TARC Report

Improvement of Raising Method of Dairy Calves in Malaysia

2. Substitutes for imported soybean meal in calf starter rations

By EITARO IMAIZUMI* and C. DEVENDRA**

*Animal Physiology Division, National Institute of Animal Industry
(Kukizaki, Ibaraki, 305 Japan)
**Malaysian Agricultural Research and Development Institute
(Peti Surat 2301, Pejabat Besar Pos, Kuala Lumpur, 01-02 Malaysia)

Introduction

Two experiments were conducted to know whether or not the imported soybean meal can be replaced with small amount of urea and/or a certain amount of groundnut meal in the calf starter ration. This series of study also aims at shortenning the nursing period of calves from 12 weeks[5] to 10 weeks of age, and preventing the decreased growth rate after weaning. The quality of calf starter rations used in this experiment was improved by decreasing the content of cassava chips which caused the occurrence of bloat-like symptoms in the former trial.[5]

Experimental procedure

Experiment 1
Utilization of urea as a protein supplement in calf starter ration

Eight pre-weaned calves were divided into two groups D and E. The experimental design is illustrated in Fig. 1. The characteristics of calves and their performances before the experiment are shown in Table 1. Feed ingredients and their percentages in Calf Starter Rations D(R-D), E(R-E), and F(R-F), and their TDN and DCP (percentages) are shown in Table 2. Ration E and R-F contained 1% of urea. The percentages of TDN and DCP in R-D and R-E were designed to be similar to those in the former trial.[5] The TDN and DCP levels of R-F were lower than those in R-D and R-E by 5%. The amount of cassava chips was decreased from that used in the former trial.[5]

Groups D and E were fed respective R-D and R-E, together with whole milk and green Napier grass (*Pennisetum purpureum*) in the same manner as those in the former trial.[5] After they were weaned, both groups were fed R-F with green Napier grass.

The body weight of calves was measured once

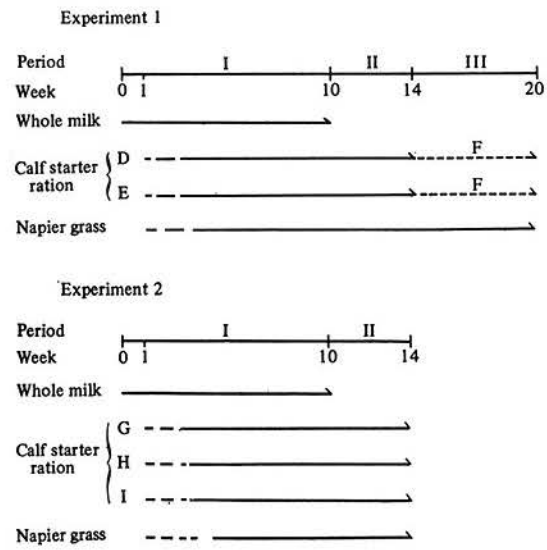

Fig. 1. Schematic illustration of experimental designs

Table 1. The characteristics of experimental calves and thier performances before the experiment

Group	No.	Sex	Weight at birth (kg)	Days of age at the beginning of experiment (day)	Weight gain before experiment (kg)	Daily weight gain before experiment (kg)	Breed
Experiment 1							
D	1	M	23.0	50	20.0	0.401	SF•LJ*
	2	M	26.5	41	12.0	0.293	L•J
	3	F	21.5	42	12.3	0.292	J
	4	M	28.5	15	1.0	0.063	L•J
Ave.			24.9±3.2			0.262±0.142	
E	5	M	20.5	46	12.1	0.263	L•J
	6	F	21.5	38	7.6	0.199	J
	7	M	16.5	32	7.1	0.221	J
	8	M	29.0	29	5.0	0.172	SF•LJ
Ave.			21.8±5.2			0.214±0.038	
Experiment 2							
G	1	M	26.0	26	0.3	0.012	50.0**
	2	M	34.0	13	6.8	0.523	62.5
	3	M	35.0	14	2.2	0.179	50.0
	4	M	28.0	18	2.4	0.133	62.5
Ave.			30.8±4.4			0.212±0.010	
H	5	M	20.0	23	8.3	0.361	50.0
	6	M	30.0	18	7.6	0.422	50.0
	7	M	38.0	34	9.8	0.288	56.3
	8	M	30.0	23	4.4	0.191	50.0
Ave.			29.5±7.4			0.316±0.099	
I	9	M	21.0	18	6.6	0.367	50.0
	10	M	20.0	16	3.1	0.194	50.0
	11	M	35.0	23	9.9	0.430	62.5
	12	M	28.0	25	5.5	0.220	50.0
Ave.			26.0±7.0			0.303±0.114	

Average ± S.D.
Breed * SF; Sahiwal cross Friesian
LJ; Local Indian Dairy (LID) cross Jersey
J; Jersey
** All Sahiwal cross Friesian, expressed in the density of Friesian blood.

a week. The digestion trials for R-D, R-E and R-F were conducted at the end of the Periods II and III.

Experiment 2

Utilization of groundnut meal as a substitute for soybean meal in calf starter ration

Twelve pre-weaned calves were divided into three groups G, H and I. The experimental design is shown in Fig. 1. Characteristics of experimental calves of Sahiwal-Friesian cross are given in Table 1, in which their breed is expressed in the percentage of Friesian blood density. Feed ingredients in Calf Starter Rations G(R-G), H(R-H) and I(R-I), and their TDN, DCP and crude fiber percents are shown in Table 2. Ration G which is the control feed in this experiment is the same as R-D used in Experiment 1. The TDN and DCP in R-G, R-H and R-I were similar to those used in the former trial.[5] The main protein sources were soybean meal for R-G, groundnut meal for R-H, and groundnut meal plus urea for R-I. Groups G, H and I were fed R-G, R-H and R-I, respectively, in the same manner as Experiment 1.

The body weight of calves was measured weekly. The digestion trial for R-G, R-H and R-I was conducted at the end of Period II.

Table 2-1. The constituents and TDN, DCP and crude fiber contents of calf starter rations (%)

Ingredient	Period	Experiment 1			Experiment 2		
		I and II		III	I and II		
	Ration	D	E	F	G	H	I
Cassava chips		20	25	20	20	25	20
Soybean meal		20	5	—	20	—	—
Groundnut meal		—	—	—	—	20	10
Coconut meal		25	25	20	25	25	25
Palm kernel cake		15	5	20	15	10	17
Brewer's grain		10	25	20	10	10	15
Leaf meal		—	5	8	—	—	—
Palm oil		2	2	2	2	2	2
Molasses		5	5	5	5	5	5
Urea		—	1	1	—	—	1
M.V. and Salt		3	3	4	3	3	5
TDN		75.5	75.6	70.4	75.5	76.8	75.2
DCP		19.5	19.3	16.3	19.5	19.1	18.3
Crude fiber		8.3	9.7	11.5	8.3	7.2	8.3

Table 2-2. TDN and DCP contents in young Napier grass (%)

Base	TDN	DCP
Dry matter	61.0	8.5
Fresh grass	9.2	1.3

(Cited from Devendra, C.[3])

Table 3. Average body weight gains and daily gains for five groups of calves during the experimental period (kg)

Item	Experiment 1		Experiment 2		
	Group D	E	G	H	I
Period I					
Weight at the beginning of Period I	36.2±5.8	29.6±4.7	33.7±6.5	37.0±8.2	32.3±9.4
Weight at the end of Period I	53.9±4.9	46.5±2.5	57.8±8.9	57.7±9.0	50.5±13.7
Body weight gain	17.7±8.3	17.0±2.6	24.1±6.6	20.7±4.8	18.3±5.4
Daily gain	0.439±0.114	0.456±0.098	0.431±0.112	0.424±0.093	0.350±0.115
Period II					
Weight at the end of Period II	65.2±3.2	55.8±6.1	72.1±9.1	71.8±6.6	62.9±13.7
Body weight gain	11.4±2.5	9.3±4.1	14.4±1.3	14.1±3.6	12.3±1.3
Daily gain	0.407±0.090	0.332±0.145	0.513±0.046	0.503±0.127	0.440±0.048
Period III					
Weight at the end of Period III	78.0±4.9	68.6±6.0			
Body weight gain	13.9±2.2	12.7±5.7			
Daily gain	0.456±0.022	0.513±0.084			
Whole experimental period					
Body weight gain	39.4±4.4	39.0±1.9	38.4±5.8	34.8±3.1	30.6±5.2
Daily gain	0.438±0.050	0.434±0.020	0.458±0.062	0.453±0.047	0.381±0.073

Average ± S.D.

Table 4. Digestibilities, DCP, TDN and DE utilizations of calf starter rations*

Ration	Digestion coefficient (%)							DCP (%)	TDN (%)	DE (cal/g)
	DM	Energy	CP	EE	CF	NFE	Ash			
Experiment 1										
D	72.2		78.2	88.4	45.0	77.7	65.4	14.8	72.2	
E	70.6		75.2	89.7	45.0	78.2	64.8	13.3	73.6	
F	66.5		70.6	85.3	40.2	73.7	56.2	11.3	69.0	
Experiment 2										
G	70.1	71.8	78.9	77.4	52.8	73.5	64.4	15.6	71.2	3,129
H	67.1	69.8	75.2	74.1	51.0	70.8	60.3	15.0	68.3	3,021
I	70.8	70.9	79.5	74.2	57.4	71.2	60.8	16.7	70.8	3,114

* Digestion trials of calf starter rations were conducted under the following conditions : In the Experiment 1, calves of Groups D and E were fed 1.0 kg of R-D and R-E, respectively, per calf per day, together with 2 kg of green Napier grass. Later, the both groups were fed 1.2 kg of R-F and 3.5 kg of green Napier grass daily. In the Experiment 2, calves in each group were fed 1.0 kg of respective calf starter ration and 2.3 kg of green Napier grass daily.

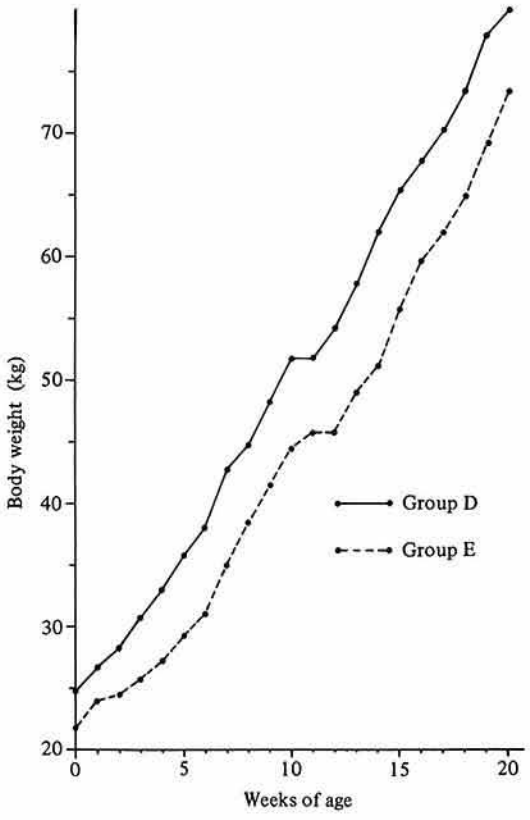

Fig. 2-1. Growth curves of two groups in Experiment 1

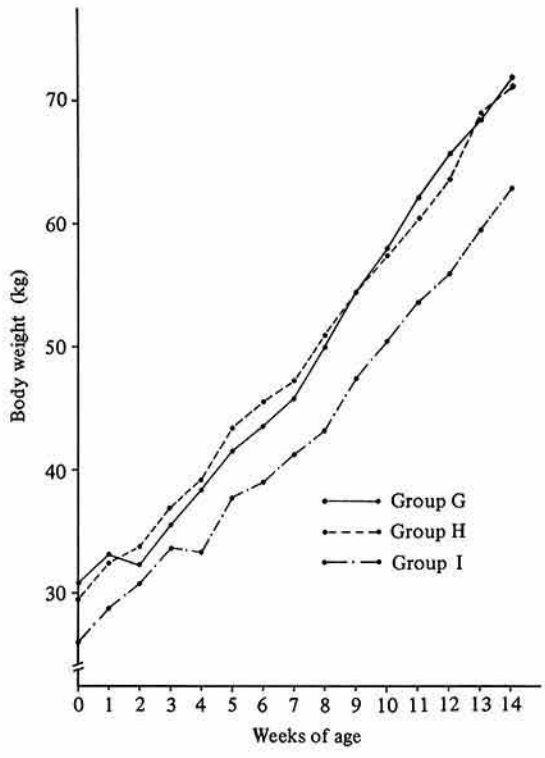

Fig. 2-2. Growth curves of three groups in Experiment 2

Experimental results

Experiment 1

1) Body weight gain

Weekly average body weight gains for Groups D and E are illustrated in Fig. 2-1. Body weight gains and daily gains in each experimental period and in whole experimental period are summarized in Table 3. Average daily gains shown before the experiment (Table 1) were very low (0.262 kg for Group D and 0.214 kg for Group E). However, they could obtain 0.439 kg and 0.456 kg, respectively, of daily gains in Period I. Daily gains during the Period II which corresponds to 4 weeks after weaning were 0.407 kg and 0.332 kg, respectively. In Period III, Groups D and E were fed R-F with green Napier grass. They could obtain 0.456 kg and 0.513 kg of daily grains during that period. Average daily gains for Groups D and E in the whole experimental period were 0.438 kg and 0.434 kg, respectively.

2) Digestibility of feed

Digestion coefficients (%) and TDN and DCP utilizations (%) of the rations are shown in Table 4. Statistically significant differences in these values are not recognized between R-D and R-E. R-F which was fed to both groups in the later stage showed rather lower digestion coefficients, and TDN and DCP utilizations.

3) Feed intake

Estimated feed intake of Groups D and E for the whole experimental period is given in Table 5. The Group D shows more intake of the ration and green Napier grass than Group E. Accordingly, TDN and DCP intakes also show the same tendency. However, the difference is not statistically significant. Average daily TDN and DCP intakes by week are illustrated in Figs. 3-1 and 4-1. The straight lines in these figures show the TDN and DCP requirements estimated on the basis of the U.S. NRC feeding standard[12] for a calf which increases its body weight to 75 kg starting from 25 kg of birth weight by gaining 0.3 kg daily. Calves of both groups took lower amount of TDN compared to NRC feeding standard. Nevertheless, they were able to take the amount of DCP required to gain 0.3 kg of body weight per day. The amount of Napier grass they fed was too small, and was not enough to maintain their necessary nutrient only by Napier grass during the period after weaning.

Table 5. Estimated feed intake of calves during the whole experimental period

(kg)

Group	Whole milk	Calf starter	Napier grass	TDN	DCP
Experiment 1 (20 weeks of experimental period)					
D	201.6	85.6	167.5	119.9	24.5
E	201.6	80.2	139.1	113.6	22.5
Experiment 2 (14 weeks of experimental period)					
G	172.2	50.1	71.9	76.4	15.8
H	172.2	47.4	77.6	75.5	15.1
I	172.2	43.8	49.6	68.8	13.8

Experiment 2

1) Body weight gain

Weekly average body weight gains for Groups G, H and I are shown in Fig. 2–2, and body weight gains and daily gains during Period I, Period II and the whole experimental period are shown in Table 3. Average daily gains for Group I were the lowest among the three groups, in Period I though not statistically significant. The low gains of Group I may have been due to the fact that some calves of the group were suffered from diarrhoea more severely and longer time than other groups in Period I. Groups G and H showed daily gains exceeding 0.5 kg in Period II and they achieved 0.458 kg and 0.453 kg of daily gains respectively, during the whole experimental period, in contrast with only 0.381 kg in Group I. There were however no significant differences among the three groups in the whole experimental period.

2) Digestibility of feed

Digestion coefficients (%) and TDN, DCP and DE utilizations (%) of three groups are shown in Table 4. Figures of R-H are slightly lower than those in R-G and R-I. However, no statistically significant differences in the digestibilities of rations, DCP, TDN and DE contents

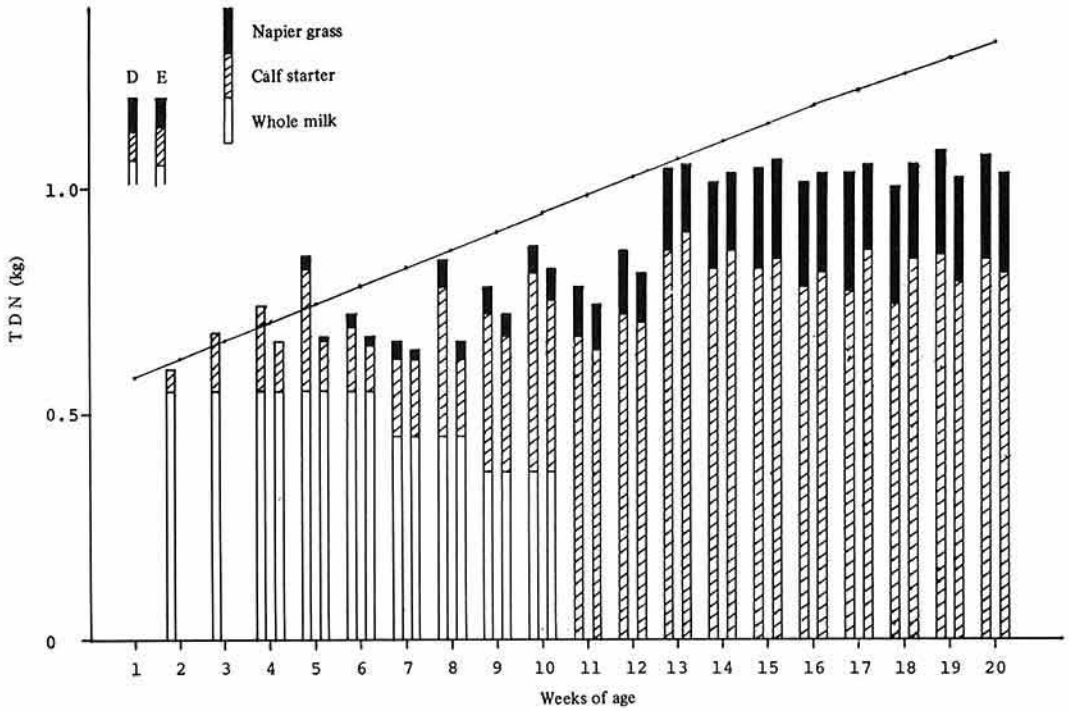

Fig. 3-1. Average daily TDN intake of two groups from different feed sources in Experiment 1

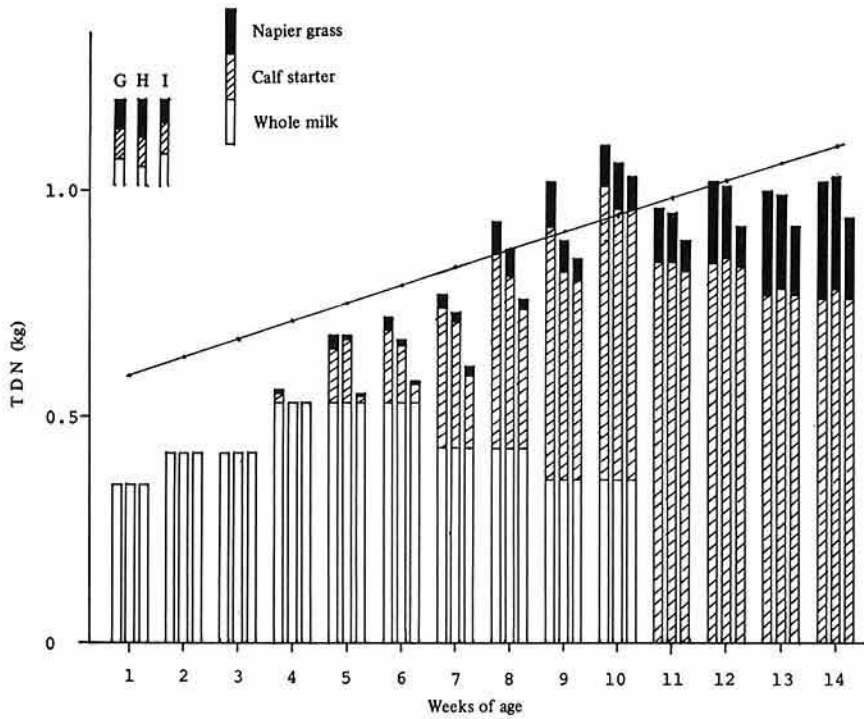

Fig. 3-2. Average daily TDN intake of three groups from different feed sources in Experiment 2

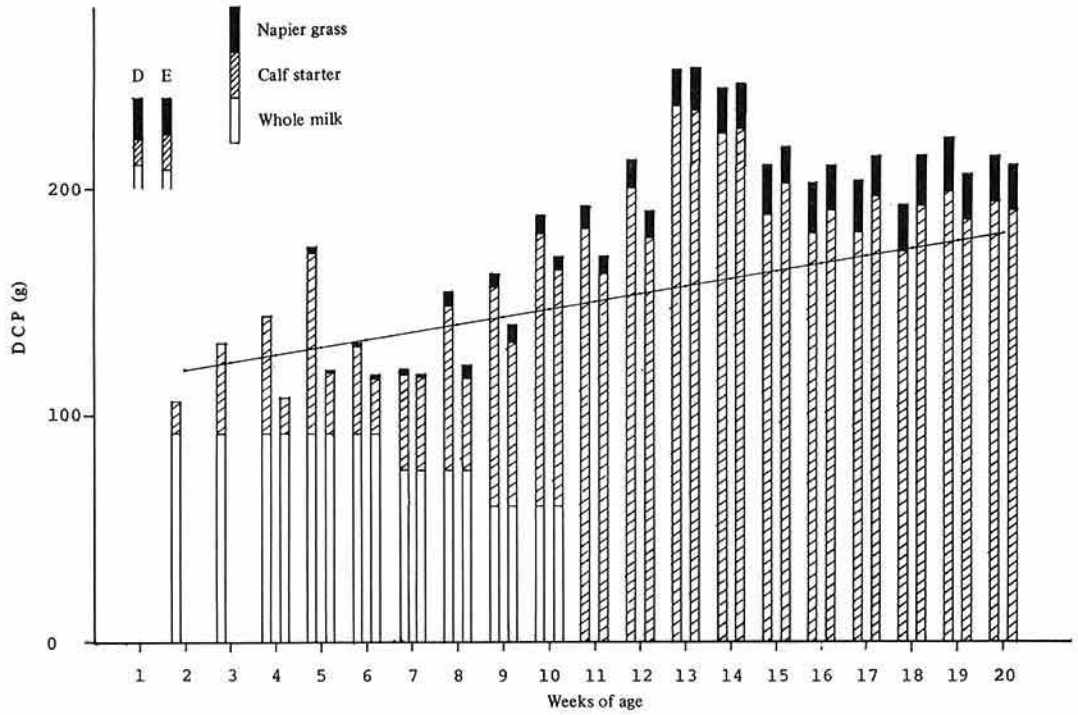

Fig. 4-1. Average dialy DCP intake of two groups from different feed sources in Experiment 1

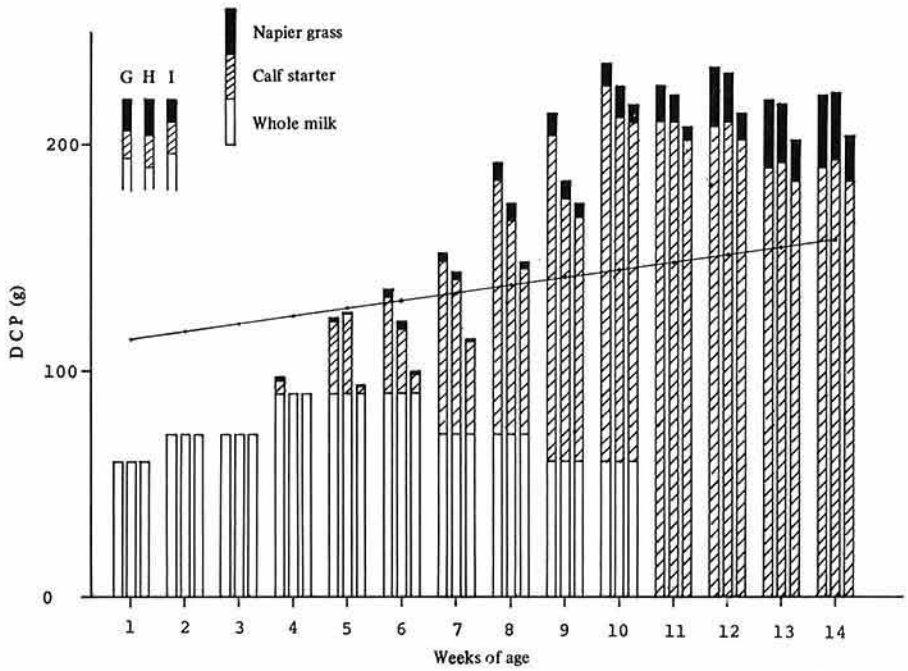

Fig. 4-2. Average daily DCP intake of three groups from different feed sources in Experiment 2

are recognized among three calf starter rations fed together with a certain amount of green Napier grass.

3) *Feed intake*

Estimated feed intake of three groups during the experimental period is shown in Table 5. Average daily TDN and DCP intakes are illustrated in Figs. 3-2 and 4-2. The amounts of TDN and DCP consumed by Groups G and H were almost the same, but those of Group I were the lowest among three groups during the whole experimental period. The straight lines in the figures show the TDN and DCP requirements of a calf to maintain 0.3 kg of daily gain based on the NRC feeding standard.[12] Calves in Groups G and H could take enough amounts of TDN during 8 to 12 weeks of age, mainly from whole milk and calf starter ration (8 to 10 weeks) and calf starter ration and green Napier grass (11 to 12 weeks). However, Group I could not take sufficient amount of TDN during the whole experimental period compared to NRC feeding standard.[12]

4) *Amino acid content in groundnut meal*

Amino acid content in groundnut meal and that in soybean meal are shown in Table 6. The amino acids in soybean meal are only essential amino acids for chicken.[16] Among the essential amino acids in groundnut meal, cystine and lysine were less, while other amino acids showed approximately the same content as in soybean meal. Two types of groundnut meals contained more crude protein than soybean meal.

Aflatoxin contents were 0.08 ppm and 0.11 ppm in the two types of groundnut meal containing 50.2% and 52.3% of crude proteins, respectively.

Discussion

Breeds and characteristics of calves used in this series of experiment were not uniform among groups and even within a group. Birth weight of the calves also showed a wide range of differences. However, average birth weight of all calves used in former trial[5] and the present study was 26.2 kg. This value falls in the range of European and Indian cross-bred calves in Malaysia.[2,8] As the nursing period in this study was ten weeks, it was proved that Malaysian calves can be weaned safely by ten weeks of age. After the weaning, the calves could grow continuously, maintaining the daily gain more than 0.4 kg by the feeding with the calf starter ration as a main supplement for nutrient requirement for growth. On the other hand, the calves at the younger stage could not take a sufficient amount of nutrient from fresh grass, to meet the need for their rapid growth. This is due to the immature development of rumen function and its volume. Therefore, the use of concentrate, easily digestible and high in energy and protein, is needed.

In this study, the feeding schedule of six types of diets was designed to maintain 0.3 kg daily gain throughout the experimental period, based on the TDN requirement of NRC feeding standard.[12] Daily gains in the all groups except the Group I in Experiment 2 exceeded 0.4 kg. On the other hand, it was found that the calves could not take sufficient amount of nutrient in early stage of experiment to maintain 0.3 kg of daily gain. This contradiction suggested that there could be some differences in nutritional requirement in early stage of calves between tropical and temperate regions. Further research on nutrient requirement of calves in an early stage in tropical area is therefore necessary to give more accurate information for formulating the feeding system for dairy calves.

The ability of young ruminants to utilize urea nitrogen as a supplement of protein diet, has been demonstrated by various workers. However, there are many contradictory results regarding the ability to utilize urea-N at six to twelve weeks of age. Some reports stressed that calves weaned by 5 to 6 weeks of age could not utilize urea-N[6,11,14] Kay et al.[6] suggested that 1.6% and 3.0% of urea-N out of 19% of crude protein in the calf starter ration were too high, and wastage of nitrogen occurred since there was still sufficient amount of high quality protein available from other sources. On the other hand, experimental evidences[1,7,9,10] proved that young calves weaned at 4 to 7 weeks of age could sufficiently utilize urea-N as the supplement of protein to meet nitrogen requirement for growth.

The weaning method, period of adaptation to

Table 6. Amino acid contents of groundnut meals in comparison with those of soybean meal

(%)*

Amino acid	Groundnut meal (CP content 50.2%)	Groundnut meal (CP content 52.3%)	Soybean meal ** (CP content 44.0%)
Aspartic acid	5.14	5.61	—
Threonine	1.34	1.38	1.81
Serine	2.32	2.59	2.45
Glutamic acid	8.97	9.33	—
Proline	2.41	2.22	—
Glycine	2.61	2.79	2.29
Alanine	1.94	2.03	—
Cystine	0.48	0.31	0.69
Valine	1.91	2.01	2.34
Methionine	0.54	0.51	0.65
Isoleucine	1.86	1.72	2.39
Leucine	3.27	3.13	3.52
Tyrosine	1.96	1.95	1.28
Phenylalanine	2.41	2.35	2.27
Histidine	1.13	1.09	1.15
Lysine	1.57	1.49	2.93
Ammonia	1.69	1.49	—
Arginine	4.76	4.91	3.28

* Percent of sample
** Cited from S.W. Yeong[16]

urea-N, age of calf and combination of urea-N level with natural protein level contained in other dietary components would be important factors influencing the ability of non-protein nitrogen utilization by early-weaned calves.

Leibholz and Kang[7] showed that more than 12% of crude protein in the calf starter ration was required for maximal growth of the calf weaned at 5 weeks of age. However, the DCPs in the calf starter rations used in this experiment were approximately 5% higher than the recommended DCP level.[4] These calf starter rations were fed together with fresh Napier grass which contained high moisture and low level of DCP.[3] It was necessary to maintain the DCP level high in calf starter ration to balance with the other low quality ration. All of the literatures cited[1,6,7,9,10,11,14] discussed only about the level or percentage of crude protein or DCP in calf starter rations. It would be necessary to take the protein level in the whole diets into consideration.

By adding 1% of urea and increasing the level of brewer's grain and that of leaf meal in the ration, R-E could save 15% of imported soybean meal. In R-F, which was fed in the Period III of the Experiment 1, soybean meal was fully substituted by 1% of urea and local protein feed materials. Since the body weight gain was the same for Groups D and E, and the estimated feed intake, and TDN and DCP intakes were not statistically different, it may be certain that urea can safely replace a part of protein supply in calf starter rations.

The availability of groundnut meal in calf starter rations as a main protein source has been studied.[13,15] Groundnut meal used in this experiment contained Aflatoxin at a concentration of about one-tenth of Japanese regulation.[4] The groundnut meal contents in the R-H and R-I were 20% and 10%, since Aflatoxin level in the feed should be less than 0.05 ppm as a whole for the ordinary concentrate mixture.[4] Aflatoxin levels in R-H and R-I did not exceed over the Japanese regulation. To lower Aflatoxin level below 0.05 ppm, the content of groundnut meal should be kept in line with safety assurance of feed.

The differences in quality and quantity of amino acids between soybean meal and groundnut meal would not be a serious problem in the supply of amino acids in the later stage of calf

provided that the calf can take sufficient quantity of protein source for its growth. Results of the present study are not certain that 1% of urea with 10% of groundnut meal contained in R-I gave the similar nutritive value to 20% of soybean meal contained in R-G and 20% of groundnut meal contained in R-H.

It had been proved that the nursing period of Malaysian calves could be shortened to 10 weeks of age by employing the early weaning method in combination with the supply of whole milk, calf starter ration and green Napier grass. Pre-weaning calf mortality could be lowered by feeding sufficient amount of nutrient as the calf starter ration. European and Indian cross-bred calf in Malaysia has a potential ability to attain more than 0.4 kg of daily gain in pre- and post-weaning periods. Calves after 10 to 12 weeks of weaning, could not take sufficient amount of nutrient from green Napier grass only.

Feed resources used in this experiment which were available in Malaysia, were proved to be useful for formulating calf starter ration. When urea is to be used, its optimum level in calf starter ration would be around 1%. For the use of groundnut meal, it is advisable to maintain the Aflatoxin level below 0.05 ppm in the concentrate mixture. To establish a well balanced concentrate mixture with necessary nutrients, it is preferable to use various kinds of ingredients, so as to obtain complementary effect from different nutrient sources.

Summary

The possiblity of saving imported soybean meal contained in calf starter rations by replacing it with urea or groundnut meal was examined in the Experiment 1 and 2.

Experiment 1: Eight calves were divided into two groups D and E, to which calf stater rations R-D and R-E were supplied respectively, during the Periods I and II. Then the both groups were fed R-F. All calves were fed whole milk until 10 weeks of age, and were fed green Napier grass from the first to the end of the experiment. The R-D contained 20% of soybean, while the R-E contained only 5% of soybean meal and 1% of urea. The R-F contained 1% urea and increased amount of leaf meal and brewer's grain, but not soybean meal. The percentages of TDN and DCP for R-D, R-E and R-F were 75.5%, 19.5%, 75.6%, 19.3% and 70.4%, 16.3%, respectively.

Groups D and E gained 39.4 kg and 39.0 kg of body weight with 0.438 kg and 0.434 kg of daily gain, respectively during the whole experimental period.

Digestivilities, TDN and DCP contents of R-D and R-E did not show statistically significant differences but R-F was lower in digestibility, TDN and DCP contents than R-D and R-E.

Groups D and E could not consume sufficient amount of TDN at the later stage of experiment. However, both groups could get sufficient amount of DCP compared with the TDN and DCP requirements for 0.3 kg of daily gain. The calf starter ration which contained 1% of urea in addition to 5% soybean meal and other protein feed materials gave the similar growth rate to the control diet containing 20% of soybean meal as a main protein source and the other protein feed materials.

Experiment 2: The possibility of replacing soybean meal with groundnut meal or less amount of groundnut meal plus urea in calf starter ration was investigated.

Twelve calves were divided into three groups G, H and I. They were fed calf starter rations R-G, R-H and R-I, respectively, in pre- and post-weaning period. The percentages of TDN and DCP for R-G, R-H and R-I were 75.5%, 19.5%, 76.8%, 19.1% and 75.2%, 18.3%, respectively.

Average daily gains for Groups G, H and I in the whole experimental period were 0.458 kg, 0.453 kg and 0.381 kg, respectively. Group I shows a lower daily gain than other groups, but the difference was not significant.

Digestibility and TDN, DCP and DE contents of R-H were slightly lower than those of R-G and R-I, but statistically significant differences were not recognized among the three diets.

All the calves of three groups could not take sufficient amount of TDN at the first 7 weeks of age and later 13 to 14 weeks of age. They were also unable to consume sufficient amount of DCP till 4 weeks of age.

Calves receiving diets with 20% of groundnut meal or 10% of groundnut meal plus 1% of urea

as a substitute for soybean meal could attain almost the same growth rate as those fed control diet containing 20% of soybean meal. Due to the presence of Aflatoxin in groundnut meal, the amount of this ingredient in calf starter rations must always be within the safe level, for the avoidance of causing any ill effect to calves

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