A STUDY OF THE CALF STARTER WITH LOCALLY AVAILABLE FEED INGREDIENTS

By

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THESIS

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D E C L A R A T I O N

I hereby declare that this thesis entitled "A STUDY OF THE CALF STARTER WITH LOCALLY AVAILABLE FEED INGREDIENTS" is a bona fide 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.

U.T. FRANCIS.

Mannuthy,

9-1-1978.

C E R T I F I C A T E

Certified that this thesis, entitled "A STUDY OF THE CALF STARTER WITH LOCALLY AVAILABLE FEED INGREDIENTS" is a record of research work done independantly by Sri. U.T. Francis under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.

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C O N T E N T S

INTRODUCTION

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In the field of livestock wealth, India has the largest cattle population in the world. The world cattle population in 1972 was 1165.4 million (Ranga Rau, 1975) and the bovine population in India was estimated as 178.86 million. India has been ranked as fifth among the milk producing countries of the world, the estimated annual milk production being 254.7 lakh tonnes. Kerala has 2.86 million cattle and 0.47 million buffaloes. The total milk production in the State during 1973-74 was estimated as 4.4 lakh tonnes with an average daily per capita availability of 50.3 g (Nagarcenkar, 1977). At present, the availability of milk is just enough to cater to the needs of 25 per cent of the people of Kerala. This indicates that the milk production of the State has to be increased by four to five times to reach a reasonable level of consumption.

Eventhough India has got the largest cattle population, the average annual production of a cow is 173 kg and that of buffalo 491 kg. As against this, the average annual milk yield per cow in Netherlands is 4220 kg; U.S.A. 4250 kg; Denmark 3710 kg and West Germany 3430 kg (Singh and Moore, 1968). The introduction of temperate genes for getting faster growth and higher milk production in Indian cattle by a process of cross breeding was keenly felt. As a result of this, cross breeding with the infusion of exotic germplasm was initiated on an

experimental basis in the hilly and heavy rainfall areas where the cattle were non-descript and had low production capacity. The result of these trials showed that halfbred crosses produced 1200 to 1800 kg of milk in their first lactation under village conditions and as such proved to be reasonably good dairy cows. Large scale cross breeding programmes have been launched in the country using exotic breeds such as Holstein-Friesian, Brown Swiss, Jersey and Red Dane.

At present there are a large numbersof crossbred calves in the country. If these calves have to become high producing cows or good quality bulls they have to be well cared for. The best way of building up a good herd is to raise heifer calves of the high quality cows in the herd. Raising calves and building up a herd is a difficult but important job. Since the feed and labour costs are high, normally it does not pay to raise a calf unless it shows promise of developing into a high producing cow. Successful calf raising begins with the right type of feeding and good care of the pregnant cow. The whole milk is the ideal diet for the calf till its delicate fore-stomach assumes structural and functional features similar to the adult. The central role of milk in the nutrition of humans especially those of infants makes it too luxurious an item to be fed to calves in sizeable quantities. This prompted animal nutrition workers the world over in formulating calf diets of non-milk

origin. Considerable work has been done in this direction in developed countries in the last two decades while only a limited progress has been made in India. In order to reduce the cost involved in the raising of calves, emphasis has been laid on the early development of the rumen. As long as milk feeding is continued the functional development of the rumen is delayed. To achieve early development of the rumen the calves must receive a liberal supply of concentrates and roughages in addition to whole milk in their daily diets.

Economical raising of calves with milk substitutes for optimum rate of growth is a problem which has received attention by many workers in order to save milk for human consumption. Reducing whole milk in the diet of calves results in slow rate of gain in body weight, reduced vitality and health problems. Some workers have suggested that whole milk should be given as an essential diet upto a certain age and later replaced by calf starter. Because of increasing demand for milk and milk products there is considerable interest in replacing more of the milk in the calf's diet. The practical goal is to raise thrifty calves at the lowest cost. To meet this general goal, the use of calf starters and the limited whole milk plan were developed. Milk substitutes are being used to further reduce the whole milk required to raise the calf. Varying degrees of success have been reported from the

use of milk substitutes. However, calves can be raised satisfactorily on milk replacers when recommended procedures are followed. The calves developed rougher hair coats and in many instances make less rapid growth than calves fed more liberally on milk but at later stages they generally compare favourably. Adoption of such a system will depend upon the value of the milk saved, the cost of the milk substitutes, and also the value of the calves.

The purpose of the present study is to compare the system of rearing calves with calf starters suitably prepared making use of the locally available feed ingredients in comparison to the raising of calves with whole milk alone taking into consideration the performance of the calves and the economics of rearing them for a period of 24 weeks from birth.

REVIEW OF LITERATURE

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The use of milk replacers for calf feeding is increasing in importance because more whole milk is marketed. The formulation of the first milk replacer is credited to Liebig by Kellner (1926). Since then numerous formulae for milk replacer feeds and methods of feeding have been proposed.

According to Carpenter (1951) soyabean oil meal is an excellent source of vegetable protein. However, Shopton (1936) using soyabean milk, Wallace et al. (1951) using a milk replacement, reported that the soyabean flour caused diarrhoea in calves. Satisfactory results with calf starters containing 15 to 18 per cent of processed soyabean oil meal were reported by Norton and Eaton (1946). Heller and Huffman (1953) reported the successful use of a special processed soyabeanflour as the principal source of protein in calf rations. The successful use of soyabean flour in milk replacer rations was found out by Stein et al. (1954). Colvin and Henry (1968) found that calves fed on acid treated soyabean flour grew at nearly twice the rate of those receiving untreated soyabean flour and calves on cooked soyabean flour lost weight rapidly.

Vidyasagar and Pradhan (1975) reported that calves fed on cluster bean meal grew significantly faster than those without cluster bean meal. The gains in heart girth, height and width in the experimental calves were higher as compared to those in the control group. But the reverse was true for

the body length of the calves. They further found that when gaur meal was fed as a sole protein supplement in the ration for calves there was no difference in feed efficiency and weight gain of calves fed on control ration and gaur meal ration. Heart girth and body length also showed no statistically significant difference. Prasad et al. (1977) conducted an experiment on feeding calves with the lucern extract. They found that the calves fed lucern extract grew at the rate of 410 g per day as compared to 476 g per day in whole milk group. No significant increase in the rate of growth was found when two to six months old calves were fed with ten per cent fish meal in the concentrate mixture (Ansari and Talapatra, 1966). Leelaprasad et al. (1977) conducted experiment on feeding pre-ruminant calves with lucern extract as part of milk replacer. They divided twenty calves into four groups and fed milk replacer with lucern extract, milk replacer with skim milk powder, skim milk and whole milk. It was noticed that whole milk when fed at ten per cent was superior to milk replacer feeding from birth to three months while the milk replacer was superior to skim milk feeding for the same period.

Awate et al. (1975) while studying the effect of different protein energy ratios on the growth rate of weaned calves found that the calves fed with higher protein energy ratios gained more body weight than the calves on lower and

medium protein energy ratios and the female calves gained higher body weight than the male counterparts. They also noticed that no significant differences in gain in chest girth, paunch girth and height at withers.

Lassiter et al. (1963) studied the effect of protein level in milk replacers on the growth and protein metabolism of dairy calves. Results of their studies indicated that calves made normal growth when fed milk replacer rations containing 24 per cent protein and their growth rates were equal to calves fed higher levels of protein. They concluded that the protein level could be decreased approximately to 19 per cent without seriously affecting the growth rate of calves.

While studying the effect of fish flour as a protein in calf milk replacers, Huber and Slade (1967) found that the average daily gains and feed efficiencies were not significantly depressed when fish flour furnished upto 40 per cent of the dietary protein. However, upto 60 to 67 per cent marked decreases in daily gains and feed efficiencies were observed and at 100 per cent level death occurred.

Brown and Lassiter (1962) studied the protein energy ratios for dairy calves. The results of their study indicated that the optimum protein energy ratio would be 1:46 or slightly less.

Bryant et al. (1967) conducted experiments to study the

protein and energy requirements of the young calf and the relative efficiency of various milk replacers by using 68 three-day old male calves from four to sixty days of age. The energy requirements for maintenance was 46.2 Kcal digestible energy daily per kg of body weight. The requirement for growth was 370 Kcal per 100 g gain in body weight.

There is a scarcity of data relevant to the digestion of vegetable milk replacers by the young calf particularly with respect to the effect of age. An investigation in the use of vegetable milk replacers in calf nutrition indicated that weight gain and feed consumption were unsatisfactory until the calves were approximately 25 days of age (Moller et al. 1956). Earlier studies by Shaw et al. (1918) demonstrated that four to seven day old calves were able to digest only one-fifth of the starch consumed but by three to four weeks of age the calves were able to digest over 90 per cent of the starch. A study conducted by Archibald (1928) on raw and cooked calf meals indicated that nine-week old calves were able to digest feed almost like adult cattle. Digestion studies on whole milk have been conducted with calves and in all cases the whole milk was highly digestible (Blaxter and Wood, 1952 and Parish et al. 1953).

Pardue et al. (1962) studied the performance of dairy calves weaned at 24 days of age and fed vegetable versus animal source protein in the dry starters. The results

indicated that calves can be weaned successfully from milk at 24 days of age. The addition of dried skim milk provided little additional benefit over a vegetable source of protein in the starter of early weaned calves.

Whitaker et al. (1957) studied the influence of level and source of crude fibre in calf starters on weight and feed consumption in calves. Their study indicated that there were no important differences among the calves due to level or source of crude fibre in weight gain and starter consumption at either eight or sixteen weeks. They also fed the calves with starters containing 5, 9 and 13 per cent of crude fibre with the fibre of the higher levels coming from either corn cobs and shrunks or alfalfa meal.

The influence of milk replacers containing various levels of fat on the growth rate in calves was studied by Lassiter et al. (1957). They fed the calves with milk replacer rations containing 10, 20 and 30 per cent added fat. A fat derived from cotton seed was used as the source of fat. The calves fed a replacer ration which contained ten per cent added fat gained in body weight approximately nine per cent faster than the calves fed a replacer ration which contained either 20 or 30 per cent fat. The tendency of the calves to consume less calf starter was noticed as the level of fat increased in the ration. Data from their studies indicated the advantageous effect of including ten per cent fat in milk

replacer rations but there did not appear to be any advantage from feeding higher levels. Olson and Williams (1959) conducted experiments on the effect of five levels of animal fat in calf milk replacer. They found that there was value in feeding of a three per cent animal fat reconstituted milk replacer to calves under four weeks of age. The digestibility of fat in dairy calves was studied by Hopkins et al. (1959). They showed that the fat was poorly digested when the milk replacer composed predominently of dried skim milk was supplemented with tallow, coconut fat, grease or butter in the unhomogenised state. However, the inclusion of crude soyabean lecithin in the milk replacer improved the utilization of tallow, coconut fat and grease. The inclusion of lecithin in the milk replacer was found to improve the digestibility of coconut fat to a greater extent than that of tallow or grease.

Adams et al. (1959) studied the effect of feeding corn oil filled milk to dairy calves. They noticed that the calves were emaciated unthrifty and had marked diarrhoea and increased susceptibility to pneumonia. Symptoms of diarrhoea, muscular involvement, poor feed utilization and unsatisfactory weight gains were also noticed in the calves. Animals receiving lard and butter oil prepared from oxidized butter also exhibited symptoms of muscular involvement. Supplementation of corn oil and lard filled milk diets with high levels of tocopherol prevented the development of muscular involvement but did not

have any improvement in weight gains. Inclusion of corn oil in the diet depressed the growth. Their findings were that diets containing as low as 0.10 to 0.15 per cent butter fat were not detrimental to growth.

Shinde and Sangle (1976) studied the growth of cross-bred calves fed with sugar calf meal and farm made calf meal from birth to 24 weeks. Their findings were that the average total cost required to rear a calf under control and experimental groups was Rs.462.95 and Rs.456.50 respectively. Considering the practical aspects the difference between the two treatments was rather negligible. It was concluded from this study that the two milk replacers could not produce any appreciable change in body weight.

The effect of raising calves on milk substitutes was studied by Arora et al. (1975). They fed the calves with milk substitutes containing lactose, starch and molasses. It was inferred from their studies that calves could stand the combination of sugars as early as upto one month. Riggs and Beaty (1947) fed lactose at 20, 25 and 30 per cent levels to calves and found that it caused diarrhoea in calves. Huffman et al. (1954) found that five per cent or ten per cent lactose had a favourable effect. Heller et al. (1956) divided calves into three groups and placed them on three milk replacer rations; basal, basal plus five per cent dried whey and basal plus 3.5 per cent lactose. The difference in the average daily

gains of the calves on the three diets were not statistically significant. Growth patterns indicated a critical period in the life of the young calf from birth to approximately 25 days of age. The end of the critical period was characterised by an increase in feed consumption, increased body weight and improved appearance of the calf. Lactose appeared to have no benefit under the conditions of their experiment.

Velu et al. (1959) studied the utilization of various sugars by the young dairy calf. Sugars in aqueous solutions were fed to calves following a 24 hour fast at the rate of two gram of sugar per pound body weight. Glucose, lactose and galactose were found to give marked elevations in blood reducing sugars and produced no diarrhoea. Calves were unable to utilize sucrose while the uptake of fructose and maltose was comparatively low. Diarrhoea resulted from the feeding of each of these sugars. Sucrose inverted by invertinase or citric acid was readily utilized.

The effect of supplementation of enzymes in the diet of dairy calves was studied by Rust et al. (1965). Enzyme (bacterial protease) supplementation was found to increase the apparent nitrogen and energy digestibility. There was no apparent effect on total concentration or on the ratios of volatile fatty acids in rumen fluid but significant differences between rations in ruminal ammonia concentration. Protein nitrogen concentration was significantly higher for the

supplemental ration. Lassiter et al. (1959) conducted experiments on the effect of pepsin on the growth and health of young dairy calves fed various milk replacer rations. They found that pepsin fed calves tend to consume less calf starter and more hay and required more feed per pound of gain than did the calves which did not receive pepsin.

Bush et al. (1968) compared the pelleted milk replacers with liquid replacers in diets of dairy calves. In three separate eight weeks trials responses of calves fed milk replacers in pelleted form were compared to those of calves fed replacers in liquid form. Whole milk was withdrawn from the diet at different stages. The form of the replacer did not effect consistent difference in total weight gains, health or general thriftiness of the calves.

Harrison et al. (1960) studied the relative growth and appearance of young dairy calves fed two levels of milk with a simple or complex calf starter. They conducted experiments using 350 versus 250 pounds of whole milk and a simple versus complex dry calf starter. Calves consuming 350 pounds of whole milk gained 1.20 pound per day which was significantly greater than the 1.12 pound per day gain for the 250 pound group. The starter consumption was significantly greater for the 250 pound group.

Swanson (1963) studied the effect of chlortetracycline

in calf starter and milk. From eight to sixteen weeks antibiotic feeding in starter produced slightly greater weight gain and feed consumption but the differences were not significant statistically. After weaning the effects of antibiotic feeding were of small importance.

Chik et al. (1975) studied the growth and feed efficiency of young calves fed on a milk replacer, waste milk or fermented colostrum. They found that the group of calves fed milk replacer was the best in dry matter intake, total weight gain and feed efficiency. Otterly et al. (1976) compared fermented colostrum with milk replacer for growing Holstein calves. The effects of feeding milk replacer and fermented colostrum were studied on growth, health and feed intake. Weight gains upto four weeks of age were less for calves fed with milk replacer but thereafter the weight gains did not differ.

The responses of young calves to starters containing supplements such as soyabean meal, soyabean meal and branched chain volatile fatty acids, urea, urea and branched chain volatile fatty acids were studied by Miron et al. (1968). Calf starters and high quality alfalfa hay were fed ad libitum. Calves fed starters containing supplementation of soyabean meal gained faster than those fed starters containing supplementation of urea. The addition of volatile fatty acid mixture had no effect on the weight gains.

Moller et al. (1956) studied the effect of the age of the calf on the availability of nutrients in vegetable milk replacer rations. The amounts of nitrogen, calcium and phosphorus retained were greater in calves fed raw whole milk than for those fed the evaporated or milk replacer rations. Nitrogen and phosphorus balances were low or negative in 10 to 22 day old calves fed with the milk replacer rations but the older calves had positive balances. The milk replacers were not satisfactorily utilized until the calf was approximately 25 days of age.

The feed intake and performance in calves fed ad libitum and four times daily were studied by Lineweaner and Hafez (1969). The composition of colostrum and milk replacer was studied in Holstein and Hereford calves. The average daily consumption during their first three days ranged from 9.0 to 21.7 per cent of the birth weight for the Holsteins and 4.9 to 16.4 per cent for Herefords. Average daily body weight gains ranged from 1.8 to 3.6 per cent for Herefords. Holsteins and Herefords required 4.56 kg and 7.16 kg of colostrum respectively for an average one kg of gain in body weight. There were no significant differences between groups fed four times daily and ad libitum on the 6.5 or 19.5 per cent total solid rations when one kg of milk replacer required to produce one kg of gain were compared.

Macleod et al. (1970) compared the growth of Holstein and

Jersey calves in response to four feeding programmes in a breed by ration interaction study. Feed intake, rate of gain and feed efficiency were superior for Holstein calves. Starter intake was higher when the milk consumption was lower. No significant differences were observed in the growth rate of calves between milk levels of starters.

Murdock and Hodgson (1961) compared the growth rate and body measurements of dairy calves fed all milk by product replacer and limited whole milk with and without chlortetracycline. Normal growth was obtained by calves on both milk and replacer rations. Weight gains were significantly greater at 80 days of age for calves fed whole milk. No difference in body weight gain was evident at the weaning age. The type of milk fed did not affect the height at withers or heart girth. Chlortetracycline resulted in significant increases in weight gains at weaning age. However, by 90 days no differences in weight responses to antibiotic feeding were evident. By milk replacer feeding there was an increase in the incidence and severity of scours and chlortetracycline feeding did not decrease them.

Moller et al. (1962) studied the value of hay and rumen inoculation in an early weaning system for dairy calves. The starter consumption was found to increase rapidly as milk was withdrawn. The feed intake and utilization after 21 days of

age were adequate for maintenance plus a satisfactory weight gain. The cud inoculation had little value in the 21 day weaning system.

A comparison was made between calf starters regarding the acceptability and nutrition response in calves by Gardner (1967). A total of 48 Holstein calves were assigned at birth to one of the three calf starter treatments viz., calf starter containing principally barley and cotton seed oil meal prepared as pellets, calf starter containing the same ingredients prepared as mash and a pelleted commercial starter containing a complexity of protein sources, vitamins and minerals. Calves consuming the simple starter as either mash or pellets consumed more starter daily than the calves offered the complex starter. As compared to the calves fed complex starter the other two groups of calves had rapid gains in body weight. The calves fed with the complex starter consumed more hay per day. There was no advantage in pelleting the simple calf starter except for preventing feed wastage. The total digestible nutrient contents and nitrogen utilization values of the different starters were approximately equal.

Hurley et al. (1957) compared the system of feeding milk replacement formulae to dairy calves. It was found possible to eliminate whole milk after the colostrum feeding after 30 days of age and to use modified starter to raise dairy calves successfully.

Johnson et al. (1956) added inedible tallow to calf starters. A total of 24 calves were fed limited whole milk to 35 days of age, a minimum of four pounds per day of calf starter containing 0, 2.5, 5 and 10 per cent inedible stabilized tallow and ad libitum alfalfa pellets to 92 days of age. The calves fed on starters containing tallow consumed more calculated total digestible nutrients which resulted in five to six per cent greater increase in growth. Results of their study indicated that inedible stabilized tallow could be used in calf starters.

Perry et al. (1967) conducted two trials with fattening calves to determine the comparative efficiency of oral and initially injected Vitamin A. The ration contained a level of 1.5 mg of carotene per kg. Both methods of administration of Vitamin A resulted in significant increases in daily gain and feed consumption. The efficiency of feed conversion was improved by Vitamin A treatments.

Rice et al. (1967) studied the effect of injectable iron on blood values of calves. The effect of supplemental iron at birth or approximately two months of age was found to increase the blood haemoglobin and haematocrit values. When mild anaemia was observed in calves, this treatment was found to increase the weight gain in them.

The effect of mineral mixture supplementation on blood

composition and growth rate of calves was studied by Kshirsagar and Mudgal (1972). The mineral mixture had significant effect on packed cell volume, haemoglobin, R.B.C., inorganic phosphorus and blood iron. No significant differences in growth rate were observed. The results indicated that mineral mixture supplementation was beneficial in the calf starters.

Some of the factors which contributed to significant variation in the weight gain of dairy calves were breed, sex, degree of inbreeding and ration (Martin et al. 1962). Roy et al. (1955) noticed that there was significant effect of birth weight on the live weight gain. Greater weight gains were noticed when calves were on leys than on permanent pasture.

The effect of different levels of digestible crude protein on the cellular constituents of blood was investigated by Jagannadham et al. (1977). The control group of calves were fed with digestive crude protein and total digestible nutrients as recommended by Morrison (1956). The experimental calves were fed with digestible crude protein ten per cent more than Morrison's recommended level. There was no significant difference between the groups with respect to all the blood cellular constituents thereby indicating that feeding digestible crude protein ten per cent more than Morrison's recommended level had no effect.

Mullick (1959) studied the effect of feeding aureomycin to calves. The growth rate, feed consumption, heart girth, leucocyte count and haemoglobin concentration showed no significant difference between the control and treated groups. All the supplemented groups were free from calfhood diseases whereas some animals in the control group suffered from scours.

Kohli et al. (1962) studied the growth in Haryana calves. Their findings were that at birth the male calves were heavier than the female calves. There was an increase of 100, 150 and 200 per cent over the birth weight at the age of 3, 6 and 9 months respectively irrespective of the sex of the calf. The live weight of the cow had no effect on the growth rate of the calves. The birth weight of the calf was also not influenced by the age at calving. But the age of the calf had significant effect on the body weight of the calf.

Wood et al. (1971) evaluated the effect of imposing a weekly fast on calves receiving a milk replacer diet once or twice daily. The experimental calves were divided into four groups and given the following treatments.

1. Non fasted and fed once a day.
2. Non fasted and fed twice a day.
3. Weekly 39 hour fasts and fed once a day.
4. Weekly 39 hour fasts and fed twice a day.

They found that among the groups there was no significant difference in the body weights of the calves due to the treatment.

The effect of cold milk substitutes to that of warm milk substitutes was showed by Khammouma Caumox (1973). The growth of the calves was retarded when milk was mixed with water at 18 to 20°C and fed as compared to the other group which was fed on milk mixed with water at 40°C. The difference in weight was 6.7 kg per calf at the end of seven weeks.

The growth rate and blood constituents of buffalo calves raised on calf starter with and without dried rumen liquor have been reported by Goel et al. (1972). Studies on growth rate in terms of body weight, heart girth, body length and height were made. The growth and general appearance of calves was almost the same in the three groups. Due to change in dietary regime there were variations in erythrocyte counts only.

Gill et al. (1971) studied the correlation between the body weight and the linear body measurements of growing zebu and crossbred calves. In Thari and Sindhi calves there was no appreciable difference in the body weights of calves at various stages upto three years. The halfbred animals did not show any marked increase upto six months of age. Thereafter there was an accelarated growth as compared to the pure bred, the

crossbred animals had more body weight and width. There was not much difference in the other body measurements. Levy et al. (1971) measured the compensatory growth in intensively raised calves. The results indicated that there was no evidence of compensatory growth and the daily gain of the treated animals throughout the experiment was significantly lower than that of the control animals. The same was found to be true from body dimensions in general and for body length in particular.

Pathak and Ranjhan (1976) studied the effect of urea molasses liquid diet feeding as the main source of nitrogen and energy along with limited amount of cereal forage and intact protein on voluntary intake, growth response, utilisation of nutrients in crossbred calves. They observed a lower digestibility of crude protein, crude fibre and acid detergent fibre in all the groups fed urea molasses liquid diet.

MATERIALS AND METHODS

MATERIALS AND METHODS

A total of eighteen crossbred calves of the University Livestock Farm, Mannuthy, formed the animals for the experiment. These calves were weaned at birth and assigned to the control (Group I) and two experimental groups (Groups II and III). Each group consisted of one male and five female calves. The weights of all the animals were taken immediately after birth. The calves were given colostrum of their dams at the rate of ten per cent of their body weight per day upto seven days. The milk was given to the calves at the rate of one-tenth of the body weight per day at 8 A.M. and 3.30 P.M. at body temperature diluting with lukewarm water. Clean fresh water was made available to the calves throughout the day. All the calves were housed in individual calf pens and subjected to the same management conditions. From the eighth day onwards they were fed with three different dietary treatments. The calves of the control group were fed with whole milk at ten per cent of their body weight and those in the experimental groups (II and III) with calf starter I and II respectively at 100 g per calf in addition to the quantity of two kg of milk per day till 15 days of age.

The composition and cost of the calf starters fed to the experimental calves are given hereunder.

Table 1. Percentage composition and cost of the calf starters.

Item	Calf starter I	Calf starter II	Cost Rs./Kg
Groundnut cake	32	36	1.75
Yellow maize	40	-	1.28
Wheat bran	15	15	1.11
Horse gram	-	15	1.47
Tapioca chips	-	26	1.12
Fish meal	10	5	1.15
Mineral mixture	2	2	7.00
Salt	1	1	0.20
Vitablend at the rate of 25 g per 100 kg of feed			26.70 per 100 C
Cost per kg	Rs.1.56	Re.1.58	

The composition of the mineral mixture manufactured by Sarabhai Chemicals Limited, Wadi-Wadi, Baroda is furnished below.

Table 2. Composition of mineral mixture.

Minerals	Percentage
Calcium	24.00
Phosphorus	9.00
Manganese	0.12
Iodine	0.10
Copper	0.10
Iron	0.60
Cobalt	0.02
Sodium chloride	30.00
Fluorine	0.03

Vitablend manufactured by Glaxo Laboratories contained Vitamin A 50,000 I.U. and Vitamin D_3 5,000 I.U. per gram.

The calf starters were analysed for their contents of protein, fibre, fat, moisture, ash, acid insoluble ash, calcium and phosphorus as per the standard methods described in A.O.A.C. (1970).

From the fifteenth day onwards the amount of calf starter fed to calves in the two experimental groups was increased to 350 g per calf per day with decrease in quantity of milk to half the original quantity. The calves in the control group continued to receive milk at ten per cent of their body weight. The quantity of milk fed to the experimental groups of calves was reduced to one-fourth of the original quantity from the 22nd day onwards when the quantity of calf starter was increased to 400 g per day. Milk was completely withheld from the experimental animals from the 29th day onwards. At this stage, the quantity of calf starter was increased to 600 g per day. The quantity of milk fed to the control group of calves was same at the level of the ten per cent of their body weight from the 29th day onwards and at this stage the calves started getting concentrates in their diets. The schedule of feeding for the control and the experimental calves are outlined in Tables 3 and 4 respectively. The feeding experiment lasted for a period of 24 weeks from birth.

Table 3. Schedule of feeding for control calves (Group I)

Age of calf (days)	Milk (kg)	Concentrates (kg)	Green grass (kg)	Nutrient availability (kg)			Requirements (kg)	
				D.M.	D.C.P.	T.D.N.	D.C.P.	T.D.N.
0-7	2.0	-	-	0.250	0.066	0.326	0.066	0.326
8-14	2.2	-	-	0.275	0.072	0.358	0.066	0.326
15-21	2.5	-	-	0.312	0.084	0.405	0.082	0.400
22-28	3.0	-	-	0.375	0.099	0.486	0.099	0.489
29-42	2.5	0.25	0.50	0.630	0.122	0.650	0.132	0.489
43-56	2.5	0.35	0.75	0.750	0.142	0.720	0.132	0.652
57-70	1.5	0.50	1.00	0.830	0.142	0.765	0.132	0.652
71-84	1.5	0.75	1.00	1.110	0.178	0.910	0.165	0.815
85-112	-	1.00	2.50	1.500	0.184	1.120	0.185	1.100
113-140	-	1.25	6.00	2.300	0.256	1.720	0.220	1.300
141-168	-	1.25	8.50	3.100	0.280	2.140	0.250	1.600

Table 4. Schedule of feeding of experimental calves (Groups II & III)

Age of calf (days)	Milk (kg)	Concentrates (kg)	Green grass (kg)	Nutrient availability (kg)			Requirements (kg)	
				D.M.	D.C.P.	T.D.N.	D.C.P.	T.D.N.
0-7	2.0	-	-	0.250	0.056	0.326	0.066	0.326
8-14	2.0	0.10	-	0.340	0.086	0.396	0.066	0.326
15-21	1.0	0.35	-	0.390	0.103	0.408	0.082	0.400
22-28	0.5	0.40	0.50	0.520	0.101	0.431	0.099	0.489
29-42	-	0.60	0.50	0.660	0.125	0.490	0.132	0.489
43-56	-	0.80	0.75	0.900	0.160	0.660	0.132	0.652
57-70	-	0.90	1.00	1.060	0.180	0.770	0.132	0.652
71-84	-	1.00	2.00	1.300	0.220	0.980	0.165	0.815
85-112	-	1.00	3.00	1.500	0.230	1.120	0.180	1.100
113-140	-	1.10	4.00	1.800	0.260	1.330	0.220	1.300
141-168	-	1.25	5.00	2.300	0.300	1.610	0.250	1.600

All the calves were weighed at birth and subsequently at intervals of seven days. Linear body measurements such as height at withers, body length, heart girth, paunch girth and chest depth were also recorded from birth upto 24 weeks of age at intervals of seven days as detailed by Russel (1975).

Blood samples for laboratory examination were collected using reagent grade Ethylenediamine tetra-acetic acid disodium salt (EDTA) as anticoagulant at the rate of 10 mg for every 10 ml of blood. About five ml of blood was drawn for haematological studies from the jugular vein under aseptic conditions at intervals of four weeks in the morning before feeding the calves.

The method described by Coffin (1953) was adopted for finding out the R.B.C. count and the technique with the Sahli's haemoglobinometer was employed to find out the haemoglobin content of the blood samples.

The Biuret assay method of Inchiosa (1964) was followed in the estimation of plasma protein content of the blood samples.

At the end of the study a nitrogen balance trial involving five days collection period was conducted (Mattan and Owen, 1970). Daily feed consumption records for the calves were maintained. The samples of feed and fodder were analysed for the dry matter and nitrogen contents. All precautions were

taken to ensure the quantitative collection of dung uncontaminated by urine, any feed residue or other foreign matter. The dung was collected manually at 9 A.M. every day. The dung voided during the previous 24 hour period was weighed accurately and representative samples were taken after thorough mixing. Dry matter content of dung of each calf was determined every day separately. A representative sample of dung collected from each animal was preserved in a refrigerator. A known quantity of dung was taken from the pooled samples for the estimation of nitrogen content. The process of collection, weighing, sampling and drying of dung was continued till the end of the trial.

Urine from male calves was collected by urine collection bags whereas that from female calves was done manually and preserved in polythene cans containing 100 ml of 25 per cent of sulphuric acid. The quantity of urine voided out was measured daily and 1/1000 of the volume was taken for the estimation of nitrogen. The weight of the animals before and after the nitrogen balance studies were recorded to find out the gain in body weight and the nitrogen balance.

The mean weight of the calves assigned to the control and experimental groups were analysed by using student's t. The means of the other body measurements such as height, body length, heart girth, paunch girth and chest depth of all the three groups of animals were also analysed. The blood values

such as R.B.C. count, haemoglobin and the plasma protein content of the calves of the three groups were also compared to find out whether there were any significant difference. The general method of analysis based on ordinary designs for experimentation given in Snedecor and Cochran (1967) were used.

R E S U L T S

R E S U L T S

The chemical composition of the calf starters I and II is given in Table 5. The body weights (kg) recorded at weekly intervals during the period of the experiment for the individual calves of the control and the two experimental groups are shown in Tables 6, 7 and 8 respectively. The total and average gains in body weight (kg) recorded at weekly intervals for the calves of all the groups are indicated in Table 9.

The average gain in body weight (kg) of the calves for the period of 24 weeks in Groups II and III was 44.17 and 30.91 respectively as compared to the value of 43.08 obtained for Group I. The mean of the weekly gain in body weights (kg) of the calves in the control group was found to be 1.80 per animal during the period of 24 weeks whereas the same was 1.84 and 1.29 for Groups II and III respectively. The summarised data on the weekly average body weights (kg) of the calves of the control and the experimental groups are given in Table 10 and represented in Fig. 1.

The analysis of variance (Table 11) showed that there was a significant difference between Groups II and III with regard to the gain in body weight of the calves. The average body weight gain of the calves in Group II was higher than that of the calves of the control group. But the calves in Group III had a lower average weight gain as compared to that of the calves

in the control group. On examining the rate of growth of the calves, it was found that the gain in body weight (kg) was not uniform in all the groups and there were differences in the weight gains for each week.

The height at withers (cm) recorded at weekly intervals during the period of the experiment for the individual calves of the Groups I, II and III are shown in Tables 12, 13 and 14 respectively. The total and average gains in height at withers (cm) recorded at weekly intervals for the calves of all the groups are indicated in Table 15. The average gain in height at withers (cm) of the calves for the period of 24 weeks in Group II and Group III was 22.0 and 19.5 respectively as compared to the value of 19.5 obtained for Group I. The mean of the weekly gain in height at withers (cm) of the calves in the control group was found to be 0.81 per animal during the period of 24 weeks whereas the same was 0.92 and 0.76 for Groups II and III respectively. The summarised data on the weekly gains in height at withers (cm) of the calves of the control and the experimental groups are given in Table 16 and represented in Fig. 2. The analysis of variance (Table 17) showed that there was no significant difference in the gain in height at withers of the animals of the different groups.

The body length (cm) of the calves taken at weekly intervals during the period of the experiment for the individual calves of the Groups I, II and III are shown in Tables 18, 19

and 20 respectively. The total and average gains in body length (cm) recorded at weekly intervals for the calves of all the groups are furnished in Table 21. The sum of the gains in body length (cm) of the calves for the period of 24 weeks in Groups II and III was 23.8 and 21.5 respectively as compared to the value of 22.3 obtained for the control group. The mean of the weekly gain in body length (cm) of the calves in the control group was found to be 0.93 for the period of 24 weeks whereas the same was 0.99 and 0.89 for Groups II and III respectively. The summarised data on the weekly average body length of the calves of the control and the experimental groups are furnished in Table 22 and represented in Fig. 3. The analysis of variance (Table 23) showed that there was no significant difference in the gain in body length of the animals of the three groups. But the gain in body length was not uniform in all the three groups and also for the different weeks.

The heart girth (cm) of the calves recorded at weekly intervals during the period of the experiment for the individual calves of the Groups I, II and III are given in Tables 24, 25 and 26 respectively. The total and average gain in heart girth (cm) recorded at weekly intervals for the calves of all the groups are furnished in Table 27. The sum of the gains in heart girth (cm) of the calves for the period of 24 weeks in Groups II and III was 29.2 and 21.7 respectively as

compared to the value of 24.5 recorded for the control group. The mean of the weekly gain in heart girth (cm) of the calves in the control group was found to be 1.02 for the period of 24 weeks whereas the same was 1.22 and 0.90 for Groups II and III respectively. The summarised data on the weekly average heart girth of the calves of the control and the experimental groups are furnished in Table 28 and represented in Fig. 4. The analysis of variance (Table 29) showed that there was no significant difference in the gains of heart girth of the calves in the three groups. The gain in heart girth of the calves in Group II were more than the same for calves of the Groups I and III. On examining the data on the rate of gain in heart girth it was observed that the gain in heart girth was not uniform in all the groups and there were differences in gains for each week.

The paunch girth (cm) of the calves recorded at weekly intervals of all the calves in Groups I, II and III are presented in Tables 30, 31 and 32 respectively. The total and average gains in paunch girth (cm) recorded at weekly intervals for all the calves are furnished in Table 33. The sum of the gains in paunch girth (cm) of the calves for the period of 24 weeks in Groups II and III was 52.83 and 37.66 respectively as compared to the value of 48.66 obtained for the control group. The mean of the weekly gain in paunch girth (cm) of the calves in the control group was 2.03 whereas the same was 2.20 and 1.57 for Groups II and III respectively. The summarised

data on the weekly average paunch girth (cm) of all the calves are furnished in Table 34 and represented in Fig. 5. The analysis of variance (Table 35) showed that there was a significant difference in the gains of paunch girth of the animals of the three different groups. The gain in paunch girth of the calves in Group II was more than the same in Groups I and III.

The chest depth (cm) of the calves in the Groups I, II and III recorded at weekly intervals during the experimental period of 24 weeks are given in Tables 36, 37 and 38 respectively. The total and average gains in chest depth (cm) recorded at weekly intervals are furnished in Table 39. The sum of the gains in chest depth (cm) of the calves for the period of 24 weeks in Groups II and III was 13.00 and 11.50 respectively as compared to the value of 13.66 obtained for the calves of the control group. The mean of the weekly gain in chest depth (cm) in the calves of the control group was 0.57 for a period of 24 weeks whereas the same was 0.54 and 0.48 for Groups II and III respectively. The summarised data on the weekly average chest depth (cm) of the calves of all the groups are furnished in Table 40 and represented in Fig. 6. The analysis of variance (Table 41) showed that there was no significant difference in the gain in chest depth of all the groups.

Blood samples collected from the calves of all the groups were analysed for R.B.C. count, haemoglobin and plasma protein content. The R.B.C. count of the calves of all the groups are furnished in Table 42. In the calves of the Group I the R.B.C. count (million/mm^3) ranged from 6.88 to 9.79. The count varied from 7.34 to 9.46 (million/mm^3) in the calves of Group II. The calves of the Group III had the R.B.C. count (million/mm^3) from 7.02 to 9.73. The analysis of variance (Table 43) showed that there was no significant difference among the three groups of animals with regard to the R.B.C. count.

The haemoglobin content (g/100 ml) in the blood samples of the calves of all the three groups are furnished in Table 44. The haemoglobin (g/100 ml) of blood ranged from 7.75 to 12.50 and 8.00 to 11.50 for the calves of Groups II and III respectively. For the calves in Group I the value varied from 7.50 to 12.00. The analysis of variance (Table 45) indicated no significant difference among the three groups of calves.

The values obtained on the plasma protein concentration (g/100 ml) in the blood samples of the calves of the three groups are furnished in Table 46. The plasma protein values (g/100 ml) ranged from 8.88 to 11.25 for the calves in the experimental groups as against the value of 8.88 to 10.00 obtained for the calves of the control group. No

significant difference was revealed among the three groups by the analysis of variance (Table 47).

The results of nitrogen balance trial involving five days collection period conducted in all the calves at the termination of the study are shown in Table 48. The calves in all the groups showed a positive nitrogen balance even-though there were differences among the individual calves and groups. The calves in Group II showed a nitrogen balance ranging from 9.168 to 29.831 g per day whereas the value ranged from 7.052 to 18.437 g per day in the calves of Group III. The calves in the control group indicated a nitrogen balance ranging from 2.373 to 20.448 g per day. The nitrogen balance was more for the calves in Group II as compared to the same in the other two groups. The data presented in the analysis of variance (Table 49) indicated that there were significant differences in positive nitrogen balance among the three groups. For the period of five days of nitrogen balance trial the gain in body weights (kg) of the calves of all the groups were recorded. The increases in body weight for the calves of the group I varied from 0 to 2 kg per calf as against the value of 1 to 3 kg per calf recorded for the calves in Group II. The gain in body weight of the calves in Group III ranged from 1.0 to 2.5 kg per calf. There was a positive correlation between the nitrogen balance and the gain in body weight of the calves in all the groups.

The average values of feed consumption, feed efficiency and the economics involved in the feeding of calves are detailed in Table 50 and represented in Figs. 7 and 8.

Table 5. Chemical composition of calf starters I and II.

Sl. No.	Items	Calf starter I	Calf starter II
1	Protein	23.89	24.05
2	Moisture	15.20	13.70
3	Ash	11.20	7.50
4	Acid insoluble ash	8.50	1.80
5	Calcium	1.47	0.95
6	Phosphorus	0.93	0.71
7	Fibre	4.90	3.90
8	Ether extract	1.71	4.48

Table 6. Weekly body weight (kg) of the calves - Group I (control).

Weeks	Tattoo number of the calves					
	664	680	681	672	689	687
0	19.0	20.0	19.0	28.0	19.0	17.5
1	19.0	22.0	21.5	29.5	20.5	19.0
2	20.5	23.0	23.0	31.0	21.5	21.0
3	22.5	25.5	25.0	36.0	22.0	22.0
4	24.0	26.0	26.0	38.0	24.5	23.0
5	26.0	28.0	27.0	40.0	25.5	24.5
6	27.5	28.0	28.5	42.0	26.0	26.5
7	28.5	27.5	30.5	45.0	26.5	27.0
8	29.0	30.0	32.0	47.0	28.0	28.5
9	29.0	32.0	33.0	48.0	29.5	29.0
10	29.5	33.0	36.5	49.5	32.5	31.0
11	31.5	34.0	39.5	52.0	36.0	34.0
12	33.5	36.0	40.0	54.5	40.0	36.0
13	35.5	40.5	44.0	56.0	40.0	37.5
14	36.0	41.0	48.0	59.5	40.0	38.0
15	39.0	45.0	49.0	62.0	42.0	39.0
16	40.5	49.0	49.0	66.0	43.0	40.0
17	43.0	49.0	51.0	66.0	45.0	42.0
18	47.0	49.5	53.0	69.0	46.0	43.0
19	49.5	51.0	54.0	72.0	46.0	44.0
20	52.0	53.0	56.0	75.0	48.0	46.0
21	52.5	55.0	59.0	76.0	50.0	47.0
22	57.0	57.5	63.0	78.0	52.0	49.0
23	62.0	58.0	64.0	81.0	54.0	50.0
24	65.0	58.0	65.0	84.0	56.0	53.0

Table 7. Weekly body weight (kg) of the calves - Group II (calf starter I).

Weeks	Tattoo number of the calves					
	661	665	668	674	676	682
0	23.5	20.5	19.5	23.5	19.0	22.0
1	24.5	22.0	21.0	24.5	20.0	23.0
2	27.0	25.0	23.0	27.0	23.0	25.0
3	28.5	26.5	24.5	29.5	25.0	27.0
4	30.5	27.0	25.5	31.0	26.0	29.0
5	31.0	28.0	28.0	34.0	28.0	32.0
6	31.5	28.5	31.0	36.0	29.5	33.5
7	31.0	31.0	33.0	37.0	31.0	34.0
8	31.0	34.0	36.0	38.5	32.5	36.0
9	32.0	36.5	38.0	41.5	34.0	40.0
10	34.0	38.5	41.0	42.0	35.0	44.5
11	35.0	40.0	43.0	45.0	36.5	47.0
12	37.0	42.0	44.5	48.0	38.0	49.0
13	38.0	43.0	46.0	51.0	41.5	51.5
14	41.0	46.0	47.0	54.0	45.5	52.0
15	40.0	47.0	51.0	54.0	46.0	52.0
16	42.0	50.0	53.0	57.0	48.5	53.0
17	44.0	52.0	54.5	60.0	51.5	55.0
18	45.0	55.0	57.5	60.0	52.0	56.0
19	46.5	61.0	59.0	61.0	52.0	58.0
20	50.5	64.0	61.0	63.0	53.0	59.0
21	53.0	67.0	61.5	65.0	55.0	59.0
22	54.5	71.0	62.0	67.0	56.0	62.0
23	55.0	71.5	64.0	68.0	57.0	66.0
24	56.0	72.0	67.0	71.0	57.0	70.0

Table 8. Weekly body weight (kg) of the calves - Group III (calf starter II).

Weeks	Tattoo number of the calves					
	662	667	673	675	678	671
0	21.5	19.0	25.0	18.0	21.0	22.0
1	21.5	21.0	26.0	19.0	22.0	25.0
2	23.0	22.0	27.0	20.0	23.0	27.5
3	24.5	23.5	29.0	23.0	25.0	27.0
4	26.0	24.0	31.0	23.0	26.0	27.0
5	27.0	24.5	32.0	23.0	27.5	27.5
6	27.5	28.0	32.0	24.5	29.0	29.5
7	28.0	30.0	33.0	25.0	31.0	31.0
8	28.5	31.5	34.0	27.0	30.0	33.0
9	30.0	33.5	33.0	28.0	32.5	34.5
10	30.4	36.0	34.0	28.0	33.0	35.0
11	31.0	37.0	35.0	29.0	33.0	36.0
12	32.0	37.0	35.5	32.0	33.0	38.0
13	33.5	39.5	37.5	33.5	35.0	38.0
14	35.0	40.0	38.0	35.5	36.0	40.0
15	35.0	41.0	40.0	35.5	37.0	43.0
16	34.0	43.0	43.0	36.0	39.0	44.5
17	37.0	45.5	44.0	36.0	41.0	46.0
18	38.0	47.0	46.0	36.0	43.0	48.0
19	39.0	49.5	48.0	36.0	43.0	50.0
20	40.0	51.0	48.0	37.0	44.0	51.0
21	45.0	53.0	50.0	39.0	45.0	51.0
22	48.0	53.0	52.0	41.0	47.0	53.0
23	51.0	53.0	53.0	43.0	49.0	55.0
24	54.0	54.0	54.0	43.0	50.0	57.0

Table 9. Total and average gains in body weight (kg) recorded at weekly intervals of all the groups of calves.

Week	Group I			Group II			Group III		
	Body weight			Body weight			Body weight		
	Total	Average	Gain	Total	Average	Gain	Total	Average	Gain
0	122.5	20.4	-	128.0	21.3	-	126.5	21.1	-
1	131.5	21.9	1.50	135.0	22.5	1.17	134.5	22.4	1.33
2	140.0	23.3	1.42	150.0	25.0	2.50	142.5	23.8	1.33
3	153.0	25.5	2.16	161.0	26.8	1.00	152.0	25.3	1.50
4	161.5	26.9	1.42	169.0	28.2	2.16	157.0	26.2	0.83
5	171.0	28.5	1.58	181.0	30.2	2.00	161.5	26.9	0.75
6	178.5	29.7	1.25	190.0	31.7	1.50	170.5	28.4	1.50
7	185.0	30.8	1.09	197.0	32.8	1.17	178.0	29.7	1.25
8	194.5	32.4	1.58	208.0	34.7	1.83	184.0	30.7	1.00
9	200.5	33.4	1.00	222.0	37.0	2.34	191.5	31.9	1.25
10	212.0	35.3	1.92	235.0	39.2	2.16	196.0	32.7	0.75
11	227.0	37.8	2.50	246.5	41.1	1.92	201.0	33.5	0.84
12	240.0	40.0	2.16	258.5	43.1	2.00	207.5	34.6	1.08
13	253.5	42.2	2.25	271.0	45.2	2.08	217.0	36.3	1.58
14	262.5	43.7	1.50	280.5	46.8	1.42	224.5	37.4	1.25
15	276.0	46.0	2.25	290.0	48.3	0.75	231.5	38.6	1.17
16	287.5	47.9	1.92	303.5	50.6	2.25	239.5	39.9	1.33
17	296.0	49.3	1.42	317.0	52.8	2.25	249.5	41.6	1.67
18	307.5	51.3	1.91	325.5	54.3	1.42	250.0	43.0	1.42
19	316.5	52.8	1.39	337.5	56.3	2.00	265.5	44.3	1.25
20	330.0	55.0	2.36	350.5	58.4	2.16	271.0	45.2	0.91
21	339.5	56.6	1.59	360.5	60.1	1.67	283.0	47.2	2.00
22	356.5	59.4	2.83	372.5	62.1	2.00	294.0	49.0	1.84
23	369.0	61.5	2.08	381.5	63.6	1.50	304.0	51.0	1.66
24	381.0	63.5	2.00	393.0	65.5	1.92	312.0	52.0	1.34
Total			43.08			44.17			30.91
Mean			1.80			1.84			1.29

Table 10. Summarised data on weekly average body weights (kg) of the calves on the control and experimental groups.

Treatments	Week 0	1	2	3	4	5	6	7	8	9
Group I	20.40 ± 1.37	21.90 ± 1.42	23.30 ± 1.44	25.50 ± 1.53	26.90 ± 1.57	28.50 ± 1.62	29.70 ± 1.66	30.80 ± 1.69	32.40 ± 1.73	33.40 ± 1.76
Group II	21.30 ± 1.39	22.50 ± 1.51	25.00 ± 1.52	26.80 ± 1.56	28.20 ± 1.59	30.20 ± 1.74	31.70 ± 1.78	32.80 ± 1.80	34.70 ± 1.82	37.00 ± 1.83
Group III	21.10 ± 1.38	22.40 ± 1.42	23.80 ± 1.47	25.50 ± 1.51	26.20 ± 1.54	26.90 ± 1.55	28.40 ± 1.58	29.70 ± 1.63	30.70 ± 1.66	31.90 ± 1.70

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
35.30 ±1.80	37.80 ±1.84	40.00 ±1.92	43.70 ±1.97	43.70 ±2.01	46.00 ±2.02	47.90 ±2.10	49.30 ±2.13	51.30 ±2.17	52.80 ±2.20	55.00 ±2.25	56.60 ±2.28	59.40 ±2.33	61.50 ±2.37	63.50 ±2.39
39.20 ±1.88	41.10 ±1.93	43.10 ±1.97	45.20 ±2.02	46.80 ±2.08	46.30 ±2.09	50.60 ±2.14	52.80 ±2.18	54.30 ±2.20	56.30 ±2.26	58.40 ±2.30	60.10 ±2.33	62.10 ±2.36	63.60 ±2.40	65.50 ±2.44
32.70 ±1.72	33.50 ±1.74	34.60 ±1.77	36.20 ±1.79	37.40 ±1.84	38.60 ±1.88	39.90 ±1.91	41.60 ±1.94	43.00 ±1.97	44.30 ±2.00	45.20 ±2.02	47.20 ±2.04	49.00 ±2.10	51.00 ±2.14	52.00 ±2.17

Average gain per day (g) - Group I - 257
Group II - 263
Group III - 215

Table 11. Analysis of variance - Weight gain.

Source	df	SS	MSS	F
Treatments	2	4.51	2.25	11.25*
Weeks	23	3.50	0.15	0.75*
Error	46	9.23	0.20	
Total	71	17.24		

Pairwise comparison

T_1	T_2	T_3
1.80	1.84	1.29

C.D. = 0.26

T_1-T_2 = 0.04

T_2-T_3 = 0.55*

T_1-T_3 = 0.51*

* Significant at 5% level.

Table 12. Weekly height at withers (cm) of the calves - Group I (control).

Weeks	Tattoo number of the calves					
	664	680	681	672	689	687
0	67	67	66	70	62	62
1	67	68	66	72	64	63
2	68	69	67	73	65	65
3	70	69	67	74	66	66
4	71	70	70	75	67	67
5	72	71	71	75	68	69
6	72	71	72	76	68	70
7	72	72	73	76	69	71
8	72	72	74	77	69	72
9	72	73	75	78	70	72
10	72	74	75	80	72	73
11	73	74	76	81	73	74
12	73	75	76	82	73	74
13	75	75	78	82	74	75
14	77	75	80	83	74	76
15	77	77	80	83	75	76
16	78	78	81	84	75	77
17	80	79	81	84	76	77
18	81	79	82	85	76	78
19	82	80	82	86	76	78
20	82	81	83	87	78	79
21	83	81	85	89	78	79
22	84	82	87	90	79	80
23	85	83	87	92	79	80
24	85	85	88	92	80	81

Table 13. Weekly height at withers (cm) of the calves - Group II (calf startor I).

Weeks	Tattoo number of the calves					
	661	665	668	674	676	682
0	66	69	64	70	60	63
1	68	71	66	70	61	65
2	69	73	67	70	63	66
3	69	73	68	72	65	68
4	72	74	69	74	67	69
5	73	74	71	74	69	70
6	73	74	72	75	70	71
7	75	75	73	77	72	72
8	75	75	74	79	72	73
9	76	75	74	80	73	74
10	76	75	76	80	73	75
11	76	76	78	81	74	76
12	76	76	80	83	75	78
13	76	77	81	83	76	80
14	76	79	82	84	77	80
15	78	80	82	84	77	81
16	78	81	83	84	78	82
17	78	82	83	85	79	83
18	80	83	84	85	79	83
19	81	83	86	85	81	84
20	81	84	87	86	82	86
21	82	86	87	87	82	88
22	82	88	88	87	83	88
23	83	89	88	88	83	89
24	83	90	90	88	84	89

Table 14. Weekly height at withers (cm) of the calves - Group III (calf starter II).

Weeks	Tattoo number of the calves					
	662	667	673	675	676	671
0	63	65	70	61	64	70
1	63	66	70	62	65	71
2	64	68	71	64	66	72
3	66	68	72	66	67	72
4	70	69	73	67	68	72
5	70	70	74	69	69	72
6	71	71	75	69	69	72
7	71	72	75	70	71	73
8	72	72	75	72	73	73
9	72	73	75	73	74	74
10	72	73	76	73	75	75
11	72	74	76	73	76	76
12	72	75	77	74	76	77
13	73	76	78	75	77	77
14	74	77	79	76	78	78
15	75	78	80	76	79	79
16	75	79	81	76	79	81
17	76	80	81	77	80	81
18	77	81	81	78	80	81
19	78	82	82	78	81	81
20	78	83	84	78	82	82
21	80	84	84	79	82	82
22	81	84	85	80	83	83
23	81	85	85	80	83	84
24	82	85	86	81	84	84

Table 15. Total and average gains in height at withers (cm) recorded at weekly intervals of all the group of calves.

Week	Group I			Group II			Group III		
	Height at withers			Height at withers			Height at withers		
	Total	Average	Gain	Total	Average	Gain	Total	Average	Gai
0	394	65.7	-	392	65.3	-	393	65.5	-
1	400	66.7	1.0	401	66.8	1.5	397	66.2	0.
2	407	67.8	2.2	408	68.0	2.7	405	67.5	2.
3	412	68.7	3.0	415	69.2	3.8	411	68.5	3.
4	420	70.0	4.3	425	70.8	5.5	419	69.8	4.
5	426	71.0	5.3	431	71.8	6.5	424	70.7	5.
6	429	71.5	5.8	435	72.5	7.2	427	71.2	5.
7	433	72.2	6.5	444	74.0	8.7	432	72.0	6.
8	436	72.7	7.0	448	74.7	9.3	437	72.8	7.
9	440	73.3	7.7	452	75.3	10.0	441	73.5	8.
10	446	74.3	8.7	455	75.8	10.5	444	74.0	8.
11	451	75.2	9.5	461	76.8	11.5	447	74.5	9.
12	453	75.5	9.8	468	78.0	12.7	451	75.2	9.
13	459	76.5	10.8	473	78.8	13.5	456	76.0	10.
14	465	77.5	11.8	478	79.7	14.3	462	77.0	11.
15	468	78.0	12.3	482	80.3	15.0	467	77.8	12.
16	473	78.8	13.2	486	81.0	15.7	471	78.5	13.
17	477	79.5	13.8	490	81.7	16.3	475	79.2	13.
18	481	80.2	14.5	494	82.3	17.3	478	79.7	14.
19	484	80.7	15.0	500	83.3	18.3	482	80.3	14.
20	490	81.7	16.0	506	84.3	19.0	487	81.2	15.
21	495	82.5	16.8	512	85.3	20.0	491	81.8	16.
22	502	83.7	18.0	516	86.0	20.7	496	82.7	17.
23	506	84.3	18.7	520	86.7	21.3	498	83.0	17.
24	511	85.2	19.5	524	87.3	22.0	502	83.7	18.
Total			19.5			22.0			18.
Mean			0.81			0.92			0.76

Table 16. Summarised data of weekly average height at withers (cm) of calves on the control and experimental groups.

Treatment	Week 0	1	2	3	4	5	6	7	8	9	10	11	12
Group I	65.7 ±2.3	66.7 ±2.3	67.8 ±2.4	68.7 ±2.5	70.0 ±2.5	71.0 ±2.5	71.5 ±2.5	72.2 ±2.5	72.7 ±2.5	73.3 ±2.6	74.3 ±2.6	75.2 ±2.6	75.5 ±2.6
Group II	65.3 ±2.4	66.8 ±2.5	68.0 ±2.5	69.2 ±2.5	70.8 ±2.5	71.8 ±2.6	72.5 ±2.6	74.0 ±2.6	74.7 ±2.6	75.3 ±2.7	75.8 ±2.7	76.8 ±2.7	78.0 ±2.7
Group III	65.3 ±2.5	66.2 ±2.5	67.5 ±2.5	68.5 ±2.5	69.8 ±2.6	70.7 ±2.6	71.2 ±2.6	72.0 ±2.6	72.8 ±2.6	73.5 ±2.6	74.0 ±2.6	74.5 ±2.6	75.2 ±2.6

13	14	15	16	17	18	19	20	21	22	23	24	Av. gain/day(cm)
76.5 ±2.6	77.5 ±2.6	78.0 ±2.6	78.8 ±2.7	79.5 ±2.7	80.2 ±2.7	80.7 ±2.7	81.7 ±2.7	82.5 ±2.7	83.7 ±2.7	84.3 ±2.8	85.2 ±2.8	0.116
76.8 ±2.7	79.7 ±2.7	80.3 ±2.7	81.0 ±2.7	81.7 ±2.7	82.3 ±2.7	83.3 ±2.7	84.4 ±2.8	85.3 ±2.8	86.0 ±2.8	86.7 ±2.8	87.3 ±2.8	0.151
76.0 ±2.6	77.0 ±2.6	77.8 ±2.6	78.5 ±2.6	79.0 ±2.6	79.7 ±2.6	80.3 ±2.7	81.2 ±2.7	81.8 ±2.7	82.7 ±2.7	83.0 ±2.7	83.7 ±2.7	0.109

Table 17. Analysis of variance - Height gain.

Source	df	SS	MSS	F
Treatments	2	83.93	41.99	1.79
Weeks	23	1079.40	46.93	2.00
Error	46	1077.27	23.42	
Total	71	2240.71		

Table 18. Weekly body length (cm) of the calves - Group I (control).

Week	Tattoo number of the calves					
	664	680	681	672	689	667
0	50	58	62	59	56	59
1	56	59	62	62	57	61
2	57	59	62	63	58	63
3	63	59	63	64	59	64
4	64	60	66	65	60	64
5	66	62	66	65	60	65
6	66	63	66	66	60	66
7	66	64	68	66	60	67
8	66	65	69	67	62	68
9	66	65	70	70	63	69
10	66	66	71	70	63	70
11	66	67	72	70	64	70
12	67	69	72	72	65	71
13	69	70	73	73	66	71
14	72	70	73	74	69	71
15	72	71	73	75	69	72
16	72	72	74	76	70	72
17	73	75	74	76	70	73
18	74	76	75	79	71	73
19	75	76	75	83	71	74
20	76	76	76	84	72	75
21	76	77	78	84	72	75
22	78	77	80	85	73	76
23	81	78	80	85	73	76
24	81	79	81	86	74	77

Table 19. Weekly body length (cm) of the calves - Group II (calf starter I).

Week	Tattoo number of the calves					
	661	665	668	674	676	682
0	60	60	54	58	58	57
1	65	61	55	58	59	59
2	68	63	56	59	60	60
3	68	64	58	61	61	61
4	69	65	58	61	63	61
5	70	65	59	62	64	63
6	70	66	61	62	64	64
7	70	68	63	63	65	65
8	70	68	65	64	67	66
9	71	68	68	66	67	66
10	72	68	70	67	68	67
11	72	69	70	68	69	68
12	72	70	71	70	69	70
13	73	70	72	71	70	73
14	75	71	73	73	71	75
15	76	71	75	73	71	75
16	78	74	75	75	72	76
17	78	75	76	77	73	76
18	79	76	76	79	75	77
19	79	76	77	80	76	77
20	80	78	78	81	77	77
21	81	80	79	81	77	78
22	81	82	79	82	78	78
23	82	83	80	82	78	79
24	84	84	80	83	79	80

Table 20. Weekly body length (cm) of the calves - Group III (calf starter II).

Week	Tattoo number of the calves					
	662	667	673	675	678	671
0	55	52	60	54	60	58
1	57	56	62	56	61	60
2	60	57	63	58	62	62
3	60	58	64	62	64	62
4	62	58	66	63	67	62
5	63	59	68	63	68	63
6	64	60	68	64	70	64
7	64	62	69	64	70	65
8	64	64	71	64	71	65
9	65	66	72	64	71	66
10	65	67	72	66	71	68
11	65	67	72	66	73	69
12	67	67	73	67	73	71
13	67	68	74	68	73	71
14	68	68	75	69	74	71
15	70	69	76	69	74	72
16	71	70	76	69	75	72
17	72	71	77	70	76	73
18	72	73	78	70	76	74
19	72	74	79	72	77	76
20	72	74	80	72	78	79
21	73	75	80	73	78	80
22	74	75	80	73	79	80
23	75	76	81	74	79	80
24	76	76	81	74	80	81

Table 21. Total and average gain in body length (cm) recorded at weekly intervals of all the groups of calves.

Week	Group I			Group II			Group III		
	Body length			Body length			Body length		
	Total	Average	Gain	Total	Average	Gain	Total	Average	Gain
0	344	57.3	-	347	57.8	-	339	56.5	-
1	357	59.5	2.2	357	59.5	1.6	352	58.7	2.2
2	362	60.3	3.0	366	61.0	3.2	362	60.3	3.8
3	372	62.0	4.7	373	62.2	4.3	370	61.7	5.2
4	379	63.2	5.8	377	62.8	5.0	378	63.0	6.5
5	384	64.0	6.7	383	63.8	6.0	384	64.0	7.5
6	387	64.5	7.2	387	64.5	6.7	390	65.0	8.5
7	391	65.2	7.8	394	65.7	7.8	394	65.7	9.2
8	397	66.2	8.8	400	66.7	8.8	399	66.5	10.0
9	403	67.2	9.8	406	67.7	9.8	404	67.3	10.8
10	406	67.7	10.3	412	68.7	10.8	409	68.2	11.7
11	409	68.2	10.8	416	69.3	11.5	412	68.7	12.2
12	416	69.3	12.0	422	70.3	12.5	418	69.7	13.2
13	422	70.3	13.0	429	71.5	13.7	421	70.2	13.7
14	429	71.5	14.2	438	73.0	15.2	425	70.8	14.3
15	432	72.0	14.7	441	73.5	15.6	430	71.7	15.2
16	436	72.7	15.3	450	75.0	17.2	433	72.2	15.7
17	441	73.5	16.2	455	75.8	18.2	439	73.2	16.7
18	448	74.7	17.3	462	77.0	19.2	443	73.8	17.3
19	454	75.7	18.3	465	77.5	19.7	450	75.0	18.3
20	459	76.5	19.2	471	78.5	20.6	455	75.8	19.3
21	462	77.0	19.7	476	79.3	21.5	459	76.5	20.0
22	469	78.2	20.8	480	80.0	22.2	461	76.8	20.3
23	475	78.8	21.5	484	80.7	22.8	465	77.5	21.0
24	478	79.7	22.3	490	81.7	23.8	468	78.0	21.5
Total			22.3			23.8			21.5
Mean			0.93			0.99			0.89

Table 22. Summarised data on weekly average body length (cm) of calves on the control and experimental groups.

Treatments	Week 0	1	2	3	4	5	6	7	8	9	10	11	12
Group I	57.3 ±2.3	59.5 ±2.3	60.3 ±2.3	62.0 ±2.3	62.2 ±2.4	64.0 ±2.4	64.5 ±2.4	65.2 ±2.4	66.2 ±2.5	67.2 ±2.5	67.7 ±2.5	68.2 ±2.5	69.3 ±2.5
Group II	57.8 ±2.1	59.5 ±2.2	61.0 ±2.2	62.2 ±2.3	62.8 ±2.3	63.8 ±2.3	64.5 ±2.4	65.7 ±2.4	66.7 ±2.4	67.7 ±2.4	68.7 ±2.4	69.3 ±2.5	70.3 ±2.5
Group III	56.5 ±2.3	58.7 ±2.3	60.3 ±2.3	61.7 ±2.4	63.0 ±2.4	64.0 ±2.4	65.0 ±2.4	65.7 ±2.4	66.5 ±2.4	67.3 ±2.5	68.2 ±2.5	68.7 ±2.5	69.7 ±2.5

13	14	15	16	17	18	19	20	21	22	23	24	Av. gain/day (cm)
70.3 ±2.5	71.5 ±2.5	72.0 ±2.5	72.7 ±2.5	73.5 ±2.6	74.7 ±2.6	75.7 ±2.6	76.7 ±2.6	77.0 ±2.6	78.2 ±2.7	78.2 ±2.7	79.7 ±2.7	0.133
71.5 ±2.5	73.0 ±2.5	73.5 ±2.6	75.0 ±2.6	75.8 ±2.6	77.0 ±2.6	77.5 ±2.6	78.5 ±2.7	79.3 ±2.7	80.0 ±2.7	80.7 ±2.7	81.7 ±2.7	0.142
70.2 ±2.5	70.8 ±2.5	71.7 ±2.5	72.2 ±2.6	73.2 ±2.6	73.8 ±2.6	75.0 ±2.6	75.8 ±2.6	76.5 ±2.6	76.8 ±2.6	77.5 ±2.6	78.0 ±2.6	0.127

Table 23. Analysis of variance - Body length gain.

Source	df	SS	MSS	F
Treatments	2	5.87	2.93	0.19
Weeks	23	2755.69	119.87	7.85
Error	46	702.33	15.27	
Total	71	3465.19		

Table 24. Weekly heart girth (cm) of the calves - Group I (control).

Week	Tattoo number of the calves					
	664	680	681	672	689	687
0	64	64	66	70	62	66
1	69	65	69	72	63	66
2	70	65	69	73	65	66
3	71	68	70	75	66	66
4	72	69	70	78	66	67
5	73	69	70	78	67	69
6	73	70	71	80	68	70
7	73	71	72	82	69	71
8	73	71	73	82	70	71
9	74	72	74	83	70	72
10	74	73	75	85	72	72
11	74	74	76	87	74	74
12	75	76	77	88	77	76
13	79	76	79	88	79	78
14	79	76	82	90	81	78
15	80	78	84	92	81	79
16	81	80	84	93	82	80
17	82	82	85	93	82	80
18	84	83	85	94	83	81
19	86	83	86	96	83	81
20	87	84	86	96	84	83
21	88	84	88	96	85	84
22	90	85	90	97	85	84
23	91	85	90	98	86	85
24	92	87	91	98	86	85

Table 25. Weekly heart girth (cm) of the calves - Group II (calf starter I).

Week	Tattoo number of the calves					
	661	665	668	674	676	682
0	65	66	62	66	61	63
1	70	67	65	67	61	65
2	73	73	67	70	63	66
3	74	73	68	70	66	69
4	76	74	69	70	69	69
5	76	74	71	73	70	71
6	76	74	73	73	71	71
7	76	75	75	76	73	73
8	76	79	76	77	73	74
9	76	79	76	79	76	75
10	77	82	79	80	76	77
11	80	83	79	82	77	77
12	80	83	82	84	78	79
13	81	85	83	85	80	82
14	82	87	85	88	82	84
15	82	88	85	88	82	85
16	82	90	86	89	83	85
17	82	91	88	90	83	86
18	84	91	88	93	85	86
19	86	93	89	93	88	87
20	87	93	90	93	89	89
21	87	96	92	93	89	90
22	88	99	92	94	90	90
23	88	100	93	94	90	91
24	88	100	93	95	91	92

Table 26. Weekly heart girth (cm) of the calves - Group III (calf starter II).

Week	Tattoo number of the calves					
	662	667	673	675	678	671
0	62	61	73	60	65	66
1	66	66	73	61	66	68
2	68	67	73	63	66	69
3	68	67	74	66	68	70
4	73	70	75	67	70	72
5	75	70	75	69	72	73
6	76	71	75	69	73	74
7	76	72	76	71	73	75
8	76	75	76	71	74	75
9	76	77	76	71	74	77
10	76	77	76	71	75	78
11	76	79	77	73	76	78
12	76	80	78	75	77	80
13	77	80	79	76	77	81
14	78	82	80	77	78	81
15	78	83	81	77	79	82
16	80	85	82	78	79	83
17	81	85	84	78	80	83
18	82	85	85	78	81	85
19	84	86	85	79	81	85
20	84	86	85	80	81	86
21	85	87	86	81	82	86
22	85	89	86	81	82	87
23	87	89	87	82	83	88
24	89	90	87	82	83	88

Table 27. Total and average gains in heart girth (cm) recorded at weekly intervals of all the groups of calves.

Week	Group I			Group II			Group III		
	Heart girth			Heart girth			Heart Girth		
	Total	Average	Gain	Total	Average	Gain	Total	Average	Gain
0	392	65.3	-	384	64.0	-	387	64.5	-
1	404	67.3	2.0	395	65.8	1.8	400	66.7	2.2
2	408	68.0	2.7	412	68.7	4.7	406	67.7	3.2
3	416	69.3	4.0	420	70.0	6.0	413	68.8	4.3
4	422	70.3	5.0	427	71.2	7.2	427	71.2	6.7
5	426	71.0	5.7	435	72.5	8.5	433	72.2	7.7
6	432	72.0	6.7	438	73.0	9.0	438	73.0	8.5
7	438	73.0	7.7	448	74.7	10.7	443	73.8	9.3
8	440	73.3	8.0	455	75.8	11.8	447	74.5	10.0
9	445	74.2	8.8	461	76.8	12.8	451	75.2	10.7
10	451	75.2	9.8	471	78.5	14.5	453	75.5	11.0
11	459	76.5	9.2	478	79.7	15.7	459	76.5	13.0
12	469	78.2	12.8	486	81.0	17.0	466	77.7	13.2
13	479	79.8	14.5	496	82.7	18.8	470	78.3	13.8
14	486	81.0	15.7	508	84.7	20.7	476	79.3	14.8
15	494	82.3	17.0	510	85.0	21.0	480	80.0	15.5
16	500	83.3	18.0	515	85.8	21.8	487	81.5	16.7
17	504	84.0	18.7	520	86.7	22.7	491	81.8	17.3
18	510	85.0	19.7	527	87.8	23.8	496	82.7	18.2
19	515	85.8	20.5	536	89.3	25.3	500	83.3	18.8
20	520	86.7	21.3	541	90.2	26.2	502	83.7	19.2
21	525	87.5	22.2	547	91.2	27.2	507	84.5	20.0
22	531	88.5	23.2	553	92.2	28.2	510	85.0	20.5
23	535	89.2	23.8	556	92.7	28.7	516	86.0	21.2
24	539	89.8	24.5	559	93.2	29.2	519	86.5	21.7
Total			24.5			29.2			21.7
Mean			1.02			1.22			0.90

Table 28. Summarised data on weekly average heart girth (cm) of calves on the control and experimental groups.

Treatments	Week 0	1	2	3	4	5	6	7	8	9	10	11	12
Group I	65.3 ±2.4	67.3 ±2.4	68.0 ±2.4	69.3 ±2.4	70.3 ±2.4	71.0 ±2.5	72.0 ±2.5	73.0 ±2.5	73.3 ±2.5	74.2 ±2.6	75.2 ±2.6	76.5 ±2.6	78.2 ±2.6
Group II	64.0 ±2.4	65.8 ±2.4	68.7 ±2.4	70.0 ±2.5	71.2 ±2.5	72.5 ±2.5	73.0 ±2.6	74.7 ±2.6	75.0 ±2.6	76.8 ±2.6	78.5 ±2.7	79.7 ±2.7	81.0 ±2.7
Group III	64.5 ±2.4	66.7 ±2.4	67.7 ±2.4	68.6 ±2.4	71.2 ±2.5	72.2 ±2.5	73.0 ±2.5	73.8 ±2.5	74.5 ±2.5	75.2 ±2.5	75.5 ±2.6	76.5 ±2.6	77.7 ±2.6

13	14	15	16	17	18	19	20	21	22	23	24	Av. gain/day (cm)
79.8 ±2.6	81.0 ±2.7	82.3 ±2.7	83.3 ±2.7	84.0 ±2.7	85.0 ±2.8	85.8 ±2.8	86.7 ±2.8	87.5 ±2.8	88.5 ±2.8	89.2 ±2.8	89.8 ±2.8	0.146
82.7 ±2.7	84.7 ±2.7	85.0 ±2.7	85.8 ±2.8	86.7 ±2.8	87.8 ±2.8	89.3 ±2.8	90.2 ±2.8	91.2 ±2.8	92.2 ±2.9	92.7 ±2.9	93.2 ±2.9	0.174
78.3 ±2.6	79.3 ±2.6	80.0 ±2.6	81.5 ±2.7	81.8 ±2.7	82.7 ±2.7	83.3 ±2.8	83.7 ±2.8	84.5 ±2.8	85.0 ±2.8	86.0 ±2.8	86.5 ±2.8	0.129

Table 29. Analysis of variance - Heart girth gain.

Source	df	SS	MSS	F
Treatments	2	1.195	0.598	1.694
Weeks	23	8.256	0.359	1.017
Error	46	16.256	0.353	
Total	71	25.707		

Table 30. Weekly paunch girth (cm) of the calves - Group I (control).

Week	Tattoo number of the calves					
	664	680	681	672	689	687
0	64	66	66	72	62	66
1	70	66	69	74	65	64
2	70	66	70	74	67	64
3	71	68	76	78	68	68
4	76	71	79	81	70	71
5	74	74	74	81	75	76
6	74	74	75	86	77	75
7	74	73	77	86	77	78
8	74	73	82	89	79	82
9	75	76	85	89	78	83
10	76	82	86	89	80	85
11	78	82	87	94	85	88
12	82	86	85	100	87	89
13	87	87	88	97	94	95
14	85	88	93	104	96	94
15	92	89	105	113	98	95
16	92	91	105	112	98	96
17	97	100	108	110	100	99
18	97	100	109	116	104	102
19	103	102	110	124	105	105
20	105	102	112	118	104	108
21	106	105	111	116	106	110
22	109	111	114	118	107	112
23	112	112	116	120	110	115
24	110	109	118	121	112	118

Table 31. Weekly paunch girth (cm) of the calves - Group II (calf starter I).

Week	Tattoo number of the calves					
	661	665	668	674	676	682
0	66	68	62	67	62	65
1	70	69	61	69	63	65
2	70	74	67	70	67	69
3	77	75	70	71	70	73
4	86	75	70	74	72	71
5	86	77	74	77	75	72
6	87	77	76	78	77	74
7	87	82	82	82	81	77
8	86	86	85	84	79	83
9	87	90	86	85	80	83
10	89	94	92	92	82	90
11	95	94	89	96	87	92
12	96	99	90	97	88	100
13	94	96	93	104	92	106
14	96	97	96	103	95	105
15	96	98	96	104	92	105
16	95	101	98	109	100	105
17	96	102	99	115	110	102
18	99	112	100	115	108	104
19	101	105	103	113	111	112
20	107	106	106	115	113	115
21	103	116	112	112	112	119
22	104	122	106	116	115	121
23	113	120	111	118	118	123
24	116	119	109	119	119	125

Table 32. Weekly paunch girth (cm) of the calves - Group III (calf starter II).

Week	Tattoo number of the calves					
	662	667	673	675	678	671
0	70	62	73	63	65	69
1	68	63	73	63	67	69
2	70	67	74	66	69	70
3	75	67	77	68	71	72
4	76	69	77	70	71	74
5	75	70	80	74	76	75
6	78	73	82	76	78	76
7	84	76	84	77	76	79
8	83	80	85	77	75	80
9	85	82	81	76	77	83
10	88	84	82	79	76	79
11	90	87	82	81	79	83
12	92	84	85	85	79	83
13	93	83	89	92	84	88
14	94	89	88	93	85	83
15	88	91	88	92	88	93
16	94	92	90	93	89	94
17	92	98	98	95	90	95
18	97	98	104	97	94	101
19	101	97	99	95	92	101
20	97	95	104	95	95	101
21	102	97	106	93	96	99
22	98	105	103	96	97	102
23	98	106	107	100	100	104
24	100	108	110	102	102	106

Table 33. Total and average gains in paunch girth (cm) at weekly intervals of all the groups of calves.

Week	Group I			Group II			Group III		
	Paunch girth			Paunch girth			Paunch girth		
	Total	Average	Gain	Total	Average	Gain	Total	Average	Gain
0	396	66.0	-	390	65.0	-	402	67.0	-
1	408	68.0	2.0	397	68.2	1.2	407	67.8	0.8
2	411	68.5	2.5	417	69.5	4.5	416	69.3	2.3
3	429	71.5	5.5	436	72.7	7.7	430	71.7	4.7
4	448	74.7	8.7	448	74.7	9.7	437	72.8	5.8
5	454	75.7	9.7	461	76.8	11.8	449	74.8	7.8
6	461	76.8	10.8	469	78.2	13.2	463	77.2	10.2
7	465	77.5	11.5	491	81.8	16.8	476	79.3	12.3
8	479	79.8	13.8	503	83.8	18.8	485	80.5	13.5
9	486	81.0	15.0	516	86.0	21.0	484	80.7	13.7
10	498	83.0	17.0	539	89.8	24.8	488	81.3	14.3
11	514	85.7	19.7	553	92.2	27.2	502	83.7	16.7
12	529	88.2	22.2	570	95.0	30.0	508	84.7	17.7
13	548	91.3	25.3	582	97.0	32.3	529	88.2	21.2
14	560	93.3	27.3	590	98.3	33.3	537	89.5	22.5
15	592	98.7	32.7	589	98.2	33.2	540	90.0	23.0
16	594	99.0	33.0	608	100.3	36.3	552	92.0	25.0
17	614	102.3	36.3	624	104.0	39.0	569	94.7	27.7
18	628	104.7	38.7	638	106.3	41.3	591	98.5	31.5
19	649	108.2	42.2	645	107.5	42.5	589	97.5	30.9
20	649	108.2	42.2	662	110.3	45.3	587	97.8	30.8
21	654	109.0	43.0	674	112.3	47.3	593	98.8	31.8
22	671	111.8	45.8	684	114.0	49.0	605	100.8	33.8
23	685	114.2	48.2	703	117.2	52.2	615	102.5	35.5
24	688	114.7	48.7	707	117.8	52.8	629	104.7	37.7
Total			48.7			52.8			37.7
Mean			2.03			2.20			1.57

Table 34. Summarised data on weekly average paunch girth (cm) of calves on the control and experimental groups.

Treatments	Week 0	1	2	3	4	5	6	7	8	9	10	11	12
Group I	66.0 ±2.4	68.0 ±2.4	68.5 ±2.4	71.5 ±2.5	74.7 ±2.5	75.7 ±2.6	76.8 ±2.6	77.5 ±2.6	79.8 ±2.6	81.0 ±2.7	83.0 ±2.7	85.7 ±2.7	88.2 ±2.9
Group II	65.0 ±2.4	68.2 ±2.4	69.5 ±2.5	72.7 ±2.5	74.7 ±2.5	76.8 ±2.6	78.2 ±2.6	81.8 ±2.6	83.8 ±2.7	86.0 ±2.7	89.8 ±2.8	92.2 ±2.9	95.0 ±2.9
Group III	67.0 ±2.4	67.8 ±2.4	69.3 ±2.5	71.7 ±2.5	72.8 ±2.5	74.8 ±2.6	77.2 ±2.6	79.3 ±2.6	80.5 ±2.6	80.7 ±2.7	81.3 ±2.7	83.7 ±2.7	84.7 ±2.7

13	14	15	16	17	18	19	20	21	22	23	24	Av. gain/day (cm)
91.3 ±2.9	93.3 ±2.9	93.7 ±3.0	99.0 ±3.0	102.3 ±3.0	104.7 ± 3.0	108.2 ± 3.1	108.2 ± 3.1	109.0 ± 3.1	111.8 ± 3.1	114.2 ± 3.2	114.7 ± 3.2	0.287
97.0 ±2.9	98.3 ±2.9	98.2 ±2.9	100.3 ±3.0	104.0 ± 3.1	106.3 ± 3.2	107.3 ± 3.2	110.3 ± 3.2	112.3 ± 3.3	114.0 ± 3.3	117.2 ± 3.3	117.8 ± 3.3	0.314
88.2 ±2.8	89.5 ±2.8	90.0 ±2.8	92.0 ±2.9	94.7 ± 2.9	98.5 ± 3.0	97.5 ± 3.0	97.8 ± 3.0	98.8 ± 3.0	100.8 ± 3.1	102.5 ± 3.1	104.7 ± 3.1	0.224

Table 35. Analysis of variance - Paunch girth.

Source	df	SS	MSS	F
Treatments	2	5.118	2.559	4.075*
Weeks	23	57.639	2.506	3.990*
Error	46	28.887	0.628	
Total	71	91.664		

Pairwise comparison

T_1	T_2	T_3
2.03	2.20	1.57

C.D. = 0.458

$T_1 - T_2$ = 0.17

$T_2 - T_3$ = 0.63*

$T_1 - T_3$ = 0.46*

* Significant at 5% level.

Table 36. Weekly chest depth (cm) of the calves - Group I (control).

Week	Tattoo number of the calves					
	664	680	681	672	689	687
0	28	28	27	28	27	27
1	28	28	29	28	27	27
2	29	29	30	30	27	28
3	30	29	30	30	28	29
4	31	30	31	31	29	29
5	31	30	32	31	29	29
6	31	30	32	32	29	30
7	32	31	32	33	30	31
8	32	31	33	33	31	32
9	32	31	33	34	32	33
10	32	32	34	35	33	33
11	32	33	34	36	34	34
12	33	34	35	36	35	34
13	34	35	36	36	35	35
14	34	35	37	37	35	35
15	35	36	38	38	36	35
16	35	36	38	39	37	36
17	36	37	39	40	37	36
18	36	37	39	41	37	36
19	37	38	40	43	38	37
20	38	39	40	43	38	38
21	38	39	40	43	39	38
22	40	40	40	44	39	38
23	41	40	40	44	40	39
24	42	40	41	44	40	40

Table 37. Weekly chest depth (cm) of the calves - Group II (calf starter I).

Week	Tattoo number of the calves					
	661	665	668	674	676	682
0	30	27	27	28	27	27
1	30	29	28	29	28	28
2	30	30	28	30	29	28
3	31	30	28	31	30	29
4	32	31	29	32	30	29
5	33	31	30	33	30	30
6	34	32	30	33	31	31
7	34	32	32	34	32	31
8	34	32	32	34	32	32
9	34	34	33	34	32	33
10	34	34	34	35	33	34
11	34	35	35	35	33	34
12	34	35	35	35	34	35
13	35	35	35	36	35	36
14	35	36	36	37	35	37
15	35	36	36	37	36	37
16	35	37	36	38	36	37
17	35	38	37	39	37	38
18	36	39	38	39	38	38
19	36	40	38	39	38	39
20	37	40	39	39	38	39
21	38	41	40	39	38	40
22	38	42	40	40	39	40
23	38	42	41	40	39	41
24	39	42	41	41	40	41

Table 38. Weekly chest depth (cm) of the calves - Group III (calf starter II).

Week	Tattoo number of the calves					
	662	667	673	675	678	671
0	27	28	30	26	27	28
1	27	29	30	27	28	29
2	28	30	31	28	28	29
3	29	30	32	29	29	30
4	30	30	32	30	30	30
5	30	30	33	30	31	31
6	31	31	33	31	31	32
7	32	32	34	31	32	32
8	32	33	34	32	32	33
9	33	33	34	32	32	33
10	33	34	35	32	33	34
11	33	34	35	33	33	34
12	33	34	35	33	33	34
13	34	35	36	34	34	34
14	34	36	36	35	34	35
15	35	36	37	35	35	36
16	35	37	37	36	36	36
17	36	38	38	36	37	36
18	36	38	38	36	37	37
19	36	38	38	36	37	38
20	36	39	39	36	37	38
21	37	39	39	36	37	39
22	38	39	39	37	38	39
23	38	40	40	37	38	40
24	38	40	40	38	38	40

Table 39. Total and average gains in chest depth (cm) at weekly intervals of all the groups of calves.

Week	Group I			Group II			Group III		
	Chest depth			Chest depth			Chest depth		
	Total	Average	Gain	Total	Average	Gain	Total	Average	Ga
0	165	27.5	-	166	27.7	-	166	27.7	-
1	167	27.8	0.3	172	28.7	1.0	170	28.3	0.
2	173	28.8	1.3	175	29.2	1.5	174	29.0	1.
3	176	29.3	1.8	179	29.8	2.2	179	29.8	2.
4	181	30.2	2.7	183	30.5	2.8	182	30.3	2.
5	182	30.3	2.8	187	31.2	3.5	185	30.8	3.
6	184	30.7	3.2	191	31.8	4.2	189	31.5	3.
7	189	31.5	4.0	195	32.5	4.8	193	32.2	4.
8	192	32.0	4.5	196	32.7	5.0	196	32.7	5.
9	195	32.5	5.0	200	33.3	5.7	197	32.8	5.
10	199	33.2	5.7	204	34.0	6.3	201	33.5	5.
11	203	33.8	6.3	206	34.3	6.7	202	33.7	6.
12	207	34.5	7.0	208	34.7	7.0	202	33.7	6.
13	211	35.2	7.7	212	35.3	7.7	207	34.5	6.
14	213	35.5	8.0	216	36.0	8.3	210	35.0	7.
15	218	36.3	8.8	217	36.2	8.5	214	35.7	8.
16	221	36.8	9.3	219	36.5	8.8	217	36.2	8.
17	225	37.5	10.0	224	37.3	9.7	221	36.8	9.
18	226	37.7	10.2	228	38.0	10.3	222	37.0	9.
19	233	38.8	11.3	230	38.3	10.7	223	37.2	9.
20	236	39.3	11.8	232	38.7	11.0	226	37.7	10.
21	237	39.5	12.0	236	39.3	11.7	229	38.2	10.
22	241	40.2	42.7	239	39.8	12.2	230	38.3	10.
23	244	40.7	13.2	241	40.2	12.5	233	38.8	11.
24	247	41.2	13.7	244	40.7	13.0	235	39.2	11.
otal			13.7			13.0			11.
ean			0.57			0.54			0.48

Table 40. Summarised data on weekly average chest depth (cm) of calves on the control and experimental groups.

Treatments	Week 0	1	2	3	4	5	6	7	8	9	10	11	12
Group I	27.5 ±1.6	27.8 ±1.6	28.8 ±1.6	29.3 ±1.6	30.2 ±1.6	30.3 ±1.6	30.7 ±1.6	31.5 ±1.6	32.0 ±1.6	32.5 ±1.7	33.2 ±1.7	33.8 ±1.7	34.5 ±1.7
Group II	27.9 ±1.6	28.7 ±1.7	29.2 ±1.7	29.8 ±1.7	30.5 ±1.7	31.2 ±1.7	31.8 ±1.7	32.5 ±1.7	32.7 ±1.8	33.3 ±1.8	34.0 ±1.8	34.3 ±1.8	34.7 ±1.8
Group III	27.7 ±1.6	28.3 ±1.6	29.0 ±1.7	29.8 ±1.7	30.3 ±1.7	30.8 ±1.7	31.5 ±1.7	32.2 ±1.7	32.7 ±1.7	32.8 ±1.7	33.5 ±1.7	33.7 ±1.7	33.7 ±1.7

13	14	15	16	17	18	19	20	21	22	23	24	Av. gain/day (cm)
35.2 ±1.7	35.5 ±1.8	36.3 ±1.8	36.8 ±1.8	37.5 ±1.8	37.7 ±1.9	38.8 ±1.9	39.3 ±1.9	39.5 ±1.9	40.2 ±1.9	40.7 ±1.9	41.2 ±1.9	0.081
35.3 ±1.8	36.0 ±1.8	36.2 ±1.8	36.5 ±1.8	37.3 ±1.8	38.0 ±1.8	38.3 ±1.9	38.7 ±1.9	39.3 ±1.9	39.8 ±1.9	40.2 ±1.9	40.7 ±1.9	0.077
34.5 ±1.8	35.0 ±1.8	35.7 ±1.8	36.2 ±1.8	36.8 ±1.8	37.0 ±1.8	37.2 ±1.8	37.7 ±1.8	38.2 ±1.8	38.3 ±1.8	38.8 ±1.9	39.2 ±1.9	0.069

Table 41. Analysis of variance - Chest depth.

Source	df	SS	MSS	F
Treatments	2	0.102	0.510	1.796
Weeks	23	1.378	0.060	0.020
Error	46	13.044	0.284	
Total	71	14.524		

Table 42. Monthly R.B.C. count (million/mm^3) of the calves.

Group I (control)

Month	Tattoo number of the calves					
	664	680	681	672	689	687
1	8.08	8.31	8.00	9.06	8.00	8.50
2	7.64	7.01	8.30	9.30	7.34	7.78
3	8.46	8.26	8.46	8.21	8.34	8.43
4	6.88	8.67	8.36	8.79	8.46	8.63
5	8.05	8.32	8.21	8.54	8.15	8.42
6	9.16	8.39	7.04	9.79	7.93	8.04

Group II(calf starter I)

	661	665	668	674	676	682
1	7.80	7.75	8.83	8.96	9.12	8.66
2	8.79	8.01	9.46	7.89	8.46	9.15
3	9.01	8.09	9.19	9.26	8.62	8.87
4	8.27	7.77	8.64	7.77	7.44	9.09
5	8.26	8.17	7.92	8.41	8.32	9.29
6	7.34	7.45	8.01	8.43	7.01	8.59

Group III (calf starter II)

	662	667	673	675	678	671
1	7.78	7.27	7.12	8.27	8.53	7.19
2	7.89	8.24	8.35	8.58	9.73	8.52
3	8.13	9.11	8.09	8.07	9.65	8.30
4	7.29	7.55	7.02	8.17	8.45	7.22
5	8.61	8.90	8.16	8.36	8.64	8.24
6	9.19	8.57	8.51	8.62	7.95	8.45

Table 43. Analysis of variance - R.B.C. count.

Source	df	SS	MSS	
Treatments	2	0.13	0.065	0.059
Error	15	1.66	0.116	
Total	17	1.79		

Table 44. Monthly haemoglobin (g/100 ml) of the calves.

Group I (control)

Month	Tattoo number of the calves					
	664	680	681	672	689	687
1	12.0	9.0	8.8	11.5	9.0	8.8
2	11.0	8.0	8.5	8.5	7.5	8.0
3	10.0	8.0	9.0	8.5	8.5	8.5
4	7.5	9.0	9.0	8.5	8.5	9.0
5	8.5	9.0	9.0	9.0	9.0	9.0
6	9.5	8.5	7.8	9.0	8.0	8.3

Group II (calf starter I)

	661	665	668	674	676	682
1	9.5	11.5	11.0	9.0	8.5	8.5
2	10.5	12.5	8.5	7.8	8.0	8.8
3	9.0	8.5	10.0	9.5	8.0	9.5
4	8.0	8.0	8.5	8.0	8.0	10.0
5	8.5	8.5	8.5	9.0	8.5	9.5
6	8.0	8.0	9.0	8.5	8.0	8.5

Group III (calf starter II)

	662	667	673	675	678	671
1	8.5	11.0	10.0	8.5	10.0	8.5
2	9.0	11.5	9.5	8.0	11.0	9.5
3	9.5	10.0	8.0	8.0	10.0	8.5
4	8.0	9.0	8.0	8.0	9.0	8.0
5	8.5	10.0	8.5	9.0	9.5	8.0
6	10.0	9.0	8.5	9.0	8.3	8.5

Table 45. Analysis of variance - Haemoglobin content.

Source	df	SS	MSS	F
Treatments	2	0.1	0.05	0.02
Error	15	3.6	0.24	
Total	17	3.7		

Table 46. Monthly plasma protein content (g/100 ml) of the calves.

Group I (control)

Month	Tattoo number of the calves					
	664	680	681	672	669	667
1	10.00	10.00	11.25	9.44	9.44	10.00
2	10.00	10.00	10.00	11.25	11.25	8.88
3	10.00	10.00	10.00	9.44	9.44	10.00
4	10.00	10.00	9.44	10.00	10.00	9.44
5	8.88	9.44	9.44	9.44	9.44	9.44
6	9.44	9.44	9.44	9.44	9.44	8.88

Group II (calf starter I)

	661	665	668	674	676	682
1	10.00	9.44	9.44	10.00	10.00	9.44
2	10.00	9.44	10.00	10.00	10.00	10.00
3	9.44	10.00	10.00	9.44	8.88	9.44
4	10.00	10.00	9.44	10.00	9.44	10.00
5	10.00	8.88	9.44	10.00	9.44	9.44
6	9.44	9.44	8.88	8.88	10.00	9.44

Group III (calf starter II)

	662	667	673	675	678	671
1	10.00	9.44	10.00	11.25	10.00	10.00
2	9.44	11.25	10.00	9.44	10.00	10.00
3	10.00	11.66	10.00	8.88	10.00	10.00
4	10.00	9.44	9.44	9.44	10.00	8.88
5	9.44	10.00	10.00	9.44	9.44	9.44
6	9.44	9.44	10.00	9.44	10.00	8.88

Table 47. Analysis of variance - Plasma protein.

Source	df	SS	MSS	F
Treatments	2	0.10	0.050	0.084
Error	15	0.89	0.059	
Total	17	0.99		

Table 48. Particulars of nitrogen intake and outgo and the weights of the calves.

Group I (control)

Sl. No.	T.No.	Nitrogen intake (g)	Nitrogen outgo (g)	Nitrogen balance (g)	Initial weight (kg)	Final weight (kg)	Weight gain (kg)
1	664	40.239	30.700	9.539	68.5	70.0	1.5
2	680	40.239	32.875	7.364	58.5	59.5	1.0
3	681	40.239	33.553	6.686	64.5	65.5	1.0
4	672	40.239	32.974	7.265	98.0	99.0	1.0
5	689	40.239	19.791	20.448	54.0	56.0	2.0
6	687	40.239	37.866	2.373	53.0	53.0	0.0

Group II (calf starter I)

1	661	42.994	26.336	16.658	58.0	61.0	3.0
2	665	42.994	20.748	22.646	70.5	73.0	2.5
3	668	42.994	27.484	15.510	63.0	65.0	2.0
4	674	42.994	22.617	20.377	81.0	83.5	2.5
5	676	42.994	13.163	29.831	57.0	60.0	3.0
6	682	42.994	33.828	9.168	70.0	71.0	1.0

Group III (calf starter II)

1	662	43.474	27.105	16.369	54.0	56.0	2.0
2	667	43.474	27.453	16.021	55.5	58.0	2.5
3	673	43.474	33.719	9.755	59.0	60.0	1.0
4	675	43.474	25.037	18.437	50.0	51.0	1.0
5	678	43.474	36.422	7.052	63.0	63.5	0.5
6	671	43.474	31.456	12.018	63.0	64.5	1.5

Table 49. Analysis of variance - Nitrogen balance.

Source	df	SS	MSS	F
Treatments	2	303.10	151.51	4.32*
Error	15	526.68	35.11	
Total	17	829.78		

Pairwise comparison

T_1	T_2	T_3
8.91	18.93	13.27

C.D. = 4.416

$T_1 - T_2$ = 10.02*

$T_2 - T_3$ = 5.66*

$T_1 - T_3$ = 4.36*

* Significant at 5% level.

Table 50. Average feed consumption, feed efficiency and economics.

Treatments	Total feed intake (kg)				Feed efficiency (Kg ration/kg gain)				Cost of raising a calf for 24 weeks*				Cost/kg gain			
	Milk	Con/ calf starter	Green grass	Weight gain	Milk	Con/ calf starter	Green grass	Gain	Milk	Con/ calf starter	Green grass	Total	Milk	Con/ calf starter	Green grass	Total
Group I	179.9	123.90	521.5	43.08	4.13	2.88	12.10	19.11	314.83	140.68	78.23	541.74	7.31	3.45	1.82	12.58
Group II	38.5	145.95	399.0	44.17	0.87	3.30	9.19	13.36	67.38	227.68	59.85	354.91	1.53	5.15	1.36	8.04
Group III	38.5	149.95	399.0	30.91	1.28	4.72	12.90	18.90	67.38	230.60	59.85	357.83	2.18	7.46	1.94	11.58

* Cost of milk - Rs.1.75/Kg
Cost of concentrates - Rs.1.20/ "
Cost of calf starter I - Rs.1.56/ "
Cost of calf starter II - Rs.1.58/ "
Cost of green grass - Re.0.15/ "

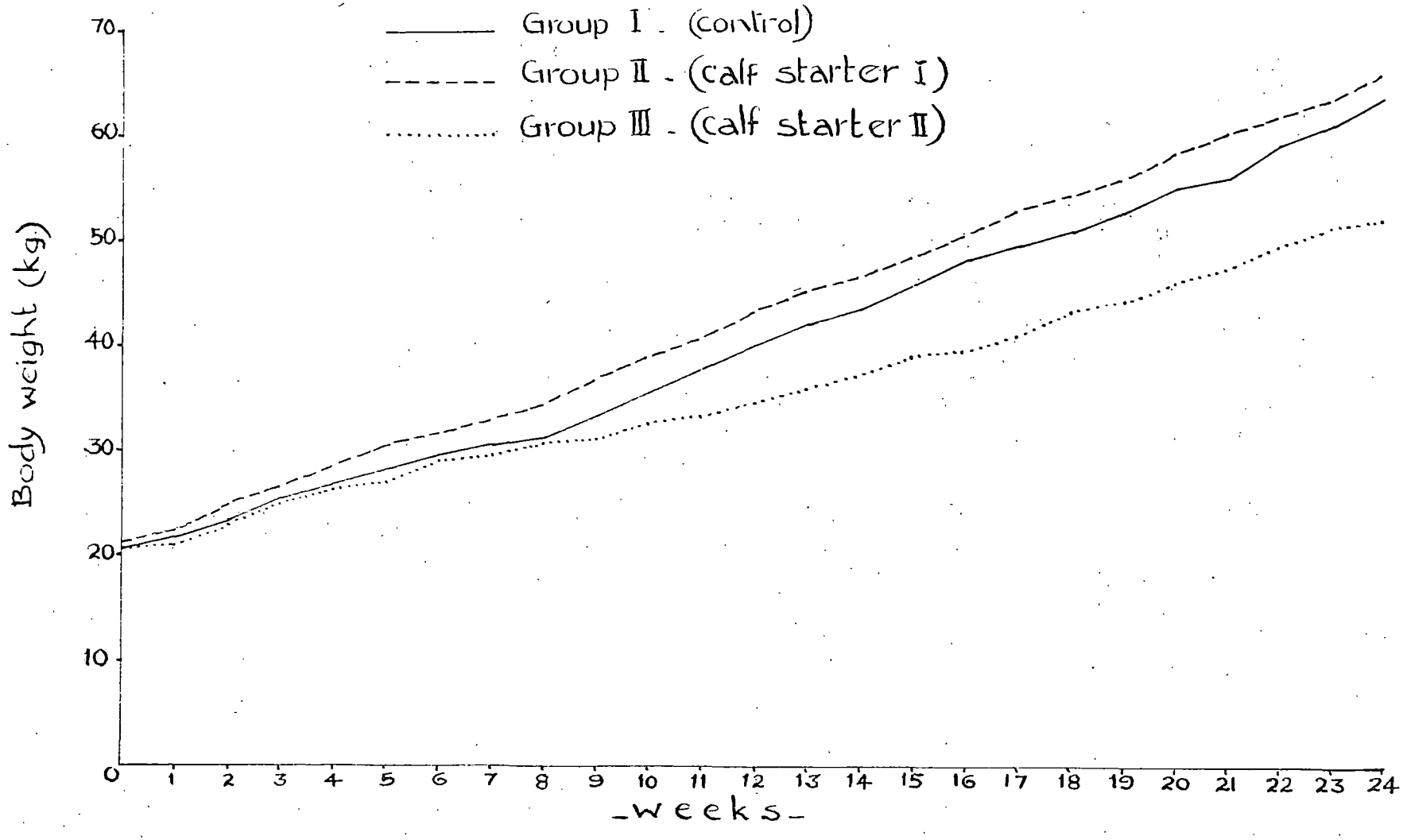

Fig. 1 - Average body weight of calves.

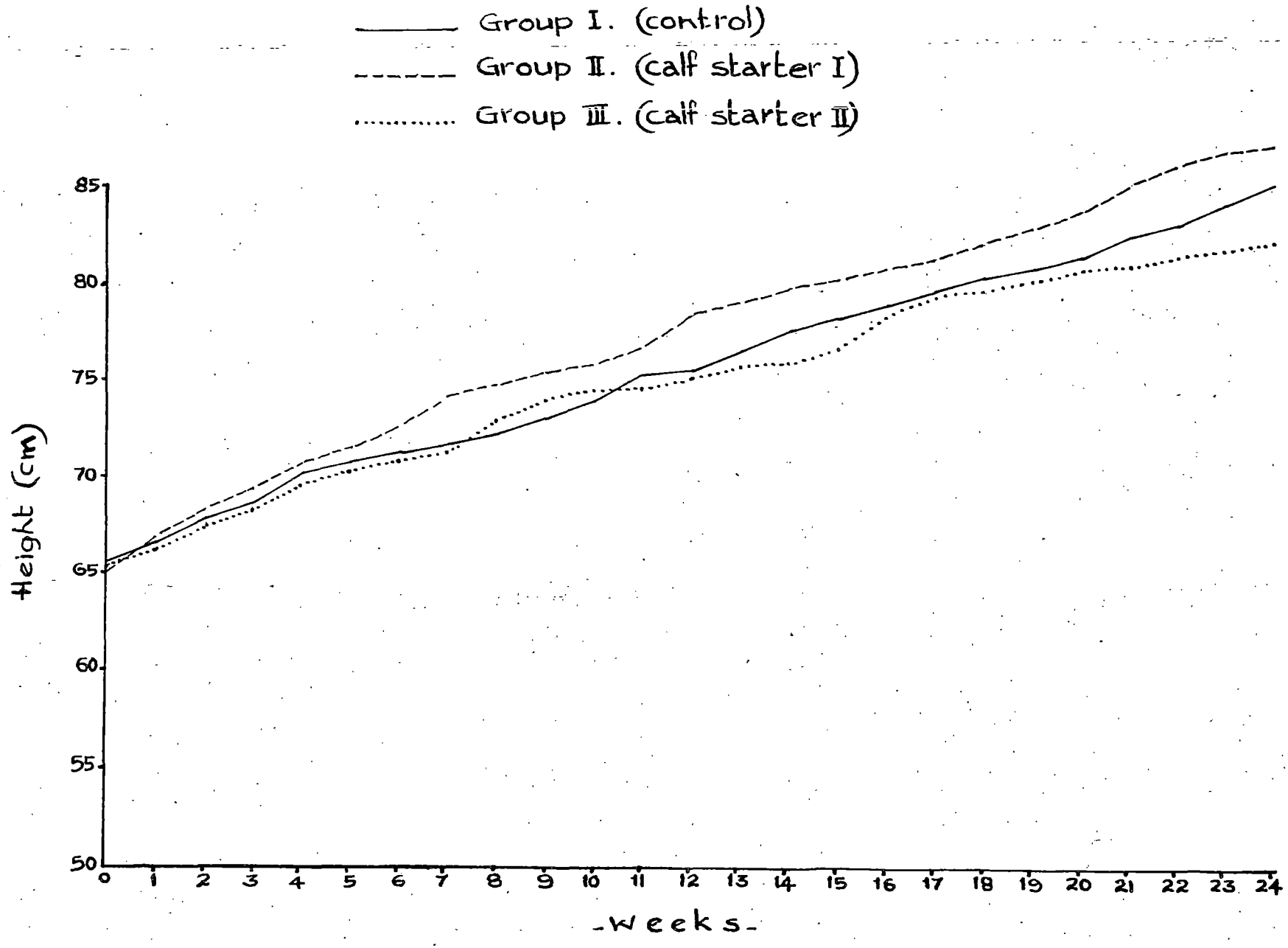

Fig-2. Average height at withers of calves.

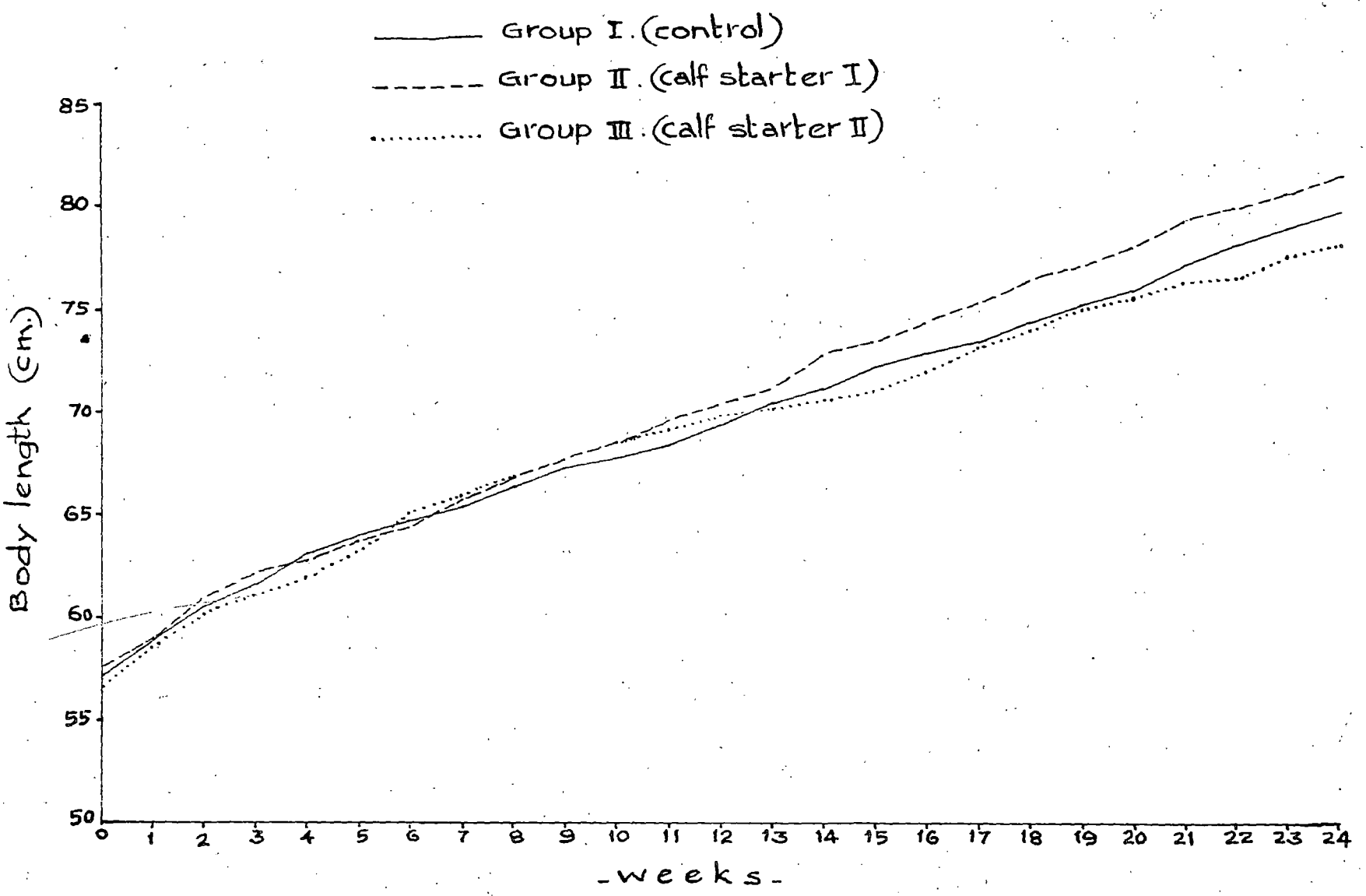

Fig-3. Average body length of calves.

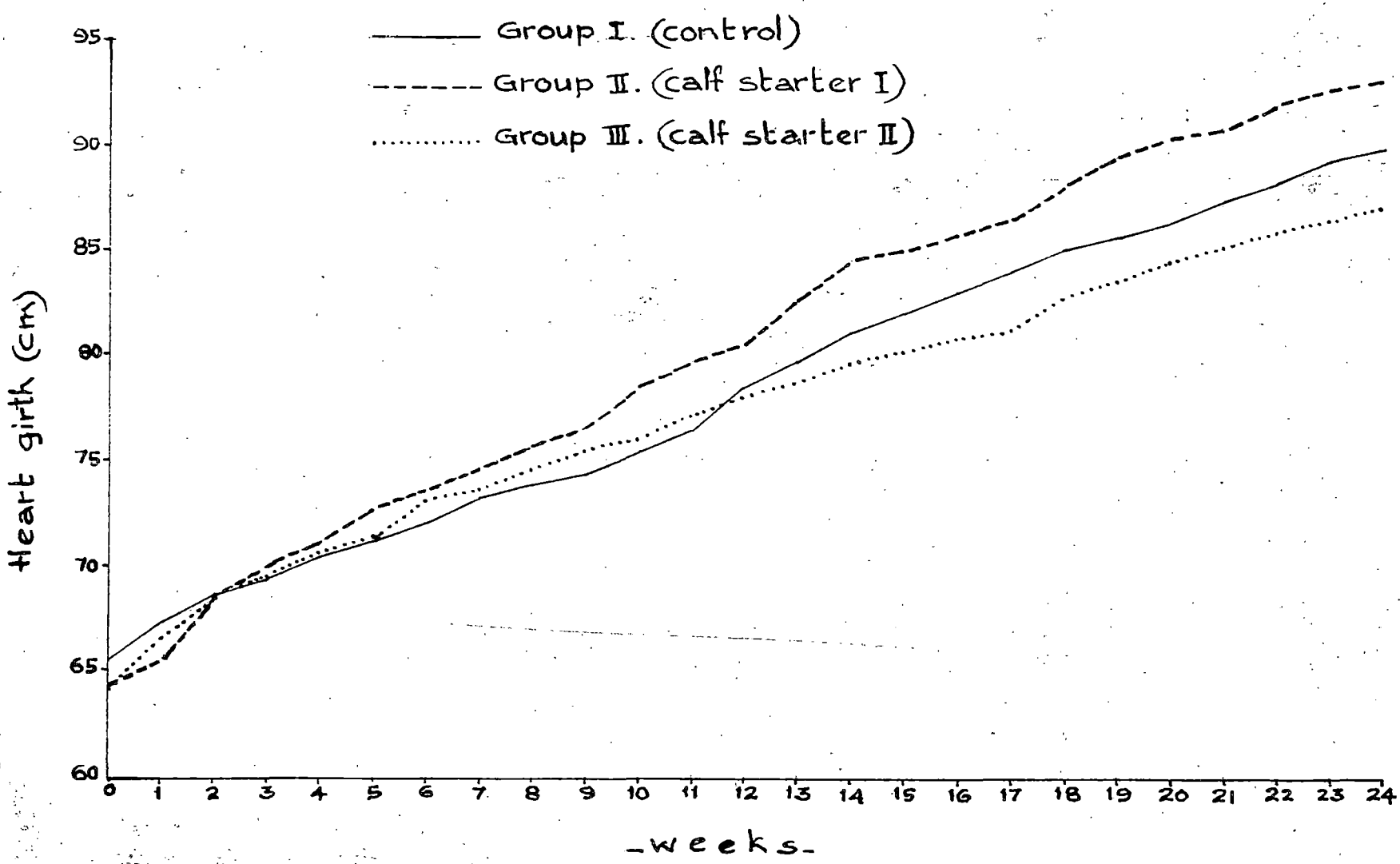

Fig. 4. Average heartgirth of calves.

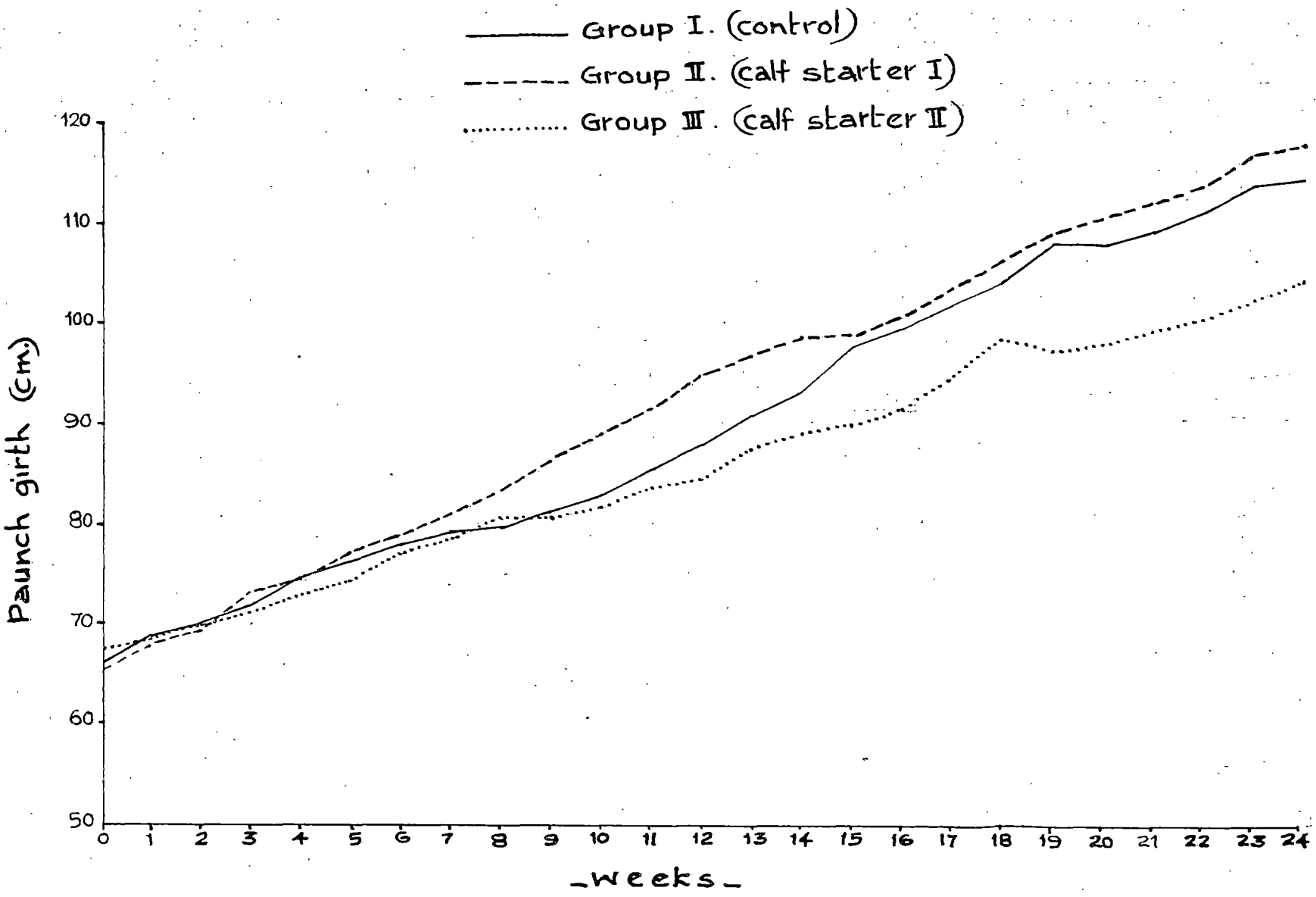

Fig-5. Average paunch girth of calves.

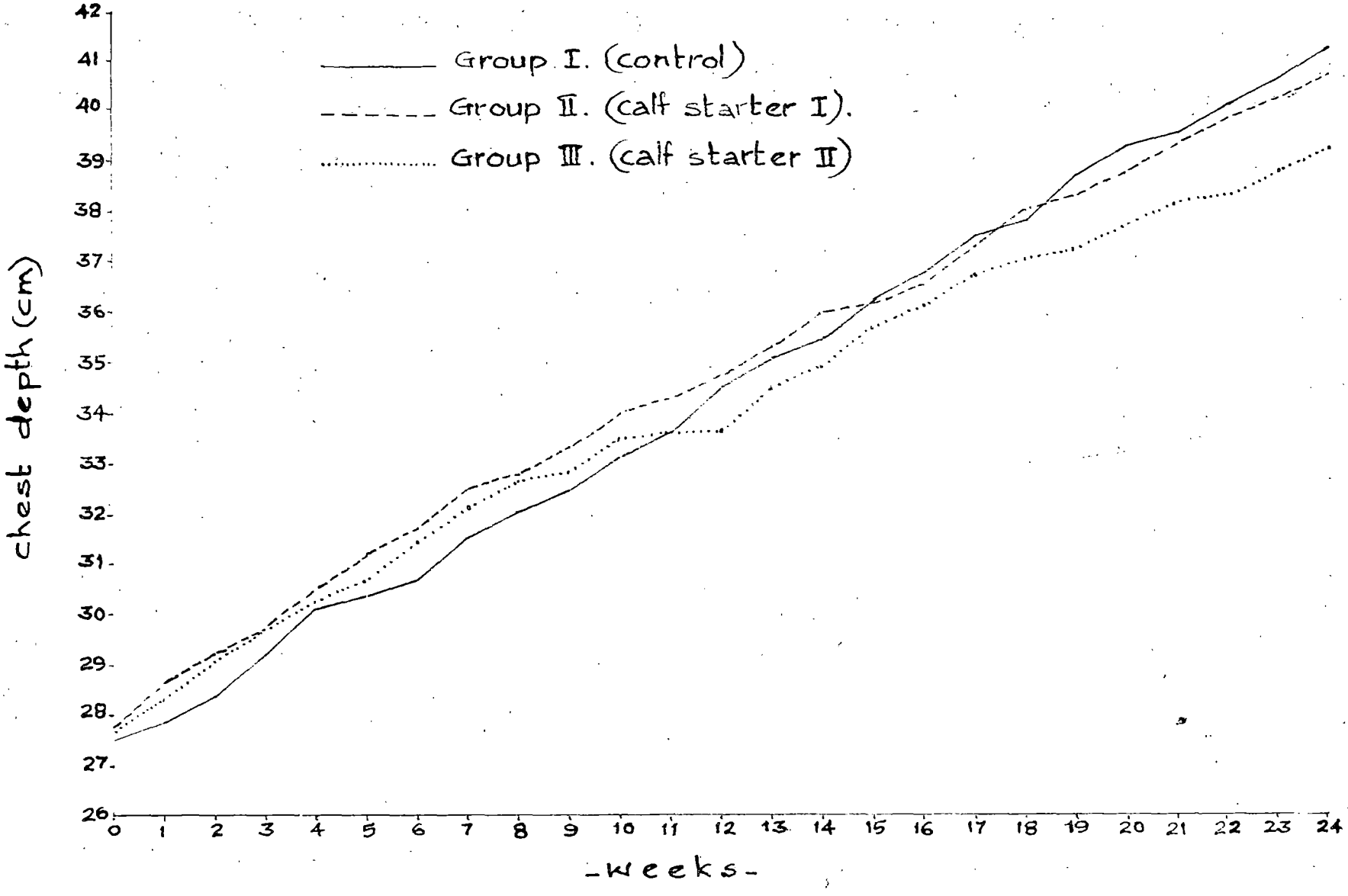

Fig. 6. Average chest depth of calves.

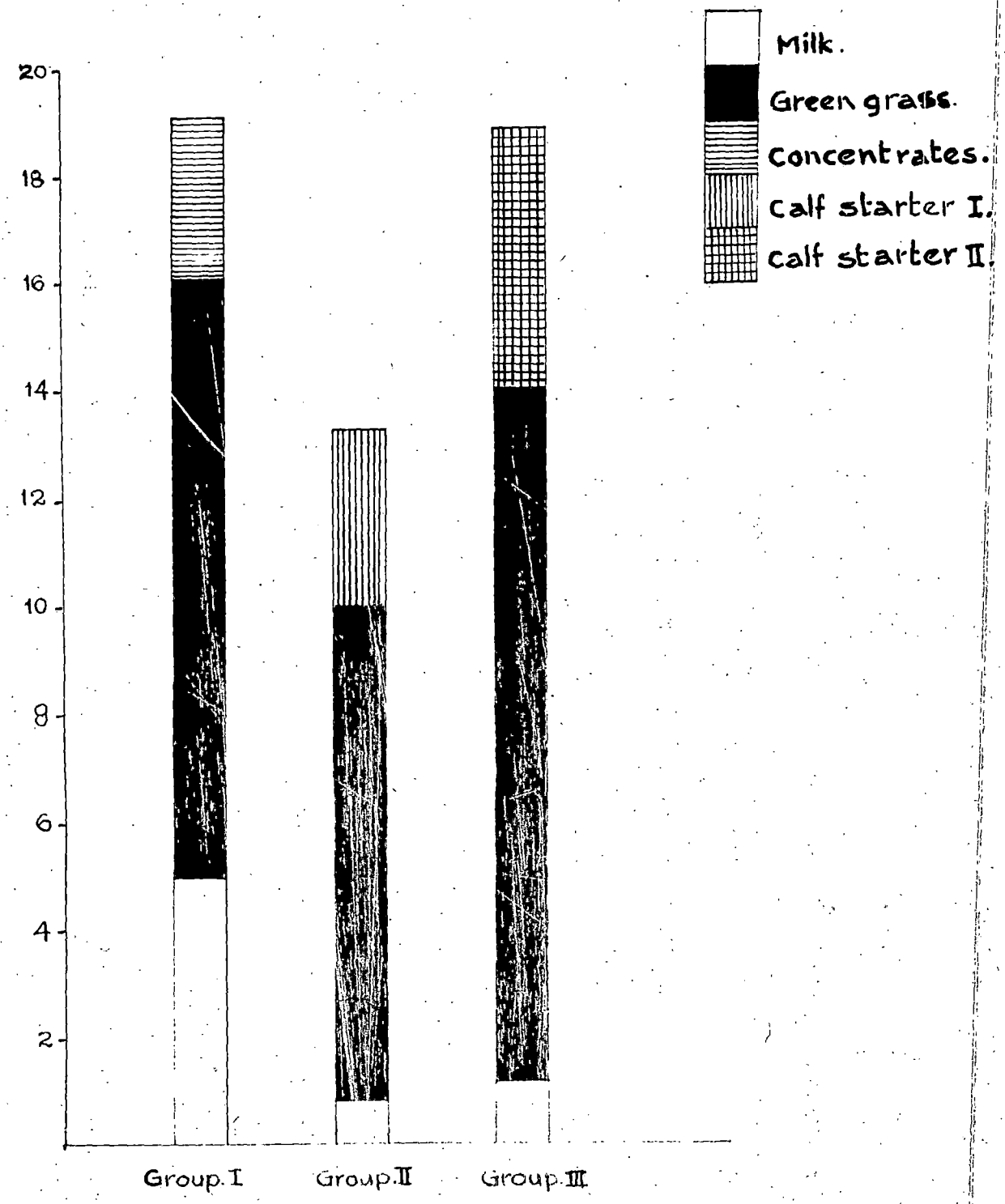

Fig-7. Feed required per kilogram body weight gain.

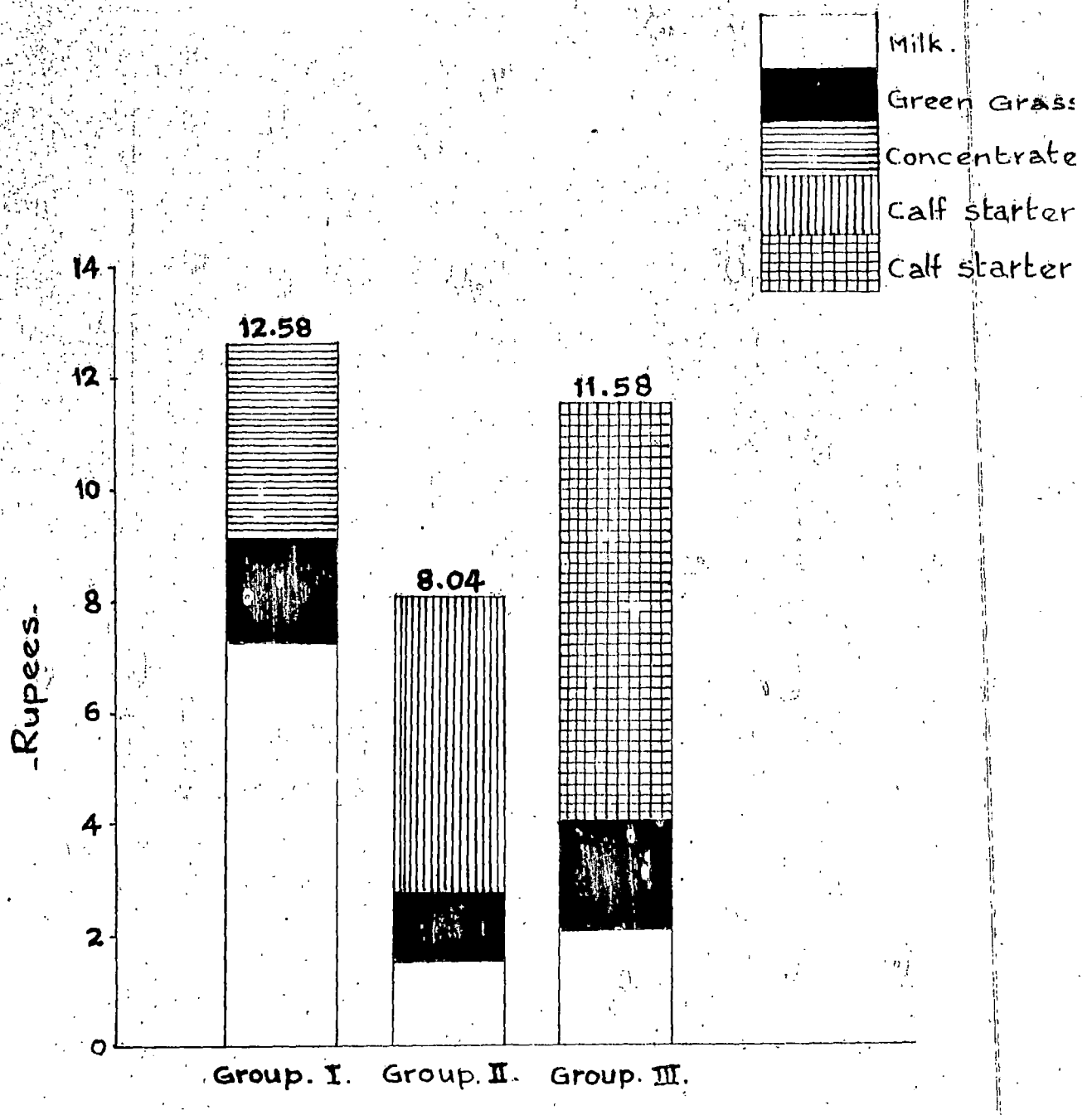

Fig-8. Cost of feed per kilogram body weight gain.

DISCUSSION

DISCUSSION

Weaning of calves at birth and rearing them on milk replacers and calf starters have been receiving considerable importance in recent years. There are many published reports on the growth rate and performance of calves fed calf starters containing different ingredients available at each place of study. The present study was carried out to get information regarding the growth rate and performance of the calves with two different types of calf starters suitably prepared for the calves with locally available ingredients in comparison to rearing of calves with whole milk. The saving in terms of the quantity of whole milk that can be made available for human consumption by introducing calf starters in the diet of calves at an early age and the economics of rearing them on calf starters were also studied.

Both calf starters are approximately iso-proteinous (24% protein) and iso-caloric (60% TDN). The average growth performance measured in terms of gain in body weight (Table 9) indicated that the calves in Group II gained 44.17 kg during the experimental period of 24 weeks while those in Group I and Group III the weight gain (kg) was 43.00 and 30.91 respectively. The analysis of variance table indicated that the difference in growth rate among the groups was significant ($P < 0.05$). The growth rate (g/day) was highest in calves of Group II (263) followed by Group I (257) and Group III (215). The rate of

growth (g/day) ranged from 167 to 472 for the calves of the Group I and it varied from 167 to 357 for Group II and 107 to 286 for Group III. The data collected revealed that during the experimental period of 24 weeks the calves in Group II fed on calf starter I had better growth rate as compared to the other groups. The growth rate obtained in the present study was found to be in agreement with the expected gain of 227 g per day for small breeds of cattle having a birth weight of 22 to 23 kg reported by Henderson (1954).

Goel et al. (1972) conducted experiments on feeding of buffalo calves with whole milk and calf starter and reported overall mean body weight (g) gain per day as 319 and 324 for the calves fed whole milk and calf starter respectively. However, Leelaprasad et al. (1977) have reported the growth rate (g) per day for Holstein x Gir male calves whose average body weight ranged from 21.5 to 23.8 kg to be varying from 393 to 484. Kohli et al. (1962) showed that there was an increase of 100, 150 and 200 per cent over the birth weight at 3, 6 and 9 months of age respectively irrespective of the sex of the calf. In the present study an increase of 200 per cent over the birth weight of the calves was noticed at six months of age in Groups I and II which indicated that the gain in body weight was quite satisfactory.

Based on the mean gain in body weight per day it was found that the calves fed with calf starter I containing maize

had a better rate of growth than those fed calf starter II containing tapioca and whole milk and concentrates alone. The calves fed calf starter II were found to have a lesser gain in body weight as compared to the control calves fed whole milk and concentrates. Calf starter I was found to be superior to both calf starter II and whole milk feeding.

The initial and final height at withers (cm) of the calves in Group I, II and III were 65.7 ± 2.8, 65.2 ± 2.8, 65.3 ± 2.4, 87.3 ± 2.8, 65.5 ± 2.5, 83.7 ± 2.7 respectively. The increase in height at withers was higher in calves in Group II fed calf starter I. Shinde and Sangle (1976) studied the growth rate of crossbred calves (Jersey x Red Sindhi) fed sugar calf meal and farm made calf meal from birth upto 24 weeks of age. They reported an increase in height at withers ranging from 28.0 to 29.4. The results obtained in the present study in terms of gain in height at withers were found to be much less compared to the values obtained by Shinde and Sangle. But the values recorded at birth and at six months of age were found to be almost similar to the values reported for Jersey calves (Wing, 1963). The mean gain in height at withers (cm) per day was found to be 0.116, 0.131 and 0.109 for Groups I, II and III respectively. These values were found to be less in comparison to the values obtained by Shinde and Sangle (0.168 and 0.175). But the values were closer to the value of 0.160 obtained by Gardner (1967).

The initial and final body length (cm) of the calves in Groups I, II and III were 57.3 ± 2.3, 79.7 ± 2.7, 57.8 ± 2.1, 81.7 ± 2.7, 56.5 ± 2.3, 78.0 ± 2.6 respectively. The gains in length in the calves in Group II fed calf starter I was found to be more than of those in other groups. Shinde and Sangle (1976) reported a gain in body length (cm) from 56.1 to 58.0 on calves fed sugar calf meal and farm made calf meal. The results obtained in the present study were found to be less as compared to the gains in length obtained by Shinde and Sangle. The mean gain in length (cm) per day was found to be 0.133, 0.142 and 0.127 for Groups I, II and III respectively. The values were found to be less in comparison to those obtained (0.320 and 0.344) by Shinde and Sangle. But the values were in agreement with those reported by Cool (1972) for buffalo calves. The gain in length (cm) reported as 0.200 to 0.220 by Gardner (1967) was found to be above the value obtained in the present study.

The initial and final heart girth values (cm) of the calves in Groups I, II and III fed whole milk, calf starter I and calf starter II were 65.3 ± 2.4, 89.8 ± 2.8, 64.0 ± 2.4, 93.2 ± 2.9, 64.5 ± 2.4, 86.5 ± 2.8 respectively. The gains in heart girth (cm) were higher in calves in Group II fed calf starter I. Shinde and Sangle (1976) studied the growth rate and body measurements of crossbred calves fed sugar calf meal and farm made calf meal from birth to 24 weeks. They have

reported a gain in heart girth ranging from 46.2 to 49.0. The results obtained in the present study, in terms of gain in heart girth, were found to be much less as compared to the values obtained by Shinde and Sangle. The mean heart girth gain (cm) per day were found to be 0.146, 0.174 and 0.129 for Groups I, II and III respectively. These values were found to be less in comparison to those of Shinde and Sangle (0.191 and 0.208). But the values were much nearer to 0.196 and 0.200 reported by Goel (1972) for the buffalo calves. The heart girth values recorded at birth and at six months of age in the present study were in keeping with those reported for Jersey calves (Wing, 1963).

The initial and final paunch girth (cm) of the calves of the Groups I, II and III were 66.0 ± 2.4, 116.7 ± 3.2, 65.0 ± 2.4, 117.2 ± 3.3, 67.0 ± 2.4, 104.7 ± 3.1 respectively. The gains in paunch girth were higher in Group II fed calf starter I. The average daily gains (cm) in paunch girth for the Groups I, II and III were 0.287, 0.314 and 0.224 respectively. From the data obtained on the mean increase in paunch girth per day, it was found that the calves of Group II fed calf starter I had a better rate of increase in paunch girth than those of the other two groups. This indicated that the calves in Group II were found to be superior in terms of producing better paunch girth.

The initial and final chest depth (cm) of the calves

in the Groups I, II and III were 27.5 ± 1.6, 41.2 ± 1.9, 27.7 ± 1.6, 40.7 ± 1.9, 27.7 ± 1.6, 39.2 ± 1.9 respectively. The average gains in chest depth per day in Groups I, II and III were 0.061, 0.077 and 0.069 respectively.

The analysis of data on the body weight and body measurements of the calves in the three groups revealed that calves fed on calf starter I had significantly higher body weight and greater paunch girth as compared to those fed calf starter II. The gain in body weight recorded for the calves of the control group was significantly higher as compared to the calves fed calf starter II. With regard to the body measurements such as height at withers, body length, heart girth and chest depth there were no significant differences among the three groups.

The studies on the blood components of calves in the three groups were made to assess the nutritional adequacy of the whole milk diet and the calf starters. The average R.B.C. count (million/mm^3) recorded for Groups I, II and III were 8.26 ± 0.28, 8.40 ± 0.36, 8.22 ± 0.22 respectively. The average haemoglobin (g/100 ml) level recorded for the Groups I, II and III were 8.85 ± 0.20, 8.93 ± 0.22, 9.02 ± 0.17 respectively. The analysis of the blood for the plasma protein (g/100 ml) content gave the average values for the Groups I, II and III as 9.77 ± 0.10, 9.64 ± 0.10, 9.82 ± 0.10 respectively.

The statistical analyses of the data revealed no significant difference among the three groups in respect of R.B.C. count, haemoglobin and plasma protein values thereby indicating that the three feeding regimes produced almost the same physiological status in calves. The values obtained were within the normal range of values reported by several authors (Schalm, 1965; Ramakrishna Pillai, 1976; and Jagannadham *et al.* 1977). The average values of haemoglobin were higher at birth followed by a gradual decline upto 24 weeks of age. This was also in agreement with the observations made by Hazdan *et al.* (1965) and Jagannadham *et al.* (1977).

The data on nitrogen balance indicated a positive balance in all the groups of calves. The calves in the Group II had a significantly higher retention of nitrogen as compared to Groups I and III. The positive nitrogen balance of the calves in Group I was significantly higher than that of calves in Group III. The values obtained in the nitrogen balance trial were similar to those reported by Lassiter *et al.* (1963).

From Fig. 7 the average amount of milk, grass and concentrates/calf starters required per kg of gain in body weight were 4.18, 2.88, 12.11, 0.87, 9.03, 3.30 and 1.25, 12.91, 4.72 for the Groups I, II and III respectively. With

regard to the feed efficiency the calves in Group II required lesser amounts of milk, grass and calf starter as compared to those in Group III thereby indicating that the calf starter I was superior to calf starter II.

Further, the results presented in Table 50 and Fig. 8 indicated that the cost of ration per unit gain in body weight was Rs.12.58, Rs.8.04 and Rs.11.51 for the calves in Groups I, II and III respectively. The average cost of feeding a calf upto 24 weeks of age was Rs.541.74, Rs.354.91 and Rs.357.85 in Groups I, II and III respectively.

The foregoing discussion has revealed that feeding of calves upto 24 weeks of age with limited quantity of milk and calf starter I was more beneficial in terms of body weight gain, physiological status and cost of feeding in comparison to the feeding of calves with either whole milk and concentrates or limited milk and calf starter II. The quantity of whole milk fed to one calf in the control group was 179.9 kg whereas the same in a calf of the experimental group was 38.5 kg. By adopting the feeding system with calf starter I there was a saving of 141.4 kg of milk which could be released for human consumption and a reduction in the cost of feeding to the tune of Rs.186.83 per calf during the period upto 24 weeks of age.

SUMMARY

SUMMARY

The purpose of the study was to compare the physiological status and performance of calves fed with two different kinds of calf starters prepared from locally available feed ingredients with those of calves fed whole milk and concentrates. A total of 18 crossbred calves of the University Livestock Farm, Mannuthy, were assigned randomly at birth to one of the two experimental groups receiving calf starter and the control group receiving whole milk. Each group consisted of one male and five female calves.

The two calf starters used for the feeding of experimental calves were iso-proteinous (24% protein) and iso-caloric (68% TDN). In addition to the other ingredients calf starter I contained maize whereas calf starter II had tapioca and horsegram. All the calves were weaned at birth and fed fresh colostrum of their dams at ten per cent of their body weight for the first seven days. From the eighth day onwards each of the calves of the experimental groups received 100 g of calf starter in addition to the quantity of 2 kg of whole milk. The quantities of calf starter to the experimental calves were gradually increased from the level of 100 g fed during the second week to 1250 g when the calves attained the age of 21 weeks. But the quantity of 2 kg of milk fed during the second week was gradually reduced to 0.5 kg at the time the calves attained the age of three weeks. Milk was completely withdrawn from the

diet of the experimental calves when they completed four weeks of age. The calves of the control group received whole milk at ten per cent of their body weight till they attained the age of four weeks. The quantity of milk fed was gradually reduced and it was completely withdrawn at 12 weeks of age. In addition to milk the calves in the control group received concentrates at the rate of 250 g from the fifth week onwards. The quantity of concentrates was gradually increased to 1250 g when they attained the age of 16 weeks. The calves were on the feeding trial from birth to 24 weeks of age.

The body weight and body measurements such as height at withers, body length, heart girth, paunch girth and chest depth were taken at birth and subsequently at intervals of seven days till the termination of the study. Samples of blood were collected from the calves at intervals of four weeks for the determination of total erythrocyte count, haemoglobin content and plasma protein estimation.

Statistical analyses of the data collected revealed that the growth rate of calves fed on calf starter I was significantly higher as compared to those fed calf starter II. But there was no significant difference in the growth rate of calves receiving calf starter I as compared to the calves of the control group receiving whole milk and concentrates. The calves in the control group had a significantly higher growth

rate as compared to the calves fed calf starter II. The total gain in body weight recorded for the calves fed calf starter I was 44.17 kg for a period of 24 weeks in comparison to the values of 43.08 kg and 30.91 kg for the calves of the control group and the calves fed calf starter II respectively. The mean gain (kg) in body weight per week was 1.80, 1.84 and 1.89 for Groups I, II and III respectively. The analyses of data collected on body measurements revealed that the calves fed calf starter I had significantly higher paunch girth as compared to the calves of the calf starter II. There was no statistical difference with regard to the other body measurements.

The study of the blood values revealed that the physiological status of the calves in all the groups was normal and satisfactory. There was no statistical difference in the blood values among the calves of the three groups.

The nitrogen balance trial conducted at the close of the experiment showed a positive nitrogen balance for the calves in all the three groups. The positive nitrogen balance was more in the calves fed calf starter I and there were significant differences among the three groups.

The feeding of calf starter I to young calves was found to be beneficial in terms of general condition, physiological status and weight gain of the calves. A total quantity of 141.4 kg of whole milk could be saved for human consumption

while incorporating the calf starter I in the feeding schedule of a calf since the quantity of milk required was 38.5 kg only in the experimental calf whereas 179.9 kg was required for the control calf. In addition, there was a reduction of Rs.136.83 in the cost of feeding a calf of calf starter I upto 24 weeks of age.

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A STUDY OF THE CALF STARTER WITH LOCALLY AVAILABLE FEED INGREDIENTS

By

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ABSTRACT OF A THESIS

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ABSTRACT

An investigation was carried out to compare the physiological status and performance of the calves fed two different kinds of calf starters. The calves fed with whole milk and concentrates were used as the control. A total of 18 crossbred calves of the University Livestock Farm, Mannuthy, immediately after birth were assigned at random to one of the following three groups. Group I (control), Group II (fed with calf starter I) and Group III (fed with calf starter II). There were one male and five female calves in each group.

The two calf starters used for the experiment contained 24 per cent protein and 68 per cent TDN. The calves on the experimental group started getting calf starter on the eighth day onwards and the milk was completely withdrawn at the beginning of the fifth week of age. The calves of the control group were fed with concentrates at the beginning of the fifth week when the quantity of milk was reduced. At 12 weeks of age milk was completely withdrawn. The feeding trial was a period of 24 weeks from the birth of the calves.

The statistical analyses of the data collected revealed that the growth rate of calves fed calf starter I was significantly higher as compared to the calves fed calf starter II. But the growth rate of calves in Groups I and II was almost the same. The total gain in body weight was 44.17 kg in a period

of 24 weeks for the calves getting calf starter I as compared to the value of 43.08 and 30.91 for Groups I and III respectively.

Eventhough there was no significant difference with regard to other body measurements in the three groups, the calves that received calf starter I had a higher paunch girth in comparison to the calves on calf starter II.

The physiological status of the calves in all the groups as revealed by the study of the blood values was normal and satisfactory.

Eventhough all the calves showed a positive nitrogen balance at the termination of the experiment the calves fed calf starter I had a greater nitrogen balance.

Calf starter I was found to be beneficial in terms of general condition, physiological status and weight gain of the calves. By incorporating calf starter I in the feeding schedule of calves, a quantity of 141.4 kg whole milk could be made available for human consumption in addition to a saving of Rs.186.83 in the cost of feeding a calf during the first 24 weeks of age.