The Effect of Early Feeding of Soybean and Fishmeal Based Calf Starter Ration on Feed Utilisation and Growth Performance by Dairy Calves

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Abstract

Twelve calves (4 Friesian, 5 Ayrshire and 3 Friesian x Boran crosses) were randomly allocated to three weaning regimes. These were Soybean-Fishmeal (SBFM) + 8 weeks weaning (treatment I), SBFM + 12 weeks weaning (treatment II) and cottonseed cake -maize bran Dairy Meal Concentrate (DMC) + 16 weeks weaning (Control treatment III). Their growth performance was assessed up to 20 weeks of age. A digestibility trial was conducted immediately after weaning using three calves from each treatment group. Mean birth weight of calves was 28.33± 3.45 kg and mean weights at 20 weeks of age were 99.2, 107.9 and 66.9 kg reflecting an overall growth rate of 0.51, 0.57 and 0.28 kg/day for treatment I, II and III, respectively. The mean growth rate of calves on treatment III was significantly lower (P=0.05) than those on treatments I and II from the 17th to 20th week of age. There were significant differences (P=0.01) in %CP digestibility between treatments I (75%), II (72%) and III (54%). Amounts of milk consumed during experimental period were136.5, 241.5 and 353.5 litres per calf for treatments I, II and III. Cost of milk constituted 80.4%, 76.7% and 89.9 % of the total feed cost for treatments I, II and III. Based on growth performance and cost, it was concluded that early feeding of calves with soybean-fishmeal based calf starter was more efficient and economical than cotton seed cake -maize bran based feeds commonly used in feeding dairy calves in Tanzania.

Keywords: Soybean-fishmeal, Calf starter, Early feeding, Weaning

Introduction

In most sub-Saharan countries with a developing dairy industry, calves are generally weaned at 12 to 16 weeks of age, or when they have reached the target weaning weight, normally about 60 - 70 kg. Calves may require more than 12 weeks to attain the desirable weaning weight due to a variety of factors, such as, low birth weights combined with low growth rates caused by poor feeding regimes or parasitic and non parasitic infections. Weaning at 16 - 24 weeks is not uncommon in Tanzania (Akarro and Makiriye, 1986). This leads to the consumption of 300 - 400 litres of milk by the calf from birth to weaning, costing 75,000 to 100,000 Tanzanian shillings per calf. Such high costs of feeding calves makes heifer calves very expensive relative to the final market value of the heifers (about Tshs. 300,000 for in-calf heifers). Raising bull calves for beef production becomes uneconomical if the cost of liveweight gain is above the present market price of beef animals (approximately Tshs 500 - 600 per kg - liveweight or Tshs 1000 per kg beef).

High growth rate of calves is important so that calves may be weaned early when they have attained the target weaning weight, thereby saving valuable milk for human consumption and sale. Every dairy farmer should therefore be concerned with rearing methods that enable calves to grow fast and be weaned as early as possible thereby increasing profitability of the enterprise. Apart from the economic viewpoint, early weaning of calves may

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be desirable in milk deficient developing countries as a way of making more milk available for human consumption (Babiker et al., 1988).

There is therefore a need to develop cheaper calf rearing methods which minimise the amount of milk fed to calves while maximising calf growth rates to attain a weaning weight of 70 kg at 12 weeks or earlier. Towards this objective, a series of studies are being conducted at Sokoine University of Agriculture (SUA) using locally available feedstuffs. This paper reports results of the first trial involving the use of extruded soybean-fish meal based calf starter in calf feeding.

Materials and Methods

The experimental treatments and feeding

Twelve calves (4 pure-bred Friesian, 5Ayrshire and 3 F_1 (Friesian x Boran) cross breds; 5 bull and 7 heifer calves) were randomly allocated to three rearing regimes, i.e. Soybean-fishmeal based concentrate (SBFM) + 8 weeks weaning (treatment I), SBFM + 12 weeks weaning (treatment II) and Cotton seedcake based Dairy Meal Concentrate (DMC) + 16 weeks weaning (Control treatment III). During the first week all calves were fed on colostrum, thereafter the feeding regimes in Table 1 were adopted. Mixing 33% Extruded full fat soybean meal, 5% fishmeal, 60% Maize bran and 2% Maclic® (Cooper, Kenya Ltd.) mineral premix compounded the SBFM calf starter diet.

Mixing 69% maize bran, 30% Cottonseed cake and 1-% Maclic® (Cooper, Kenya Ltd.) mineral premix compounded the Dairy Meal Concentrate (DMC).

Due to the small number of calves no attempt was made to balance the breeds among the three treatments.

Calves in all groups were also given a small amount of green guatemala grass from the 2nd

Table 1: Feeding regimes of calves on the three treatments

Treatment / Week	SBFM + Weeks weaning		SBFM + 12 Weeks weaning		DCM + 16 Weeks weaning	
	Whole milk (l/day)	SBFM (kg/day)	SBFM (kg/day)	SBFM (kg/day)	Whole milk (l/day)	DCM (kg/day)
1	2	-	2	-	2	-
2	3	0.25	3	0.25	3	0.25
3	4	0.25	4	0.25	4	0.25
4	4	0.5	4	0.5	4	0.5
5	3	1.0	4	0.5	4	0.5
6	2	1.0	4	1.0	4	1.0
7	1	1.0	4	1.0	4	1.0
8	0.5	Conc ad lib	3	Conc. ad lib	4	Conc. ad lib
9	0	"	3	"	4	"
10	0	"	2	"	4	"
11	0	"	1	"	4	"
12	0	"	0.5	"	3	"
13	0	"	0	"	3	"
14	0	"	0	"	2	"
15	0	"	0	"	1	"
16	0	"	0	"	0.5	"
17-20	0	"	0	"	0	"

Note:
All calves were fed colostrum for 5 days from birth and were offered green guatemala grass from the 2nd week onwards
SBFM = Soybean-fish meal / maize bran concentrate
DMC = Cotton seed cake / maize bran concentrate

week of age. A vitamin premix was provided to all calves via water according to manufacturer's recommendations (Pharmavita and Horticultural Inputs Ltd., Kenya). Weighing and recording all feed offered and refusals monitored daily feed intake. All calves were weighed once a week at 08.00 hrs before feeding during the entire experimental period.

Digestibility trial

Three calves from each rearing system (regime) were taken immediately after weaning, weighed and put in metabolic cages adjusted according to the size of the calves for a duration of two weeks; one week preliminary period and a collection period of one week. The faeces were trapped onto a nylon screen (2 x 2 mm) which could allow the urine but not the faeces to pass through. The calves were re-weighed at the end of collection period. All weighings were carried out at 8.00 a.m. before feeding.

The SBFM starter ration, DMC and the green grass were weighed and recorded every morning before feeding. Refusals of both concentrates and grass were collected daily before feeding, weighed and recorded. The grass was sampled every day, dried and bulked for chemical analysis. Faeces were collected at the same time each day, weighed and recorded. Ten percent of the daily faeces was bulked and deep-frozen for nitrogen determination. Twenty percent of the faeces were dried at 60 °C for dry matter determination. Urine from each calf was collected in plastic pails containing 20 ml of preservative made of sulphuric acid and copper sulphate in the ratio of 1:1.3375 volume to weight, and made up to 1 litre using distilled water. Five percent of the daily urine output was sampled and stored in stoppered plastic bottles for nitrogen determination.

Chemical analyses

Samples for chemical analyses were ground to pass through 1-mm sieve in a laboratory hammer mill. Proximate analysis was carried out using standard methods for DM, N, EE, CF, Ash, and NFE (AOAC, 1990). Phosphorous was determined in a UV/VIS spectrophotometer Model 100-20 (Hitachi, Japan) while Calcium was determined using an ion meter (Radiometer®, Denmark) according to AOAC, (1990). ME content of feed ingredients was obtained from feed tables and ME for the compounded starter diets was calculated using the proportional contribution of the feed ingredients in the diets.

Statistical analysis

The data for both feeding and digestibility study were analysed using the GLM procedure (Statistical Analysis Systems (SAS) Institute, Inc., 1985) for a complete randomized design (CRD) - (Snedecor and Cochran 1967). Birth weight and sex of calves were included as covariates in the model to remove the effect of initial body weight and sex on weight gains and feed intake.

Results

Composition of the rations

Chemical composition of the feed ingredients and the two rations i.e., SBFM calf starter ration and DMC is presented in Table 2. The SBFM calf starter ration had 23.35 %CP and 5.95 %CF while the DMC had 15.59 %CP and 8.77 %CF.

Growth rate of calves

With the exception of a few cases of mild diarrhoea in all the treatment groups, the calves were generally of good health throughout the experimental period.

The least square means of weight and average daily gain of calves are presented in Tables 3. The mean birth weight of calves was 28.33 3.45 kg in all the weaning regimes. Fig. 1 shows the growth curves of the calves on the three treatments. The mean body weights of calves at 20 weeks of age were not significantly different ($P=0.05$).

There were no significant differences in average daily gain of calves between treatments up to 16 weeks of age. From the 17th week to 20th week of age and the overall average daily gains were higher ($P=0.05$) for SBFM fed calves (Treatment I and II) than the DMC fed calves (Treatment III, Table 3).

Table 2: Chemical composition of feed ingredients and the two experimental rations (as analysed)

Chemical composition	Feed ingredient ration				
	SBM	Fish meal	Maize bran	SBFM starter	DMC
DM (%)	98.36	98.28	93.04	99.32	98.46
CP (%)	42.57	49.59	10.22	23.35	15.59
EE (%)	14.26	14.01	8.79	6.76	7.75
CF (%)	5.95	0.69	7.76	5.37	8.77
NFE (%)	29.48	10.42	63.55	54.41	58.4
Ash (%)	6.10	23.57	2.72	6.03	7.95
Ca (%)	1.82	4.20	0.92	1.25	0.88
P (%)	0.65	2.24	0.64	0.66	0.62
Calculated ME (MJ/kg DM)	12.3	14.5	11.7	11.88	11.79

Note:
SBM = Extruded full fat soybean
SBFM = Soybean-fish meal
DMC = Dairy meal concentrate

Post- weaning feed intake and metabolic studies

Least square means of dry matter and crude protein intake and their utilisation by calves immediately after weaning are presented in Table 4. Mean dry matter intake iinmediately after weaning were lower (P=0.05) for treatment I than treatments II and III. There were no significant differences in mean dry matter intake between calves on Treatment II and III. However, when intake was expressed on metabolic body weights basis there were no significant differences in DM intake between the three treatment groups.

Higher (P= 0.05) mean post- weaning crude protein intake was observed for calves on treatment II followed by treatment I and treatment III. Calves receiving the SBFM calf starter ration (treatment I and II) tended to have more crude protein intake than those receiving the dairy meal concentrate (DMC). When CP

Table 3: Least squares means (+ SE) of average daily gain (kg) of calves for the different feeding / weaning regimes

Period (weeks)	Feeding / Weaning Regime		
	SBFM + 8th week weaning	SBFM + 12th week weaning	DMC + 16th week weaning
1 - 8	0.33 ± 0.10^{a1}	0.44 ± 0.10^{a}	0.17 ± 0.08^{a}
1 - 12	0.42 ± 0.07^{a}	0.45 ± 0.08^{a1}	0.25 ± 0.06^{a}
1 - 16	0.5 ± 0.11^{a}	0.52 ± 0.12^{a}	0.27 ± 0.09^{a1}
9 - 20	0.62 ± 0.11^{a2}	0.65 ± 0.12^{a}	0.34 ± 0.09^{a}
13 - 20	0.64 ± 0.15^{a}	0.75 ± 0.16^{a2}	0.31 ± 0.12^{a}
17 - 20	0.52 ± 0.09^{a}	0.77 ± 0.09^{a}	0.30 ± 0.07^{b2}
Overall (1 - 20th week)	0.51 ± 0.10^{a}	0.57 ± 0.11^{a}	0.28 ± 0.08^{b}

Note:
a, b = Values in a row bearing different superscripts are significantly different (P = 0.05)
[1]Pre-weaning growth rate
[2]Post-weaning growth rate

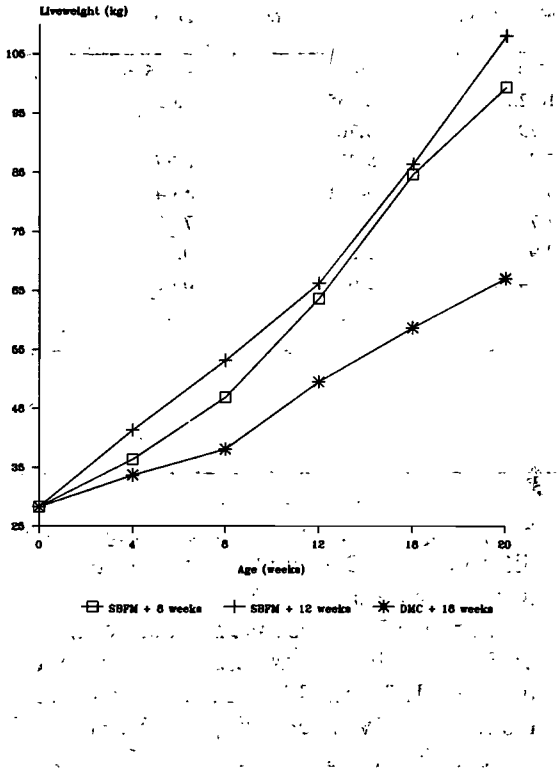

Figure 1: Growth curves for the different feeding regimes

intake was expressed on metabolic body weight basis, the post weaning protein intake for calves on treatment III was lower (P) than for the other treatment groups.

Post weaning Nitrogen balance measured over a 7- day period for each weaning age group is shown in Table 4. Mean total crude protein excretion (mean faecal plus mean urinary crude protein) were different (P=0.05) between treatments (Table 4). Crude protein digestibility were lower for DMC + 16 weeks weaning than the other treatments (P= 0.001). Mean urinary crude protein excreted were higher (P 0.05) for treatment II than treatment I and III. Crude protein retention was higher (P 0.05) for calves in treatment I than the other treatments.

There were no significant differences in digestibility coefficient of the dry matter of the treatment rations.

Cost evaluation of the feeding regimes

Table 5 shows the cost of the three diet treatments during the entire experimental period. The cost of the SBFM calf starter was three times that of the dairy meal concentrate. Weaning at 16 weeks required 2.6 times more milk than weaning at 8 weeks (treatment I). Calves weaned at 12 weeks consumed 1.8 times more milk than did those on treatment I feeding regime. Milk consumed up to weaning constituted 80.4%, 76.7% and 89.8% of the total feed cost for treatments I, II and III, respectively.

The feed cost data calculated on the basis of the cost of the individual ingredients and their percentage composition in the two starter rations were Tshs126.8 and Tshs 40.70 per kg for the SBFM and DMC, respectively (Table 5). The amount of SBFM starter ration and dairy meal concentrate consumed were 35, 77 and 119 kg per calf for treatments I, II and III. The total feed cost of the control diet (treatment III) was 2.3 times that of 8 weeks weaning and 1.25 times that of the 12 weeks weaning (Treatment II). The cost of gain of the control treatment was 4.25 times that of the 8 weeks weaning and 2.6 that of the 12 weeks weaning group.

Discussion

The high values of CF (0.69%) and Ash (23.35%) for fishmeal (sardines) were observed from the analysis and attributed to sandy contaminants and hay. This did not affect acceptability of the diets.

The growth rate study clearly shows that the dairy meal concentrate was inadequate in supporting sufficient growth of calves to enable weaning to be done within 12 weeks as expected. The main reason was that the DMC ration had lower CP (15%) compared to the SBFM ration which had 23.35% CP. The calculated ME content of the two diets was similar (Table 2) and thus energy could not have contributed to the differences in growth performance of the calves.

Crude protein levels in calf starter should, according to Zambian Standards institute

Table 4: Least squares means+SE) of post-weaning DM and CP intake and their utilisation by calves on three weaning regimes

Parameters	Treatments (Feeding / Weaning Regime) SBFM + 8th Week Weaning	SBFM + 12th Week Weaning	DMC + 16th Week Weaning
DM Intake			
g d^{-1}	1467 ± 80.8^b	1841 ± 80.8^a	1835 ± 80.8^a
g $kg^{-1}W^{0.75}$ day^{-1}	70.5 ± 2.76^a	79.6 ± 2.76^a	74.9 ± 2.76^a
DM digestibility coefficient (%)	73^a	71^a	70^a
CP Intake			
g d^{-1}	38.2 ± 2.52^b	49.3 ± 2.52^a	34.0 ± 2.52^b
$g/W^{0.75}day^{-1}$	1.83 ± 0.09^a	2.13 ± 0.09^a	1.39 ± 0.09^b
Faecal CP (g day^{-1})	9.72 ± 0.60^b	13.6 ± 0.60^a	15.5 ± 0.60^a
Urinary CP (g day^{-1})	7.97 ± 1.05^b	16.9 ± 1.05^a	10.8 ± 1.05^b
Total CP Excreted (g day^{-1})	17.7 ± 0.66^c	30.5 ± 0.66^a	26.2 ± 0.66^b
CP Retained			
gd^{-1}	20.5 ± 2.42^a	18.8 ± 2.42^a	7.74 ± 2.42^b
$gW0.75day^{-1}$	0.98 ± 0.09^a	0.81 ± 0.09^a	0.32 ± 0.09^b
CP Digestibility Coefficient (%)	75^a	72^a	54^b

Table 5: Summary for the amount and cost of whole milk, SBFM calf starter ration and DMC consumed up to weaning and weight gain up to 20 weeks of age

Weaning Regime	Whole Milk Amount (l)	Whole Milk Cost (Tshs)	Concentrates Amount (kg)	Concentrates Cost (Tshs)	Total Cost (Tshs)	Total Grain (kg)	Weight Cost of Grain (Tshs/kg lwt)
SBFM + 8 Weeks	136.5	16380	35	4000.5	20380.5	70.87	287.60
SBFM + 12 Weeks	241.5	28980	77	8801.1	37781.1	79.56	474.90
DMC + 16 Weeks	353.5	42420	119	4843.3	47263.3	38.61	1224.12

(1976) and Whitelaw et al (1961), be at least 18% CP, while Roy (1969) gives a figure of 20% CP and Loosli and Cunningham (1954) recommended 24% CP as being optimum for early weaning starter rations. The level of % CP for SBFM was therefore within the recommended range and it is not surprising it showed better results than the DMC commonly used in feeding calves in Tanzania, if at all supplementation is done.

Apart from the different level of % CP content in the starter rations, the essential amino acid profile of soybean and fish meal is almost similar to that of cows milk (Himson and Hartwig, 1977 and Opsvet *et al*, 1978). This implies that replacing milk with this starter may have provided the calves with a diet more suitable for replacing milk than the DMC.

On the other hand, the amino acid profile of CSC in the DMC is very different from that of milk. Moreover, CSC has some anti-nutritional factors like gossipol that could interfere with the growth of the calves. Gossipol is known to reduce growth in monogastric animals including young calves, which are considered to be monogastric animals. The degradability of fish-meal in the rumen is normally low (Ørskov, 1982) implying that for the weaned calves, the escape protein will supply a better amino acid profile to the animal. The growth rate results of the present study are in agreement with those of other workers (Whitelaw and Preston, 1963; Chalupa, 1975; Ørskov and Reid, 1985 and Silva *et al*, 1986). Results obtained elsewhere (Silva *et al*, 1986 and Opstvet *et al*, 1978) show that higher growth rates are possible with soy-

bean/fishmeal based starter rations.

Results of the digestibility trial further demonstrated the superiority of the SBFM ration over the dairy meal concentrate in terms of crude protein digestibility, and nitrogen retention and hence confirm the superiority of the extruded soybean meal and fishmeal as protein source for growing calves. These results are in agreement with those of Silva *et al* (1986), using soybean meal protein and those of Opsetvet *et al* (1978), using fish meal as protein replacer in starter diets for calves. It is therefore not surprising that soybean has been extensively used in formulation of early calf starter rations (Silva *et al*, 1986, Akinyele and Harshbarger, 1983; Nitsan *et al*, 1971).

Results of the present study showed tremendous differences in the cost of rearing calves depending on the type of starter diets and weaning regimes used. Although the cost of SBFM starter ration was three times that of the DMC ration, this was adequately offset by the more favourable cost of gain, which was 3 - 4 times cheaper. This observation is in agreement with findings by Winter (1978 and 1985) who reported that an early weaning program is an alternative to reduce feed costs and labour requirements in calf rearing practices.

Conclusions

The results of this study have demonstrated that using properly formulated calf starter rations such as the Soybean-fishmeal-maize meal (SBFM) diet with a 23% CP and 11.9 MJ ME/kg DM can promote faster growth rates of calves. This will promote weaning at 8 - 12 weeks and cutting down the cost of calf rearing considerably under Tanzanian conditions.

Given the low acceptability of soybean as human food, Tanzania, which produces very little soybean per annum, could expand output by targeting the animal feed industry, including calf starter rations.

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