UTILIZATION OF LOCAL AGRICULTURAL PRODUCTS AND BY-PRODUCTS FOR THE IMPROVEMENT OF CALF STARTER RATION IN MALAYSIA

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ABSTRACT

Dairy calves in Malaysia which are exposed to severe malnutrition, infectious diseases and harsh climatic conditions, show very high morbidity and mortality rates before weaning. Their daily weight gains are less than 0.2 kg and their nursing period exceeds six months.

Experiments were conducted to develop a calf starter ration (CSR) composed of local agricultural products and by-products for the purpose of shortening the nursing period and getting the calf accustomed to highly nutritious solid food from the early stage of growth. Cross-bred calves (Indian × European breed) were used and fed whole milk, experimental feeds i.e. CSRs (DCP 19%, TDN 75%) and green Napier grass (*Pennisetum purpureum*).

In the first trial, weight gains of calves fed CSRs which were composed of 40% of maize and imported feed materials, were compared to those of calves fed CSRs made of 45% and 30% of ground cassava chips and local feed materials except for soybean meal. The performance of calves fed CSRs including cassava was similar to that of animals fed CSR to which maize had been added. It was possible to prepare local CSR using cassava chips as the main energy source.

In the second trial, to reduce the use of costly imported soybean meal, the utilization of groundnut meal replacing soybean meal in CSR was evaluated. Three groups of calves fed CSRs composed of local feed materials to which 20% of soybean meal, 20% and 10% of groundnut meals respectively had been added were compared. There were no significant differences in the growth rate among the three groups. It was possible to prepare local CSRs using groundnut meal as the main protein source.

Malaysian calves could be weaned at the age of 10 weeks and gain 0.4 kg per day, by feeding on whole milk, locally made CSR and green Napier grass.

It is concluded that local feed resources available in Malaysia which were used in these experiments can be useful for formulating CSR. However, when large amounts of cassava chips or groundnut meal are used, it would be advisable to maintain a certain safety level to prevent possible hazard of contamination with linamalin or aflatoxin contained in the diet.

Introduction

Under the hot and humid climate of Malaysia, crossbreeding between the local and exotic breeds is more efficient for rapid and reliable improvement of native dairy cattle in order to increase the output of dairy products (Rajagobal, 1975). However, calf raising for herd replacement, which is necessary for maintaining and increasing the size of dairy herd is not a common practice in dairy operation. It is well known that calf mortality before weaning is very high in Malaysia. Since crossbred cattle can release milk without requiring calf suckling, calves from crossbred cattle can be separated from their dams immediately after birth (Leong, 1975). Calf can then be artificially nursed and weaned by appropriate raising methods using milk replacers or whole milk and calf starter rations (CSRs).

On the other hand, most of the feeds used for cattle raising by small holders in Malaysia consist of natural grasses in paddy fields in the dry season, grasses growing along roadsides, grasses in rubber and oil palm plantations, and various agricultural products and by-products. However, the use of these agricultural products and by-products as animal feed requires transportation and processing facilities as well as the development of methods of preparation

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to make them suitable for cattle nutrition.

Special emphasis has been placed on the utilization of the local feed resources as a substitute for imported feed materials such as maize or soybean meal, which are comparatively costly. These local feed materials which are readily available at a low cost to the farmers could be used for the preparation of nutritive CSR to help reduce the high calf mortality associated with malnutrition in the early stage of growth. And farmers can save large quantities of milk suckled by the calf by applying early weaning methods whereby calves consume solid feeds from the early stage of growth.

A series of experiments was carried out to develop methods for shortening the nursing period of calves and decrease calf mortality before weaning by offering them whole milk, CSR and green Napier grass (*Pennisetum purpureum*).

Materials and methods

1 First trial

Fifteen European and Indian crossbred calves were divided into three groups A, B and C. Data on breed, sex and weight at birth are shown in Table 1. The experimental design is illustrated in Fig.1 Period I (nursing) covered the period from one week to 12 weeks of age and Period II (post-weaning) followed up to the age of 16 weeks. Group A was fed the Calf Starter Ration A(R-A), Group B the Ration B(R-B) and Group C the Ration C(R-C) from the beginning of the experiment. These three groups also received whole milk and six-week old green Napier grass. Water was provided individually *ad libitum* from a pail.

Ration A was composed mainly of imported feed ingredients, but R-B and R-C were composed of feed ingredients produced locally in Malaysia as agricultural products and by-products, with the exception of 20% of soybean meal. Ration B and R-C were designed to emphasize the use of cassava chips as a main energy source (Table 2). Ration B and R-C contained 45% and 30% of cassava chips as a substitute for maize, respectively. The percentages of estimated Digestible Crude Protein (DCP) in R-A, R-B and R-C were 19.1%, 19.4% and 20.7%, and those of Total Digestible Nutrients (TDN) were 75.2%, 76.6% and 75.9%, respectively. The feeding scheme was set up to have the animals gain 0.3kg per day, according to the US NRC feeding standard (US National Research Council, 1978). The growth rate, health and feed efficiency were compared. The body weights of calves were measured weekly and the digestion trial for the rations was conducted at the end of Period II.

2 Second trial

Twelve pre-weaned crossbred calves were divided into three groups D, E and F. The characteristics of the calves of a Sahiwal-Friesian cross used for the experiment are shown in Table 1. Breed was expressed as the percentage of the proportion of Friesian blood.

The schematized experimental design is shown in Fig. 1. Period I (nursing) covered the period from one week to 10 weeks and Period II (post-weaning) followed up to 14 weeks of age. Groups D, E and F were fed R-D, R-E and R-F, respectively, including whole milk, and green Napier grass.

Data on feed ingredients and percentages of constituents in R-D, R-E-E and R-F, and on DCP, TDN and crude fiber contents are listed in Table 2. These percentages were designed to be almost identical with those in the first trial. The main protein source in R-D consisted of 20% of soybean meal. However, R-E and R-F contained 20% of groundnut meal, and 10% of groundnut meal with 1% of urea, respectively, as the substitute for soybean meal in CSRs to economize the use of costly imported protein sources. The growth rate, health and feed efficiency among the groups were compared as in the first trial.

Table 1 Characteristics of European and Indian crossbred calves used in the two trials

Group	No.	Sex	Weight at birth (kg)	Age at the beginning of experiment (week)	Breed
First trial					
A	1	M	26.0	6	SF(F) ×LF (M)*
	2	F	28.0	6	×LF
	3	F	30.0	4	×LF
	4	F	20.5	2	×LJ
	5	M	24.5	1	×LJ
Average			25.8±3.6		
B	6	M	30.0	6	×LF
	7	F	26.0	4	×LF
	8	M	29.0	2	×LF
	9	F	21.5	1	×LJ
	10	M	23.0	2	×LJ
Average			25.9±3.7		
C	11	M	26.0	5	×LF
	12	F	23.0	4	×LF
	13	M	32.0	4	×LF
	14	F	24.0	1	×LJ
	15	M	22.0	1	×LJ
Average			25.4±4.0		
Second trial					
D	1	M	26.0	4	50.0#
	2	M	34.0	2	62.5
	3	M	35.0	2	50.0
	4	M	28.0	3	62.5
Average			30.8±4.4		
E	5	M	20.0	4	50.0
	6	M	30.0	3	50.0
	7	M	38.0	5	56.3
	8	M	30.0	4	50.0
Average			29.5±7.4		
F	9	M	21.0	3	50.0
	10	M	20.0	3	50.0
	11	M	35.0	4	62.5
	12	M	28.0	4	50.0
Average			26.0±7.0		

Note :* SF ; Sahiwal×Friesian
LF ; Local Indian Dairy (LID)×Friesian
LJ ; LID×Jersey
Sahiwal×Friesian ; expressed as the proportion of Friesian blood (%).
Average±S.D.

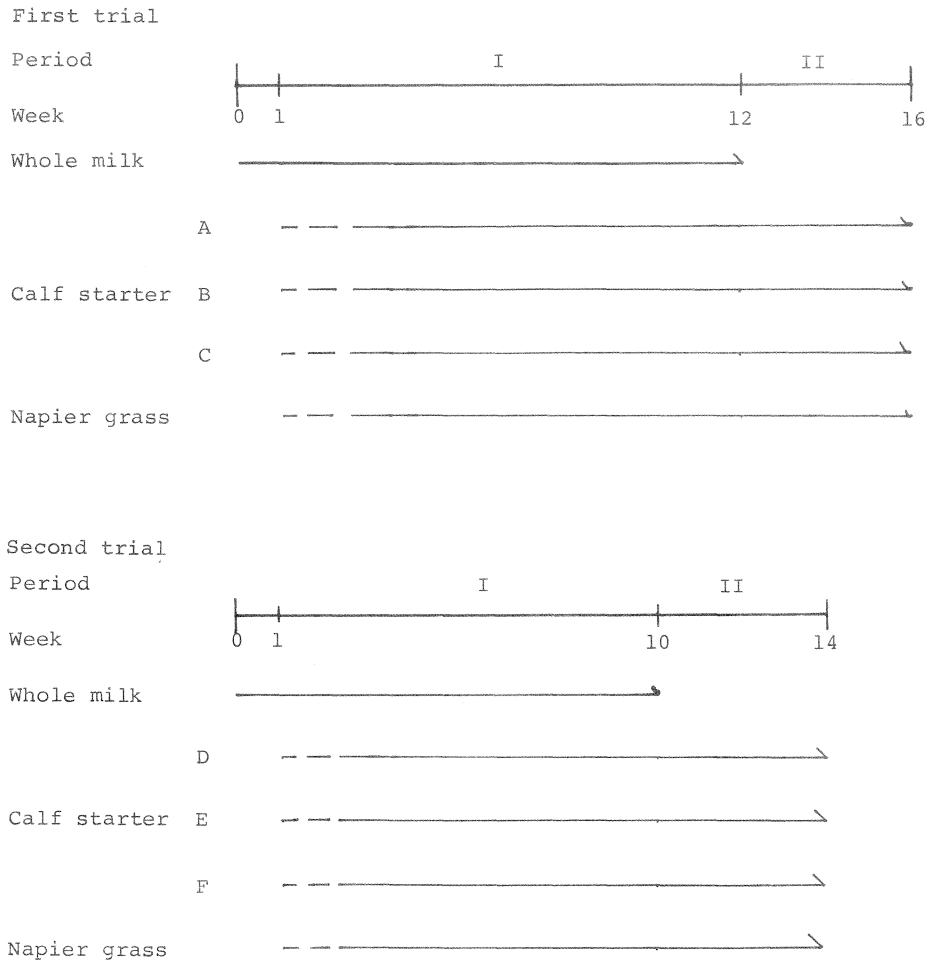

Fig. 1 Schematic representation of experimental design.

Experimental results

1 Body weight gain

Changes in weekly average body weight gains in Groups A, B and C in the first trial, and Groups D, E and F in the second trial are shown in Fig. 2-1 and 2-2. Average weight gains and daily gains in both trials during the Periods I , II and the whole experimental period are shown in Table 3. Total weight gain and daily gain in Group B were lower than those in Groups A and C, but there were no statistically significant differences among the groups in the first trial. The daily gains in Groups A, B and C during the whole experimental period were 0.420kg, 0.386kg and 0.444kg, respectively. Body weight gains in Groups D and E were almost identical during the whole experimental period in the second trial. Body weight gain in Group F in Period I was the lowest among the groups and accordingly, the average daily gain in Group F was the lowest due to the occurrence of diarrhea in Period I. Daily gains in Groups D and E were 0.458kg and 0.453kg, but the animals in Group F were able to gain

Table 2 Constituents of calf starter rations, with estimated TDN, DCP and crude fiber contents and estimated TDN and DCP contents in young Napier grass

(%)

Ingredient	Period	First trial I and II			Second trial I and II		
	Ration	A	B	C	D	E	F
Maize		40	—	—	—	—	—
Wheat bran		15	—	—	—	—	—
Soybean meal		20	20	20	20	—	—
Alfalfa meal		5	—	—	—	—	—
Cassava chips		—	45	30	20	25	20
Groundnut meal		—	—	—	—	20	10
Coconut meal		—	15	30	25	25	25
Palm kernel cake		—	5	—	15	10	17
Brewer's grain		10	—	10	10	10	15
Fish meal		—	5	—	—	—	—
Molasses		5	5	5	5	5	5
Palm oil		—	—	—	2	2	2
Urea		—	—	—	—	—	1
Minerals, vitamins, common salt and antibiotics		5	5	5	3	3	5
TDN		75.2	76.6	75.9	75.5	76.8	75.2
DCP		19.1	19.4	20.7	19.5	19.1	18.3
Crude fiber		6.8	3.9	6.5	8.3	7.2	8.3

Item		TDN	DCP
Napier grass[3)]	dry matter base	61.0	8.5
	fresh grass	9.2	1.3

0.381kg daily throughout the experimental period.

There were however no statistically significant differences among the three groups during the whole experimental period.

2 Digestibility, DCP, TDN and Digestible Energy (DE) contents

The digestion trial was conducted at the end of Period II, when three calves in each group were fed a fixed amount of 0.5kg of respective CSR and 2.0kg of green Napier grass in the first trial. Digestibility, and DCP, TDN and DE contents of rations are shown in Table 4. There were no statistically significant differences in the digestion coefficients in each item as well as in the DCP, TDN and DE contents among the groups. Three calves in each group in the second trial were fed 1.0kg of respective CSR together with 2.3kg of green Napier grass at the end of Period II. The results of digestion trial are shown in Table 4. The figures for each item in R-E were slightly lower than those in R-D and R-F. However, there were no statistically significant differences in the digestibility of diets, DCP, TDN and DE contents among the groups.

3 Feed intake

Estimated feed intake, TDN and DCP intakes for Groups A, B and C in the first trial,

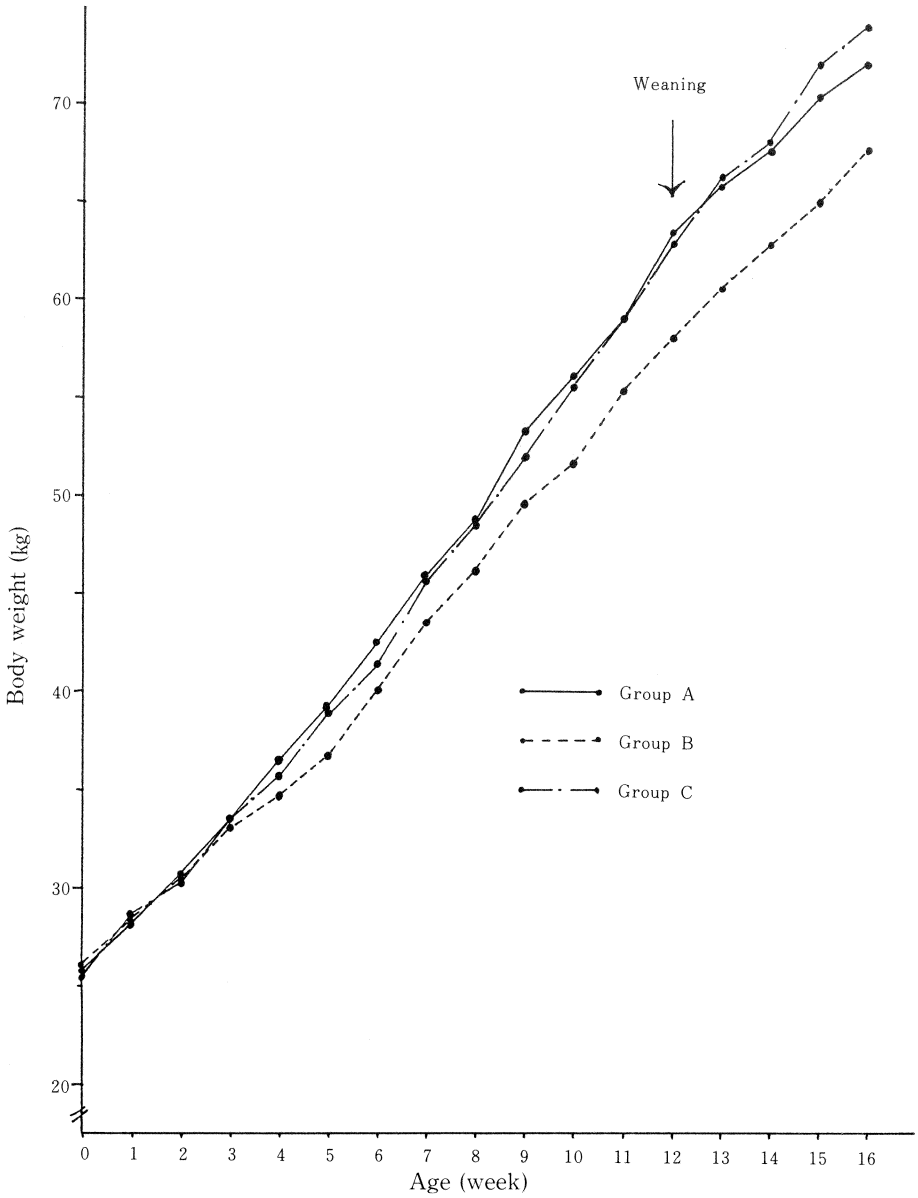

Fig. 2-1 Average weight gains of the three groups during the experimental period in the first trial.

and for Groups D, E and F in the second trial during the whole experimental period are shown in Table 5. Daily TDN and DCP intakes within a week are illustrated in Fig. 3-1, 2 and Fig. 4-1, 2. The straight lines in the figures show the amounts of TDN and DCP required to maintain 0.3kg of daily gain in dairy calves with a birth weight of 25kg until they reached a body weight of 75kg, based on the NRC feeding standard (US National Research Council, 1978). There were no statistically significant differences in the estimated amounts of feed

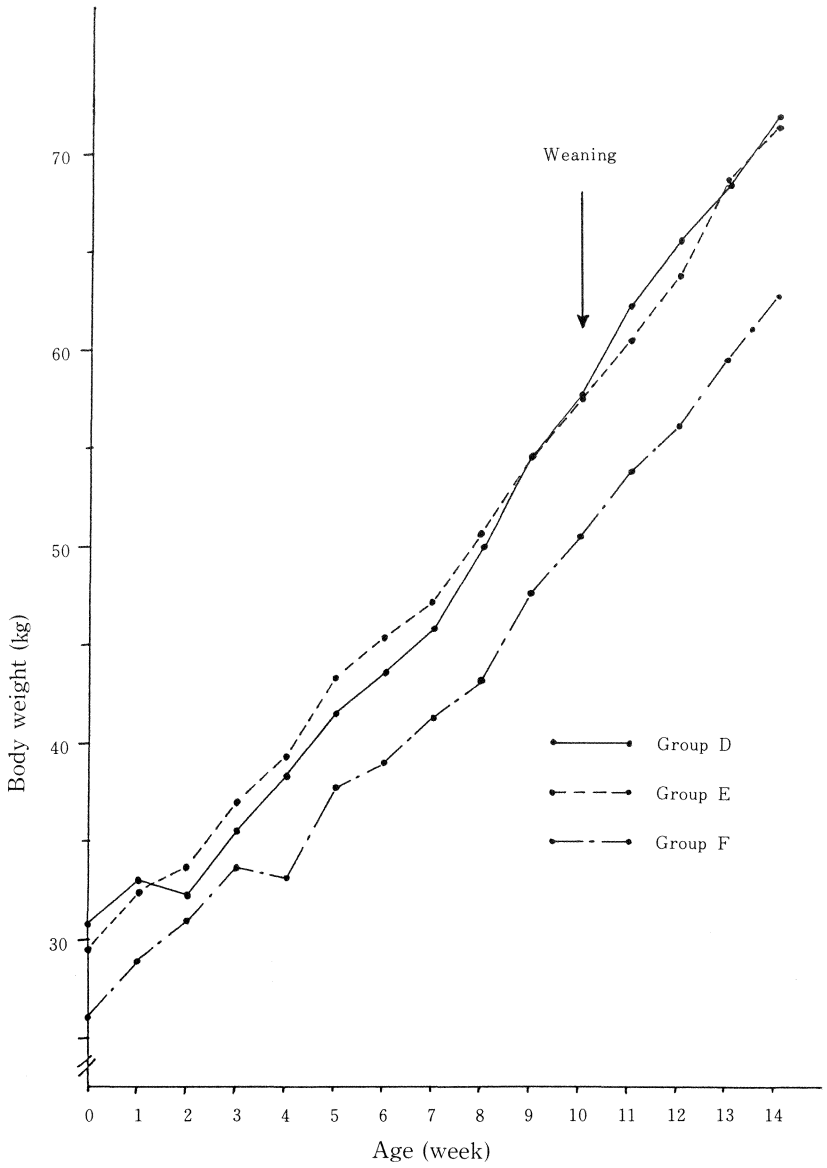

Fig. 2-2 Average weight gains of the three groups during the experimental period in the second trial.

intake, TDN and DCP intakes as well as in the average daily TDN and DCP intakes with age (week) among the groups. Although, all the three groups in the first trial could take approximately the same amounts of TDN and DCP, the objective of increasing green Napier grass intake by decreasing the amount of CSR could not be achieved to meet the TDN feeding schedule due to the bulkiness and moisture content of Napier grass. The amounts of TDN and DCP consumed by Groups D and E were almost identical and those by Group F were the lowest during the whole experimental period in the second trial. Average daily TDN

Table 3 Average body weight gain and daily gain of the groups in two trials during the experimental period

(kg)

Item	Group	First trial A	First trial B	First trial C	Second trial D	Second trial E	Second trial F
Period I							
Weight at the beginning of Period I		36.1±9.4	33.3±6.8	34.1±7.0	33.7±6.5	37.0±8.2	32.3±9.4
Weight at the end of Period I		63.4±3.1	58.0±4.9	62.9±4.5	57.8±8.9	57.7±9.0	50.5±13.7
Body weight gain		27.3±7.7	24.7±7.1	28.8±2.5	24.1±6.6	20.7±4.8	18.3±5.4
Daily gain		0.478±.053	0.408±.030	0.467±.057	0.431±.112	0.424±.093	0.350±.115
Period II							
Weight at the end of Period II		72.2±1.9	67.8±6.7	74.1±4.9	72.1±9.1	71.8±6.6	62.9±13.7
Body weight gain		8.8±2.1	9.8±2.4	11.2±0.9	14.4±1.3	14.1±3.6	12.3±1.3
Daily gain		0.314±.076	0.346±.084	0.400±.032	0.513±.046	0.503±.127	0.440±.048
Whole experimental period							
Body weight gain		36.1±9.4	34.5±9.2	40.0±2.2	38.4±5.8	34.8±3.1	30.6±5.2
Daily gain		0.420±.048	0.386±.047	0.444±.043	0.458±.047	0.453±.047	0.381±.073

Note : Average±S.D.

Table 4 Digestibility, DCP, TDN and DE contents of diets estimated in two digestion trials*

Ration	Digestion coefficient (%) DM	Energy	CP	EE	CF	NFE	Ash	DCP (%)	TDN (%)	DE (cal/g)
First trial										
A	63.2	65.2	59.6	59.7	65.8	77.5	—	9.5	71.1	2,192
B	63.9	69.9	60.9	55.3	61.6	78.3	—	9.9	69.3	2,147
C	61.7	67.7	60.3	60.3	63.0	78.0	—	10.3	70.6	2,101
Second trial										
D	70.1	71.8	78.9	77.4	52.8	73.5	64.4	15.6	71.2	3,129
E	67.1	69.8	75.2	74.1	51.0	70.8	60.3	15.0	68.3	3,021
F	70.8	70.9	79.5	74.2	57.4	71.2	60.8	16.7	70.8	3,114

Note :*Digestion trials of diets were conducted under the following feeding conditions : calves in each group were fed 0.5kg of the respective calf starter ration plus 2.0kg of green Napier grass daily in the first trial and calves in each group were fed 1.0kg of the respective calf starter ration plus 2.3kg of green Napier grass daily in the second trial.

intake from the three kinds of feed sources showed that these three groups did not receive a sufficient amount of TDN from whole milk only at the early stage of growth. Although calves in Groups D and E received an adequate amount of TDN, Group F did not receive the amount of TDN required for maintaining a daily gain of 0.3kg throughout the experimental period.

The DCP intakes of calves in the early stage of growth (4 weeks of age) did not enable them to reach the level required. Supplement of feeding with a large amount of CSR resulted in the increase of DCP intakes in calves in each group to more than the level required in the latter half of the experiment in both trials. The amount of DCP derived from green Napier grass was extremely small compared to that from CSR. The aflatoxin level contained in the groundnut meal used in the second trial was 0.08ppm.

Table 5 Estimated feed intake in each group throughout the experimental period

(kg)

Group	Whole milk	Calf starter	Napier grass	TDN	DCP
First trial : 16 weeks					
A	198.8	65.9	68.3	90.9	18.1
B	198.6	60.2	64.1	86.6	17.6
C	198.6	56.7	84.2	86.0	18.4
Second trial : 14 weeks					
D	172.2	50.1	71.9	76.4	15.8
E	172.2	47.4	77.6	75.5	15.1
F	172.2	43.8	49.6	68.8	13.8

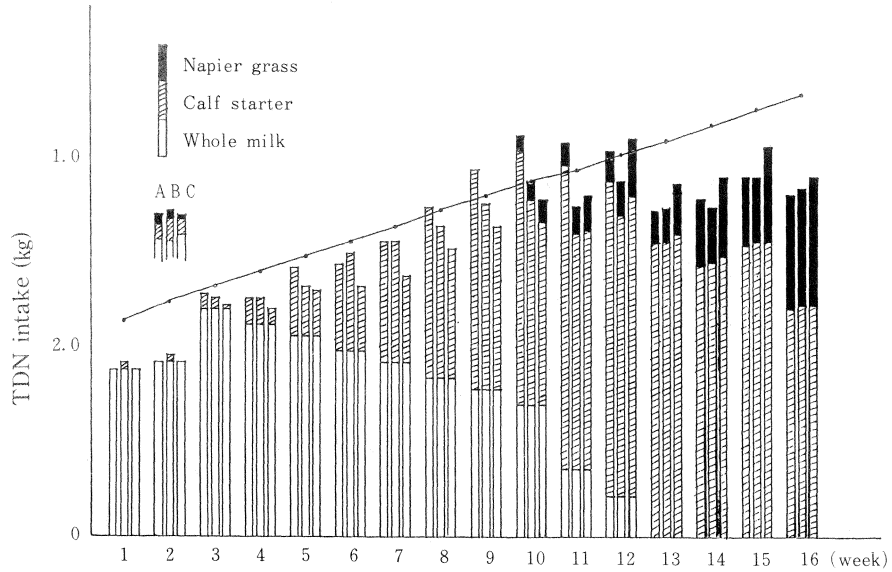

Fig. 3-1 Average daily TDN intake in the three groups per week during the experimental period in the first trial.

Discussion

This series of experiments aimed at defining the suitable duration of the nursing period after which calves could be weaned safely without any risk of high morbidity and mortality under the conditions prevailing in Malaysia. The nursing periods in these experiments were set at 12 weeks and 10 weeks. Compared to the practices in temperate countries, these periods were relatively long. This is however an improvement compared to the usual nursing period adopted in Malaysia i.e. feeding milk until lactation in the dam ceases completely (6-7 months) (Leong, 1975).

The daily gain of calf in Malaysia is said to be around 0.2kg under small holder conditions (Abdul Rahman, 1981). Statistics or data enabling to obtain accurate information on the status of calf management in small holdings are scarce. Calves fed on locally made milk replacer plus imported CSR gained only 0.25kg per day up to 8 weeks of age, and calves

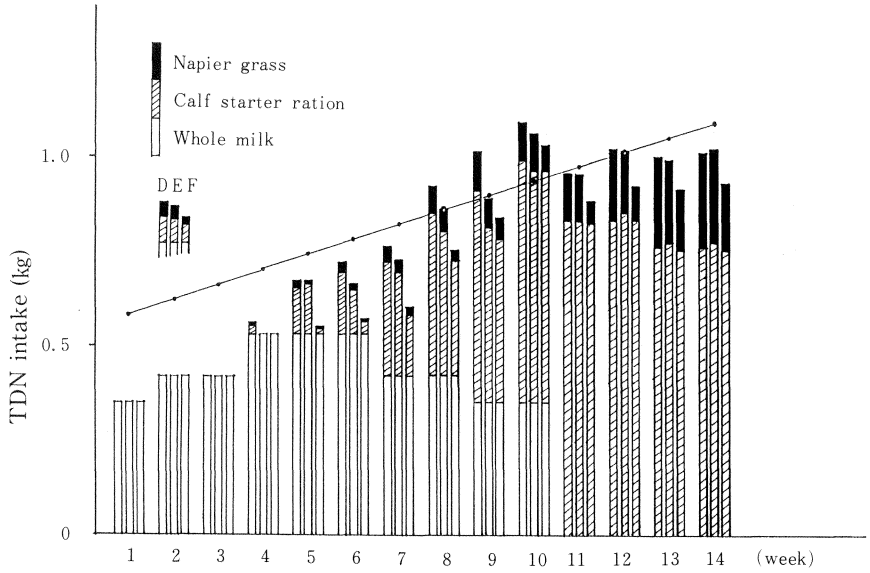

Fig. 3-2 Average daily TDN intake in the three groups per week during the experimental period in the second trial.

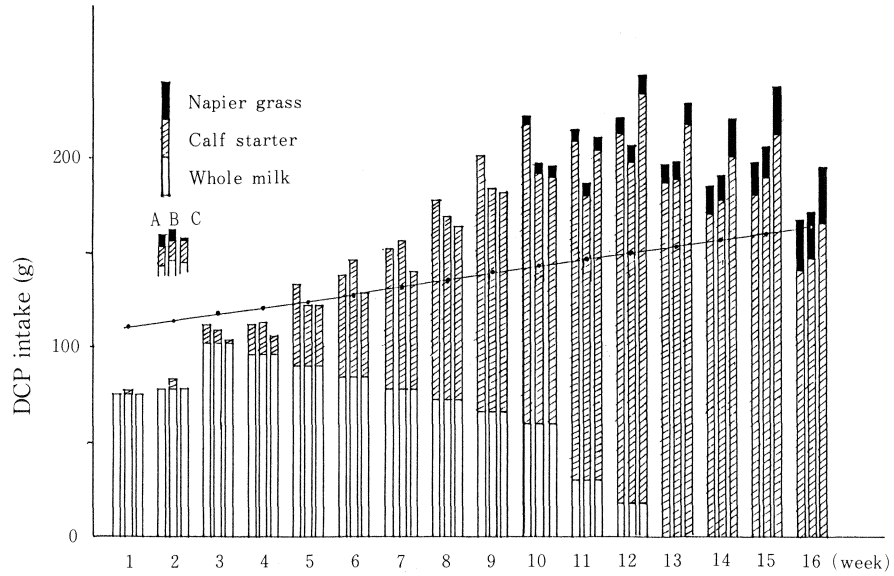

Fig. 4-1 Average daily DCP intake in the three groups per week during the experimental period in the first trial.

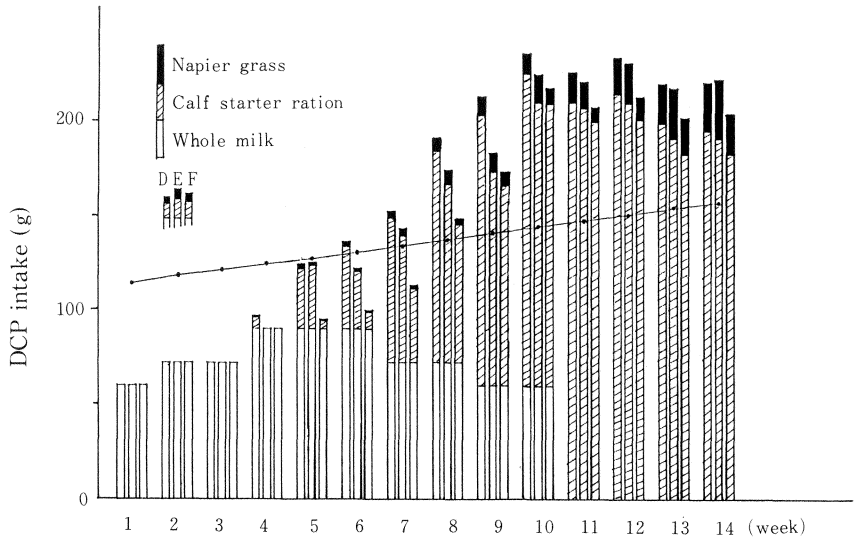

Fig. 4-2 Average daily DCP intake in the three groups per week during the experimental period in the second trial.

fed on imported milk replacer, and whole milk with imported CSR gained 0.32kg and 0.30kg per day, respectively (Abu Bakar Chik, 1984). All the calves gained around 0.42kg per day under the feeding conditions adopted in this series of experiments. Although, the feeding schedule of the six types of CSRs offered to the 6 groups of calves was designed to maintain a daily gain of 0.3kg throughout the experimental period, the daily gain in both experiments showed that in Groups A and C, and D and E the daily gains exceeded 0.4kg, and in Groups B and F the daily gains were 0.386kg and 0.381kg, respectively. On the other hand, calves in all groups did not receive a sufficient amount of TDN in the early and late stages of the experimental period to maintain a daily gain of 0.3kg. This discrepancy suggests that there may be some differences in the nutritional requirements in the early stage of growth between tropical and temperate environments. Further research on the nutritional requirements of calves in the early stages of growth in the tropical area is necessary to acquire more accurate information so as to develop appropriate systems of feeding for dairy calves. In the first trial, the average amount of TDN intake was the lowest in Group C, due to the low TDN intake from CSR. However, these calves consumed the largest amount of bulky green Napier grass, which enabled them to achieve the highest weight gain among the three groups at the end of the experiment. The body weight gain of the animals in Group C as well as those in other groups was largely affected by the weight of the gut which was filled up with a large amount of green Napier grass.

The feed materials used for composing the R-A were mainly imported materials consisting of maize, wheat bran, soybean meal and alfalfa meal, and a few local materials such as brewer's grain and molasses. The other ingredients included minerals, vitamins, common salt and antibiotics. The feed materials for the other CSRs were mainly local products such as cassava chips, fish meal, coconut meal, palm kernel cake, brewer's grain, molasses and palm oil with the addition of minerals, vitamins, common salt and antibiotics. Soybean meal had to be used in R-B, R-C and R-D as the main protein source, although it was an imported material, due to its ready availability and its role as a control ingredient.

Maize was replaced by 45% of cassava chips in R-B and 30% in R-C, respectively in the first trial. Attempts to improve the quality of CSR were also made by decreasing the level of cassava chips to 20% in R-D and R-F, and 25% in R-E in the second trial.

Twenty percent of groundnut meal and 10% of groundnut meal plus 1% of urea were used for the replacement of 20% of soybean meal in R-E and R-F, respectively in the second trial. Six kinds of CSRs in this series of experiments were prepared, which contained an average of 19.4% of DCP and 75.9% of TDN, by combining these feed materials. The values of digestion coefficients of two combined diets i.e. CSR and green Napier grass, did not show statistically significant differences among the groups in both trials. Since the quality and quantity of Napier grass fed to each group in each trial was identical, it could be concluded that the digestibility of CSRs in each trial was similar. Accordingly, DCP, TDN and DE contents in those rations were also at the same level. Further research on the combination of CSR with forage crops including Napier grass, and other grasses and legumes is necessary for the purpose of establishing an appropriate feeding system for dairy calf in the tropical area.

The occurrence of soft feces which was often observed in several calves in Groups B and C in the first trial, was presumably associated with the high percentages of cassava chips composing the R-B and R-C diets. Linamarin (cyanogenic glucoside), which is present in cassava even after processing to dried chips contains 55ppm of hydrocyanic acid (HCN) [Max. 133ppm, Min. 23ppm] (JETRO Thai Office, 1982) on the average. It could not be determined whether the soft feces observed in calves fed R-B and R-C were attributable to the high contents of carbohydrates or HCN in cassava. Also the occurrence of bloat-like symptoms twice in Group B and once in Group C in the first trial, suggests that the levels of 45% and 30% of cassava chips in CSRs is too high to enable the utilization of cassava as the main energy source. The safer level of cassava content in CSR should be below 30%.

Groundnut meal used in the second trial contained 0.08ppm of aflatoxin. However, groundnut meal contents in R-E and R-F amounted to 20% and 10%, respectively. Since the safe level of aflatoxin concentration in animal feed has been set at 0.05ppm in Japan (Hoseigijutsuken, 1976), the aflatoxin concentrations in R-E and R-F did not reach the critical toxic level. To maintain the aflatoxin level below 0.05ppm, using groundnut meal containing around 0.1ppm aflatoxin, the amount of groundnut meal added to the animal feed should be set up in taking account of the safety level of the feed.

By decreasing the amounts of cassava chips added to the feed and in spite of the presence of aflatoxin in groundnut meal, calves fed R-E did not show any toxic symptoms and were able to achieve the same growth rate as calves fed R-D containing 20% of soybean meal as the main source of dietary protein.

Conclusions

The experiments showed that the nursing period of Malaysian dairy calves could be shortened and they could be weaned at 10 weeks of age by applying the early weaning method with the use of whole milk, calf starter ration and green Napier grass. European and Indian crossbred calves in Malaysia are able to achieve a daily gain of 0.4kg in the pre- and post-weaning periods. Pre-weaning calf mortality could be lowered by supplying a sufficient amount of nutrients from the calf starter ration. Calves did not receive a sufficient amount of nutrients only in the case of the green Napier grass, after 10 to 12 weeks of post-weaning period.

The feed resources used in this series of experiments which are available in Malaysia, were found to be useful for the formulation of calf starter rations. However, the dietary level of cassava chips should be kept below 30% and the aflatoxin level in groundnut meal should be maintained below 0.05ppm in the concentrate mixture for the purpose of preventing the occurrence of toxic effects.

To establish a well-balanced concentrate mixure, it is preferable to use various kinds of ingredients, so as to obtain a complementary effect from different nutrient sources. Even if concentrate mixtures consisting of simple combinations of agricultural products and by-products contain enough nutrients including TDN, DCP and DE, a larger proportion of a certain ingredient in such concentrate mixture may lead to the accumulation of toxic substances in the diet.

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Discussion

Okubo, T. (Japan): I am most interested in your experiments dealing with the utilization of Napier grass and I am also studying the growth of Napier grass. What do you mean by "green Napier grass"? Indeed our data seem to indicate that there are significant differences in the digestibility between the leaf parts and the stem parts.

Answer: "Green Napier grass" is a mixture of stems and leaves.

Siregar, M. E. (Indonesia): Did you evaluate these tests from the economic point of view?

Answer: No, we did not make any economic evaluation.

Mendoza, R. C. (The Philippines), **Comment:** It appears that for the utilization of local agricultural by-products the nutritional requirements of the breeds should be evaluated since they may vary with the breed.