and Gupta *et al.* (1997) obtained concordant values in dairy calves. In contrary to this Razdan *et al.*

(1965) and Nangia *et al.* (1970) observed significantly higher haemoglobin values in calf starter fed group as compared to the milk fed calves.

5.5.2 Plasma Protein

Data on the monthly plasma protein values of calves of group I, II and III are presented in Table 14 and 18 and depicted in Fig.7 and was not significantly different ($P>0.05$) between the groups. The values varied from 6.24 to 6.87, 6.22 to 6.68 and 6.25 to 6.91mg/100ml for group I, II and III respectively. The plasma protein concentration recorded for the calves of the present study was within the normal range and comparable to that reported by Sagathevan (1995); Subramanian (1995) and Jith (2004).

5.5.3 Plasma Glucose

The plasma glucose values of experimental calves was in the range of 61.43 to 96.99, 60.80 to 97.05 and 60.95 to 97.3 mg/100ml for group I, II and III respectively (Table 15 and 18 and Fig. 8). There was no significant difference in plasma glucose level among the groups in the first month of the experiment where all the calves received milk at the same rate.

In the second month, there was significant decrease ($P<0.01$) in plasma glucose values of group III calves which received milk up to 28 days of age as compared to milk fed calves(Table 18). In third and fourth month of age, group II and group III calves, which received milk up to 56 and 28 days of age respectively, recorded significant reduction ($P<0.01$) in plasma glucose values compared to calves of control group, which received milk up to 84 days of age. During fifth month of the experiment, calves of all the three dietary treatments registered similar plasma

glucose concentration. The significant reduction in plasma glucose values in early weaned calves compared to control can be due to change in metabolic pattern as a result of early rumen development. Hibbs *et al.* (1961) and Garg *et al.* (1974) reported similar values of blood glucose in early weaned calves. Puri *et al.* (1983) and Babu *et al.* (2003) also observed greater reduction of blood glucose level in early weaned calves. Comparable values of blood glucose concentration were also reported by Asitha (2002); Jith (2004) and Raja (2005) in cross breed calves at first and fifth month of age.

5.5.4 Serum Calcium

The Serum calcium values varied from 10.82 to 11.21, 11.04 to 11.34 and 10.89 to 11.17 mg/100ml for group I, II and III respectively and there was no significant difference ($P>0.05$) between the groups. (Table 16 and 18 and Fig.9). Similar serum calcium values of 11 to 13.6 mg/100ml were reported by Kunjikutty (1969) in calves below one year of age. Prabha *et al.* (2000) also obtained almost similar serum calcium values in calves of four to five months of age. The values of serum calcium concentration of cross bred calves in the present study were well within the normal range reported for the species and comparable with values reported by Asitha (2002) and Jith (2003).

5.5.5 Serum Phosphorus

The serum phosphorus concentration in the experimental animals varied from 6.09 to 6.80, 5.97 to 6.79 and 6.41 to 6.78 mg/100ml for group I, II and III respectively and values were within the normal range (Table 17 and 18 and Fig.10). The different milk feeding schedule has no effect ($P >0.05$) on the serum phosphorus concentration through out the study. In agreement with the present study Kunjikutty

(1969) reported serum phosphorus level of 3.5 to 7.3 mg/100 ml in calves of similar age group. Asitha (2002) and Jith (2004) also reported similar serum phosphorus concentration in cross bred calves of similar age groups.

5.6 ECONOMICS OF GAIN

The feed cost per kilogram gain for the three experimental groups I, II and III fed on whole milk up to twelve, eight and four weeks of age respectively with *ad libitum* calf starter and green grass for a period of 150 days are presented in Table18 and the values were Rs. 88.14, Rs.65.62 and Rs.53.95 respectively. There was a saving of Rs.22.52 and 34.19 for group II and group III calves respectively compared to the control group. In agreement with the present study, Khoury *et al.* (1967), Nangia *et al.* (1970) and Krishnamohan *et al.* (1987) reported that the cost of feeding was minimum for early weaned calves. Misra *et al.* (1994) also reported that the feed cost reduced considerably in calves weaned at 63 days than at 90 days of age.

It could be inferred from the present study that cross bred calves can be weaned as early as four weeks of age without any adverse effect on their growth performance. This will spare whole milk for human consumption and at the same time make the calf rearing economical by reducing the cost of production considerably.

Summary

SUMMARY

A study was conducted to assess the effect of restricted milk feeding on growth performance in cross bred calves. Eighteen healthy cross bred calves of below one week of age were selected from University Livestock Farm and Fodder Research and Development Scheme (ULF&FRDS), College of Veterinary and Animal Sciences, Mannuthy and divided into three groups (group I, II and III) as uniformly as possible with regard to age, sex and body weight and were randomly allotted to three dietary treatments. All the experimental calves were maintained under identical conditions of feeding and management through out the experimental period of 150 days. Calves of group I, II and III were fed with whole milk up to twelve, eight and four weeks of age respectively at the rate of $1/10^{th}$ of their body weight from birth to six weeks of age, $1/15^{th}$ of body weight from seven to eight weeks and $1/20^{th}$ of body weight from nine to twelve weeks of age. All the calves were given calf starter prepared as per BIS specification and good quality green grass from first week onwards. Fresh drinking water was made available *ad libitum* to all the experimental calves through out the study. Individual records of daily dry matter intake and weekly body weight of the calves were maintained through out the trial. Haematological parameters such as haemoglobin, plasma protein, plasma glucose, serum calcium and serum phosphorus were also recorded at monthly interval. A digestion trial was conducted in all the calves at the fourth month of age with a collection period of five days to arrive at the digestibility coefficient of nutrients.

Average daily gain was 300, 307.78 and 321.67g, respectively and total body weight gain was 45, 46.17 and 48.25 kg, respectively for the calves in the group I, II and III and the values were not significantly different ($P>0.05$). Average daily dry matter intake (kg per day) was 1.19, 1.10 and 1.31 kg, respectively for the group I, II and III. There was no significant difference among the groups ($P>0.05$). The mean

cumulative feed to gain ratio was 4.14, 3.59 and 4.23 for group I, II and III respectively and there was no significant difference between the groups (P>0.05). The digestibility coefficient of nutrients observed was 77.74, 74.14 and 73.75 for dry matter, 81.51, 79.66 and 79.15 for crude protein, 84.41, 82.83, 82.80 for ether extract, 84.55, 81.97, 81.20 for NFE, 65.08, 58.92, 58.19 for NDF and 54.38, 46.97 and 45.64 for ADF for group I, II and III, respectively. Statistical analysis of data further revealed that weaning at fourth, eight or twelfth week did not influence the digestibility coefficient of nutrients.

Haematological parameters are in the range of 11.39 to 12.35 for haemoglobin, 6.22 to 6.91 for plasma protein, 60.80 to 97.30 for plasma glucose, 10.82 to 11.34 for serum calcium and 5.97 to 6.80 for serum phosphorus. Statistical analysis of the data did not reveal any significant difference between the groups, except for glucose. A significant reduction in plasma glucose values was observed at second, third and fourth month in early weaned groups than in control group. Cost per kilogram body weight gain was Rs. 88.14, 65.62 and 53.95 respectively for group I, II and III. There was a saving of Rs.22.52 and Rs.34.19 for group II and III, respectively compared to group I.

On a critical evaluation of results obtained in the present study, it was revealed that calves fed milk up to 28 days registered similar body weight gain, dry matter consumption, feed efficiency, digestibility of nutrients and haematological parameters at least cost compared to the late weaned calves.

On summarizing the results it could be inferred that cross bred calves can be successfully weaned from milk as early as four weeks of age with out any adverse effect on their growth performance.

References

REFERENCES

Agabawi, K.A., Osman, H.E. and Abou-Akkada, A.R. 1968. Feed efficiency, ruminal activity and effects on some blood constituents of early-weaned calves. *J. Dairy Sci.* 51: 744-747

Akayezu, J.M., Linn, J.G., Otterby, D.E. and Hansen, W.P. 1994. Evaluation of calf starters containing different amounts of crude protein for growth of Holstein calves. *J. Dairy Sci.* 77(7): 1882 –1889

Anderson, K.L., Nagaraja, T.G. and Morrill, J.L. 1987. Ruminal metabolic development in calves weaned conventionally or early. *J. Dairy Sci.* 70: 1000-1005

A.O.A.C. 1990. *Official Methods of Analysis.* Fifteenth edition. Association of Official Analytical Chemists, Washington D.C., 587p.

Asitha, T.V. 2002. Effect of supplementation of dried yeast (NEUTRAMIX-MDY) on growth performance in preruminant calves. M.V.Sc. thesis, Kerala Agricultural University, Thrissur, 64p.

Babu, L.K., Pandey, H.N. and Sahoo, A. 2003. Effect of individual versus group rearing and feeding of different levels of milk and skim milk on nutrient utilization in crossbred calves. *Asian – Aust. J. Anim. Sci.* 16(10): 1455 –1459

Bar-peled, U., Robinzon, B., Maltz, E., Tagari, H., Folman, Y., Bruckental, I., Voet, H., Gacitua, H. and Lehrer, A.R. 1997. Increased weight gain and effects on production parameters of Holstein heifer calves that

were allowed to suckle from birth to six weeks of age. *J. Dairy Sci.* 80: 2523-2528

Bhosrekar, M.R., Daniel, S.J. and Mullick, D.N. 1967. A study on the blood and serum composition of female calves from birth to six months of age. *Indian J. Dairy Sci.* 20: 75-80

BIS. 1983. *Bureau of Indian Standards*. Specification for compounded feeds for young stock: IS: 5560-1970. Manak Bhavan, 9, Bhahaadur Shah Zafar Marg, New Delhi, 15p.

Borhami, B.E.A., el-Shazly, K., Abou-Akkada, A.R. and Ahmed, I.A. 1967. Effect of early establishment of ciliate protozoa in the rumen on microbial activity and growth of early weaned buffalo calves. *J. Dairy Sci.* 50: 1654-1659

Coverdale, J.A., Tyler, H.D., Quigley III, J.D. and Brumm, J.A. 2004. Effect of various levels of forage and form of diet on rumen development and growth in calves. *J. Dairy Sci.* 87: 2554-2562

Franklin, S.T., Amaral-Philips, D.M., Jackson, J.A. and Campell, A.A. 2003. Health and performance of Holstein calves that suckled or were hand fed colustrum and were fed on three physical forms of starter. *J. Dairy Sci.* 86: 2145-2153

Garg, M.C., Gill, S.S. and Punj, M.S. 1974. Effect of feeding restricted amount of whole milk on the blood glucose and total volatile fatty acids of buffalo calves. *Indian. J. Dairy Sci.* 27(2): 113- 117

Godfrey, N.W. 1961. The functional development of calves. I. Growth of the stomach of the calf. *J. Agric. Sci.* 57: 173- 175

Guler, O., Yanr, M. and Bayram, B. 2003. Effect of different milk feeding schedules on the growth and feed conversion effiencies in Holstein Friesian and Brown Swiss calves. *Indian. J. Anim. Sci.* 73(11): 1278-1280

Gupta, N., Chauhan, H.V.S. and Gupta, V.K. 1997. Studies on the normal haematological parameters of Sahiwal calves. *Inter. J. Anim. Sci.* 12: 259- 261

Head, H.H. and Ventura, M. 1967. Relationship of age and glucose metabolism in dairy calves. *J. Dairy Sci.* 50: 612

Hibbs, J.W., Conrad, H.R. and Vandersall, J.H. 1961. A high roughage system for raising calves based on the early development of rumen function. X. Whole blood, plasma and corpuscle glucose relationships in calves fed high roughage ration with and with out chlortetracycline. *J. Dairy Sci.* 44: 466 – 474

Hopkins, B.A. 1997. Effect of the method of calf starter delivery and effects of weaning age on starter intake and growth of Holstein calves fed milk once daily. *J. Dairy Sci.* 80: 2200-2203

Huber, J.T. 1969. Development of the digestive and metabolic apparatus of the calf. Symposium on calf nutrition and rearing. *J. Dairy Sci.* 52(8): 1303-1315

Jasper, J. and Weary, D.M. 2002. Effect of adlibitum milk intake on dairy calves. *J. Dairy Sci.* 85: 3054- 3058

Jith, J.M. 2004. Effect of replacing dried fish with lysine and methionine in the calf starter on the growth performance of cross bred calves. M.V.Sc. thesis, Kerala Agricultural University, Thrissur 56p.

Khalili, H.S., Crosse and Varvikko, T. 1992. The performance of cross bred dairy calves given different levels of whole milk and weaned at different ages. *Anim. Prod.* 54: 191-195

Khoury, F.K., Ahmed, I.A. and el-Shazly, K. 1967. Early weaning in cow and water buffalo calves *(Bos bubalus L.).* I. Growth rates, efficiency of feed utilization and cost of unit gain. *J. Dairy Sci.* 50: 1661-1666

Krishnamohan, D.V.G., Das, D.R. and Ranjhan, S.K. 1987. Performance of young cross bred calves fed different levels of milk and different types of calf starter (III) Growth, feed efficiency and cost of feeding calves from birth to three months of age. *Indian. J. Dairy Sci.* 40(1): 18-22

Kunjikutty, N. 1969. Studies on the nutritional status of the farm animals maintained on standard rations with and without the incorporation of unconventional feeds and fodder of local importance. M.Sc. thesis, Kerala Veterinary College and Research Institute, Thrissur, 146p.

Little, W., Kay, R.M., Manston, R., Rowlands, G.J. and Stark, A.J. 1977. The effect of age, live weight gain and feed intake on the blood composition of young calves. *J. Agric. Sci.* 89: 291- 297

Luchini, N.D., Lane, S.F. and Combs, D.K. 1993. Pre weaning intake and post weaning dietary energy effects on intake and metabolism of calves weaned at 26 days of age. *J. Dairy Sci.* 76(1): 255-265

Misra, A.K., Mehra, U.R. and Das, S. 1994. Growth performance, feed efficiency and economics of rearing pre-ruminant calves on two different plane of nutrition. *Indian J. Dairy* Sci. 47(12): 1067-1069

Nangia, O.P., Razdan, M.N. and Ray, S.N. 1970. Studies on functional development of rumen in bovines. 1. The effect of ration and rumen inoculation on the growth of calves reared on milk substitutes. *Indian J. Dairy Sci.* 23: 16-23

Prabha, B., Singh, C., Murtuza, M. and Pandey, R.P. 2000. Total serum calcium and inorganic phosphorus concentration in cross bred (Friesian x Hariyana) pregnant cows and calves. *Indian J. Anim. Sci.* 70(1): 50-51

Preston, T.R., Archibald, J.D.H. and Tinkler, W. 1957. The digestibility of grass by young calves. *J. Agric. Sci.* 48: 259- 265

Puri, J.P., Nangia, O.P., Garg, S.L., Punia, J.S. and Singh, N. 1983. Early development of rumen function in buffalo calves, nitrogen metabolism and blood metabolites as influenced by age and diet. *Indian J. Anim. Sci.* 53(8): 880-882

Quigley III, J.D., Schwab, C.G. and Hylton, W.E. 1985. Development of rumen function in calves: Nature of protein reaching the abomasum. *J. Dairy Sci.* 68: 694-702

Raja, D. 2005. Utilization of urea at different stages of development of rumen in weaned calves. M.V.Sc. thesis, Kerala Agricultural University, Thrissur, 76p.

Ranjhan, S.K., Katiyar, R.C., Bhatt, P.N. and Raina, B.L. 1972. Studies on the growth responses of cross bred calves. 1. Effect of limited milk feeding on the growth of cross bred calves up to three months of age. *Indian J. Anim. Sci.* 42(10): 754-759

Ratcliff, L., Jacobson, N.L. and Allen, R.S. 1958. Effect of age and of dietary regime on hemoglobin and reducing sugar levels in the blood of dairy calves. *J. Dairy Sci.* 41: 1401-1406

Raut, P.K., Pandey, H.N., Nath, B. and Srivastava, B.B. 1998. Performance of restricted milk fed cross bred calves. *Indian J. Anim. Prod. Mgmt.* 14(2): 87-90

Razdan, M.N. Bhosrekar, M.R. and Ray, S.N. 1965. Performance of calves reared on milk substitutes. *Indian J. Dairy Sci.* 18: 96-100

Sagathevan, S. 1995. Effect of dried spleen as a growth promoter in the ration of cross bred calves. M.V.Sc. thesis, Kerala Agricultural University, Thrissur, 123p.

Snedecor, G.W. and Cochran, W.G. 1994. *Statistical Methods.* Eighth edition. Iowa State University press, Iowa, 313p.

172564

Subramanian, R. 1995. Effect of fishmeal on growth and feed conversion efficiency in cross bred calves. M.V.Sc thesis, Kerala Agricultural University, Thrissur, 96p.

Van Soest, P.J. 1963. Use of detergents in analysis of fibrous feeds. II. A rapid method for the determination of fibre and lignin. *J. Assoc. Off. Analyt. Chem.* 46: 829

Van Soest, P.J. and Whine, R.H. 1967. Use of detergents in the analysis of fibrous feeds. IV. The determination of plant cell wall constituents. *J. Assoc. Off. Analyt. Chem.* 50: 50

Williams, W.P. and Dinusson, W.G. 1973. Ruminal volatile fatty acid concentration and weight gain of calves reared with and without ruminal ciliated protozoa. *J. Anim. Sci.* 36(3): 588-591

Winter, K.A. 1978. Response to weaning at two to five weeks of age by young dairy calf. *Can. J. Anim. Sci.* 58: 377-383

Winter, K.A. 1985. Comparative performance and digestibility in dairy calves weaned at three, five and seven weeks of age. *Can. J. Anim. Sci.* 65: 445-450

EFFECT OF RESTRICTED MILK FEEDING ON GROWTH PERFORMANCE IN CROSS BRED CALVES

JASMINE RANI. K.

Abstract of the thesis submitted in partial fulfillment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University, Thrissur

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Department of Animal Nutrition
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR-680651
KERALA, INDIA

ABSTRACT

An experiment was conducted with eighteen cross bred calves below one week of age for 150 days to assess the effect of restricted milk feeding on growth performance in cross bred calves. Calves were divided into three groups (group I, II and III) as uniformly as possible. Calf starter prepared as per BIS specification formed the experimental diet. Calves of group I, II and III were fed with whole milk up to twelve, eight and four weeks of age respectively at the rate of $1/10^{th}$ of their body weight from birth to six weeks of age, $1/15^{th}$ of the body weight from seven to eight weeks and $1/20^{th}$ of body weight from nine to twelve weeks of age. Good quality green grass was fed *ad libitum*. Body weight gain, daily dry matter consumption, feed conversion efficiency, cost per kg gain, digestibility of nutrients and haematological parameters such as haemoglobin, plasma protein, plasma glucose, serum calcium and serum phosphorus were the criteria employed for the evaluation.

Average daily gain and total weight gain, respectively were 300g and 45 kg for group I, 307.78g and 46.17kg for group II, 321.67g and 48.25kg for group III and the values were not significantly different ($P>0.05$). Average daily dry matter intake (kg/day) was 1.19, 1.10 and 1.31 kg respectively for group I, II and III and there was no significant difference ($P > 0.05$) among the groups. Feed to gain ratio for group I, II and III was 4.14, 3.59 and 4.23 respectively and was not significantly different ($P>0.05$) among the groups. The digestibility coefficient of nutrients observed was 77.74, 74.14, and 73.75 for dry matter, 81.51, 79.66, and 79.15 for crude protein, 84.41, 82.83, and 82.80 for ether extract 84.55, 81.97, and 81.20 for NFE, 65.08, 58.92, and 58.19 for NDF and 54.38, 46.97 and 45.64 for ADF for group I, II and III respectively. There was no significant difference ($P>0.05$) between the groups in the digestibility of any of the nutrients studied. The haematological parameters such as haemoglobin, plasma protein, serum calcium and serum phosphorus did not show any

significant difference ($P > 0.05$) among the groups. A significant reduction ($P < 0.01$) in plasma glucose values was observed at second, third and fourth month in early weaned groups than in control group. The cost per kg gain was Rs. 88.14, 65.62 and 53.95 for group I, II and III, respectively. There was a saving of Rs.22.52 and Rs.34.19 for group II and III, respectively compared to the control group.

On a critical evaluation of results obtained in the present study, it was revealed that calves fed milk up to 28 days registered similar body weight gain, dry matter consumption, feed efficiency, digestibility of nutrients and haematological parameters at least cost, compared to the late weaned calves. On summarizing the overall results of the study, it could be inferred that cross bred calves can be successfully weaned from milk as early as four weeks of age with out any adverse effect on their growth performance as they had superior economical efficiency and similar biological efficiency to calves received milk up to eight or twelve weeks of age.