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Comparison of Colostrum Quality and Immune Status in Neonatal Dairy Calves in Debrezeit Agricultural Research Center

Sadia Hajie
Oromia Livestock and Fishery Resource Development Bureau, Addis Ababa, Ethiopia

Abstract
A study was conducted in Debrezeit agricultural research center from November 2008 to April 2009 to measure colostrums quality and total serum protein in neonatal calves to evaluate the extent of passive immunity transfer. A total of 40 dairy cows (Borana *Holstein=12, Barca*Holstein=27 and Borana =1) were used for the study. The colostrums were collected from 40 cows to measure the colostrum quality using colostrometer. According to quality grading the first milked colostrum from 33 cows were classified as superior quality, where as colostrum milked from 6 cows with moderate quality and only one with inferior quality. From the second milked colostrums from 24 cows were superior quality, from 15 cows were moderate and only 1 cow was inferior in quality grading standard. From the two local breeds (Borana and Barca) crosses included in the study the mean 1st and 2nd milked colostrum quality for Borana crosses was superior to that of Barca crosses at the 1^{st} milked colostrum but Barca crosses was superior to Borana at the 2^{nd} milked colostrum quality .The overall mean of 1^{st} and 2^{nd} colostrum quality were 84.5mg/ml and 78.9 mg/ml both are classified under the superior quality category. There was also great variation was observed in volume of individually milked 1^{st} and 2^{nd} colostrum which range from 0.5 to 6 liter respectively. Blood samples were collected before colostrum feeding after 6 hours and 24 hours after colostrums feeding from both groups calves (suckle and fed from bucket) for total serum protein analysis. The calf serum protein analysis result has shown that mean total serum protein before colostrums feeding after 1^{st} and 2^{nd} feeding were 5.3g/dl, 6.4g/dl and 7.8g/dl, respectively. However the bucket feeding group had significant (6.72g/dl: $p<0.05$) higher mean total serum protein level than suckling group (6.08g/dl) during consecutive sampling. Analysis made by sodium sulfite on calf serum analysis before colostrum feeding in bucket feeding group has shown that 42.8% lower, 42.9% medium and 14% higher total serum protein levels respectively.
Keywords: Colostrum, Immunoglobulin, Calves, Breed. Parity and Colostometer.

INTRODUCTION

Neonates born virtually agammaglobulinemic because the nature of physiology of bovine placenta prevents transfer of maternal serum immunoglobulin to the calf before it is born. As a result neonatal calf is entirely depending on colostral immunoglobulin (passive immunity) for disease protection .In addition to disease prevention, colostrum also provides neonatal calves with high quality nutrition ,growth factors and hormones that help in initiating function and growth of digestive tract (4,14).

Colostrum represents the accumulated secretion of the mammary gland over the last few weeks of pregnancy together with proteins transferred from the blood stream. It is very different from the milk produced during lactation. It constituted of higher in total solids, fat, vitamins. proteins and minerals but lower in lactose. In recent years researchers have discovered that colostrum contains numerous growth factors and hormones like insulin,cortisol and thyroxine (4).

During the transition from colostrum to whole milk, the level of total protein, fat, total solids and colostral immunoglobulins declines rapidly while lactose increase (15).The greatest difference in colostrum and later milk is the extremely high level of the protein and globulins that contain antibodies (9).This high level of immunoglobulinin colostrums plays an important role in establishing passive immunity in the young calf and localized in intestinal level (8).

The immunoglobulin intake depends on colostrum in take and its immunoglobulin concentration. Thus, the successful absorption of colostral immunoglobulin immediately supplies neonates with serum immunoglobulin particularly IgG and IgA. Colostral IgA and IgM are produced by specific plasma cells that are adjacent to secretary cells in the mammary gland but not transferred to colostrum from the dam blood (15). The predominant immunoglobulin in the colostrum of most of the domestic animal is IgG which may account for 65-90% of its total immunoglobulin content and other immunoglobulins are usually minor but are significant components.

All IgG, most of the IgM and about half of the IgA in the bovine colostrum are derived from serum (17).The initial absorption of IgG from colostrum is required for the protection of young animals against various disease but failure to do so predisposes young animals to infection. There are two major reasons for the failure of adequate colostral transfer insufficient or poor quality colostrum and inadequate intake of colostrums (17).Thus, inadequate or improper colostrum feeding and management causes a significant portion of the calf mortality on dairy farms (8).

On other hand the ability of the calf to absorb antibodies from the digestive tract decline with the age and is only effective for about 24hrs after birth. For efficient utilization ,a calf should receive the colostrum as soon as possible after birth, preferably within an hour and additional colostrum is desirable for 2 to 3 day after birth (9).This is due to the fact that the efficiency of immunoglobulin absorption by intestinal cells decrease as the calf ages more due to maturation of the intestinal cells and progressive decrease in the rate of absorption in both the initial period after feeding and over time emphasize the importance of sufficient colostrum intake during its first feeding to activate all potential absorptive cells lining the wall of small intestine (16).All calves fed colostrum prior to 12 hrs of age are subjected to gut closure before any Ig absorption takes place (15).

The Ig that is not absorbed also play an important role in protecting against intestinal disease (6, 1). The immunoglobulin ingested by the calf is taken up by the epithelial cells of the small intestine and passes lymph spaces the blood circulation through the thoracic duct .This transfer mechanism (passive transfer) starts to decline approximately 12 to 23 hrs after birth and ceases on average at 24 hrs. Although the level of Ig that provides adequate protection will vary with exposure to infectious organisms, stress environment and temperature. A management target of 10mg/ml has been suggested as a minimum level of IgG (8).

The volume of colostrum produced is affected by breed,for instance dairy cows produce more colostrums than beef cows and cows produce more than heifer (13).An important factor that influences the colostrum quality (immunoglobulin concentration) is the age of the cows. Heifers have poor quality colostrums while older cows have the best quality of colostrum. The first milking colostrums have twice the immunoglobulin content from the second milking colostrum. Factors like nutritional status of the dam, premature parturition, vaccination status, disease history, udder conformation and dystocia affect the passive transfer of colostral antibodies during the first 24 hours of life (6, 20).

Table 1.**The Ig Levels in Colostrum and Whole Milk**

	IgG1(g/l)	IgG2(g/l)	IgM(g/l)	IgA(g/l)
Colostrum	75.00	1.90	4.90	4.40
Whole milk	0.35	0.06	0.04	0.05

Source (Roy, 1980)

Generally the management factors have also a greatest influence on the probability of failure of passive immunity transfer. Furthermore, the volume of colostrums fed affects the amount of immunoglobulin received by the calf.In dairy that used artificial feeding methods failure of passive transfer was infrequent in calves fed greater than or equal to 100gIgG in the first colostrum feeding,but in the dairys that allowed calves to suckle.The prevalence of failure of passive transfer was greater than 50% even among calves nursed by cows with above average colostral immunoglobulin concentration (1)

Thus the objectives of this study are:

- To determine the colostrum quality of Holstein cross with local bred dairy cows
- To determine the immunity level of neonatal calves let to suckle and bucket fed calves sampled on 1st, 6th and 24 hrs of age.

MATERIALS AND METHODS

Study Area

The study was conducted in Debre zeit Agricultural Research Center (DZARC) which is located in Debrezeit town,East showa zone of Oromia Regional State that is 47km south East of the capital city, Addis Ababa. Debrezeit town is located 9o N latitude and 4oE longitudes at an altitude of 1850m.a.s.l. It receives an annual rainfall of 866 mm and a mean annual maximum and minimum temperature of 26oc and 14oc respectively with mean relative humidity of 61.3% (19), The study was undertaken from November 2008 to April 2009. Sampling as well as colostrum quality measurement, chemical analysis for total protein measurement was done in the veterinary clinic of DZARC and total serum protein analysis using total protein analyzer was done in physiology laboratory of Biomedical Science department Faculty of veterinary medicine, Addis Ababa University (14).

Study Animals

The dairy cows and calves utilized in this study (Borana=1.Barca cross with Holstein =27 and Borana cross with Holstein =12) were from DZARC farm. All dam and new born calves were kept under standard management system of the center. The dams were vaccinated for Anthrax, Black leg, Bovine Pasteurollosis and FMD before 6 months of pregnancy stage .All the suckling group calves were kept with their dam for three days while the bucket fed group were allowed to have twice feeding of milked colostrums as well as whole milk. The bucket fed groups were allowed to have the milked colostrum for those total yields were below two liters and for those milked above two liters only two liters were fed at each milking time .The general health of the calves was monitored daily for a month for the occurrence of any health problems or treatments recorded.

Sampling Strategy and Sample Processing

Calves in group 1 (n=13) was allowed to suckle their dam immediately in 1-2 hrs after delivery by themselves.

Before allowing the calves to suckle about 50ml of colostrum was milked twice (with in 30 min – 1 hrs after delivery and 8-12 hrs after delivery) and measured for colostrum quality analysis. About 5-10ml of whole blood was drawn aseptically from the jugular vein of calves before 1,6and 24 hours after delivery in plain vacuntainer test tubes. The collected blood sample was left to clot at room temperature and then the serum was separated from the clotted blood and stored at -20oc until analysis.

Calves in group II(n=27) was fed 0.5 to 2 liters of colostrum after the first blood sampling was done from the bucket of first milked colostrum within 30min to 1hrs after completion of delivery and fed the second milked colostrum 8-12 hrs after delivery. The second and third blood sampling was done at 6th and 24 hours of age to separate serum for total serum protein analysis. The first and second milked colostrum was measured for colostrums quality using colostrometer while the temperature of the colostrum is about 20oc, serum total protein was measured by using total protein analyzer and Sodium sulfite turbidity test method (14) .

Study Design

All calves will be grouped in the two treatment groups.Treatment (1) will be allowed to suckle their dam by themselves and treatment (2) will be fed from bucket. Soon after completion of delivery process the first blood sample was taken from jugular vein of new born calf within 30 min -1 hrs and then the calf would either let to suckle the dam by themselves or let to feed after delivery .Sampling was done on randomly bases by immediately allocating and sampling immediately after the natural calving.

Data Analysis

The data were analyzed by using general linear model (SAS, 2001) was used to analyze the colostrum quality and calf serum total protein level with respect to different breeds.

RESULTS

A quality analysis was made on colostrum milked from Borana (n=1),Barca cross with Holstein (n=27) and Borana cross with Holstein (n=12) a total of 80 colostrum sample that were milked twice immediately after calving and 6-8hrs after calving as 1st and 2nd milked colostrum respectively.

According to the quality grading made by using colostrometer on the first milked colostrum,the colostrum milked from 33 cows were classified as superior quality ,where as colostrum milked from 6 cows with moderate quality and only one with inferior quality .From the second milked colostrum milked from 24 cows were having superior quality, colostrum milked from 15 cows were having moderate and colostrum milked from only one cows was having inferior based on quality grading standard.From the two local breeds (Borana and Barca crosses included in the study the mean of 1st milked colostrums quality for a Borana crosses was superior to to that of Barca crosses (106$\pm$ 29.7mg/ml vs 89.25 $\pm$42mg/ml).In the second colostrum Barca cross were found to be superior to that of Borana crosses (62.5$\pm$ 48mg/ml vs 68.5$\pm$38mg/ml).(Table 2&3).The overall mean of 1st and 2nd milked colostrum quality was 84.3mg/ml and 78.9mg/ml which according the standard in colostrometer measure are classified under superior quality category.

Despite the overall superior quality of the colostrum observed there was great variability in volume of individually milked 1st and 2nd colostrum which range from 0.5 liter to 6 liter repectively (Table 4, 5 &6).In the analysis made on colostrum quality with respect to the number of parity of the dam,there was a trend of increasing parity number up to 8th parity (maximum of 140mg/ml) however low colostrum quality in Barca cross was observed on the second parity due to unidentified reason.

Table 2:Quality of First Milked Colostrum by Breed and Parity Measured by Colostrometer

Breed	Parity	No	Mean	S.D
Holstein *Barca	1	4	100	29.44
	2	5	40	21.2
	3	4	77.5	3.04
	4	6	115	20.7
	5	1	140	-
	6	4	67.5	55
	7	2	130	14.14
	8	1	140	-
	Total	27	89.25	42
Holstein *Borana	1	1	50	-
	3	4	125	17.32
	5	1	80	-
	6	1	110	-
	7	3	100	40
	8	1	120	-
	9	1	120	-
	Total	12	106.7	29.7
Borana	1	1	60	-

Table 3: Quality of second Milked Colostrum by Breed and Parity Measured by Colostrometer

Breed	Parity	No	Mean	S.D
Holstein *Barca	1	4	87.5	34
	2	5	40	20
	3	4	47.5	35.9
	4	6	70	29.66
	5	1	60	-
	6	4	67.5	49.92
	7	2	120	28.3
	8	1	120	-
	Total	27	68.5	38
Holstein *Borana	1	1	30	-
	3	4	25	12.9
	5	1	60	60
	6	1	100	-
	7	3	73.33	32.15
	8	1	140	-
	9	1	100	-
	Total	12	62.5	48
Borana	1	1	60	-

Table 4:Volume of Total Colostrum Milked

	Volume of 1st Colostrum	Volume of 2nd colostrum
Mean	1.678	1.667
S. deviation	1.0775	1.286
Minimum	0.5	0.5
Maximum	5.0	6.0

Table 5: Volume and Percentage of First Milked Colostrum

Range of Recorded Volume	Frequency	Percent
0.5	3	11.1
1	9	33.3
1.3	1	3.7
1.5	5	18.5
2	3	11.1
2.5	2	7.4
3.0	2	7.4
4.0	1	3.7
5.0	1	3.7
Total	27	100

Table 6: Volume and Percentage of Second Milked Colostrum

Range of recorded volume	Frequency	Percent
0.5	5	18.5
1	9	33.3
1.5	3	11.1
3	6	22.2
1	1	3.7
4	2	7.4
6	1	3.7
Total	27	100

From the result of calf serum protein analysis made by using total protein analyzer, the total serum protein before and after colostrum feeding based on their feeding system showed a trend of increasing total serum protein in the three consecutive sampling. In suckling group the mean total serum protein before colostrum feeding was 5.24g/dl, after first feeding 6.0g/dl and after the second feeding 7.1g/dl. In bucket feeding group the mean total serum protein before colostrum feeding was 5.4g/dl and the total serum protein after first and second colostrum feeding was 6.7 g/dl and 8.3g/dl respectively (Table 7).Although the breed effect is not

stastically significant (p>0.05) but there is a difference in total serum protein during the three different sampling periods.

In both breeds the mean total serum is higher in bucket feeding group as compared to suckling group .The Barca cross in bucket feeding group had mean total serum protein before colostrum feeding of 5.6± 1.3g/dl after the first feeding 7.12±1.35g/dl and after the second feeding was 8.4± 1.6g/dl where as in suckling group the mean total serum protein was 5.09±1.25g/dl,after first and second feeding was 6±0.9g/dl and 7.05±1.53g/dl respectively.

Borena cross in bucket feeding group the mean total serum protein before colostrum feeding was 5.13±2.23g/dl, after first feeding 6.08± 2.56g/dl and the second feeding was 8.06±2.56g/dl. In suckling group the mean total serum protein before colostrum feeding was 6.05±2.73g/dl,after first and second colostrum feeding was 6.05± 2.75 and 7.4 ± 3.67g/dl respectively.

From the total serum protein analysis made by sodium sulfite in suckled group the serum collected before colostrum feeding 42.9% were identified to have lower total protein level (2500mg/ml),42.9% has medium total protein level (500-1000mg/ml) and only 14.3% were having higher total serum protein level (>1500mg.ml).From the serum collected 6 hours after colostrum feeding 40.7%lower.42.7%medium and 16.7% higher total serum protein levels respectively.From the serum collected 24hrs after delivery 18.2%,45.5% and 36.4% were having lower, medium and higher total serum protein leve. In bucket feeding group the serum collected before colostrum feeding 31.3% have lower have lower total protein level (<500mg/ml),31.3 have medium (500-1000mg/ml) and 37.5% have higher total protein serum protein level. From the serum collected 6 hrs after colostrum feeding 19.1 % lower,42.5% medium and 38.1% higher total serum protein level. From the serum collected 24 hrs after delivery 7.4 %,47.8% and 34.8% were having lower ,medium and higher total serum protein levels respectively.

Table 7; Result of Serum Protein Level before and after Colostrum Feeding based on their feeding system.

Bucket feeding group	Mean	S.D
At birth (before 13olostrums feeding)	5.4	±1.7
After 6 hrs (after clostrum feeding)	6.7	±1.9
After 24 hrs (after clostrum feeding)	8.3	±2.04
Suckling group		
At birth(before 13olostrums feeding)	5.2	±1.4
After 6 hrs (after clostrum feeding)	6.0	±1.1
After 24 hrs (after clostrum feeding)	7.1	±1.75

Table 8; Total Serum Protein Analysis Made by Sodium Sulfite before and After Colstrum Feeding Based on their Feeding System

I: Suckling group

	500mg/ml	500-1000mg/ml	100mg/ml
At birth (before 13olostrums feeding)	42.8	42.9	14.3
After 6hrs	40.7	42.7	46.7
After 24 hrs	18.2	45.5	36.4

II: Bucket feeding group

	500mg/ml	500-1000mg/ml	100mg/ml
At birth (before 13olostrums feeding)	31.3	31.3	37.5
After 6hrs	19.05	42.9	38.1
After 24 hrs	17.4	47.8	34.8

DISCUSSION

The acquisition and absorption of adequate amount of colostral immunoglobulin are essential to the health of the neonates as it is born virtually devoid of circulating immunoglobulin and relies on antibody acquired from colostrum for protection against common environmental pathogens. During this study the overall mean of first and second milked colostrum quality were 84.5mg/ml and 78.9mg/ml which according the standard set is classified under the superior quality category. (In superior quality Ig concentration range from 50-140mg/ml), in moderate 20-50mg/ml, in inferior <20mg/ml (18) Efficient immunoglobulin absorption by the calf depends on the concentration of Ig the colostrum which is express in colostrum quality and volume of the colostrum available to the calf.

In the study the overall colostrum quality was superior in standard set. However (22.2%) cows were milked above two liters of colostrum during the first milking and (14.8%) were milked during the second

milking. During this study above 75% of the calves received volume of colostrum levels the recommendation (2 liter in 1-2 hour s after birth) (8). There are number of factors that are known to affect the passive immunity, among those factors breed difference exist in the efficiency of Ig absorption. According to their report Jersy beed has highest colostrum Ig (9.0%). Ayrshires (8.1%0). Brown Swiss (6.6%), Guernsey (6.3%) and Holstein (5.6%).From the two bred, (Borana and Barca) crosses included in this study. Borana crosses were superior to that of Barca in the first milked colostrum quality (Table 2 and 3). With regard to the parity versus colostrum quality (13) has reported that the concentration of immuneglobin is lower in the colostrum of first calf heifers than older cows. This difference is associated with continued antigenic stimulation with age. Cows tend to a greater number of pathogens tend to produce colostrum with greater IG than exposed to fewer pathogens this is often why older cows will produce colostrum with greater than if caws exposed to fewer pathogens this is often why older cows will produce.

Colostrum containing more Ig than younger cows. In addition older cows have larger mammary gland capacity with an associated increase in functional secretary cells and a more efficient active Ig transport mechanism. Studies made on major dairy breeds indicated that the Ig concentration in the colostrum of first calf heifers is 28mg/ml and increased to 59mg/ml in second lactation to 82mg/ml in third and 73mg/ml on fourth lactation (5).

The above mentioned studies goes in line with the current findings the analysis made on colostrum quality with respect to the number of parity of the dam in the current study there was a trend of the increasing in colostrum quality with increasing parity number up to 8^{th} parity (maximum of 140mg/ml). However, low colostrum quality was observed in Barca cross on the second parity due to unidentified reason. The most important factor affecting efficient Ig absorption is the time after birth at which colostrum is fed, because the efficiency of absorption of immuneglobulin from colostrum decreases linearly from birth particularly after 12 hours and same calves fail to absorb immunoglobulin if fed after 12 hours. This is because efficiency of Ig absorption by intestinal cells decreases as the calf ages due to maturation of the intestinal cells and progressive decrease in the rate of Ig absorption (6). All calves feed colostrum prior to 12 hours of age absorb all classes of Ig and calves not ingesting colostrums 12 hrs of age are subject to gut closure before any Ig absorption take place (16).

The result of the current study goes with the findings mentioned above with respect to time of feeding. The finding has shown that there was increasing trend in total serum protein in the three consecutive sampling before and after colostrum feeding. The mean total serum protein before colostrum feeding was 5.3g/dl. 6.4g/dl and 7.8g/dl,respectively. This indicates that the absorption of immunoglobulin was efficient enough and reflected in increasing quantity of total serum protein. Feeding system has also a significant effect on the total serum protein. Calves that were allowed to nurse the dam generally achieved lower serum concentrations and are for more susceptible to morbidity and mortality than calves fed colostrums by bucket feeding (2).

Calves allowed to nurse their dam often consume less colostrum than do calves fed by bucket feeding there by lowering Ig intake. In addition, calves allowed to nurse dam often begin consuming colostrum later than calves fed by bucket there by lowering efficient. Immunoglobulin absorption by maturation of the intestinal epithelium the above mentioned finding of different studies goes in line with the current finding the mean total serum protein in bucket feeding group before and after colostrum feeding was 5.4g/dl, 6.7g/dl and 8.3g/dl, respectively; where as in suckling group was 5.2g/dl, 5.9g/dl and 7.1g/dl respectively. As can be seen from the result the total serum protein was increasing in bucket feeding group as compared to suckling group.

Although, the breed effect is not statically significant . The result of total serum protein analysis made by using sodium sulfite goes in line with the results achieved by using spectrophotometer which indicated that the total serum protein level was increasing with feeding of good quality colostrums in enough volume.

CONCULUSION AND RECOMMENDATIONS

Neonatal dairy calves entirely depend on passive immunity for disease protection.Failure of this process deprives the neonate from immunoglobulin and predisposes young animal to infection The most important factor that affects passive immunity transfer in neonatal dairy calves colostrum fed to the neonate which in turn depends up on the colostrum quality, amount of colostrum fed,time/age of feeding colostrum. Colostrum of high quality (50 to 140 a higher total protein blood protein (604 g/dl- 708g/dl of blood) which is an indicator of higher passive immunity transfer .Based on their type of feeding, bucket feeding group is superior to suckling group in offering higher total blood protein (6.72 g/dl vs 6.08g/dl) which this confirms that adequate passive immunity transfer. Breed difference is also observed colostrum quality Boranaa cross is superior to Barca cross during the first milked colostrum. More over repeat colostrum feeding is identified gradually building up the level of total blood protein (from low level 5.3 g/dl to as high as 7.8 g/dl) within 24 hours of age which can be interpreted and building up the immunity level from low and unproductive level to optimal level. Based on above result the following recommendation is forwarded;

- The management factors like feeding quality colostrum in adequate amount and as early as possible,

repeat feeding of colostrum in the early age (within 12 hrs) would optimally offer the neonatal calf with passive immunity.

- Colostrum scarcity particularly when adequate volume of colostrum is not available to the neonates needs to be supplemented by either colostrum replacer or normal milk to build up the total protein level.

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