EFFECT OF FISH MEAL ON GROWTH AND FEED CONVERSION EFFICIENCY IN CROSSBRED CALVES

By

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THESIS

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DECLARATION

I hereby declare that the thesis entitled **"Effect of fish meal on growth and feed conversion efficiency in crossbred calves"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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CERTIFICATE

I hereby certify that this thesis entitled **"Effect of fish meal on growth and feed conversion efficiency in crossbred calves"** is a record of research work done independently by **Sri. R. Subramanian** 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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Dedicated to my parents

and brother

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Introduction

INTRODUCTION

India has the largest bovine population in the world, the total number of breedable bovines in the country is about 101.5 million and this figure is growing steadily at the rate of 1.4 per cent annually (Poonawala, 1995). About 60 million tonnes of milk worth Rs.475 million are produced annually, though the country will have to produce 80 million tonnes of milk by 2000 AD to meet the demand. The growth rate achieved in milk production is 5.5 per cent annually and per capita availability of milk improved from 107 g in 1970 to 188 g in 1995 (Mathur, 1995). This increase in milk production has been made possible by adopting crossbreeding of indigenous zebu cattle with exotic dairy breeds having superior genetic potential for growth and milk production. Crossbred heifers have high potential for growth to attain early maturity and breedable body size under proper feeding and managemental regimes.

Shortage of feeds both in terms of quantity and quality is the most significant factor that has adversely affected the animal productivity in our country. Nutrient availability in terms of DCP and TDN fell short by 41.20 per cent and 26.98 per cent in 1990 and the expected deficit is projected at 35.28 and 17.18 per cent respectively in 2000 AD (Jain and Singh, 1990).

There is little scope to further increase the fodder cultivation due to the small size of land holdings and competing demands for the production of food grains and cash crops. So efficient utilisation of the available feed resources is the most rational means to increase the animal performance and reduce production cost. Proper understanding of the nutrient requirements, nutritive value of feeds/fodders and responses to varying levels and sources of protein and energy is essential to develop a feeding system that is biologically and economically efficient in ruminant.

Dietary energy and protein level exert a critical influence on the growth of calves. While responses to energy supply have been well defined, those for protein are not so defined (Rook and Line, 1962).

Expressing protein requirements in terms of crude protein or DCP assuming that all sources of nitrogen are equivalent for ruminants, has undergone review in recent years. The consideration of outflow of protein from the rumen and stating the requirements of rumen microbes separately from the total protein requirements of the host animal is the basis of the new system of expressing actual protein requirements for ruminants (Burrough et al., 1975; Kaufman, 1977; Roy et al., 1977; Verite et al., 1979), wherein, the protein requirements

are expressed in terms of rumen degradable protein (RDP) and undegradable dietary protein (UDP).

In animals with low productivity, the bacterial protein and the protein which normally escapes degradation are enough to meet the requirements. However, higher growth rate and milk production levels require higher protein levels than can be obtained from microbial protein alone. In such cases, supplementation with rumen undegradable dietary protein may provide sufficient amino acids at the lower gut, for absorption at the tissue level.

The principal effect of supplementation with UDP is to increase the availability of amino acids for absorption from the small intestine and to increase feed intake (Kempton et al., 1979). There are considerable evidences in the literature which show that ruminants making poor growth on high roughage diet will respond to supplemental protein of low rumen degradability.

The degradability of protein in the rumen can be reduced by heat and chemical treatments of protein supplements. The level of bypass protein in the diet can be increased by increased level of feeding, by the addition of inhibitors of hydrolysis or enzymatic process in the rumen and by judicious selection of protein supplements which are found to be good

sources of UDP especially animal protein supplements. Reports also indicate that cotton seed oil cake, coconut oil cake, fishmeal, maize gluten meal, meat meal, blood meal etc. are good sources of UDP. Fishmeal has attracted interest for inclusion in the ruminant diets as an undegradable protein source, due to its better amino acid profile and availability throughout the year. However adequate data on the degradability estimates in respect of feeds and fodders commonly included in the rations of ruminants and information on the possible optimum levels of UDP and RDP for achieving higher levels of production is scanty.

Various studies have been undertaken on the effect of inclusion of fishmeal in concentrate mixtures on growth and milk production in ruminants. Inclusion of fishmeal in calf growth ration is reported to increase the daily live weight gains (Aughes, 1983; Saadullah, 1984, Davenport et al., 1990; Singh, 1991; Veira et al., 1994) and feed conversion efficiency (Kaiser et al., 1982; Thonny and Hogue 1986; Veira et al., 1994). However, Silva et al. (1989) in their study on the effect of supplementation of fishmeal to a ration on straw based diet observed a positive, but variable live weight gains in calves. A high variability in live weight gain with fishmeal supplementation has also been observed by Combellas (1991a). On the other hand, no effect has been observed in daily live weight gains (Jaiswal et al., 1988; Sil et al., 1994) and feed

conversion efficiency (Veitia, 1973 and Sil et al., 1994) by substituting fishmeal in place of vegetable protein source in calf growth rations. Thus, it can be seen that the results of studies on fishmeal supplementation are variable and hence warrants further work. Moreover, only very few studies seem to have been conducted in our country in this regard.

It is evident from the foregoing introduction that there is a great need to undertake further studies to establish better feed combinations with optimum undegradable dietary protein level in growing calves. Such rations could be fed at lower protein levels maintaining optimum growth rate at reduced feed cost when compared to conventional feed mixtures containing highly degradable nitrogen sources. As such, the present study was undertaken with the objective of finding out the effect of inclusion of fish meal as a source of UDP in the ration of growing calves on growth rate and feed conversion efficiency and thereby to formulate and recommend economic and efficient feed combinations for practical application.

Review of Literature

REVIEW OF LITERATURE

2.1 Feed and nutrients consumption

Dry matter intake of an animal is the primary factor which determines the adequacy of nutrients and energy supply, irrespective of the nutrients level in the diet. Thus, measurement of voluntary feed intake forms an integral part of feed evaluation studies. There are different reports on the dry matter and nutrients intake of the diet containing fish meal as a protein supplement.

Bowers et al. (1965) observed that the voluntary feed intake was significantly lower in Friesian steers consuming fish meal diet. Veitia (1973) conducted an experiment in fattening bulls with fish meal in molasses-urea based diets and observed no significant differences among the groups on the intake of dry matter, energy or molasses.

Wilkinson et al. (1973) incorporated 13 per cent of white fish meal or 0.9 per cent of urea in dried lucerne and maize silage based diet of beef cattle and observed that both fish meal and urea based diet increased the total DM intake. Formaldehyde treated fish meal at the rate of 40, 80 and 160 g/kg of basal diet did not show any significant difference on the DM intake of growing calves (Abe et al., 1976). Gastang

(1979) studied the effect of graded level of fish meal supplementation at the rate of 50, 75 or 100 g/kg silage DM. The total DM intake was highest with 75 g/kg silage DM of fish meal. Gaya et al. (1979) studied the effect of fish meal at the rate of 150, 300, 450 or 600 g/day in cattle fed molasses/urea and restricted amounts of forage. It was found that the daily intake of DM increased when fish meal was added to the diet and this appeared to be due mainly to a greater intake of molasses.

Smith et al. (1980) showed that there was no response in DM intake from extra nitrogen either from fish meal or urea when the CP of the diet was 8.5 per cent in young cattle receiving high fibre diet. Gill and England (1983) studied the effect of fish meal at the rate of 50, 75 and 100 g/kg silage DM on the performance of young cattle and the results showed that the total feed intake (g/kg live wt) increased as the level of fish meal in the diet increased.

Aughes (1983) studied the effect of protein supplementation on the calves fed silage ad libitum and 2.5 kg/day of barley based concentrate or a concentrate containing 80 g/kg of fish meal. The results showed that there was a slight improvement in the silage DM intake (1.31 vs 1.32 kg/d) by fish meal supplementation. Kirby and Chalmers (1983a) observed no significant difference between the sources of protein supplements viz. soyabean and fish meal on silage DM

intake of growing beef cattle. They also found no significant difference in DM intake between the compound feed prepared with or without 100 g/kg fish meal.

Gibb and Baker(1987) found no differences in the intake of hay and silage DM of the diet supplemented with fish meal at the rate of 0.75 g/kg live weight in young steers. Veira et al. (1988) observed that fish meal tended to increase total DM intake of the silage diet by an amount equivalent to the quantity of supplement offered but had no effect on DM intake of silage in beef calves. Mackie et al. (1989) observed that barley plus fish meal supplements increased the silage DM intake by about 0.3 kg/day compared with giving supplements of only barley in young growing cattle.

Newbold and Rust (1989) observed that there were no significant differences in DM intake in bull calves receiving fish meal as an undegradable protein and casein as the rumen degradable protein source. Singh and Mehra (1990) observed that the DM intake was increased in buffalo calves supplemented with fish meal.

Windschitl et al. (1991) reported that DM intake (kg/d) was lower ($P<0.01$) with the diet containing 4.2 per cent fish meal than the diet composed of soyabean of 1.4 per cent and 2.8 per cent of fish meal in the mixed diet. Makokha (1992)

reported that addition of fish meal to the control supplement which contained adequate rumen degradable nitrogen increased the straw and total DM intake in lambs.

Veira et al. (1994) studied the effect of supplementation with different sources and amount of protein on the utilization of grass silage by cattle. They found that there was no effect on silage intake with graded level of fish meal or soyabean supplementation. The results showed that there was no effect on silage intake by fish meal supplementation. Bossaibati and Bryanti (1994) studied the effect of rapeseed meal and fish meal supplementation of maize-silage based rations on lambs, the level of fish meal being adjusted to 0.4 per cent of DM intake/day. The fish meal diet reduced the maize silage intake.

Brand et al. (1994) found that supplementation of 5 per cent fish meal increased DM intake of a straw based diets in sheep. Sil et al. (1994) observed no significant difference in DM, CP, DCP and TDN intake between calves fed with groundnut oil cake and fish meal based diets.

2.2 Digestibility of nutrients

Gastang (1979) conducted an experiment in British Friesian calves by supplementing grass silage with fish meal at

the rate of 50 g/kg silage DM and it was found that supplementation with fish meal increased the DM digestibility.

Silva et al. (1989) reported that the digestibility of DM and organic matter in urea supplemented ration was significantly increased by fish meal supplementation in cattle. Ortigues et al. (1989) conducted an experiment to study the effect of increasing amounts of barley and fish meal in straw based diet in cattle. Fish meal supplementation resulted in improved digestibility of cellulose and xylose by upto 6.7 and 4.7 per cent respectively and shifted the digestion towards the large intestine. It also increased the amino acid N supply to the small intestine, as a result the contribution of amino acids at the same level of ME intake increases in proportion to the amount of fish meal in the diet.

Reddy and Singh (1991) reported that there was no significant diffrence in the digestibility of nutrients among the complete diets containing different sources of protein supplements viz. NPN, fish meal, cottonseed meal and soyabean oil meal in wheat silage based diets in calves.

Ravi et al. (1993) reported that substitution of formaldehyde treated groundnut oil cake with fish meal increased the DM digestibility, lowered the digestibility of ether extract

and exerted no effect on the digestibility of crude fibre and nitrogen free extract in crossbred calves.

Brand (1994) found that supplementation of fish meal at 5 per cent level increased the digestibility of straw based diets in sheep. Sil et al. (1994) observed that digestibility of crude protein was higher with groundnut oil cake than with fish meal based diets but there was no effect on the digestibility of other nutrients in crossbred heifers.

2.3 Growth response

Growth is the parameter which has long been used as the criteria to judge the performance of growing animals and to evaluate the feeds for their nutritive value by many workers in the field of nutrition.

Whitelaw et al. (1961) compared groundnut oil meal (14%), heat treated groundnut oil meal (15%) and fish meal (10%) as protein supplements in the diet of calves. It was found that the nitrogen retention and live weight gain differed significantly between the diets, being highest on the fish meal diet and least on the commercial groundnut oil meal.

Preston et al. (1965) conducted an experiment in calves fed with concentrate mixture containing four different levels of fish meal supplying CP 14.8, 16.8, 19.4 and 21.7 per cent

respectively. The results showed that the nitrogen retention was significantly higher in animals fed with diet containing 21.7 per cent and 19.4 per cent CP than the animals on diets with 16.8 and 14.8 per cent CP. However nitrogen retention as a percentage of dietary intake appeared to be less on the diet with 21.7 per cent CP than on the other diets. Bowers et al. (1965) tried to ascertain whether the differences between fish meal and groundnut meal were also manifested in much older calves. The results showed that there were no significant differences in nitrogen retention.

Kay et al. (1966) studied the effect of different protein sources on nitrogen retention in calves of four groups fed with isocaloric and isoproteimic diets containing fish meal, soyabean or groundnut meal or distiller dried grains respectively. It was found that nitrogen retention differed significantly between the diets, being highest on the fish meal diet and lowest on the groundnut oil meal diet. Veitia (1973) studied the effect of fish meal inclusion at 100, 200, 300 or 400 g/day in bulls fattened on molasses/urea diets fed ad libitum, and observed that the groups did not differ significantly in daily gain g/day. Abe et al. (1976) observed that growth was progressively improved by formaldehyde-treated fish meal supplement and significantly higher effect was seen at higher levels of inclusion in calves' ration.

Gastang (1979) observed that the daily body weight gain increased linearly from 0.25 to 0.54 kg/day with graded level of fish meal supplementation ranging from 0 to 100 g/kg silage DM in friesian calves. Gaya et al. (1979) studied the effect of fish meal supplementation at levels ranging from 0 to 600 g/day in calves fed molasses/urea and forage diets. The optimum level of fish meal was found to be 450 g/day at which highest daily body weight gain was obtained.

Smith et al. (1980) compared the sources of supplementary nitrogen for young cattle consuming fibre rich diets. It was found that diets supplemented with fish meal supported the higher rates of daily live weight gain and nitrogen retention than with those supplemented with soyabean oil meal or urea. In a growth trial with steers, where urea and combination of urea with soya, blood, meat and maize gluten meal were the various protein supplements to roughages so that the diets had 11.5 per cent protein, the live weight gain was highest with urea and undegradable protein (animal proteins) followed by urea with soyabean oil meal and least with urea alone (Klopfenstein, 1981).

Gill and England (1983) observed that, the live weight gain of young cattle increased with the graded level of fish meal supplements ranging from 0 to 100 g/kg silage DM. Aughus (1983) examined the effect of fish meal by increasing the level

of inclusion from 80 to 160 g/kg of concentrate mixture and reduced the allowances of concentrate mixture from 2.5 kg to 1.25 kg in Friesian bull calves. The results showed that fish meal supplementation resulted in a positive influence on live weight gain and indicated the benefit of inclusion of fish meal in the diet of growing calves.

Kirby and Chalmers (1983)a. studied the effect of different sources of protein supplements viz. soyabean and fish meal in barley based diets. The results showed that the higher daily live weight gain was obtained in calves fed with fish meal based diet than with soyabean based diet. Kirby and Chalmers (1983)b. studied the effect of fish meal supplementation on the performance of fattening Friesian steers fed with grass silage ad libitum and 2.5 kg of compound feed daily without or with 100 g/kg fish meal. It was found that fish meal supplementation significantly increased the daily live weight gain and reduced the finishing period. Similarly in another experiment when animals were fed with grass silage ad libitum and 3 kg of compound feed daily without or with 65 g/kg fish meal, fish meal supplementation significantly increased the daily live weight gain but did not reduce the finishing period significantly.

Thonney and Hogue (1986) observed that steers fed fish meal diet (30 g/kg) gained 1.34 kg/day and consumed 7.36 kg of DM of complete diet daily while steers fed cotton seed meal diet

gained 1.17 kg/day and consumed 7.4 kg DM daily. Fish meal supplementation substantially increased the growth rate on silage based diet in calves (Veira et al., 1988).

Jaiswal et al. (1988) studied the effect of various protein supplements added to urea treated rice straw on the performance of crossbred heifers. Fish meal supplementation did not show any benefit in terms of live weight gain as compared with other protein supplements like cotton seed meal.

Newbold and Rust (1989) studied the responses of young rapidly growing cattle to protein supply. They found that there were no significant differences in live weight gain by increasing the level of crude protein from 13 to 16 per cent either with RDP supplements viz. casein, soyabean or with UDP supplements viz. fish meal, corn glutenmeal.

The utilisation of alfalfa haylage by growing steers was tried to be improved by addition of fish meal at 10 per cent. Steers supplemented with fish meal gained significantly ($P<0.05$) higher (Hopper et al., 1989). Mantsaari et al. (1989) did not observe any significant difference in growth among the protein sources viz soyabean and animal by product meal in cattle.

Gonzalez et al. (1990) reported that, the live weight gain did not differ between various protein level in growing calves supplemented at the rate of 1.5 per cent of live weight with

concentrate containing fish meal, to provide 9, 13, 17 or 21 per cent crude protein. The results showed that diet with 9 per cent CP provided adequate digestible protein to the intestine for the gains attained and there was no response in performance or in economics by increasing the protein intake.

Davenport et al. (1990) studied the performance of growing calves fed corn silage supplemented with ground soyabean (GSB) without or with fish meal (FM) or with rumen protected lysine, providing an isonitrogenous feed at the rate of 2.27 kg/head/day. The overall average daily gain (ADG) of GSB calves was 14 per cent lower than the mean ADG of calves fed on supplements containing fish meal or lysine. The increased performance of FM supplemented calves indicated that the feeding value of GSB for calves given maize silage could be improved by adding proteins of relatively low ruminal degradation

The growth responses to escape protein were not different in Holstein heifers fed with grass hay and alfalfa containing either fish meal at 3.7 per cent or soyabean meal at 6.6 per cent DM (Navaes et al., 1991).

Gibb et al. (1992) reported that calves receiving feathermeal (FTM) and meat bone meal (MBM) combination as a protein supplement gained faster than those receiving urea supplementation and the addition of graded levels of blood meal

(BM) linearly increased average daily gain and the results also indicated that there was no complementary response between MBM and BM.

Makokho (1992) showed that addition of fish meal to the control diet which contained adequate rumen degradable nitrogen (urea/molasses solution and concentrate 500 g/day) increased the live weight gain in lambs. Steen (1992) studied the comparative feeding value of soyabean, fish meal and maize gluten meal as protein source for calves offered grass silage ad libitum. It was observed that the highest average daily gain was with fish meal followed by soyabean and maize gluten meal based diets.

White et al. (1993) observed that calves fed with supplements containing soyabean and fish meal gained faster than calves fed supplements containing either soyabean or fish meal on corn based diets. Sultan Singh et al. (1993) studied the comparative feeding value of different protein sources in crossbred heifers fed with ammoniated rice straw as a basal diet. They observed that the average daily gain was significantly higher in groundnut oil cake based diet as compared to other sources viz. fish meal, cotton seed cake and mustard oil cake.

Feeding trials were conducted by Combellas et al. (1993) to evaluate the influence of the addition of fish meal to diets

based on two tropical roughages of different nutritive value supplemented or not with a rumen degradable concentrate on the live weight gain of growing cattle. The results showed that the live weight gain was appreciably increased by fish meal and concentrate in both trials but the magnitude of response per unit supplement was different between sources and roughages. The live weight gain increments were 50 and 108 g per 100 g fish meal with forage and low quality silage and 33 g/100 g of concentrate with both roughages.

It was reported that, the average daily body weight gain of heifers fed adequate rumen degradable protein (molasses with grain by-products) and undegradable protein (animal by-products) sources were similar (Petit, 1993). Zinn and Owens (1993) studied the effect of supplemented escape protein in feed lot steers with corn and hay based diets. They showed that greatest response was with 2.5 per cent animal by product meals which increased rate of gain by 13.4 per cent over that of basal diet.

Sindt et al. (1994) studied the effect of urea vs urea with escape protein for finishing calves, the dietary treatments being basal diet, corn + urea (U), soyabean meal (SBM), urea and feather meal (FTH), combination of urea, feathermeal and blood meal (BM). It was found that calves supplemented with SBM gained faster during the first 32 days than calves supplemented

with other sources of nitrogen. Over the entire trial, gain was not affected by treatments.

Veira et al. (1994) studied the effect of supplementation with different sources and amount of protein on the utilisation of grass silage by cattle. The results showed that increasing level of fish meal resulted in a linear increase in live weight gain. There were no differences in live weight gain between isonitrogenous supplements of FM and SBM.

Fluhanty et al. (1994) observed that blood meal increased the average daily gain by 10.6 per cent as compared with soyabean meal when the level of CP was kept at 13 per cent of DM in calves. Drennan et al. (1994) studied the effect of protein and energy supplements on performance of young bull offered grass silage ad libitum, with supplements of barely, barley plus soyabean, and barley plus fish meal. The results showed that there was no effect of source of protein on the growth of young bull.

2.4 Body measurements

Literature available on body measurements of crossbred growing cattle in India appear to be scanty. Shinde and Sangle (1976) recorded the daily gain of body length and heart girth as

0.339 cm and 0.192 cm respectively in young crossbred (Jersey x Red Sindhi) calves fed with calf meals over a period of 24 weeks.

An increase at the daily rate of 0.133 cms and 0.146 cm respectively for body length and heart girth was observed by Francis (1978) in young crossbred calves fed with calf starter containing fish meal at 10 per cent level from birth to six months. Geetha (1981) in her studies with crossbred calves fed with fish meal and lucerne meal based calf starter diets, recorded the value for the total and daily gain in body length as 23.5 to 26.8 cm and 0.140 to 0.160 cm respectively and the gain in total and daily heart girth as 26.5 to 30.2 and 0.158 to 0.180 cm respectively.

Devasia (1989) observed that the body length and heart girth increased from 79.5 to 87.88 cms and 103.5 to 117.56 cms respectively in half bred Jersey calves, the corresponding values for the half bred Brown Swiss calves being 81.25 to 89.88 cms and 105.25 to 118.5 cms respectively from 6 to 10th month of age. Reddy et al. (1991) recorded an average body length (in cms) of 94.1 and 104.9 and average heart girth (in cms) of 110.5 and 124.4 in crossbred calves under field condition at 6th and 10th month of age respectively.

2.5 Feed and protein efficiency

Veitia (1973) observed that no significant difference in the conversion of DM to gain with graded levels of fish meal supplementation in bulls fattened on molasses-urea based diets fed ad libitum. Abe et al. (1976) reported that significantly higher effect on feed conversion efficiency with increased levels of fish meal in calves ration.

Gaya et al. (1979) observed that the optimum level of fish meal was found to be 450 g/d at which highest feed conversion efficiency obtained in calves. The protein efficiency was 195 per cent for blood meal, 161 per cent for maize gluten meal and soya bean being considered as 100 per cent in steers for growth (Klopfenstein, 1981). Fish meal supplementation improved the feed conversion ratio than groundnut oil cake in steer calves which received silage based diets (Kaiser et al., 1982).

Thonney and Hogue (1986) observed that steers fed fish meal diet consumed 12.6 per cent less of DM per unit gain than diet based on cotton seed meal. Veira et al. (1988) obtained improved feed efficiency with fish meal supplementation in silage based diet for calves.

Newbold and Rust (1989) found that the feed efficiency was unaffected by RDP supplementation but significantly higher with UDP supplements in young cattle. Hopper et al. (1989) observed that fish meal supplementation at 10 per cent level improved the feed efficiency significantly in growing steers fed with alfalfa haylage. Davenport et al. (1990) observed that the feed efficiency of calves fed ground soyabean meal was 14 per cent lower than those fed on supplements containing fish meal or lysine. In another study Petit et al.(1991) reported that calves fed on fish meal were more efficient in converting dry matter to weight gain (2.64) than calves fed on soyabean (2.77) due to low dry matter intake of animals on fish meal diet.

Dixon et al. (1993) studied the responses of young sheep fed with diet containing medium quality roughage without or with N supplements. It was observed that fish meal based diets increased weight more per gram of supplement and per MJ of dietary ME intake than equivalent levels of urea supplements. It was suggested that the low efficiency of use of urea supplements by lambs fed on straw was associated with a low protein energy ratio of absorbed nutrients and this ratio was increased by fish meal supplementation which in turn increased the efficiency of utilisation of ME also. Ravi et al. (1993) observed the DCP:TDN ratio of 1:6.2 and 1:7.0 in growing calves, weighing 54.5 kg fed with groundnut oil cake and fish meal based concentrate mixtures respectively.

Veira et al. (1994) found that on crude protein basis soyabean meal was approximately 80 per cent as effective as fish meal in increasing the live weight gain in steers.

2.6 Haematological values

The picture of certain body metabolites reflect the nutritional status of the animals. Hence the blood parameters are being considered as an important criteria for assessing the effect of dietary responses. Reports are available which indicate that source and amount of nitrogen in the diet had an effect on certain blood metabolites viz. plasma protein, blood urea nitrogen etc.

Whitelaw et al. (1961) and Bowers et al. (1965) showed that blood urea concentration was significantly lower in calves on the fish meal diets than on the diet based on groundnut meal. Smith et al. (1980) observed that blood urea nitrogen increased as nitrogen intake increases and fish meal diets gave rise to higher values than soyabean meal supplemented diets.

However Kirby and Chalmers (1983)b. reported that serum urea concentration was increased (207 vs 237 mg/l) by fish meal supplementation (100 g/kg) in Friesian steers fed with grass silage and compound feed as control. White et al. (1993) observed that serum urea-nitrogen was higher when calves were

fed with both soyabean and fish meal as a protein supplement to grazing on the pasture than either one source of protein supplement. Soyabean as the only protein source or in combination with fish meal resulted in higher serum total protein than fish meal and urea as the supplement.

Fernandez et al. (1993) studied the influence of fish meal on blood parameters of lambs and reported lower blood urea nitrogen and higher plasma total protein with addition of fish meal.

Materials and Methods

MATERIALS AND METHODS

3.1 Experimental animals

Eighteen crossbred heifer calves of 5-7 months of age and of about 70 kg mean body weight belonging to the Livestock Research Station, Thiruvazhamkunnu and University Livestock Farm, Mannuthy formed the experimental subjects for the study. The animals were divided into three groups (group I, II and III) of six animals each as uniformly as possible in regard to age and body weight. The animals were housed in well ventilated shed having individual feeding facilities. All animals were dewormed with broad spectrum anthelmentic drug (dosage according to their body weight) at the beginning of the experiment and subsequently once in a month till the end of feeding trial. The experiment lasted for 126 days.

3.2 Experimental diet

Three isoproteimic and isocaloric concentrate mixtures viz.,A, B and C using conventional concentrate feed ingredients prepared as per standard specification were used for the study. Fishmeal was included in concentrate mixtures B and C at levels of 5 and 10 per cent replacing 10 and 20 per cent respectively of total protein in the basal concentrate mixture.

Concentrate mixture A was used as the control. While animals in group I received the control concentrate mixture (A) those in group II and III were fed on mixtures B and C respectively (experimental). Grass hay was used as the roughage for all the animals.

The percentage ingredient composition of the concentrate mixtures (A, B and C) and chemical composition of the experimental diets A, B, C and grass hay are given in Tables 1 and 2.

Table 1. Percentage ingredient composition of the experimental diets

Ingredients	Diets		
	A	B	C
1. Dried tapioca chips	30	30	30
2. Coconut oilcake	10	10	10
3. Groundnut oilcake (expeller)	35	30	25
4. Fish meal	-	5	10
5 Rice polish	22	22	22
6. Mineral mixture	2	2	2
7. Common salt	1	1	1

In all the above rations, Vitablend (Vitamin AD_3, glaxo) was added at the rate of 25 g per 100 kg of feed

Vitablend AD_3 - 50,000 IU of Vit. A per g
- 5,000 IU of Vit. D per g

The composition of mineral mixture used in the concentrate mixture is as follows.

	per cent		per cent
Calcium	- 22	Cobalt	- 0.02
Phosphorus	- 9	Iron	- 0.05
Manganese	- 0.12	Fluorine	< 0.03
Iodine	- 0.12	Sodium chloride	- 22
Copper	- 0.12	Zinc	- 0.15

Table 2. Percentage chemical composition of the experimental diets (DM basis)

	Nutritional moiety	Concentrate mixtures			Grass hay
		A	B	C	
1.	Dry matter	91.31	90.40	89.60	85.20
2.	Organic matter	91.88	90.25	89.32	92.27
3	Crude protein	21.06	20.62	20.05	4.36
4	Ether extract	3.93	4.67	5.77	2.10
5	Crude fibre	8.60	7.27	6.99	35.64
6	Nitrogen free extract	58.29	57.69	56.51	50.17
7	Total ash	8.12	9.75	10.68	7.73
8	Acid insoluble ash	2.49	3.57	4.77	3.55
9.	Calcium	1.28	1.34	1.46	0.91
10.	Phosphorus	1.10	1.21	1.30	1.29

3.3 Feeding experiment

The animals in all the groups were fed with their respective concentrate mixtures and grass hay to meet their nutritional requirements as specified in the ICAR feeding standards (1985) for crossbred calves growing at the rate of 550 g/day. The allocation of the quantity of concentrate mixtures and grass hay to each animal was revised according to their body weight at fortnightly intervals.

The animals were fed with concentrate mixtures twice daily at regular intervals, 8 A.M. in the morning and 2.00 PM. in the evening. Grass hay and wholesome drinking water were given ad libitum. The calves were let out to open paddock for two hours thrice in a week for exercise.

Records of daily feed intake and fortnightly body weights, and body measurements were maintained throughout the course of the experiment. Blood samples were collected from the jugular vein of all animals at monthly intervals for the estimation of haemoglobin, plasma protein and blood urea nitrogen. Haemoglobin was estimated by acid Haematin method using 0.1 N HCl as reagent (Benjamin, 1985). Plasma protein was determined by Biuret method (Gornall et al., 1949). Blood urea nitrogen was determined by using Kit supplied by stangen immuno diagnostics.

3.4 Digestion experiment

Towards the end of the feeding experiment, a digestion trial was carried out for the estimation of the digestibility coefficients of nutrients in the experimental rations. Data on total feed intake and faecal output in respect of each animal in the experiment were gathered during the collection period lasting for 7 days. Faeces was collected manually as and when it was voided taking all precautions to avoid contamination with urine and dirt. The faeces collected every day morning at a fixed time, was weighed accurately, mixed well and representative sample at the rate of 1/10th of the total quantity were taken and stored in a refrigerator. The faecal samples from each animal taken during the collection period of seven days, were pooled and preserved for analysis. All the feed and faecal samples were analysed for proximate principles by standard procedures (A.O.A.C., 1990).

3.5 Economics of feeding

Economics of feeding with different rations were worked out by fixing the cost of feed ingredients as prevailed in the market.

The cost of the concentrate mixtures (Rs/kg of DM) A, B and C used in the study was 6.27, 6.26 and 6.35 respectively. The cost of grass hay was fixed as Rs.0.50/kg DM.

Statistical analysis of the data obtained during the course of the experiment was carried out by the method described by Snedecor and Cochran (1967).

Results

RESULTS

The results obtained during the course of present study are detailed under the following heads.

4.1 Feed and nutrients consumption

Data on fortnightly average daily feed intake, mean feed and nutrient consumption during the experimental period of 126 days, of animals in group I, II and III maintained on concentrate mixtures containing 0 (diet A), 5 (diet B) and 10 (diet C) per cent of fish meal and the results of statistical analysis are presented in Tables 3 to 12 and the data on cumulative feed intake, average daily DCP and TDN intakes are represented in Fig.1, 2 and 3.

4.2 Digestibility of nutrients

Data on plane of nutrition during the digestion trial, digestibility coefficients of nutrients of ration A, B and C and the results of statistical analysis are presented in Tables 13 to 22.

4.3 Body weight

Data on fortnightly body weights, average daily weight gain, of the animals maintained on three dietary regimes and the

results of statistical analysis are presented in Tables 23 to 29 and represented in Fig.4 and 5.

4.4 Body measurements

Data on fortnightly and average daily gain of body measurements, of the animals maintained on the three dietary regimes and the results of statistical analysis are presented in Tables 30 to 40 and represented in Figs. 6 and 7.

4.5 Feed and protein efficiency

Data on feed and protein efficiency of the animals maintained on the three dietary regimes and the results of statistical analysis are presented in Tables 41 to 46 and represented in Fig.8.

4.6 Economics of feeding

Cost of feeding per unit gain is represented in Fig.9.

4.7 Haematological values

Data on Haematological values of the animals maintained on the three dietary regimes are presented in Tables 47 to 52.

The results are summarised in Tables 53 to 55.

Table 3. Fortnightly average daily total feed intake (DM in kg) of animals maintained on ration A

Sl. No.	Animal No.	Fortnights								
		1	2	3	4	5	6	7	8	9
1.	098	3.04	3.34	3.34	3.34	3.77	3.96	4.39	4.39	4.39
2.	114	2.61	2.56	2.56	3.08	3.51	3.68	4.24	4.39	4.98
3.	129	2.61	2.56	2.56	2.98	3.08	3.51	3.68	4.11	4.24
4.	770	2.66	2.66	2.74	3.16	3.16	3.16	3.68	3.68	4.11
5.	139	2.61	2.46	2.46	2.98	2.98	3.41	3.41	3.84	3.84
	Mean	2.70	2.72	2.73	3.11	3.30	3.54	3.88	4.08	4.31
	SE	±0.08	±0.14	±0.16	±0.11	±0.15	±0.15	±0.18	±0.21	±0.19

Table 4. Fortnightly average daily total feed intake (DM in kg) of animals maintained on ration B

Sl. No.	Animal No.	Fortnights								
		1	2	3	4	5	6	7	8	9
1.	115	2.60	2.55	2.55	2.97	3.06	3.06	3.58	3.80	3.80
2.	127	2.60	2.55	2.97	3.06	3.49	3.49	3.81	4.37	4.55
3.	108	2.60	2.55	3.06	3.49	3.49	3.81	4.37	4.37	4.37
4.	100	3.03	3.06	3.06	3.15	3.58	3.67	4.19	4.37	4.37
5.	772	2.64	2.64	2.73	3.15	3.15	3.15	3.67	3.67	4.10
6.	768	2.55	2.55	2.55	3.06	3.06	3.06	3.58	3.58	3.67
	Mean	2.67	2.65	2.82	3.15	3.31	3.37	3.87	4.03	4.14
	SE	±0.08	±0.12	±0.14	±0.10	±0.13	±0.14	±0.16	±0.19	±0.17

Table 5. Fortnightly average daily total feed intake (DM in kg) of animals maintained on ration C

Sl. No.	Animal No.	Fortnights								
		1	2	3	4	5	6	7	8	9
1.	101	2.60	3.31	3.31	3.79	3.79	3.92	4.35	4.35	4.53
2.	111	2.60	2.53	2.53	3.04	3.04	3.13	3.56	3.65	4.22
3.	124	2.60	2.53	2.53	3.04	3.47	3.56	3.65	4.08	4.35
4.	773	3.04	3.04	3.47	3.56	3.49	4.08	4.59	4.77	5.38
5.	777	2.62	2.62	2.62	3.13	3.13	3.27	3.72	3.79	4.22
	Mean	2.69	2.81	2.89	3.31	3.48	3.59	3.97	4.04	4.54
	SE	±0.08	±0.14	±0.16	±0.11	±0.15	±0.15	±0.18	±0.21	±0.19

Table 6. Data on feed and nutrients consumption of animals maintained on ration A during the experimental period of 126 days

Sl. No.	Animal No.	Daily DM intake from concentrate in kg	Daily DM intake from hay in kg	Total DM intake/ day in kg	DM intake per 100 kg body weight in kg	DM intake/ kg metabolic body wt. in g	Concentrate roughage ratio (R:C)	Crude protein intake/ day in g	Crude protein intake/ $W^{0.75}$ kg/ day in g	DCP intake/ day in g	DCP intake/ $W^{0.75}$ kg/day in g	TDN intake/ day in kgs	TDN intake/ $W^{0.75}$ kg/day in g
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	098	1.64	2.13	3.77	3.18	105.00	44:56	438.00	12.20	304.00	8.46	2.35	65.44
2.	114	1.48	2.04	3.52	3.54	112.00	42:58	401.00	12.73	277.00	8.79	2.30	73.02
3.	129	1.36	1.89	3.25	3.59	111.00	42:58	368.00	12.54	251.00	8.55	2.11	71.92
4.	770	1.47	1.75	3.22	3.17	100.00	46:54	386.00	12.07	259.00	8.10	2.05	64.10
5.	139	1.22	1.89	3.11	3.19	106.00	39:61	339.00	10.92	242.00	7.80	1.97	63.49
	Mean	1.43±	1.94±	3.37±	3.33±	105.80±	43:57±	386.40±	12.09±	266.60±	8.34±	2.16±	67.59±
	SE	0.05	0.09	0.13	0.08	1.98	0.01	14.82	0.28	9.85	0.16	0.07	1.81

Table 7. Data on feed and nutrients consumption of animals maintained on ration B during the experimental period of 126 days

Sl. No.	Animal No.	Daily DM intake from concentrate in kg	Daily DM intake from hay in kg	Total DM intake/ day in kg	DM intake per 100 kg body weight in kg	DM intake/ kg metabolic body wt. in g	Concentrate roughage ratio (R:C)	Crude protein intake/ day in g	Crude protein intake/ $W^{0.75}$ kg/ day in g	DCP intake/ day in g	DCP intake/ $W^{0.75}$ kg/day in g	TDN intake/ day in kgs	TD intake/ $W^{0.75}$ kg/day in g
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	115	1.36	1.75	3.11	3.42	109.00	44:56	356.00	12.08	240.00	8.15	1.99	67.55
2.	127	1.44	1.99	3.43	3.45	109.00	42:58	384.00	12.19	260.00	8.25	2.22	70.48
3.	108	1.48	2.08	3.56	3.41	101.00	42:58	396.00	12.12	265.00	8.11	2.26	69.16
4.	100	1.48	2.13	3.61	3.07	103.00	41:59	398.00	11.15	270.00	7.57	2.30	64.44
5.	772	1.46	1.75	3.21	3.79	102.00	45:55	377.00	12.15	254.00	8.19	1.99	64.13
6.	768	1.37	1.70	3.07	3.15	101.00	45:55	356.00	11.79	232.00	7.68	1.98	65.58
	Mean	1.43±	1.90±	3.33±	3.32±	105.00±	43:57±	377.80±	11.91±	253.50±	7.99±	2.12±	66.89±
	SE	0.05	0.08	0.12	0.07	1.81	0.01	6.95	0.15	5.53	0.11	0.06	0.97

Table 8. Data on feed and nutrients consumption of animals maintained on ration C during the experimental period of 126 days

Sl. No.	Animal No.	Daily DM intake from concentrate in kg	Daily DM intake from hay in kg	Total DM intake/ day in kg	DM intake per 100 kg body weight in kg	DM intake/ kg metabolic body wt. in g	Concentrate roughage ratio (R:C)	Crude protein intake/ day in g	Crude protein intake/ $W^{0.75}$kg/ day in g	DCP intake/ day in g	DCP intake/ $W^{0.75}$ kg/day in g	TDN intake/ day in kgs	TDN intake/ $W^{0.75}$ kg/day in g
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	101	1.66	2.13	3.79	3.02	101.00	45:55	426.00	11.36	289.00	7.71	2.41	64.26
2.	111	1.35	1.80	3.15	3.39	105.00	44:56	349.00	11.65	237.00	7.91	2.04	68.11
3.	124	1.37	1.74	3.31	3.28	104.00	43:57	360.00	11.30	248.00	7.78	2.09	65.60
4.	773	1.53	2.41	3.94	3.43	112.00	39:61	412.00	11.73	277.00	7.89	2.59	73.75
5.	777	1.48	1.75	3.23	3.47	108.00	45:55	373.00	12.45	252.00	8.41	1.99	66.44
	Mean	1.48±	2.00±	3.48±	3.32±	106.00±	43:57±	384.00±	11.70±	260.60±	7.94±	2.22±	67.63±
	SE	0.05	0.09	0.13	0.08	1.98	0.01	13.40	0.18	8.66	0.11	0.11	1.48

Table 9. Analysis of variance - Feed consumption

Source	df	SS	MSS	F value
Between	2	6.066	0.033	0.401
Within	13	1.067	0..082	
Total	15	1.132		

NS - Non significant

Table 10. Analysis of variance - Intake of crude protein

Source	df	SS	MSS	F value
Between	2	753.00	376.50	0.002
Within	13	2269034.40	144541.08	
Total	15	2269787.00		

NS - Non significant

Table 11. Analysis of variance - Intake of digestible crude protein

Source	df	SS	MSS	F value
Between	2	222.117	111.058	0.199
Within	13	7259.633	558.433	
Total	15	7481.750		

NS - Non significant

Table 12. Analysis of variance - Intake of total digestible nutrients

Source	df	SS	MSS	F value
Between	2	1.68	0.84	0.177
Within	13	61.43	4.73	
Total	15	63.11		

NS - Non significant

FIG.1 AVERAGE CUMULATIVE FEED IN TAKE OF ANIMALS MAINTAINED ON THREE EXPERIMENTAL RATIONS

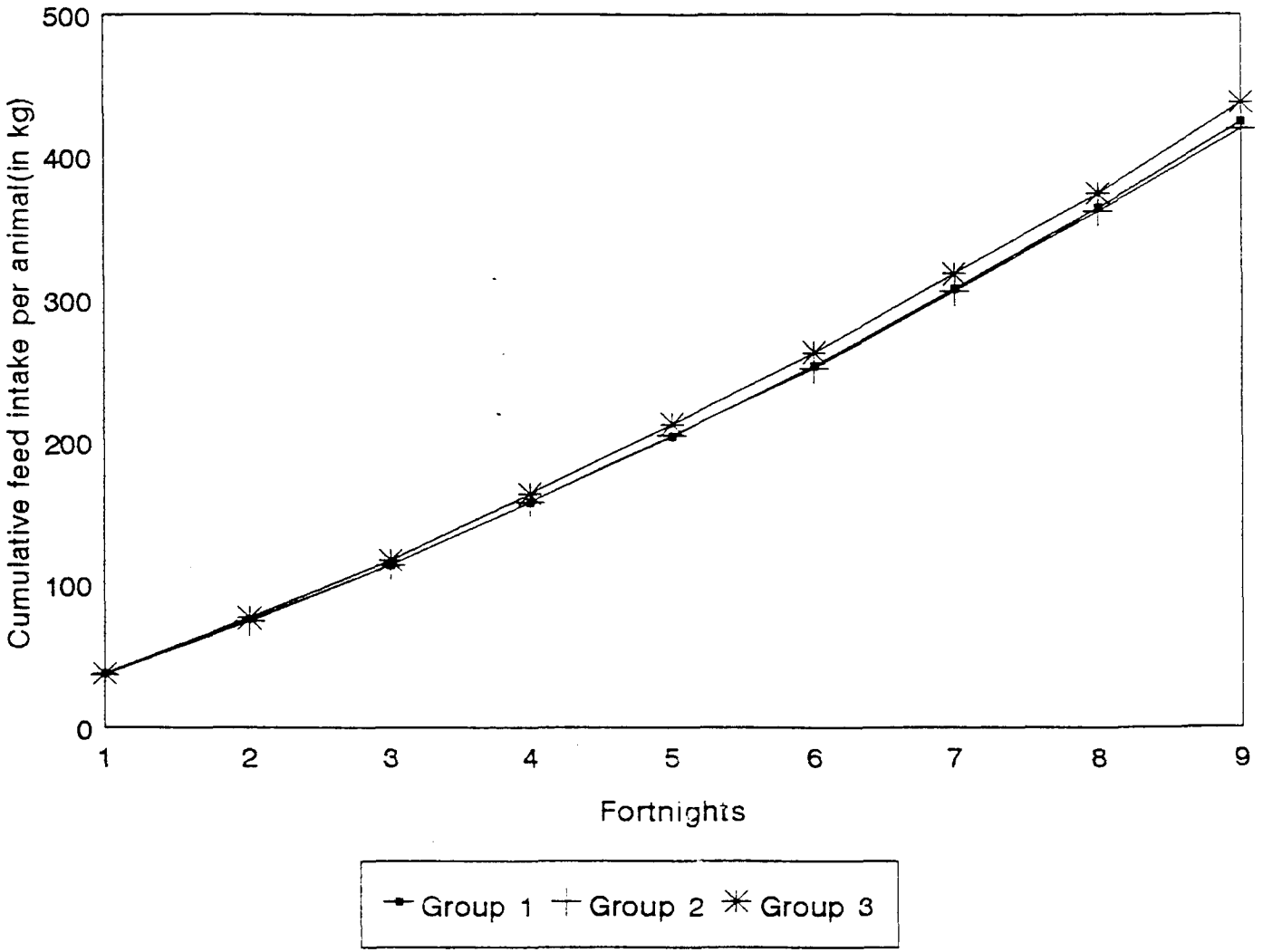

FIG.2 FORTNIGHTLY AVERAGE DAILY DCP INTAKE OF ANIMALS MAINTAINED ON THREE EXPERIMENTAL RATIONS

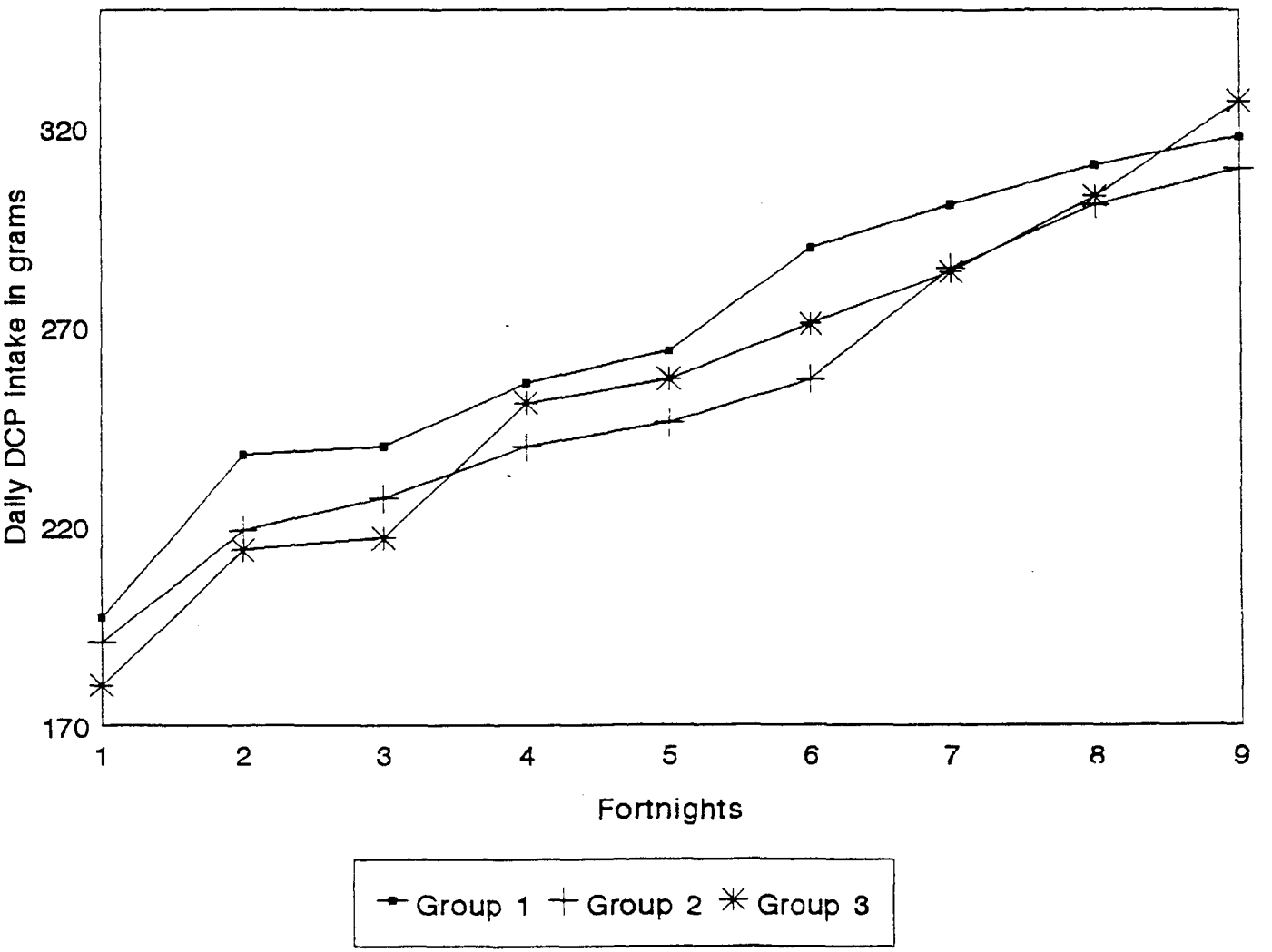

FIG.3 FORTNIGHTLY AVERAGE DAILY TDN INTAKE OF ANIMALS MAINTAINED ON THREE EXPERIMENTAL RATIONS

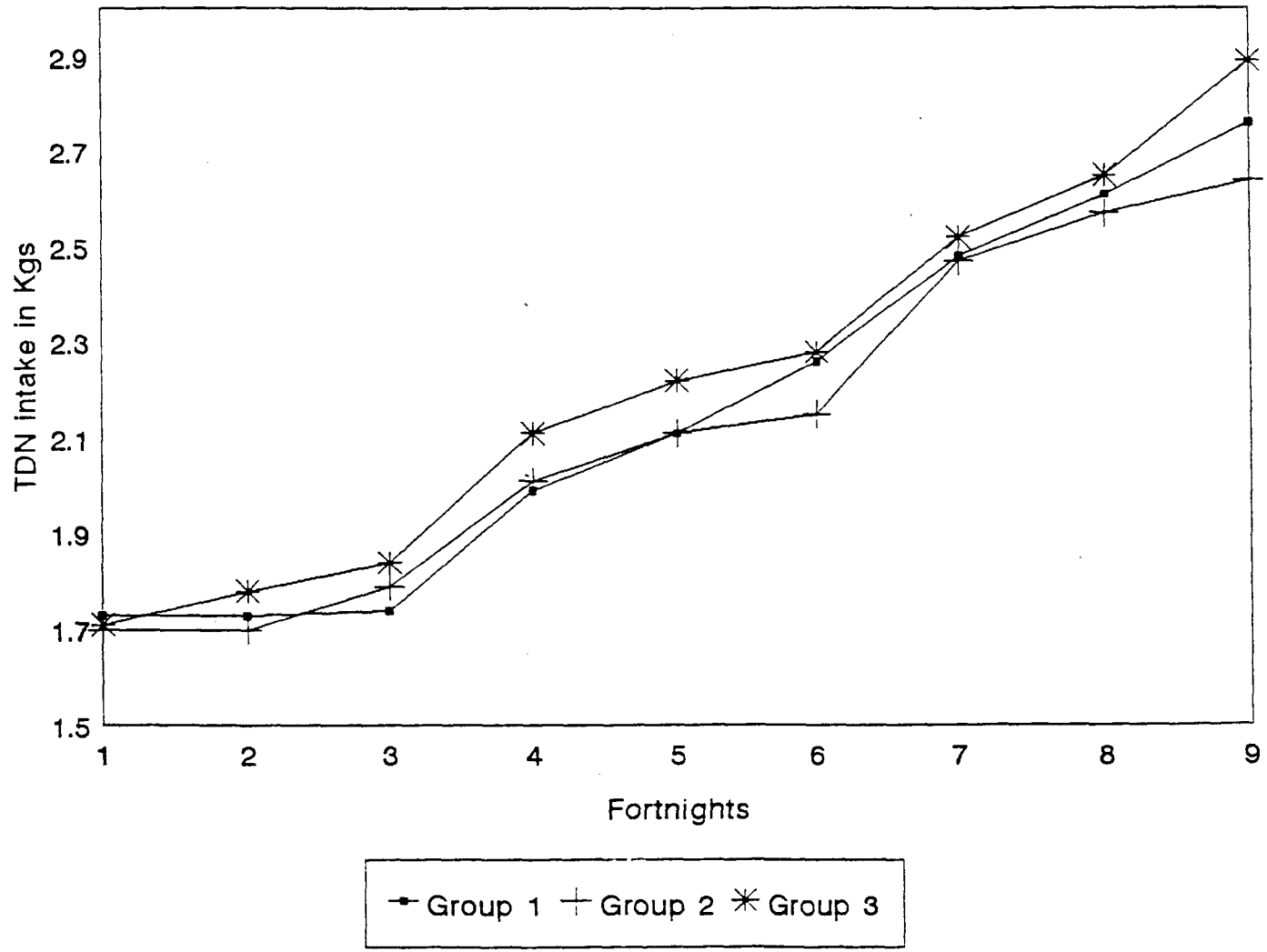

Table 13. Data on plane of nutrition of the experimental animals of three groups during the digestion trial

Sl. No.	Particulars	Groups		
		I	II	III
1.	Body weight in kg	125.60±5.25	125.00±4.19	132.40±6.39
2.	Metabolic body size ($W^{0.75}$ kg)	37.49±1.17	37.36±0.92	38.99±1.40
3.	DM intake (g/$W^{0.75}$ kg/d)	114.33±3.76	109.99±1.95	115.75±3.24
		3.42±0.13	3.29±0.07	3.42±0.12
4.	CP intake (g/$W^{0.75}$ kg/d)	12.23±0.50	12.09±0.19	12.13±0.08
5.	DCP intake (g/$W^{0.75}$ kg/d)	8.45±0.30	8.11±0.14	8.23±0.13
6.	TDN intake (g/$W^{0.75}$ kg/d)	73.16±2.98	70.10±1.16	73.62±2.31

Table 14. Data on digestibility coefficients of nutrients in ration A

Sl. No.	Animal No.	DM	OM	CP	EE	CF	NFE
1.	098	61.05	64.85	69.42	67.86	58.09	66.98
2.	114	65.49	68.40	69.13	68.25	62.59	71.28
3.	129	65.41	67.77	68.16	65.89	62.54	70.29
4.	770	63.26	66.66	67.12	66.95	58.66	70.36
5.	139	62.50	66.38	71.46	70.70	60.54	68.46
	Mean	63.54±	66.81±	69.06±	67.93±	60.48±	69.47±
	SE	0.78	0.60	0.50	0.58	0.80	0.80

Table 15. Data on digestibility coefficients of nutrients in ration B

Sl. No.	Animal No.	DM	OM	CP	EE	CF	NFE
1.	115	64.47	67.53	67.28	63.81	58.86	71.34
2.	127	64.76	68.17	67.62	63.56	61.21	71.51
3.	108	64.07	66.92	67.01	64.21	59.58	70.27
4.	100	63.84	67.17	67.84	65.73	59.77	70.31
5.	772	61.22	64.80	67.44	64.44	58.59	67.16
6.	768	65.67	67.86	65.21	63.04	60.96	71.83
	Mean	64.01±	67.08±	67.07±	64.03±	59.83±	70.40±
	SE	0.71	0.55	0.46	0.53	0.73	0.73

Table 16. Data on digestibility coefficients of nutrients in ration C

Sl. No.	Animal No.	DM	OM	CP	EE	CF	NFE
1.	101	62.25	66.75	67.85	66.33	62.21	69.08
2.	111	63.98	68.23	67.87	63.44	62.27	71.37
3.	124	61.61	66.16	68.79	64.29	59.98	68.37
4.	773	64.23	68.00	67.32	64.45	64.77	69.84
5.	777	59.72	64.58	67.64	65.44	59.38	66.19
	Mean	62.36±	66.74±	67.89±	64.79±	61.71±	68.97±
	SE	0.78	0.64	0.50	0.58	0.80	0.80

Table 17. Analysis of variance - Digestibility coefficient of dry matter

Source	df	SS	MSS	F value
Between	2	7.678	3.839	1.258
Within	13	39.671	3.052	
Total	15	47.350		

NS - Non significant

Table 18. Analysis of variance - Digestibility coefficient of organic matter

Source	df	SS	MSS	F value
Between	2	0.342	0.171	0.095
Within	13	23.539	1.811	
Total	15	23.882		

NS - Non significant

Table 19. Analysis of variance - Digestibility coefficient of crude protein

Source	df	SS	MSS	F value
Between	2	10.836	5.418	4.346
Within	13	16.207	1.247	
Total	15	27.042		

S - Significant

	Group comparison		
	Group I&II	Group II&III	Group III&I
Group mean difference	1.99*	0.82	1.17
Critical difference value at 5% level	.460	1.460	1.52

* Significant at 5 per cent level

Table 20. Analysis of variance - Digestibility coefficient of ether extract

Source	df	SS	MSS	F value
Between	2	43.269	21.635	12.691
Within	13	22.162	1.705	
Total	15	65.432		

S - Significant

	Group comparison		
	Group I&II	Group II&III	Group III&I
Group mean difference	3.8**	0.66	3.14**
Critical difference value at 1% level	2.35	2.359	2.487

** Significant at 1 per cent level

Table 21. Analysis of variance - Digestibility coefficient of crude fibre

Source	df	SS	MSS	F value
Between	2	9.837	4.918	1.523
Within	13	41.987	3.230	
Total	15	51.823		

NS - Non significant

Table 22. Analysis of variance - Digestibility coefficient of nitrogen free extract

Source	df	SS	MSS	F value
Between	2	5.868	2.934	0.924
Within	13	41.261	3.174	
Total	15	47.130		

NS - Non significant

Table 23. Fortnightly body weights (in kg) of animals maintained on ration A

Sl. No.	Animal No.	0	1	2	3	4	5	6	7	8	9
1.	098	85	92	99	108	115	122	129	137	146	152
2.	114	63	70	79	87	94	102	109	118	130	136
3.	129	61	66	75	82	90	96	103	106	112	120
4.	770	75	81	88	93	99	105	112	115	121	128
5.	139	70	78	82	88	94	97	105	112	119	125
	Mean	70.8±	77.40±	84.60±	91.60±	98.40±	104.40±	111.60±	117.60±	125.60±	132.20±
	SE	4.59	4.79	4.74	4.98	5.30	5.43	5.49	5.79	6.00	6.00

Table 24. Fortnightly body weights (in kg) of animals maintained on ration B

Sl. No.	Animal No.	0	1	2	3	4	5	6	7	8	9
1.	115	61	67	77	83	90	97	102	109	115	121
2.	127	63	70	77	88	95	101	111	119	128	136
3.	108	72	80	88	96	101	108	113	120	127	137
4.	100	84	91	99	107	114	120	126	134	145	151
5.	772	69	77	85	91	96	102	108	113	119	126
6.	768	66	73	80	85	91	97	103	109	116	122
	Mean	69.17±	76.33±	84.33±	91.67±	97.83±	104.17±	110.5±	117.33±	125.0±	132.17±
	SE	4.19	4.38	4.32	4.52	4.84	4.96	5.01	5.29	5.48	5.48

Table 25. Fortnightly body weights (in kg) of animals maintained on ration C

Sl. No.	Animal No.	0	1	2	3	4	5	6	7	8	9
1.	101	89	95	104	113	126	133	141	148	155	162
2.	111	61	67	73	80	91	96	103	109	119	125
3.	124	63	70	78	88	94	102	109	116	126	139
4.	773	79	89	95	101	108	116	125	134	143	151
5.	777	61	67	75	80	86	93	101	109	119	125
	Mean	70.60±	77.60±	85.00±	92.40±	101.00±	108.00±	115.80±	123.20±	132.40±	140.40±
	SE	4.59	4.79	4.74	4.98	5.30	5.43	5.49	5.79	6.00	6.00

Table 26. Average daily weight gain (in g) of animals maintained on ration A during the experimental period of 126 days

Sl. No.	Animal No.	Initial body wt. (kg)	Final body wt. (kg)	Total wt. gain (kg)	Average daily gain (g)
1.	098	85	152	67	532
2.	114	63	136	73	587
3.	129	61	120	59	468
4.	770	75	128	53	421
5.	139	70	125	55	437
	Mean	70.8±	132.2±	61.4±	487±
	SE	4.59	6.00	3.08	25.53

Table 27. Average daily weight gain (in g) of animals maintained on ration B during the experimental period of 126 days

Sl. No.	Animal No.	Initial body wt. (kg)	Final body wt. (kg)	Total wt. gain (kg)	Average daily gain (g)
1.	115	61	121	60	476
2.	127	63	136	73	579
3.	108	72	137	65	516
4.	100	84	151	67	532
5.	772	69	126	57	452
6.	768	66	122	56	444
	Mean	69.17±	132.17±	63.0±	500±
	SE	4.19	5.48	2.81	23.31

Table 28. Average daily weight gain (in g) of animals maintained on ration C during the experimental period of 126 days

Sl. No.	Animal No.	Initial body wt. (kg)	Final body wt. (kg)	Total wt. gain (kg)	Average daily gain (g)
1.	101	89	162	73	579
2.	111	61	125	64	508
3.	124	63	139	76	603
4.	773	79	151	72	571
5.	777	61	125	64	508
	Mean	706±	140.4±	69.8±	554±
	SE	4.59	6.00	3.08	17.94

Table 29.Analysis of variance - Average daily weight gain

Source	df	SS	MSS	F value
Between	2	12436.117	6218.058	1.908
Within	13	42371.633	3259.356	
Total	15	54807.750		

NS - Non significant

FIG.4 AVERAGE BODY WEIGHT OF ANIMALS MAINTAINED ON THREE EXPERIMENTAL RATIONS

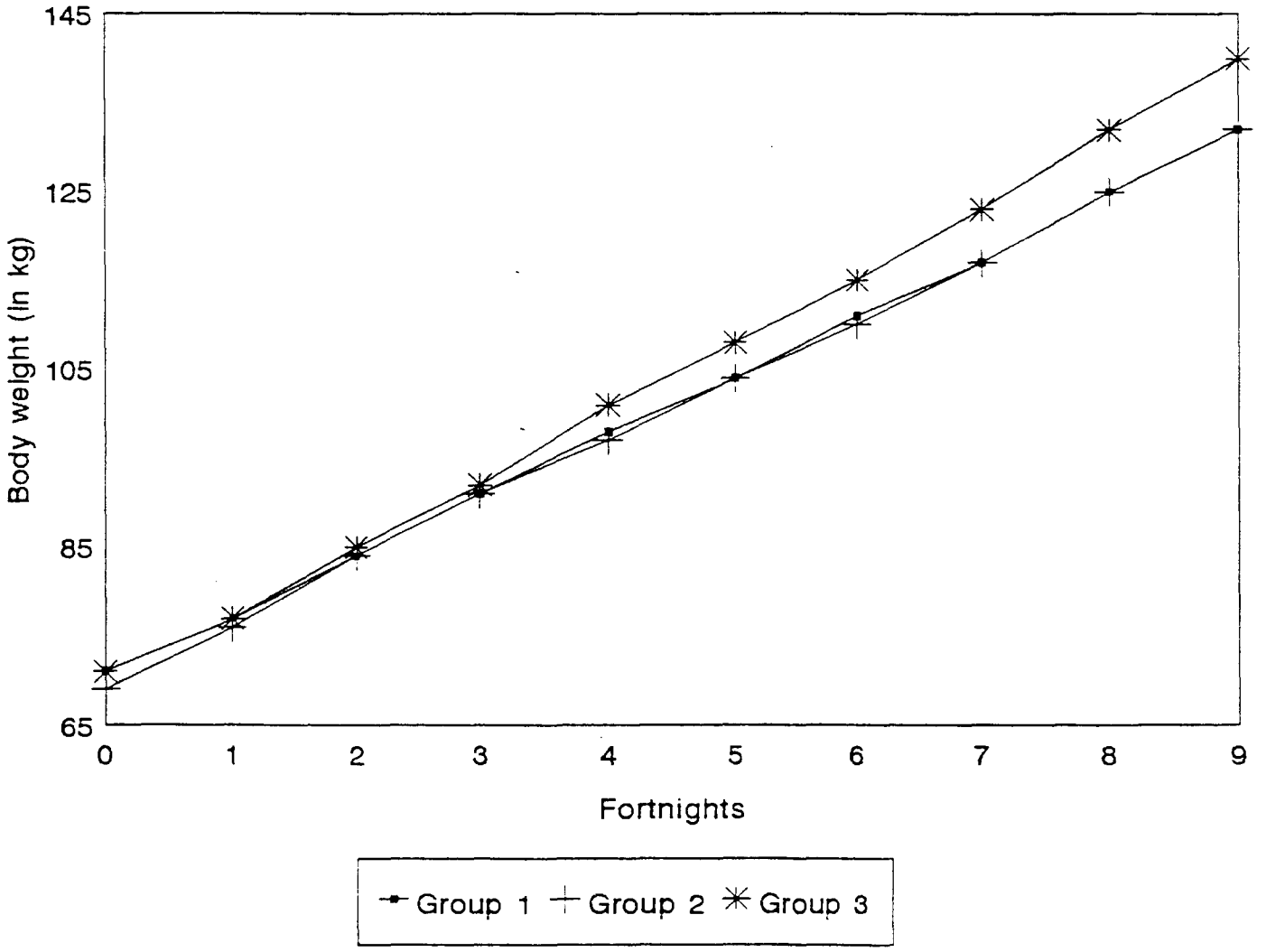

FIG.5 AVERAGE DAILY WEIGHT GAIN OF ANIMALS MAINTAINED ON THREE EXPERIMENTAL RATIONS

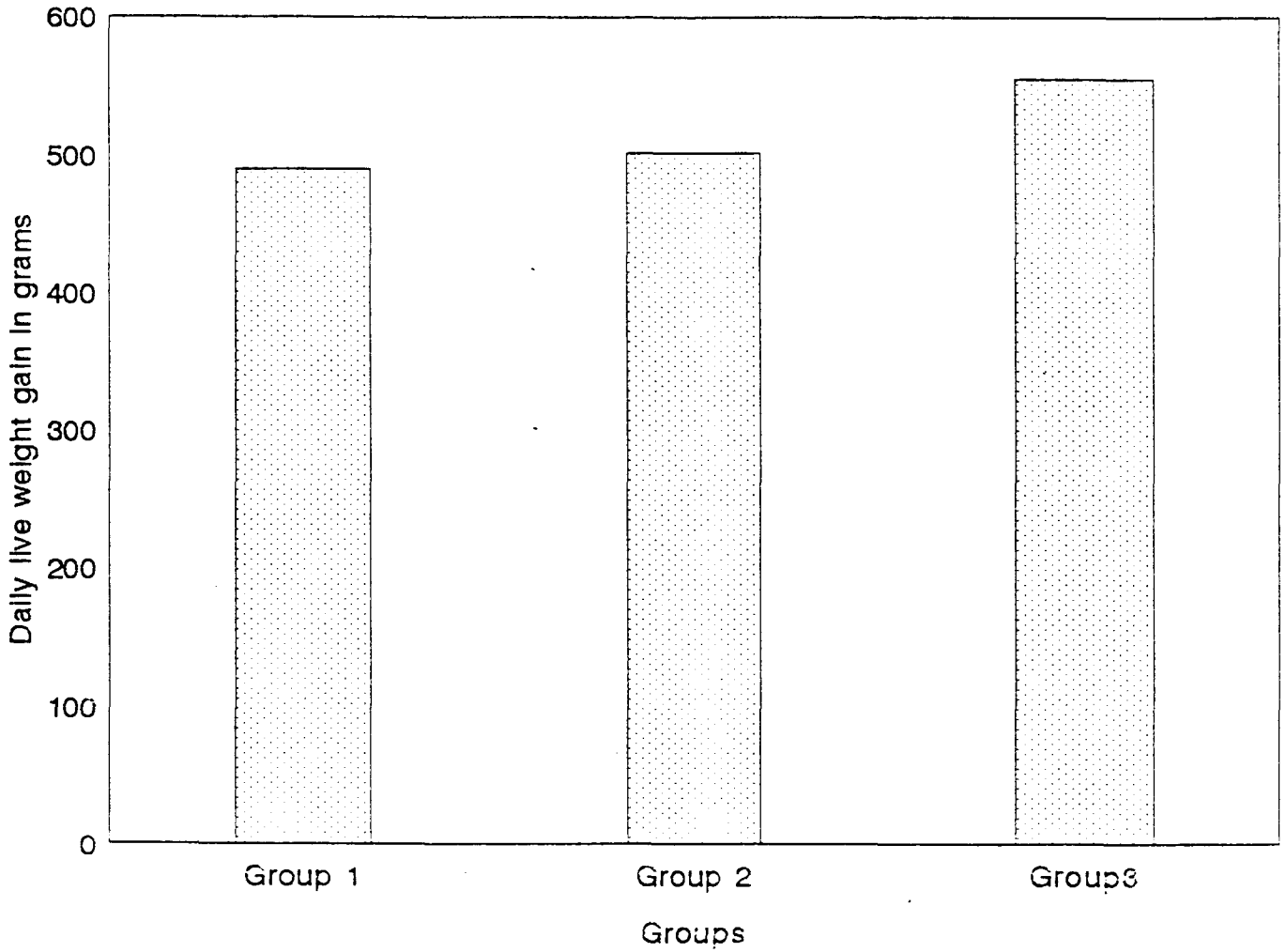

Table 30. Fortnightly body length (in cm) of animals maintained on ration A

Sl. No.	Animal No.	0	1	2	3	4	5	6	7	8	9
1.	098	89	92	97	104	105	107	107	108	110	114
2.	114	77	80	90	95	100	102	106	108	109	110
3.	129	80	82	87	92	98	101	103	105	106	106
4.	770	93	94	96	96	100	100	102	104	105	105
5.	139	80	83	87	94	98	100	101	101	103	103
	Mean	83.80±	86.20±	91.40±	96.20±	100.20±	102.00±	103.80±	105.20±	106.60±	107.60±
	SE	2.59	2.76	2.44	2.31	1.55	1.50	1.35	1.34	1.21	1.78

Table 31. Fortnightly body length (in cm) of animals maintained on ration B

Sl. No.	Animal No.	0	1	2	3	4	5	6	7	8	9
1.	115	80	83	87	89	92	95	97	100	106	107
2.	127	78	80	85	93	98	100	103	103	105	107
3.	108	89	93	97	102	102	105	105	107	108	108
4.	100	85	88	90	95	100	100	104	107	110	113
5.	772	87	92	100	100	100	101	101	103	105	105
6.	768	91	94	96	98	102	102	103	104	106	106
	Mean	85.10±	88.33±	92.50±	96.17±	99.00±	100.5±	102.17±	104.00±	106.67±	107.67±
	SE	2.37	2.52	2.23	2.11	1.41	1.37	1.23	1.22	1.11	1.62

Table 32. Fortnightly body length (in cm) of animals maintained on ration C

Sl. No.	Animal No.	0	1	2	3	4	5	6	7	8	9
1.	101	90	93	98	105	107	107	108	110	112	118
2.	111	81	83	92	97	100	103	104	105	106	108
3.	124	78	80	85	92	100	101	104	107	108	110
4.	773	90	95	97	104	104	108	110	112	112	115
5.	777	82	85	90	93	98	99	100	109	10	107
	Mean	84.20±	87.20±	92.40±	98.20±	101.80±	103.60±	106.40±	107.60±	708.60±	111.60±
	SE	2.59	2.76	2.44	2.31	1.55	1.50	1.35	1.34	21.21	1.78

Table 33. Fortnightly heart girth (in cm) of animals maintained on ration A

Sl. No.	Animal No.	0	1	2	3	4	5	6	7	8	9
1.	098	98	103	106	109	110	113	116	117	120	121
2.	114	93	94	96	100	106	111	115	118	118	119
3.	129	85	87	90	94	98	105	108	110	111	114
4.	770	95	98	102	104	105	108	109	112	112	115
5.	139	94	97	100	104	106	107	110	111	111	112
	Mean	93.00±	95.80±	98.80±	102.20±	105.00±	108.80±	111.60±	113.60±	114.40±	116.20±
	SE	2.62	2.64	2.70	2.67	2.17	1.89	1.87	2.06	2.09	2.16

Table 34. Fortnightly heart girth (in cm) of animals maintained on ration B

Sl. No.	Animal No.	0	1	2	3	4	5	6	7	8	9
1.	115	85	91	94	101	104	106	107	107	109	116
2.	127	92	96	100	102	108	112	112	117	117	120
3.	108	99	104	107	108	111	115	117	117	118	123
4.	100	99	105	110	115	115	116	116	118	119	121
5.	772	95	99	101	103	104	107	109	110	112	114
6.	768	93	95	98	98	102	104	105	107	109	111
	Mean	93.33±	98.30±	101.70±	104.50±	107.30±	110.00±	111.00±	112.70±	114.00±	117.00±
	SE	2.39	2.41	2.47	2.44	1.98	1.72	1.71	1.88	1.70	1.85

Table 35. Fortnightly heart girth (in cm) of animals maintained on ration C

Sl. No.	Animal No.	0	1	2	3	4	5	6	7	8	9
1.	101	98	100	107	110	112	114	114	117	120	120
2.	111	86	90	94	98	105	108	109	110	111	114
3.	124	88	91	98	101	105	108	108	111	112	118
4.	773	103	105	107	112	115	115	116	117	120	123
5.	777	90	93	96	101	103	106	108	110	115	115
	Mean	93.00±	95.80±	100.40±	104.40±	108.00±	110.20±	111.00±	113.00±	115.60±	118.00±
	SE	2.62	2.64	2.70	2.67	2.17	1.89	1.71	2.06	2.09	2.16

Table 36. Average daily gain in body measurements of animals maintained on ration A during the experimental period of 126 days

Sl. No.	Animal No.	Body length in cm			Gain in body length/ day	Heart girth in cm			Gain in heart girth/ day
		Initial body length	Final body length	Gain in body length		Initial heart girth	Final heart girth	Gain in heart girth	
1.	098	87	114	27	0.183	98	121	23	0.214
2.	114	77	110	33	0.206	93	119	26	0.262
3.	129	80	106	26	0.230	85	114	29	0.206
4.	770	93	105	12	0.159	95	115	20	0.095
5.	139	80	103	23	0.143	94	112	18	0.182
	Mean	83.4±	107.6±	24.2±	0.184±	93.0±	116.2±	23.2±	0.192±
	SE	2.10	1.76	23.05	0.014	2.62	2.16	1.78	0.024

Table 37. Average daily gain in body measurements of animals maintained on ration B during the experimental period of 126 days

Sl. No.	Animal No.	Body length in cm			Gain in body length/ day	Heart girth in cm			Gain in heart girth/ day
		Initial body length	Final body length	Gain in body length		Initial heart girth	Final heart girth	Gain in heart girth	
1.	115	80	107	27	0.230	85	114	29	0.214
2.	127	78	107	29	0.222	92	102	28	0.230
3.	108	89	108	19	0.190	99	123	24	0.151
4.	100	85	113	28	0.175	99	121	22	0.222
5.	772	87	105	78	0.151	95	114	19	0.143
6.	768	91	106	15	0.143	93	111	18	0.119
	Mean	85±	107.6±	22.60±	0.185±	93.83±	117.16±	23.33±	0.179±
	SE	1.91	1.05	2.25	0.013	1.96	1.79	1.70	0.018

Table 38. Average daily gain in body measurements of animals maintained on ration C during the experimental period of 126 days

Sl. No.	Animal No.	Body length in cm			Gain in body length/ day	Heart girth in cm			Gain in heart girth/ day
		Initial body length	Final body length	Gain in body length		Initial heart girth	Final heart girth	Gain in heart girth	
1.	101	90	118	28	0.222	98	120	22	0.175
2.	111	81	108	27	0.214	86	114	28	0.222
3.	124	78	110	32	0.254	88	118	30	0.238
4.	773	90	115	25	0.198	103	123	20	0.159
5.	777	82	107	25	0.198	90	115	25	0.198
	Mean	84.2±	111.6±	27.4±	0.217±	93±	118±	25±	0.198±
	SE	2.20	1.89	1.16	0.009	2.62	2.16	1.65	0.013

Table 39. Analysis of variance - Body length

Source	df	SS	MSS	F value
Between	2	51.667	25.833	0.797
Within	13	421.333	32.410	
Total	15	473.000		

NS - Non significant

Table 40. Analysis of variance - heart girth

Source	df	SS	MSS	F value
Between	2	30.304	15.152	0.608
Within	13	324.133	24.933	
Total	15	354.438		

NS - Non significant

FIG.6 AVERAGE BODY LENGTH OF ANIMALS MAINTAINED ON THREE EXPERIMENTAL RATIONS

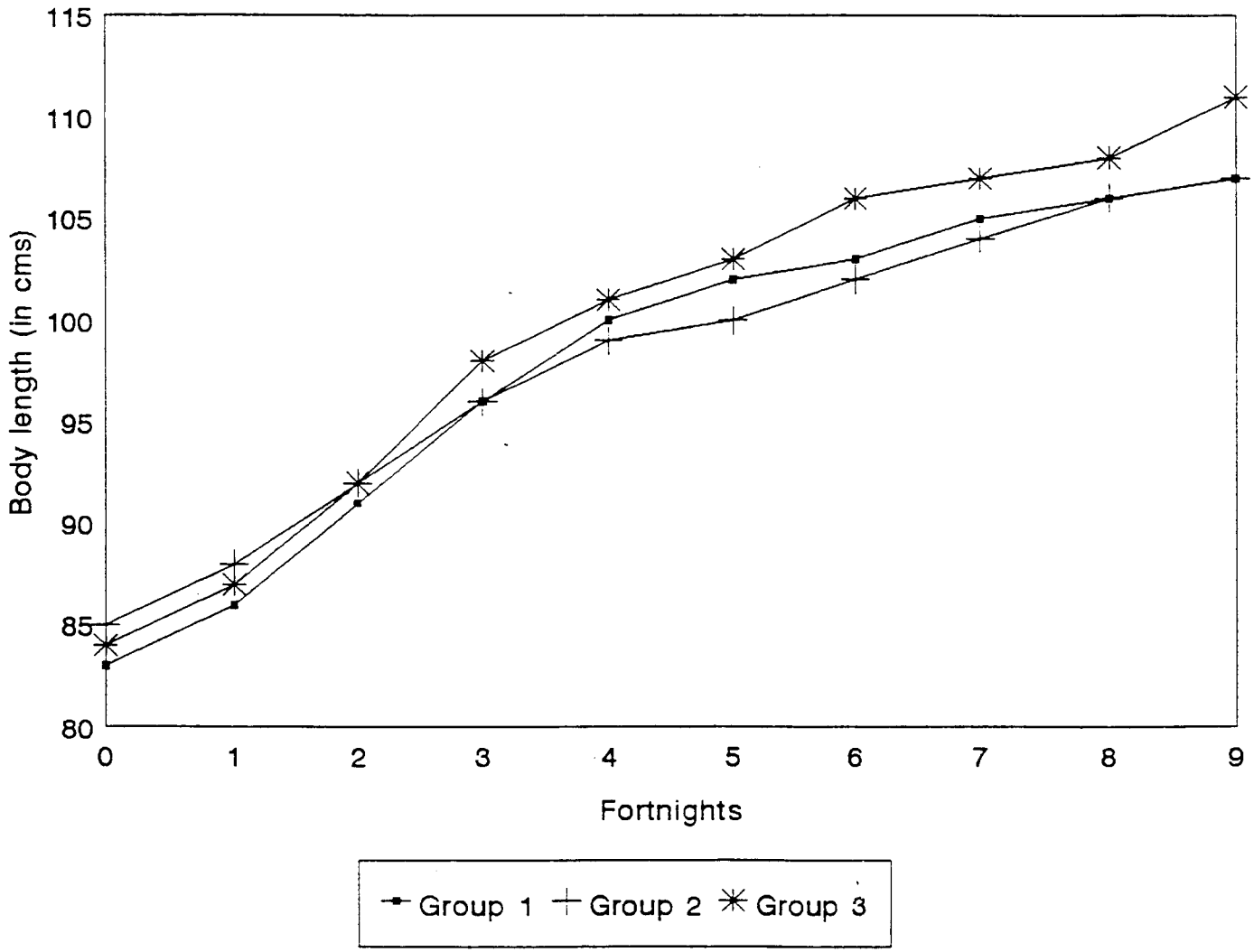

FIG.7 AVERAGE HEART GIRTH OF ANIMALS MAINTAINED ON THREE EXPERIMENTAL RATIONS

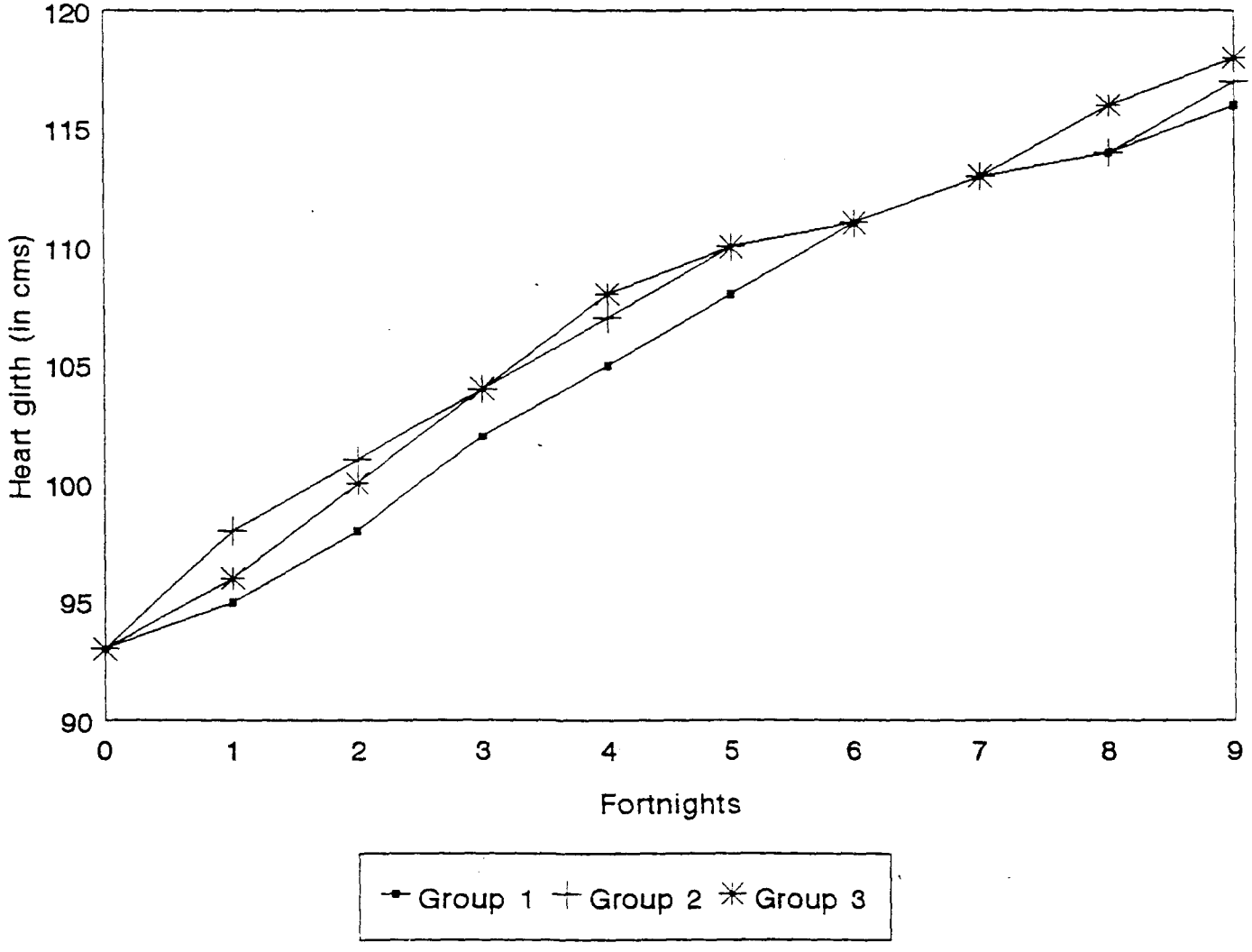

Table 41. Feed and protein efficiency of animals maintained on ration A during the experimental period of 126 days

Sl. No.	Animal No.	Feed	Crude protein	Digestible crude protein
1.	098	7.09	0.82	0.57
2.	114	6.00	0.68	0.47
3.	129	6.94	0.79	0.54
4.	770	7.65	0.92	0.62
5.	139	7.12	0.78	0.55
	Mean	6.96±	0.80±	0.55±
	SE	0.24	0.03	0.02

Table 42. Feed and protein efficiency of animals maintained on ration B during the experimental period of 126 days

Sl. No.	Animal No.	Feed	Crude protein	Digestible crude protein
1.	115	6.53	0.75	0.50
2.	127	5.84	0.65	0.44
3.	108	6.90	0.76	0.51
4.	100	6.79	0.75	0.51
5.	772	7.10	0.83	0.56
6.	768	6.91	0.80	0.52
	Mean	6.68±	0.76±	0.51±
	SE	0.17	0.02	.01

Table 43. Feed and protein efficiency of animals maintained on ration C during the experimental period of 126 days

Sl. No.	Animal No.	Feed	Crude protein	Digestible crude protein
1.	101	6.46	0.73	0.49
2.	111	6.24	0.69	0.47
3.	124	5.49	0.60	0.41
4.	773	6.90	0.72	0.49
5.	777	6.36	0.73	0.50
	Mean SE	6.29± 0.20	0.69± 0.02	0.47± 0.07

Table 44. Analysis of variance - Conversion efficiency - feed

Source	df	SS	MSS	F value
Between	2	2.146	1.073	1.862
Within	13	7.488	0.576	
Total	15	9.634		

NS - Non significant

Table 45. Analysis of variance - Conversion efficiency - crude protein

Source	df	SS	MSS	F value
Between	2	1.376	0.688	1.211
Within	13	7.392	0.568	
Total	15	8.768		

NS - Non significant

Table 46. Analysis of variance - Conversion efficiency - digestible crude protein

Source	df	SS	MSS	F value
Between	2	0.6335	0.316	1.208
Within	13	3.4068	0.262	
Total	15	4.0403		

NS - Non significant

FIG.8 MONTHLY AVERAGE FEED CONVERSION EFFICIENCY OF ANIMALS MAINTAINED ON THREE EXPERIMENTAL RATIONS

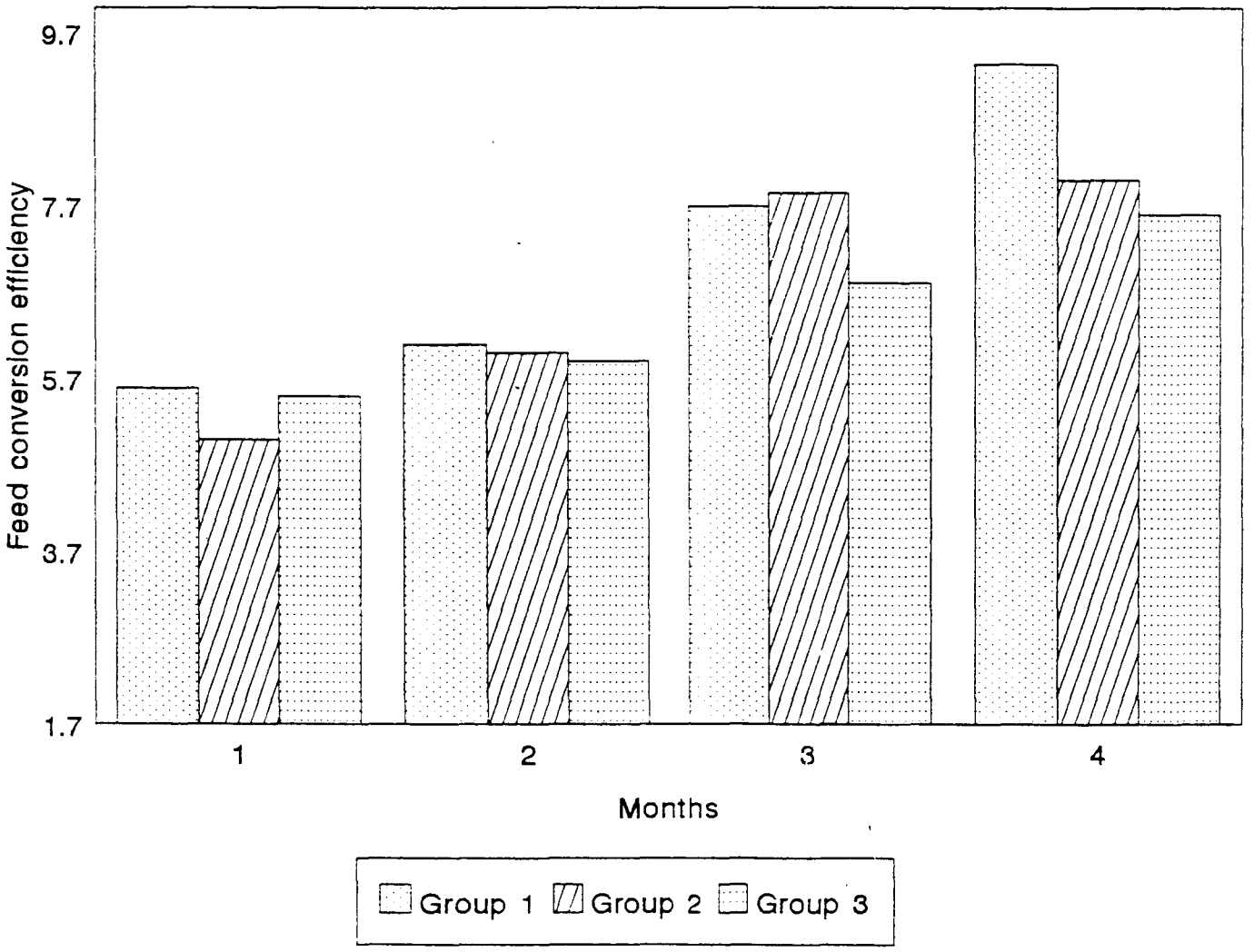

Fig.9 COST OF FEEDING PER Kg LIVE WEIGHT GAIN OF ANIMALS MAINTAINED ON THREE EXPERIMENTAL RATIONS

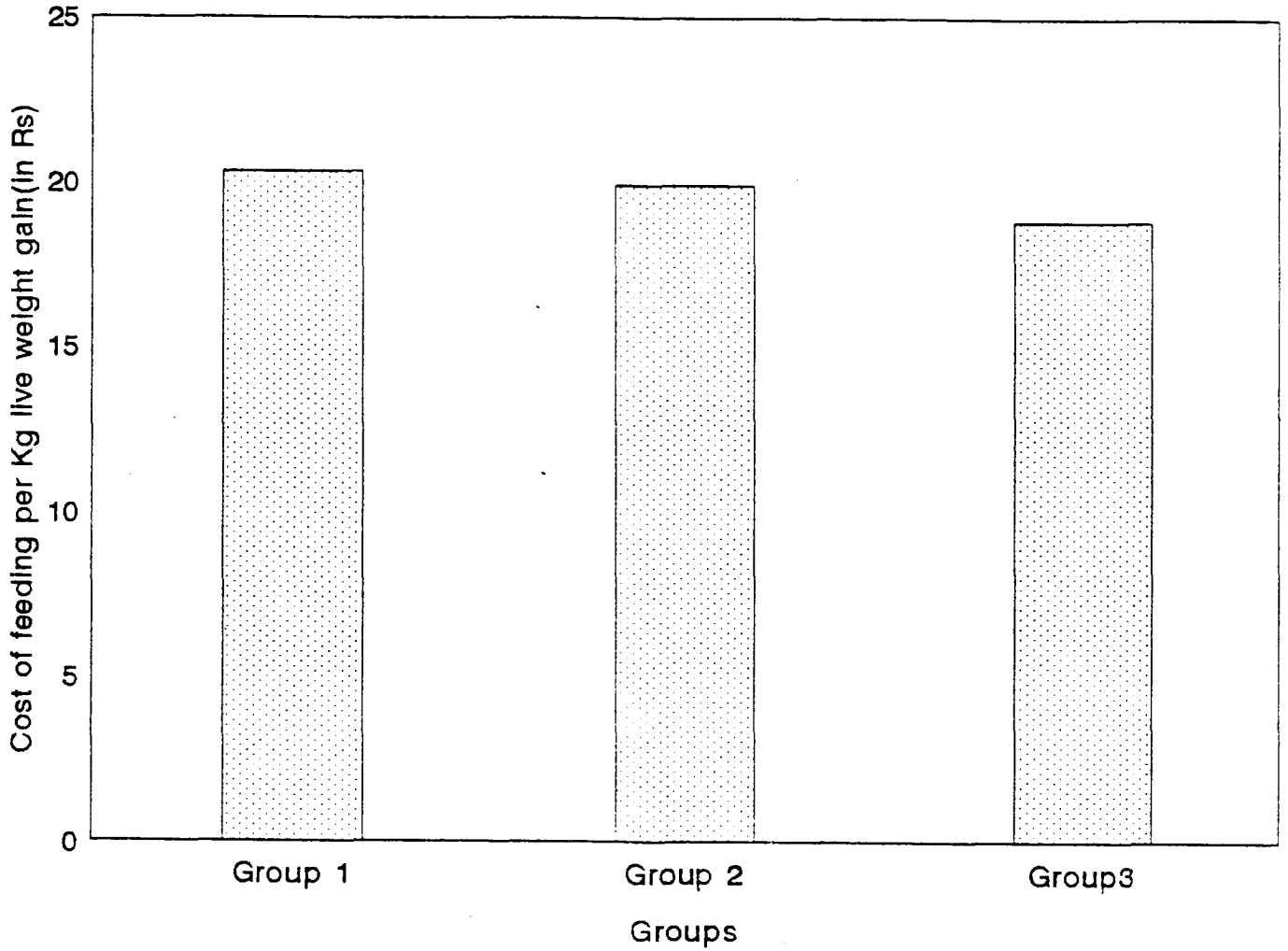

Table 47. Average haematological values of animals maintained on ration A during the experimental period of 126 days

Sl. No.	Animal No.	Haemoglobin concentration (g/100 ml)	Plasma protein (g/100 ml)	Blood urea nitrogen (mg/100 ml)
1.	098	10.95	7.3	8.5
2.	114	11.70	7.4	9.5
3.	129	11.70	7.6	8.5
4.	770	10.23	7.2	9.0
5.	139	12.20	9.1	9.0
	Mean	11.36±	7.7±	8.9±
	SE	0.31	0.32	0.17

Table 48. Average haematological values of animals maintained on ration B during the experimental period of 126 days

Sl. No.	Animal No.	Haemoglobin concentration (g/100 ml)	Plasma protein (g/100 ml)	Blood urea nitrogen (mg/100 ml)
1.	115	12.30	8.0	6.9
2.	127	12.80	7.0	8.1
3.	108	10.68	7.8	9.0
4.	100	10.90	7.8	8.5
5.	772	11.42	7.7	8.5
6.	768	12.30	7.9	9.5
	Mean	11.73±	7.7±	8.4±
	SE	0.32	0.13	0.33

Table 49. Average haematological values of animals maintained on ration C during the experimental period of 126 days

Sl. No.	Animal No.	Haemoglobin concentration (g/100 ml)	Plasma protein (g/100 ml)	Blood urea nitrogen (mg/100 ml)
1.	101	12.15	8.2	8.5
2.	111	11.60	8.3	7.5
3.	124	12.50	8.3	8.1
4.	773	11.70	7.9	8.5
5.	777	11.50	8.1	9.0
	Mean	11.89±	8.2±	8.3±
	SE	0.17	0.07	0.22

Table 50. Analysis of variance - Haemoglobin

Source	df	SS	MSS	F value
Between	2	0.759	0.379	0.728
Within	12	6.776	0.521	
Total	15	7.534		

NS - Non significant

Table 51. Analysis of variance - Plasma protein

Source	df	SS	MSS	F value
Between	2	151.01	75.50	1.220
Within	13	804.06	61.85	
Total	15	955.07		

NS - Non significant

Table 52. Analysis of variance - Blood urea nitrogen

Source	df	SS	MSS	F value
Between	2	177.7	88.85	1.210
Within	13	954.42	73.42	
Total	15	1132.12		

NS - Non significant

Table 53. Summarised data on feed and nutrients consumption of animals maintained on concentrate mixtures containing 0 (diet A), 5 (diet B) and 10 (diet C) per cent fish meal

Particulars	Treatments		
	I	II	III
Feed and nutrients consumption			
Dry matter intake (kg/day)	3.37 ± 0.13	3.33 ± 0.12	3.48 ± 0.13
Concentrate and roughage ratio	43:57 ± 0.01	43:57 ± 0.01	43:57 ± 0.01
DM intake kg/100 kg body weight	3.33 ± 0.08	3.32 ± 0.07	3.32 ± 0.08
DM intake (g)/kg metabolic body weight	105.80 ± 1.98	105.00 ± 1.81	106.00+ 1.98
CP intake (g)/day	386.40 ± 14.82	377.80 ± 6.95	384.00 ± 13.40
CP intake (g)/kg metabolic body weight	12.09 ± 0.28	11.91 ± 0.15	11.70+ 0.18
DCP intake (g)/day	266.60 ± 9.85	253.50 ± 5.53	260.60 ± 8.66
DCP intake (g)/kg metabolic body weight	8.34 ± 0.16	7.99 ± 0.11	7.94+ 0.11
TDN intake (kg)/day	2.16 ± 0.07	2.12 ± 0.06	2.22 ± 0.11
TDN intake (g)/kg metabolic body wt.	67.59 ± 1.87	66.89 ± 0.97	67.63+ 1.48

Table 54. Summarised data on body weights and body measurements of animals maintained on concentrate mixtures containing 0 (diet A), 5 (diet B) and 10 (diet C) per cent fish meal

Particulars	Treatments		
	I	II	III
Body weight			
Initial (kg)	70.80 ± 4.59	69.17 ± 4.19	70.60 ± 4.59
Final (kg)	132.20 ± 6.00	132.17 ± 5.48	140.40 ± 6.00
Gain (g/d)	487 ± 25.53	500 ± 23.31	554 ± 17.94
Body measurements			
Body length			
Initial	83.40 ± 2.10	85.00 ± 1.91	84.20 ± 2.20
Final	107.60 ± 1.76	107.60 ± 1.05	111.60 ± 1.89
Gain/day	0.184± 0.014	0.185± 0.013	0.217± 0.009
Heart girth			
Initial	93.00 ± 2.62	93.83 ± 1.96	93.00 ± 2.62
Final	116.20 ± 2.16	117.16 ± 1.79	118.00 ± 2.16
Gain/day	0.192± 0.243	0.185± 0.18	0.198± 0.013

Table 55. Summarised data on feed and protein efficiency, nutritive value of the rations, cost of feeding and haematological values of animals maintained on concentrate mixtures containing 0 (diet A), 5 (diet B) and 10 (diet C) per cent fish meal

Particulars	Treatments		
	I	II	III
Feed and protein efficiency (intake/gain)			
Feed	6.96 ± 0.24	6.68 ± 0.17	6.29 ± 0.20
Crude protein	0.80 ± 0.03	0.76 ± 0.02	0.69 ± 0.02
Digestible crude protein	0.55 ± 0.02	0.51 ± 0.01	0.47 ± 0.07
Nutritive value			
Crude protein (%)	11.54	11.35	11.11
Digestible crude protein (%)	7.97	7.61	7.54
Total digestible nutrients (%)	63.91	63.75	63.58
DCP:TDN ratio	1:8.02	1:8.38	1:8.43
Cost of feeding			
Cost of feeding/day (Rs.)	9.85 ± 0.41	9.91 ± 0.16	10.41 ± 0.35
Cost of feeding/kg live weight gain (Rs.)	20.31 ± 0.89	19.91 ± 0.65	18.83 ± 0.68
Haematological values			
Haemoglobin (g/100 ml)	11.36 ± 0.31	11.73 ± 0.32	11.89 ± 0.17
Plasma protein (g/100 ml)	7.70 ± 0.32	7.70 ± 0.13	8.20 ± 0.07
Blood urea nitrogen (mg/100 ml)	8.90 ± 0.17	8.40 ± 0.33	8.30 ± 0.22

Discussion

DISCUSSION

The results obtained during the course of experiments are discussed below.

5.1 Feed and nutrients consumption

Data on intakes of feed and nutrients are presented in Tables 3 to 12, summarised in Table 53 and represented in Fig.1, 2 and 3. The mean daily dry matter intake in kg per 100 kg body weight of calves in groups I, II and III were found to be similar, the values being 3.33, 3.32 and 3.32 respectively. Kirby and Chalmers (1983) observed no significant differences in dry matter intake of growing beef cattle fed diets containing a compound feed prepared with or without 100 g of fish meal per kg of compound feed. No significant differences in DM intake of bull calves receiving fish meal as an undegradable protein and casein as the rumen degradable protein source were also reported by Newbold and Rust (1989). Fish meal supplementation had no effect on DM intake of growing cattle in studies conducted by Veitia (1973); Abe et al. (1976) and Sil et al. (1994). On the other hand, Reddy and Singh (1991) opined that fish meal supplementation increases the DM intake by stimulating the microbial activity in the rumen. Kempton (1982) reported that supplementation with bypass protein either maintained or increased the feed intake in lambs. An increased DM intake on

fish meal based ration was also reported by Gill and England (1983) in young cattle. On the other hand a significantly lower voluntary feed intake was observed by Bowers et al. (1965) in their studies with fish meal based diets in Friesian steers.

The mean daily DM intake/kg metabolic body weight of calves in groups I, II and III were 105.8, 105.0 and 106 g respectively. Sampath (1985) reported a DM intake ranging from 98 to 108 g/kg metabolic body weight in crossbred calves while studying the effect of concentrate mixtures with different levels of degradable protein. Gupta and Saha (1983) observed a DM intake varying from 103 to 110 g/kg metabolic body weight while studying the effect of various levels of protein in crossbred calves.

The intake of crude protein, digestible crude protein and total digestible nutrients (g/kg metabolic body weight) were not significantly different among the groups. The values were 12.09, 8.34 and 67.59; 11.91, 7.99 and 66.89 and 11.70, 7.94 and 67.63 respectively in groups I, II and III. The intakes of digestible crude protein calculated using the digestibility coefficient were found to be lower by 18.7 per cent in group I, 22.7 per cent in group II and 20.6 per cent in group II than their requirements recommended for calves as per ICAR feeding standard (1985) for 550 g daily gain. Conversely, the calculated TDN intakes were higher in groups I, II and III by 20 per cent,

17.8 per cent and 23.3 per cent respectively than the recommendations of ICAR feeding standard (1985) for a similar daily live weight gain.

Ananthasubramaniam et al. (1982) recorded daily intakes of DCP and TDN in calves gaining at the rate of 313-369 g/day, the respective values being 326-371 g DCP and 2.25-2.38 kg TDN respectively. Puri and Gupta (1990) observed daily intakes of DCP and TDN ranging from 362 to 425 g and 2.5 to 3.2 kg respectively in crossbred calves weighing at the range of 90 to 150 kg.

5.2 Digestibility of nutrients

The results of digestion trials, presented in Tables 13 to 22 reveal that the digestibility coefficient of DM, OM, CF and NFE were not significantly different among the dietary treatments whereas those of crude protein and ether extract were significantly higher in control diet (A) than the other two diets B and C containing 5 and 10 per cent respectively of fish meal. The mean digestibility coefficient of DM OM, CP, EE, CF and NFE were 63.54, 66.81, 69.06, 67.93, 60.48 and 69.47 for diet A, 64.01, 67.08, 67.07, 64.13, 59.83 and 70.40 for diet B and 62.36, 66.74, 67.89, 64.79, 61.71 and 68.97 for diet C. Reddy and Singh (1991) observed no significant difference in the digestibility of nutrients between complete diets containing

fish meal and other sources of protein supplements, whereas, Gastang (1979) reported an increase in DM digestibility in Friesian calves by fish meal supplementation in grass silage based diets. An increased digestibility of DM and OM were also reported by Silva et al. (1989) and Ortiques et al. (1989) in cattle with fish meal supplemented diets. The reduced digestibility of protein in animals of group II and III might probably be due to incorporation of fish meal as one of the feed ingredients. This observation is in keeping with those of Sil et al. (1994) who recorded higher crude protein digestibility in groundnut oil cake based diets as compared to the diet containing fish meal, though the difference was not statistically significant. A lower digestibility of ether extract ($P<0.01$) was obtained with fish meal based diets B and C as compared to control diet A. A similar observation was also made by Ravi et al. (1993) who obtained lower ether extract digestibility in fish meal containing diet as compared to diets containing either groundnut oil cake or formaldehyde treated groundnut oil cake, in crossbred calves.

5.3 Growth response

The data on body weights are presented in tables 23 to 29, summarised in Table 54 and represented in Fig.4 and 5. The animals in dietary groups I, II and III receiving fish meal at 0, 5 and 10 per cent in their respective concentrate mixture

attained the final body weight of 132.20, 132.17 and 140.40 kg respectively from the initial body weight of 70.8, 69.17 and 70.60 kg during the experimental period of 126 days, the animals in group III, showing the highest final body weight. The average daily gain in body weight 487, 500 and 554 g respectively for animals in Groups I, II and III. Ananthasubramaniam et al. (1981) recorded daily live weight gain of 390 and 330 g respectively with the rations containing spent anatto seeds at 0 and 20 per cent level, in crossbred calves. Sampath (1985) recorded a daily weight gain of 346 to 448 g while studying the effect of concentrate mixtures with different levels of degradable protein in crossbred calves. An average daily weight gain of 545 g in crossbred calves of 6-10 months of age has been recorded in Dhoni farm (Anilkumar, 1995).

The results on average daily weight gain reveal that calves receiving the concentrate mixture containing fish meal at 10 per cent level had the highest daily gain followed by those receiving concentrate mixture with 5 per cent fish meal, the lowest being in animals fed with control diet without fish meal, eventhough the differences between the groups were not statistically significant. The increment of mean daily live weight gain were 2.7 per cent and 13.8 per cent in group II and III respectively over the daily gain of animals in group I. The results of the present study are in agreement with the finding of Thorney and Hogue (1986) who obtained 14.5 per cent faster

growth rate in steers fed with fish meal diet than on cottonseed diet with nearly identical daily dry matter intakes. Zinn and Owens (1993) also obtained 13.4 per cent increase in growth rate in feed lot steers fed barley based diets supplemented with 2.5 per cent animal byproducts as undegradable protein source. Increase in daily live weight gain by fish meal supplementation in calf growth rations, was also reported by several other authors (Aughes, 1983; Saadullah, 1984; Davenport et al., 1990 and Veira et al., 1994). However, the present finding is at variance with those of Sil et al. (1994) who reported higher daily live weight gain in yearling cattle fed with groundnut oil cake than on fish meal based diet, though the differences were not statistically significant. This difference might be probably due to the age factor. The increased growth response as a result of fish meal supplementation can be explained by the supply of greater proportion of bypass protein which inturn becomes available at the lower gut for better utilisation at the cellular level. Since the protein and energy contents of the three rations were almost identical, the better growth performance of animals in group II and group III can be taken as a reflection of better availability of aminoacids from the fish meal protein when compared to Groundnut oilcake as a source of protein supplement.

5.4 Body measurements

Data on body measurements recorded at fortnightly intervals are presented in Tables 30 to 40, summarised in Table 54 and represented in Fig.6 and 7. The average initial and final body length (in cm) of animals belonging to groups I, II and III were 83.4 and 107.6; 85.0 and 107.6; and 84.2 and 111.6 respectively. Devasia (1989) observed that body length (in cm) increased from 79.5 to 87.88 in half bred Jersey and 81.25 to 89.88 in half bred Brown Swiss calves respectively from 6 to 10 months of age. Reddy et al. (1991) observed average body length (in cm) of 94.1 and 104.9 in crossbred calves at 6th and 10th months of age respectively. The values for the total and daily gain in body length recorded in the present study were 24.2 and 0.192; 22.6 and 0.179 and 27.4 and 0.217 cm respectively for animals in Groups I, II and III. In a similar experiment, but in younger animals using calf starter containing fish meal at 10 per cent level, Francis (1978) recorded 22.3 and 0.133 cm respectively from birth to 24 weeks of age. Shinde and Sangle (1976) reported daily gain in body length of 0.339 cm in young crossbred calves fed on two different calf meals over a period of 24 weeks.

The average initial and final Heart girth (in cm) of animals belonging to groups I, II and III were 93.10 and 116.2; 93.83 and 117.16 and 93.00 and 118.00 respectively. The values

for total and daily gain in heart girth recorded in the present study were 23.2 and 0.184; 23.33 and 0.185 and 25, 0.198 cm respectively for the animals in group I, II and III. Devasia (1989) observed that heart girth (in cm) increased from 103.5 to 117.56 in half bred Jersey and 105.25 to 118.5 in half bred Brown Swiss calves respectively from 6th to 10th months of age. Reddy et al. (1991) recorded average heart girth (in cm) of 110.5 and 124.4 respectively in crossbred calves at the age of 6th and 10th month of age. Shinde and Single (1976) recorded daily gain in heart girth of 0.191 and 0.208 cm respectively in calves fed two different meals from birth to 24 weeks of age. Francis (1978) recorded a heart girth value of 0.146 cm in young calves fed with calf starter containing fish meal at 10 per cent level from birth to six months of age. Although, the results of body measurements among the groups were not significantly different, slightly higher gain obtained in group III reveals that calves fed with diet C had higher skeletal and muscular growth than in those fed with diets A and B.

5.5 Feed and protein efficiency

Data on feed and protein efficiency are presented in Table 41 to 46, summarised in Table 55 and represented in Fig.8. The mean feed efficiency (quantity of DM intake/kg live weight gain) obtained for the animals were 6.96, 6.68 and 6.28 respectively for the three groups I, II and III. Smith et al.

(1965) obtained a feed efficiency ranging from 4.21 to 5.99 for Holstein calves averaging 130 kg body weight. Ananthasubramaniam et al. (1983) reported feed efficiency of 13.48 and 11.36 with ration containing coconut pith at 0 and 25 per cent level in crossbred calves.

The results showed that the feed conversion efficiency was highest in group III followed by group II and group I, though the differences were not statistically significant. The calves fed with fish meal at 5 and 10 per cent levels in the concentrate mixture required 0.28 and 0.67 kg less respectively of dry matter per kg live weight gain than for the diet without fish meal. The reduction in feed required per unit gain of animals in groups II and III were 4.02 and 9.62 per cent respectively when compared to that of group I. The results are comparable to those reported by Sindt et al. (1994) who obtained 8.4 per cent increased feed efficiency from a basal diet supplemented with animal by-product meals as ruminal escape protein for the growth of steers. The results are also in agreement with those of Fluhanty et al. (1994) who observed an improvement in feed efficiency by 7.6 per cent with blood meal containing diet as compared with soyabean based diet when the crude protein was kept at 13 per cent of DM and of Thonney and Hogue (1986) who obtained a 12.6 per cent decline in feed requirement in steers on fish meal based diet (30 g/kg) in comparison to that of cotton seed meal diet. An increased feed

conversion efficiency with fish meal diet in calves was also reported by Kaiser et al. (1982) and Veira et al. (1994). However, Veitria (1973) reported, no significant difference in the conversion of feed to gain with graded levels of fish meal supplementation in molasses-urea based diets in bulls.

The conversion efficiency of crude protein and digestible crude protein were found to be 0.8 and 0.55; 0.76 and 0.51 and 0.69 and 0.51 respectively for the groups I, II and III. The results show that protein conversion efficiency was highest in group III followed by group II and group I, though the differences were not statistically significant among the different groups. Klopfenstein (1981) reported that the protein efficiency was 195 per cent for blood meal while soyabean was considered as 100 percent for growth in steers. Veira et al. (1994) reported that, on CP basis soyabean meal was approximated 80 per cent as effective as fish meal in increasing the live weight gain in steers. Sil et al. (1994) reported that the conversion efficiency of CP and DCP were not statistically significant between groundnut oil cake and fish meal based diets in yearling cattle.

The ratio of DCP:TDN (protein energy) of the diets A, B and C were 1:8.02, 1:8.38 and 1.8.43 respectively. The relatively lower DCP:TDN ratio in fish meal based diets B and C together with the better live weight gains exhibited by the

animals fed these diets as compared to those fed diet A, clearly indicates the better availability of amino acids from fish meal diet which supports the findings of Ortigues et al. (1989) who reported that the amino acid supply to the small intestine at the same level of ME intake can be increased by increasing the level of fish meal in the diet. Dixon et al. (1993) suggested that, the low protein energy ratio of absorbed nutrients in urea supplemented straw based diets in lambs, can be increased by fish meal supplementation which inturn improved the efficiency of utilisation of ME also. Ravi et al. (1993) reported DCP:TDN ratios of 1:6.2 and 1:7.0 in growing calves weighing 54.6 kg fed with groundnut oil cake and fish meal based concentrate mixtures respectively.

5.6 Economics of feeding

The cost of feeding in three groups of animals are summarised in Table 55 and represented in Fig.9. The cost of feeding per day was highest in group III (Rs.10.41) followed by group II (Rs.9.91) and least in group I (Rs.9.85). However, the cost of feeding per unit live weight gain was lowest in group III (Rs.18.83) followed by group II (19.91) and highest in group I (Rs.20.31), though the differences were not statistically significant. Thus, it can be inferred that feeding of calves with concentrate mixture containing fish meal upto 10 per cent level is economically the most efficient.

5.7 Haematological values

The results of haematological studies carried out at monthly intervals during the course of the experiment are presented in tables (47 to 52) and summarised in table (55).

The mean values for Haemoglobin (g/100 ml), plasma protein (g/100 ml) and blood urea nitrogen (mg/100 ml) were 11.36, 7.70 and 8.9, 11.73, 7.70 and 8.40 and 11.89, 8.20 and 8.3 for the group I, II and III respectively. The results did not reveal any significant difference among the different dietary treatments in regard to the various parameters studied. The slightly higher value for plasma protein in animals of group III indicated the relatively better nutritional status of animals maintained on diet C over the animals on diets A and B. This is in agreement with findings of Fernandez et al. (1993) who obtained higher serum total protein in lambs receiving diet containing fish meal than diet without fish meal.

The mean blood urea concentrations were lower in groups II and III than in group I, which is in confirmation with the reports of Whitelaw et al. (1961) and Bowers et al. (1965) who showed that blood urea concentration was significantly lower on fish meal diets than on diets based on groundnut oil meal. On the other hand, Kirby and Chalmers (1983)b reported that serum urea concentration was increased by fish meal supplementation.

A critical evaluation of the overall results obtained in the present study reveals that the diets containing fish meal exert positive, though not significant, influence on the performance of crossbred calves in terms of growth rate, feed conversion efficiency and economics. Thus, it can be reasonably concluded that replacement of vegetable protein supplements like groundnut oil cake with fish meal at 10 per cent level as a source of good quality undegradable protein in the ration of crossbred calves can have a beneficial effect in maintaining optimum growth rate with reduced feed cost.

Summary

SUMMARY

An investigation was undertaken to assess the effect of fish meal in the ration of crossbred calves on nutrient intake, digestibility of nutrients, growth rate, feed conversion efficiency and economics of feeding, using eighteen crossbred heifer calves of 5-7 months of age and about 70 kg mean body weight, divided into three groups (I, II and III) of six animals each. Calves in group I, II and III were fed concentrate rations containing 0 (diet A), 5 (diet B) and 10 (diet C) per cent fish meal respectively.

Records on daily feed intake, fortnightly body weights and body measurements were maintained throughout the course of the experiment. Blood samples were collected from all the animals at monthly intervals for the estimation of haemoglobin, plasma protein and blood urea nitrogen. Towards the end of feeding experiment, a digestion trial was carried out to assess the digestibility coefficient of nutrients of the three rations. The economics of feeding the animals with the three rations were also worked out.

The mean DM intake (kg/day and g/kg metabolic body weight/day) of calves in group I, II and III were 3.37, 3.33 and 3.48 and 105.8, 105.0 and 106.0 respectively, there being no significant difference among the groups in this regard. The intake of CP, DCP and TDN (g/kg metabolic body weight) were not

significantly different among the groups, the values being 12.09, 8.34 and 67.59; 11.91, 7.99 and 66.89; and 11.70, 7.99 and 67.63 respectively in Groups I, II and III. The slightly lower intake of CP and DCP in groups II and III as compared with group I may be due to relatively lower protein content and lower digestibility of protein in fish meal based diets (B and C).

Though the digestibility coefficients of DM, OM, CF and NFE were not significantly different in animals on the various dietary treatments, the digestibility coefficients of crude protein and ether extract were significantly higher in group I fed the control diet (A).

The animals in dietary groups, II and III receiving fish meal at 5 (diet B) and 10 (diet C) per cent in their concentrate ration recorded higher daily body weight gain than animals of group I fed with control diet without fish meal (diet A), the average daily gain being 487, 500 and 554 g respectively for animals in group I, II and III, indicating greater proportion of bypass protein and high amino acid profile from the fish meal protein when compared to groundnut oil cake as a source of protein supplement.

Although, the results of body measurements viz., body length and heart girth were not significantly different among the groups, the higher gain obtained for calves in group III

revealed that fish meal supplementation promoted higher skeletal and muscle growth.

The mean feed efficiency obtained for the animals were 6.96, 6.68 and 6.28 respectively for the three groups I, II and III. Similarly, the CP and DCP conversion efficiency were found to be 0.80 and 0.55; 0.76 and 0.51 and 0.55 and 0.57 respectively for the groups I, II and III. The results showed that the conversion efficiency of feed and nutrients was highest in group III followed by group II and I though the differences were not statistically significant.

The ratio of DCP:TDN of the diets A, B and C were1:8.02, 1:8.38 and 1:8.43 respectively. The relatively lower protein energy ratio in fish meal based diets B and C together with the better live weight gains exhibited by the animals fed these diets as compared with diet A indicated greater proportion of bypass protein which inturn increased amino acid supply from the fish meal diets.

The cost of feeding per unit of live weight gain was lowest in group III fed 10 per cent fish meal in concentrate ration followed by group II and highest in group I, though the differences were not statistically significant.

Data on haematological constituents recorded for the animals in different groups were within the normal range

reported for the species there being no significant difference among the animals fed the three diets or in any of the parameters studied. However, the slightly higher value for plasma protein in animals in group III, indicated the relatively better nutritional status of animals maintained on diet supplemented with fish meal at 10 per cent level.

From a critical evaluation of the overall results obtained in the present study, it can be reasonably concluded that the replacement of groundnut cake with fish meal at 10 per cent level as a source of good quality UDP in the ration of crossbred calves, can have a beneficial effect in maintaining optimum growth rate with reduced feed cost.

References

REFERENCES

Abe, M., Shibui, H. and Iriki, T. (1976). Effect of formaldehyde treated fish meal on the plasma amino acids concentration of growing calves given semipurified diet containing urea as a main source. Jpn. J. Zootech. Sci., **47** (12): 748-755.

Ananthasubramaniam, C.R., George Mathen and Mercy, A.D. (1981). Effect of spent annato (Bixa orellana L.) seeds on growth in calves. Indian J. Nutr. Dietet. **18**: 37-340.

Ananthasubramaniam, C.R., George Mathen and Mercy, A.D. (1982). Coconut pith in concentrate mixtures for crossbred calves. Kerala J. Vet. Sci. 13(1): 143-148.

Ananthasubramaniam, C.R., Ramachandran, P., George Mathen, Annamma Kurian, Mercy, A.D. and Jose John Chungath. (1983). Evaluation of coconut pith based complete ration for crossbred calves. Kerala J. Vet. Sci. **14**: 20-24.

Anilkumar, R. (1995). Personal Communication.

A.O.A.C. (1990). Official Methods of Analysis. Association of Agricultural Chemists', Washington, D.C.

Aughes, J. (1983). Protein supplementation of calves offered silage. Anim. Prod. **36**: 537.

Benjamin, M. (1985). Outline of Veterinary Clinical Pathology, 3rd ed. Kalyani Publishers, New Delhi.

Bossaibati, M.A. and Bryant, M.J. (1994). Effect of rapeseed meal and fish meal supplementation of maize silage-based diets upon voluntary intake, live weight gain and wool growth of store lambs. Anim. Prod. **58** (1): 49-56. Cited in Nutr. Abstr. Rev. Series (B) (1994). **64** (4): 266.

Bowers, H.B., Preston, T.R., McDonald, I., Macleod, N.A. and Philip Euphemia. (1965). Intensive beef production. 5. The effect of different sources of protein on nitrogen retention. Anim. Prod. **7**: 303-308.

Brand, A.A., Cloete, S.W.P. and Franck, F. (1994). The effect of supplementing untreated, urea supplemented and urea-ammoniated wheat straw with maize meal and/or fish meal in sheep. South African J. Anim. Sci. 21 (1): 48-54. Cited in Nutr. Abstr. Rev. Series (B) 1994: 64 (6): 387.

Burrough, W., Nelson, D.K. and Mortens, D.R. (1975). Protein physiology and its application in the lactating cow. The metabolisable protein feeding standard. J. Anim. Sci. 41: 933-944.

Combellas, J. (1991a). The importance of urea-molasses blocks and bypass protein in animal production. The situation in Tropical America. In: Isotope and Related Technique in Animal Production and Health. IAEA, Vienna, pp.115-131. Cited in Anim. Feed Sci. Technol. (42) (3-4): 319-331.

Combellas, J., Priore, F. and Peralta, J. (1993). Influence of the addition of fish meal to diets of roughage and concentrate on the consumption and live weight gain of growing cattle. Anim. Feed Sci. Technol. 42 (3-4): 319-331.

Devasia, P.A.(1989). Comparative feed efficiency of crossbred Jersey and crossbred Brown Swiss cattle. Ph.D. thesis, Kerala Agricultural University, Thrissur.

Davenport, G.M., Boling, J.A. and Gay, N. (1990). Performance and plasma aminoacids of growing calves fed corn silage supplemented with ground soyabeans, fish meal and rumen protected lysine. J. Anim. Sci. 68 (1): 3773-3779.

Dixon, R.M., Thomas, R., Thalen, A. and Egan, A.R. (1993). Responses of young sheep to supplements. In Recent Advances in Animal Nutrition in Australia. Cited in Nutr. Abstr. Rev. (Series B) (1993) 63 (10): 685.

Drennan, M.J., Moloney, A.P. and Keane, M.G. (1994). Effect of protein and energy supplements on performance of young bulls offered grass silage. Irish J. Agric. Food Res. 33 (1): 1-10. Cited in Nutr. Abstr. Rev. (Series B) (1994) 64 (9): 616.

Geetha, A. (1981). Lucerne meal as an ingredient in calf starter. M.V.Sc. thesis, Kerala Agricultural University, Thrissur.

*Fernandez, J.M., White, T.W., DeRouen, P.T., Sticker, L.S., Bidnur, T.D. and Chaga, A.M. (1993). Influence of fish meal on growth and blood parameters of lambs and kids. (Abstract). J. Anim. Sci. Suppl. I. 71: 273.

Fluhanty, F.L., Loerch, S.C. and Smith, F.E. (1994). Effect of energy density and protein source on diet digestibility and performance of calves after arrival at the feed lot. J. Anim. Sci. 72 (6): 1616-1622.

Francis, U.T. (1978). A study of the calf starter with locally available feed ingredients. M.V.Sc. thesis. Kerala Agricultural University, Mannuthy.

*Gastang, J.R. (1979). The effect of supplementation of Grass silage with fish meal on intake and performance by British Friesian calves (Abstract). Anim. Prod. 28: 423.

Gaya, H., Nasseevan, R. and Hulman, B. (1979). Effect of the level of fish meal on growth and feed conversion of cattle fed molasses/urea and restricted amounts of forage. Trop. Anim. Prod. 4 (2): 148-153. Cited in Nutr. Abstr. Rev. (Series B) 1981, 51 (4): 264.

Gibb, D.T., Klopfenstein, T.J. and Sindt, M.H. (1992). Combinations of rendered protein meals for growing calves. J Anim. Sci., 70(8): 2581-2589.

*Gill, M. and England, P. (1983). The effect of level of fish meal and sucrose supplementation on the voluntary intake of silage and live weight gain in young cattle (Abstr.). Anim. Prod. 36: 513.

Gonzalez, F., Elias, A. and Urquiza, V. (1990). Effect of different protein levels on the feed of grazing calves. Cuban J. Agri. Sci. 24 (2): 159-164. Cited in Nutr. Abstr. Rev. (Series B) 1992, 62 (3): 176.

Gornall, A.G., Bardawill, C.J. and David, M.M. (1949). Determination of serum protein by the biuret reaction. J. Biol. Chem. 177: 751-766.

Gupta, B.N. and Saha, R.C. (1983). Effect of various levels of protein intake on nutrient utilisation by crossbred calves in hot and humid climate of West Bengal. Indian J. Nutr. Dietet. 20: 394-400.

★ Hooper, G.S., Mcksight, D.R. and Veira, D.M. (1989). Improving the utilisation of alfalfa haylage fed to growing steers with the addition of fish meal or molasses (abstract). Can. J. Anim. Sci. 69 (1): 288.

ICAR (1985). Nutrient requirements of livestock and poultry. Publication and Information Division. ICAR, New Delhi.

Jain, J.P. and Shwtar Singh. (1990). Quantitative and qualitative insufficiency of livestock feeds by 2000 AD and possibilities of bridging the gap. Indian J. Anim. Sci. 60 (10): 1224-1229.

Jaiswal, R.S., Verma, M.L. and Agarwal, T.S. (1988). Effect of various protein supplements added to ammonia (urea) treated rice straw diet on nutrient intake, digestibility and growth in crossbred heifers. Indian J. Anim. Nutr. 5 (3): 188-194.

Kaiser, A.G., Osbourn, D.F. and England, P (1982). The utilisation by calves of formaldehyde treated maize silage and the response to supplementing protein. Anim. Prod. 34 (2): 179-190.

★ Kaufman, W. (1977). Calculation of protein requirements for dairy cows according to measurements of nitrogen metabolism. In protein metabolism and nutrition. E.A.A.P. Publ. 22 pp.130-132. Ed. Taminga, S. Centre for Agricultural Publishing and Documentation, Wageningen.

Kay, M., Preston, T.R., Macleod, N.A. and Philip Euphemia, B. (1966). NUtrition of early weaned calf. IX. Nitrogen retention from different protein sources in calves fed ad libitum Anim. Prod. 8: 43-45.

Kempton, T.J. (1982). Growth of lambs given a roughage diet at isocaloric amounts of various supplements. Proc. Aust. Soc. Anim. Prod. 14: 649.

Kempton, J.J., Nolan, J.V. and Leng, R.A. (1979). Protein nutrition of growing lambs. 2. Effect on nitrogen digestion of supplementing a low protein cellulose diet with either urea, casein or formaldehyde treated casein. Br. J. Nutr. 42: 303-315.

*Kirby, P.S. and Chalmers, A.J. (1983)a. A comparison of formaldehyde treated soyabean meal and two types of fish meal as protein supplements for growing beef cattle given grass silage ad libitum. Anim. Prod. (Abstr.) 36: 538.

*Kirby, P.S. and Chalmers, A.J. (1983)b. Fish meal supplementation of grass silage diets for fattening British Friesian steers. Anim. Prod. 36: 538.

*Mackie, C.K, Thomas, S. and Wilkinson, S.C. (1989). The effect of fish meal on winter and summer performance of young growing cattle. (Abstr.). Nutr. Abstr. Rev. (Series B) 59(1): 29.

Makokha, A.O. (1992). Fish meal and/or methionine supplementation of nutritionally improved straws for lambs. Bulletin of animal health and production in Africa 40(1): 41-47. Cited in Nutr. Abstr. Rev. (Series B.)1994 64:5 pp 338.

Mantysaari, P.E., Sniffen, C.J., Muscate, T.V. and Thonney, M.L. (1989). Performance of growing dairy heifers fed diets containing soyabean meal and animal byproduct meals. J. Dairy Sci. 72 (8): 2107-2114.

Mathur, B.N. (1995). Dairy industry in India, Projection for the post GATT. Indian Dairyman. XLVII, 4: 4.

*Navaes, L.P, Polan, C.E. and Stieve, DF. (1991). Growth and body composition response of Holstein heifers to varying degradable protein sources. J. Dairy Sci. (Abstr). 74: Suppl. 218.

*Newbold, J.R. and Rust, S.R. (1989). Source of rumen degradable protein influences feed efficiency and feeding behaviour in Holstein bull calves. Teaming up for Animal Agriculture. (Abstr), 530.

Obi Reddy, A., Gopalakrishna and Rao, M.K. (1991). Growth of crossbred calves under field conditions. Indian J. Anim. Sci. 61 (12): 1318-1321.

Ortigues, I., Smith, T., Oldham, J.D., Mcallan, A.B. and Sivites, J.W. (1989). Nutrient supply and growth of cattle offered straw based diets. Br. J. Nutr. 62 (3); 601-619.

Petit, H.V., Lachance, B. and Diorio, D. (1991). The effect of protein source on the growth and carcass characteristics of veal calves. Can. J. Anim. Sci. 71 (2): 409-416.

Petit, H.V. (1993). Use of protein supplements for dairy heifers fed fresh grass. J. Dairy Sci. 76 (3): 798-802.

Poonawalla, I.F. (1995). Quality milk programme. Indian Dairyman. XLVII, 4: 8.

Preston, J.R.,Whitelaw, I.G, Macleod, N.A., Philip Euphemia, B. (1965). The nutrition of early weaned calf. VIII. The effect on nitrogen retention of diets containing different levels of fish meal. Anim. Prod. 7: 53-158.

Puri, J.P. and Gupta, B.N. (1990). Effect of feeding N (urea) treated rice straw on growth and nutrient utilisation in crossbred calves. Indian J. Anim. Nutr. 7 (3): 191-194.

Ravi, A., Parthasarathy, M., Reddy, E.P. and Anjaneya Prasad, D. (1993). Effect of partial replacement of formaldehyde treated groundnut meal with urea or fish meal on utilisation of nutrient in calves. Indian J. Anim. Nutr. **10**(1): 35-38.

Reddy, D.V. and Singh, U.B. (1991). Effect of supplementation of various protein meals at catalytic levels on utilisation of ammoniated wheat straw based diets in Buffaloes. Indian J. Anim. Nutr. 8 (1): 7-14.

Rook, J.A.F. and Line, C. (1962). The influence of level of dietary protein on the yield and chemical composition of milk. 16th Intern. Dairy Congr. Copenhagen pp 57-62. Cited in Feeding strategy for the high yielding dairy cows. Ed. Broster, W.H. and Swan, H. (1979) pp.131.

★Roy, J.H.B., Balch, C.C., Miller, S.L., Orskov, E.R. and Smith, R.H. (1977). Calculation of nitrogen requirement for ruminants for nitrogen metabolism studies. In. Protein metabolism and nutrition, E.A.A.P. Publ. 22, pp. 126-129, Ed. Taminga, S. Centre for Agricultural Publishing and Documentation, Wageningen.

Saadullah, M. (1984). Studies on utilisation of rice straw by cattle. Ph.D. thesis, Royal Veterinary and Agricultural University, Copenhagen.

Sampath, K.T. (1985). Studies on the degradability of proteins and protected proteins in the rumen of cattle. Ph.D. thesis, Kerala Agricultural University, Thrissur.

Shinde, S.S. and Sangle, E.M. (1976). Studies on growth of crossbred calves (Jersey x Red Sindhi) fed with sugar calf meal and home made calf meal from birth to twenty four weeks. Indian J. Dairy Sci. 29(3): 240-242.

Sil, B., Pathak, N.N. and Kamra, D.N. (1994). Effect of different intact proteins on nutrient utilisation and growth response of crossbred (Bos taurus x Bos indicus) male calves. J. Appl. Anim. Res. 5: 153-159.

Silva, A.T., Greenhalgh, J.F. and Orskov, E.R. (1989). Influence of ammonia treatment and supplementation on the intake, digestibility and weight gain of sheep and cattle on barley straw diets. Anim. Prod. 48(1): 99-108.

Sindt, M.H., Stock, R.A. and Klopfenstein, J.J. (1994). Urea vs urea and escape protein for finishing calves and yearlings. Anim. Feed Sci. Technol 49(1-2): 103-117.

Singh, U.B. (1991). Protein as a catalyst for rumen fermentation. First International Animal Nutrition Workers Conference for Asia and Pacific. September, 23-28, Bangalore (India).

Singh, U.B. and Mehra, U.R. (1990). Utilisation of ammoniated wheat straw given in a feed block and supplemented with varying quantities of fish meal and oil extracted rice bran. Anim. Feed Sci. Technol. 28 (1-2): 129-134.

Smith, T., Broster, V.J. and Hill, R.E. (1980). A comparison of source of supplementary nitrogen for young cattle receiving fibre rich diets. J. Agric. Sci., (UK) 95(3): 687-695. Cited in Nutr. Abstr. Rev. (Series B) 1981, 51(8): 567.

Smith, G.E., Smith, W.H. and Beeson, W.M. (1965). Effect of different levels of cellulose in semipurified diets for calves. J. Dairy Sci. 48(6): 787.

Snedecor, G.W. and Cochran, W.G. (1967). Statistical methods, 6th Ed. Oxford and IBH Publishing Co., Calcutta.

Steen, R.W.T. (1992). A comparison of soyabean meal, fish meal and maize gluten feed as protein sources for cavles offered grass silage ad libitum. Anim. Prod. 54(3): 333-339.

Sultansingh, M.L., Verma, D.S. Dahiya and Panwar, V.S. (1993). Comparative feeding value of different protein sources with ammoniated rice straw in crossbred heifers (Abstr.) : Feeding strategies of livestock and poultry in relation to available feed resources. Proceedings of the Sixth Animal Nutrition Research Workers Conference (13th-16th Sept. 1993). pp.88.

Terry Klopfenstein, T. (1981). Animal protein fed as rumen bypass proteins. Feedstuff, USA 53(29): 23-24.

Thonney, M. K. and Hogue, D.E. (1986). Fish meal or cottonseed meal as supplemental protein for growing Holstein steers. J. Dairy Sc. 69: 1648-1651.

Veira, D.M., Butler, G., Proulex, J.G., Poste, L.M. (1994). Utilisation of grass silage by cattle: Effect of supplementation with different sources and amounts of protein. J. Anim. Sci., 72(6): 1403-1408.

Veira, D.M., Proulx, J.G., Butler, G. and Fortin, A. (1988). Utilization of grass silage by cattle further observation on the effect of fish meal. Can. J. Anim. Sci. 68: 1225.

Veitia, J.L. (1973). Fish meal protein supplements for bulls fattened on molasses urea diets. Cuban J. Agric. Sci. 7(3): 301-305. Cited in Nutr Abstr. Rev. (1975) 45(1): pp. 238.

Verite, Journet, M. and Jarrige, R. (1979). A new system for protein feeds of ruminants. The PDI system. Livestock Prod. Sci. 6: 349-367.

White, T.W., Fernandez, J.M. DeRouen, P.T. and Sticker, L.S. (1993). Growth and metabolic response of calves. J. Anim. Sci. 71: 255.

Whitelaw, F.G., Preston, T.R. and Dawson, G.S. (1961). The nutrition of early weaned calf. Groundnut oil meal, heat treated groundnut oil meal and fish meal as the major protein source in the diet. Anim. Prod. 3(1): 127.

Wilkinson, J.M., Lonsdale, E.R. and Tayler, J.C. (1973). The growth of beef cattle fed on maize silage supplemented with dried lucerne, fish meal or urea. British Grassland Society 28(1): 13-19. Cited in Nutr Abstr. Rev. (1973): 43-11, 912.

Windschitl, P.M., Rundall, K.M. and Brainard, D.J. (1991). Effect of fish meal in dairy cow diets on lactational performance and rumen metabolism. J. Dairy Sci. 94: 257-264.

Zinn, R.A. and Owens, F.N. (1993). Ruminal escape protein for live weight feed lot calves. J. Anim Sci. 71(7): 1677-1687.

*Original not consulted

EFFECT OF FISH MEAL ON GROWTH AND FEED CONVERSION EFFICIENCY IN CROSSBRED CALVES

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ABSTRACT OF A THESIS

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ABSTRACT

An investigation spread over a period of 126 days was carried out to assess the effect of fish meal in concentrate mixtures of calves for growth. Eighteen crossbred calves of 5-7 months of age and about 70 kg mean initial body weight, divided into three identical groups formed the experimental subjects. The calves in groups I, II and III were maintained on concentrate mixtures containing 0 (diet A), 5 (diet B) and 10 (diet C) per cent respectively of fish meal along with grass hay fed ad libitum as the sole roughage.

Data on body weight and body measurements, feed conversion efficiency, digestibility of nutrients, haematological values and economics of feeding of the calves were the criteria employed for the evaluation.

The intake of DM, CP, DCP and TDN (g/kg metabolic body weight) were not significantly different among the animals in three groups. The digestibility coefficients of crude protein and ether extract were significantly higher in animals of group I than in those of groups II and III.

The average daily gain in body weight were 487, 500 and 554 g respectively for the animals in groups I, II and III respectively and the increase in growth response was linearly and positively correlated to the level of fish meal in the diet.

Although, body measurements did not reveal any significant difference among the groups, the slightly higher values obtained in group III indicated that calves fed diet Ccontaining 10 per cent fish meal had higher skeletal and muscle growth than those fed diets A and B.

Highest feed and protein conversion efficiency were shown by calves of group III fed fish meal at 10 per cent level in the diet followed by those in group II and I. Diet C containing 10 per cent fish meal in the concentrate mixture was proved to be most cost effective.

Though the haematological parameters did not reveal any significant difference among the groups, the slightly higher value for plasma protein obtained for animals in group III indicated the relatively better nutritional status of animals maintained on diet C over the animals on diet A and B.

An overall critical assessment of the results clearly indicated that fish meal can be included in calf ration at 10 per cent level in partial replacement of vegetable protein supplements like groundnut oil cake, with beneficial results in terms of biological and economic efficiency.