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COMPARISON OF PERFORMANCE BETWEEN BUCKET-FED AND NIPPLE-FED DAIRY CALVES ON DIFFERENT LEVELS OF MILK INTAKE

H M Nuwagaba and H Kayongo-Male

Department of Animal Production, University of Nairobi, P. O. Box 29053, Nairobi, Kenya

Thirty-two Friesian and Ayrshire dairy calves balanced for breed, sex and liveweight were used in a 2 x 2 factorial designed experiment to evaluate both method(open buckets and nipple bottles) of feeding milk to calves and level of milk intake (at 5% or 10% of body weight). Milk was fed twice a day up to 63 days of age.
Calves that consumed milk from open buckets showed higher ($P < 0.05$) average daily gains (480.7 g vs 376.5 g) than those that received milk in nipple bottles.
Calves that received milk at 10% bodyweight had higher ($P < 0.05$) percentage changes in height at withers than those that consumed milk at 5% of bodyweight, but consumed less ($P < 0.05$) calf pellets (16.3 kg vs 35.7 kg) and started consuming later (3 weeks vs 2 weeks) than calves receiving milk at 5% bodyweight.
A significant positive correlation between average daily gain (ADG) and milk intake ($P < 0.05$) obtained for calves fed by nipple bottle at 5% body weight intake, between average daily gain (ADG) and pellet intake ($P < 0.05$ vs $P < 0.01$) obtained by both feeding methods, also at 5% body weight intake.
Under the conditions of the experiment, the cheapest method was feeding milk to calves at 5% bodyweight in buckets and offering liberal amounts of good quality calf starter.

Key Words: Calves, milk consumption, buckets, nipple bottles

In 1980, there were an estimated 0.17 million heifer calves from improved cows for rearing in Kenya (Kenya Dairy Farmer 1980). A large proportion of dairy in Kenya are fed artificially. The method of calf feeding employed determines the amount of milk consumed or wasted by the calf, the costs involved and the performance of the calf crop (Roy 1970).

Literature pertaining to both bucket and nipple feeding in relation to their comparative effectiveness and suitability for calf rearing is varied. Nipple feeders have been reported to be superior to pails in terms of calf performance (Wise and LaMaster 1968); whereas work by Kesler et al (1956) showed pail feeding to be more effective than nipple feeding. But, Faria (1956) reported that no significant difference in the rate of liveweight gain or incidence of scours was exhibited between pail-fed and nipple-fed calves. In view of the inconclusiveness of data on the effectiveness of pail and nipple feeding methods this study was carried out to evaluate the efficacy of pail and nipple feeding methods as tools of calf feeding under tropical conditions.

Materials and Methods

The study was conducted at the Veterinary Farm of the University of Nairobi with a total of 32 Friesian and Ayrshire calves balanced for

birthweight, breed and sex. From birth, every calf was allowed to suckle the dam for colostrum for 4 days, after which the calf was housed in an individual experimental pen up to 63 days of age. Each pen measured 1.93 m^2 and all the pens had straw bedding laid about 15 cm thick. Throughout the experimental period the average daily temperature and relative humidity were 19°C and 62%, respectively.

The experiment was designed, carried out and analysed as a 2 x 2 factorial with two methods of feeding, open bucket and nipple bottle, and two levels of milk intake at 5% and 10% bodyweight. Fresh whole milk, a composite from the University herd, balanced for butterfat and solids-not-fat variations, was fed to each calf, depending on its bodyweight, up to weaning, out of either open buckets or nipple bottles depending on the treatment. Calves were fed milk twice a day.

Calf pellets, chopped medium quality Rhodes grass (*Chloris gayana*) hay and fresh clean tap water were offered ad libitum daily from 4 days of age throughout the experiment and amounts consumed recorded daily. Nine-litre metal buckets and three-litre plastic nipple bottles, with a 9 cm rubber nipple and ping pong ball milk flow regulators, were used in milk feeding. During feeding, buckets were placed at floor level whereas nipple bottles were placed in metal rings attached to the calf pen doors at a height of 78 cm above the floor.

Measurements of bodyweight, heartgirth and height at withers were done just before the calves were transfered to the experimental pens and thereafter at weekly intervals. Measurements of headwidth, headlength, middlegirth, bodylength and pinbone witdth were taken monthly according to Taylor (1963). Evaluation of incidence of scours was based on visual observations and laboratory tests of faecal samples collected for certification. Labour cost done by timing all the operations from and including preparations for feeding, feeding and cleaning of the feeders under both methods. Routine operations, similar under both methods of feeding, were not timed.

Hay and young stock pellets were analysed for proximate components of dry matter (DM) and protein (CP) (A O A C 1975); acid fibre (ADF) (Van Soest 1963). Samples from the herd composite milk taken at biweekly intervals were analysed for butterfat and crude protein content using the Garber and Kjeldahl methods respectively (Table 1).

Experimental data were subjected to variance and regression analyses. Covariance analysis was used on growth data (Steel and Torrie 1960).

Results

Effect of method of feeding milk on liveweight gain: The average daily gain (ADG) of dairy calves fed milk from buckets and nipple bottle is summarised in Table 2. Method of feeding milk had significant ($P < 0.05$) effect on weight gain of calves. Bucket fed calves attained higher ($P < 0.05$) average daily gains than calves that were fed milk using nipple bottles. The mean daily gain for bucket fed calves was 0.481 kg, while nipple fed calves had a mean of 0.377 kg.

Table 1:

Chemical composition of herd composite milk, calf pellets and hay fed during the experimental period

Constituent % (as fed)	Milk	Calf pellets	*Chloris gayana* hay
Dry matter	13.7	90.7	90.2
Crude protein	3.4	15.4	4.6
Acid detergent fibre		13.4	55.3
Ash	0.7	5.0	10.7
Butterfat	4.2	-	-
Solids-not-fat	9.6	-	-
Total solids	13.8	-	-

Table 2:

Effect of method of feeding milk on growth of dairy calves[1]

Method	Bucket	Nipple bottles	± SE
Number of calves	16	16	
Initial weight, kg	34.3	35.5	0.75
Final weight, kg	64.6	59.2	1.44
Total gain, kg	30.3	23.7	1.09
Average daily gain, (ADG), (g)	480.7[a]	376.5[b]	17.33

[1]Calves were fed milk at 5 and 10% of body weight on both methods up to weaning at 9 weeks of age.

[2]Standard error of the mean

[a,b]Means with similar superscripts within a row are not different (P> 0.05)

Effect of method of feeding milk on milk conpumption rate of calves: The rates at which the calves consumed milk are presented in Table 3 and 4. The consumption rates of bucket-fed calves ranged from 7.5 g/second in the first week to 58.5 g/second in week 9. Nipple-fed calves had a range of 14.4 to 25.6 g per second from the first to the ninth week, respectively. Between the two methods of milk feeding the consumption rates were only significantly ($P < 0.05$) different in weeks 1, 3, 7 and 8. In weeks 1 and 3, nipple-fed calves consumed milk at a faster ($P < 0.05$) rate than bucket fed calves while in weeks 7 and 8 the bucket-fed calves were consuming more ($P < 0.05$) milk per second than did those on nipple bottles. Within bucket feeding, calves at 7, 8 and 9 weeks of

Table 3:

Effect of method of milk feeding on the milk consumption rate of calves[1]

Method of feeding milk		Bucket ——Consumption rate	Botella con tetera (g/sec)[2] ——
Age in weeks	1	7.5 ± 1.0[a]	14.4 ± 1.1[b]
	2	9.7 ± 1.0[a]	16.3 ± 2.5
	3	14.8 ± 4.3[a]	24.0 ± 1.4[b]
	4	23.9 ± 6.3	27.3 ± 3.7
	5	24.4 ± 3.8	27.7 ± 2.2
	6	33.9 ± 4.4	31.5 ± 0.9
	7	54.6 ± 1.8[a]	35.4 ± 1.5[b]
	8	56.0 ± 2.0[a]	41.6 ± 1.3[b]

[1] Milk was provided at both 5 and 10% bodyweight

[2] Consumption rates shown are means ± standard errors

[a,b] Means with similar superscripts within the same row are not different ($P > 0.05$)

Table 4:

Effect of age calf on milk consumption rate of dairy calves[1]

Method of feeding milk Age (weeks)	Bucket ——Consumption rate	Nipple bottle (gm/sec)——
1	7.5[f]	14.4[f]
2	9.7[ef]	16.3[f]
3	14.8[c]	24.0[e]
4	23.9[bde]	27.3[de]
5	24.4[bd]	27.7[de]
6	33.9[b]	31.5[cd]
7	54.6[a]	35.4[c]
8	56.0[a]	41.6[a]
9	58.5[a]	45.6[a]

[1] Calves were fed milk at both 5 and 10% bodyweight

[a,b,c,d,e,f] Means with similar superscripts within method of feeding (column) are not different ($P < 0.05$)

age consumed milk at a higher ($P < 0.05$) rate than at week 1 to 7. On average bucket-fed calves consumed milk much more rapidly than those fed via nipple bottles.

Effect of level of milk intake on liveweight gain: Average daily gain (ADG) of dariry calves fed milk at 5 and 10% bodyweight in buckets and nipple bottles is presented in Table 5. Levels of milk, expressed as percent bodyweight had no sifnificant ($P > 0.05$) effect on average daily gain of dairy calves. Calves that received milk at 5% bodyweight consumed an average of 137 kg of milk during the experimental period while those that consumed milk at 10% bodyweight averaged 291 kg. The average daily gains and final weights of the calves at the 5 and 10% level of milk intake were 0.404 kg and 60.5 kg; and 0.453 kg and 63.3 kg, respectively.

Table 5:
Effect of level of milk intake on growth of dairy calves[1]

Level	5%	10%	± S E[2]
Number of calves	16	16	
Initial weight, kg	35.03	3.475	0.75
Final weight, kg	60.47	63.31	1.44
Total gain, kg	25.44	28.56	1.09
Average daily gain, (ADG), (g)	403.81	453.33	17.33

[1]Calves were fed milk using buckets and nipple bottled at both levels of milk intake until weaning at 9 weeks of age

[2]Standard error of the mean

Effect of level of milk feeding on consumption of pellets and hay: Irrespective of method of milk feeding, the level of milk intake had a significant ($P < 0.05$) effect on the consumption of pellets by calves but not on hay intake. Calves that received milk at 5% bodyweight consumed an average of 35.7 kg of pellets which was more ($P < 0.05$) than an average of 16.3 kg consumed by calves that fed on milk at 10% bodyweight. Calves fed milk at 5% bodyweight started consuming calf pellets at an earlier age (2 weeks old) than those on 10% bodyweight which started consuming pellets at 3 weeks of age. Calves that received milk at 5% bodyweight started eating hay at 6 weeks of age whereas those at 10% level of milk intake started at 7 weeks of age.

Effect of method of milk feeding and level of milk intake on disease incidence: There was no clear pattern of disease occurrence. Most of the calves in the study remained in good health during the experimental period. During the nine weeks of experiment for each calf, only three cases of nutritional scours occured out of 32 calves.

One of the cases occured in the experiment where milk was given at 5% bodyweight using the bucket, the second case under 5% level of milk intake using the nipple bottle while the third occured under the 10% lev

el of milk intake on the bucket; and these cases occured in the 6, 2 and 3 weeks of age respectively.

Cost of rearing calves on different methods of milk feeding and levels of milk intake: Cost of rearing a calf up to 9 weeks of age, in this study, varied both between and within method of feeding milk. At the current prices of items, nipple bottle-fed calves at 10% of body weight cost twice as much as the bucket-fed calves at 5% level of milk intake. The most expensive item in calf rearing was milk.

Between methods of feeding at the same level of milk intake, cost variation was due to labour costs. Nipple feeding required more time for sanitation of feeders and was therefore more expensive than bucket feeding. Within method of milk feeding, cost variation accrued from level of milk feeding and consumption of calf starter pellets. Calves at 5% level of milk intake incurred more cost due to higher pellet consumption than those fed milk at 10% of body weight.

Relationships between feed intake and calf performance: Correlations between ADG and feed intake are presented in Table 6. Correlations coefficients of bucket-fed calves were generally lower than those

Table 6:

Correlations between average daily gain and feed intake

Method of Milk feeding	Level of milk intake	Parameters[1]	Correlation coefficient (r)
Bucket	5%	ADG vs MI	0.51
		ADG vs CI	0.76*
	10%	ADG vs MI	0.42
		ADG vs CI	0.49
Nipple bottle	5%	ADG vs MI	0.79*
		ADG vs CI	0.95**
	10%	ADG vs MI	0.56
		ADG vs CI	- 0.35

[1] ADG - Average daily gain
MI - Milk intake
CI - Concentrate intake
* Significant ($P < 0.05$)
** Significant ($P < 0.01$)

of nipple-fed calves. Milk intake at 5% bodyweight on nipple bottles was significantly ($P < 0.05$) related to ADG; whereas concentrate intake was significantly ($P < 0.05$ or $P < 0.01$) correlated to ADG when milk was offered at 5% bodyweight using both methods of feeding.

Discussion

Bucket-fed calves attained higher average daily gains than calves that were fed milk using nipple bottles, which was consistent with the results reported by Kesler et al (1956) but contrary to results reported by Alexander (1954); Faria (1960); Wise and LaMaster (1968); Fallow and Harte (1980); Morril and Dayton (1981). Earlier studies by Leufven (1896) and Hooper (1913) showed that nipple-fed calves had better growth rates and were more thrifty than bucket-fed calves during the first 7 - 10 weeks. The superiority of nipple fed calves in performance was attributed to slower ingestion and thorough mixing of milk with saliva (Hooper 1913). Suckling from nipple pails effected greater dilution, more rapid coagulation by rennet and faster hydrolysis of fat than did drinking from open pails (Wise et al 1940; Wise et al 1947); stimulated rennin and proteolytic activity of abomasal fluids in calves (Grosskopf, 1959); and increased production of salivary lipase (Grosskopf, 1965) which led to fewer digestive disturbances (Roy 1970).

It would appear that suckling through a nipple did not give a significant advantage to nipple-fed calves over bucket-fed calves in performance in this study, which may suggest other associated metabolic differences in the utilization of milk constituents (Wise and LaMaster, 1968) whose relationships to growth and clinical well-being of calves have yet to be established. Calves that fed on milk at 5% of body weight tended to consume slightly higher amounts of water than those that received milk at 10% body weight. This must be attributed to the fact that calves that consumed milk at 10% body weight consumed more water in their diet than those at 5% level of milk intake; and further still calves that fed on milk at 5% body weight ingested significantly more calf starter pellets. Atkeson et al (1934) found, with calves whose milk intake was restricted, that water intake per unit dry matter intake was high during the first 6 weeks of life.

Level of milk intake had a significant effect on the consumption of calf starter pellets by calves which was consistent with results reported by Knapp and Black (1941), Drewry et al (1959) and Totusek and Arnett (1965). In this study, also, correlations between level of milk consumption and average daily gain of calves ranged from 0.42 to 0.79 which were consistent with those earlier reported by Knapp and Black (1941); Gifford 1953; Drewry et al (1959); Neville et al (1952); Velasco (1962); and Totusek and Arnett (1965). Calves that were offered milk at 5% of body weight regardless of method of milk feeding, compensated their dry matter and nutrient intake by consuming higher amounts of calf pellets.

Milk consumption rates of bucket-fed calves were lower than those of nipple-fed calves in the in the first 5 weeks of life but higher there after up to weaning. This was attributed to the calves having to learn to drink from buckets, in the first instance, and then the restriction of milk flow from the nipple bottles in the second case.

From the data collected on the experimental calves there was no clear cut pattern of disease occurrence attributable to either method of feeding or level or milk intake which was consistent with the findings re

ported by Kesler et al (1956); Faria (1960) and Wise and LaMaster(1968) Incidence of nutritional scours has been attributed to higher levels of milk intake than those used in this study (Roy 1970).

The economics of rearing good heifer replacements has been a subject of considerable debate (Ensminger 1971; Van Velzen 1972). The best method is that which gives satisfactory weight gains at lower costs. In this study, bucket feeding was cheaper than nipple feeding at both levels of milk intake. Labour costs of sanitizing nipple bottles contributed the highest proportion to the expense of the method and this was in agreement with findings of Alexander (1954) and Hoyer and Larkin (1954). Under both methods of milk feeding, the cost of rearing calves at 5% level of milk intake was lower than that for calves at the 10% level.

Given the cost of rearing calves under systems employed based on the price prevailing during the experimental period, it was clear that even if calves that consumed milk at 10% of body weight under both methods of feeding gained slightly more weight compared to those at 5% level of milk intake, the cost of production far offset the advantage, given that milk was the most expensive feed item. Therefore, it is evident that in terms of ratios of total gain to cost of rearing, calves that received milk at 5% of body weight showed superior performance to those that consumed milk at 10% of body weight. The cheapest method that gave satisfactory weight gains was feeding milk at 5% of body weight in buckets and offering liberal amounts of good quality calf starters.

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