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Effects of Various Colostrum Feeding Methods on Growth Performance and Immunity of Holstein-Friesian Calves

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ABSTRACT

This study was carried out to evaluate the effects of various colostrum feeding methods on growth performance, and immunity of Holstein Friesian (HF) calves. The applied feeding methods were stomach tube (ST), nipple feeder (NF) and natural suckling (NS). A total of 15 newly born HF calves were selected randomly from the available stock and divided into 3 groups, each of 5 calves. The median birth weight (kg) ± S.D of calves fed by ST, NP and NS were recorded as 28.68±1.16, 28.44±0.67 and 28.56±1.13, respectively. Results of this study showed that the serum IgG levels and body weight gain were significantly ($p < 0.05$) different among the groups, the greater levels were observed in ST (15.74±0.29 mg/ml) as compared to NF (11.52±0.72 mg/ml) and NS (10.36±0.36 mg/ml) during the experiment period. Whereas; withers height, heart girth and body length were found non-significant ($p > 0.05$) among the groups. The morbidity rate of calves fed different levels of colostrum by ST, NF and NS, diarrhea was found 40, 80 and 60% calves affected among the groups respectively, whereas pneumonia problem was observed as 20, 40 and 60% calves were affected accordingly. It is concluded from the present study theconcentration of serum IgG following administration of colostrum by ST method increases at a rate to that in calves fed by NS and NB and reaches a level consistent with high calf survival, it is also concluded from the study that the body weight gain is increased by ST feeding.

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Authors' Contribution
AMS and MN designed the study and planned the experiments. MN, MGS and MH analyzed the data. AMS wrote the manuscript. QP and ZSW revised the manuscript.

Key words
Calf, Colostrum, Feeding, Growth, IgG

INTRODUCTION

Dairy calves are born without any acquired immunity as there is no transfer of Immunoglobulin across the placenta from the dam to fetus, this means that newborn calves must acquire immunity passively through the consumption of colostral IgG (Baumrucker *et al.,* 2010). Colostrum management is the single most important management factor to determine calf health and survival (Godden *et al.,* 2009a). Unfortunately, a significant proportion of dairy calves suffer from failure of passive transfer (FPT) of immunoglobulins (Ig) from colostrum, contributing to excessively high pre-weaning mortality rates as well as other short- and long-term losses associated with animal health, welfare, and productivity. A successful colostrum management program will require producers to consistently provide calves with enough volume of clean, high-quality colostrum within the first few hours of life (McGuirk and Collins, 2004; Bush *et al.,* 1984).

The methods of feeding colostrum can influence the time to first feeding, volume consumed, and possibly pathogen exposure, all of these can affect passive transfer of IgG and calf health, because high rates of FPT (serum IgG <10.0 mg/mL) have been reported in calves left to suckle the dam (Besser and Gay, 1993). It is currently recommended that the calf should be removed from the dam within 1 to 2 h of birth and fed a known volume of clean colostrum using either a nipple bottle or esophageal feeder (McGuirk and Collins, 2004). The study of Adams *et al.* (1985) reported that colostral immunoglobulin absorption efficiency improved when calves were fed through NB, compared with ST, from 20 to 32 h after first feeding, presumably because of closure of the esophageal groove directing the colostrum to the abomasum. However, it is not clear from the study whether the differences between the immunoglobulin absorption efficiencies between the NB and ST group from 20 to 32 h after first feeding were significantly different. On the other hand, the same study

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of Longenbach and Heinrichs (1998) found no significant difference between serum IgG concentrations from calves fed equal amounts of colostral IgG mass through NB or ST. The study of Chelack *et al.* (1993) concluded that enough absorption of colostral immunoglobulin (on the basis of serum immunoglobulin concentrations at 24 hours after ingestion of colostrum) occurred in tube fed calves in the absence of closure of the esophageal groove because of the rapid flow of colostrum from fore stomachs to abomasum and small intestine. The disadvantage in the study by Baumrucker *et al.* (2010) was that there was no comparison between group of calves fed by NB and calves enrolled in the study were fed unreported volumes of colostrum by ST, 3 times after birth (8, 12, and 16 h of age). In a study by Kaske *et al.* (2005) colostrum feeding by NB was compared with ST feeding based on 24 post suckle serum immunoglobulin concentration in HF calves; however, volume of colostrum fed to calves in each group was not standardized One group of calves were fed 4 L of colostrum through ST, and the comparison group of calves were fed 2 L through NB. Additionally, calves that did not ingest the 2 L offered through NB were fed the remainder of the colostrum by ST. Similarly, for calves in the ST group could not swallow the tube or that vigorously resisted tubing, 200 mL of colostrum was fed by NB prior to further ST feeding (Morrill *et al.,* 2012a).

Given the limitations of previous studies designs, the high FPT rate in dairy heifer calves, and the preference by most producers to administer colostrum by NF in the world, we hypothesized that the following: IgG would be lower in calves fed colostrum by NS and NF compared with ST; serum immunoglobulin (IgG) concentrations at 24 h after ingestion of colostrum would be lower in calves fed colostrum by NS and NF, compared with ST; and FPT rates in calves fed colostrum through NS and NF would be higher than in calves fed by ST. The objectives of the current study to compare the serum immunoglobulin concentration at 24 h after ingestion of colostrum, and to measure the FPT rates between calves fed colostrum by NS, NF and ST.

MATERIALS AND METHODS

Animal care

The experimental procedure was approved by Sindh Agriculture University Tandojam, animal care committee (SAU92487).

Location and duration of trial

The experiment was conducted in January to April 2016, the temperature ranges from 16^0C to 30^0C at commercial dairy farm of Engro (Pvt) Ltd. namely "Engro Dairy Farm Nara" near Kalmi Quran, Tehsil Saleh Patt, District Sukkur, Sindh, Pakistan. The latitude of Sukkur, Pakistan is 27.71, and the longitude is 68.836899, about 5000 exotic animals were available at the farm and the laboratory tests were performed at laboratory of Veterinary Microbiology, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam. The duration of the proposed experiment was lasted for 60 days.

Calves selection and identification

A total of 15 newly born Holstein Friesian calves were selected randomly from the available stock and divided into 3 groups (5 calves in each group). The median birth weight (kg) ± S.D of calves fed by stomach tube, nipple feeding, and natural suckling were recorded as 28.68±1.16, 28.44±0.67 and 28.56±1.13 respectively, the ear tags were used for identification of calves.

Housing and bedding

Initial body weight of each calf was noted sharp after birth then shifted into young stock section (individual pen houses allotted to each calf) between the groups then tagged for their proper identification (1-5 calf in each group). All the calves of each group were provided the similar housing and bedding.

Colostrum feeding methods

After 30 minutes of the birth colostrum was provided to each group of calves with various colostrum feeding methods, i.e. direct suckling from the dam, stomach tube feeding and nipple feeding.

Quantity of colostrum

The quantity of colostrum which was provided to the calves of two groups i.e. esophageal tube and nipple feeding based on 10% body weight of each calf with the interval of 8 hours (Priestley *et al.*, 2013), however the 3rd group was natural suckling from dam and considered as controlled group.

Blood collection and shifting

After 24 hours of first colostrum feeding; 5 ml of blood sample was collected before and after provision of colostrum feeding from each calf of three groups into vacutainer tube directly from jugular vein of each calf and centrifuges at 1000 g for 5 minutes to harvest the serum and then samples were shifted to the laboratory of Veterinary Microbiology, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam with proper standard protocols for Immunoglobulin level through radial brix refractomatery (Fleenor and Stott, 1981).

Radial immunodiffusion test

In radial immunodiffusion test the anti-IgG antibody were dissolved in an agarose gel. The samples were pipetted into small wells punched in the gel and left to precipitate. The diameter of the rings formed by the precipitation of the antibody complex were measured and compared to the size of rings formed by known concentrations of IgG. This procedure has been used successfully for bovine serum IgG (Chelack *et al.,* 1993).

Brix refractometery

In Brix refractmeter the few drops of the serum were placed on the glass side of the refractometer and the glass sides were placed in sun light, and from the eye piece of the rafractometer the indices were measured and calculated according to method of Morrill *et al.* (2012a).

Feeding of calves up to end of trial

From second day to 7th day of the trial daily 10% of the Body weight milk was provided to all the experimental calves and from 8th day up to the end of trial 10% of BW of milk and 1 kg of concentrate (Vanda) were provided by Vasseur *et al*. (2010a).

Morbidity and mortality assessment

Each calf was assessed daily for respiratory illness (Virtala *et al.,* 1999; Davis and Drackley, 1998) and diarrhea (Frank and Kaneene, 1993). Respiratory disease is defined as discharge from the nose or eyes or repetitive coughing. Diarrhea is defined as the presence of watery feces. Death of each calves were also assessed every day.

Body weight, body conformation measurement

Body weight was measured of each calf by weighing machine on every 15 days. Body conformation i.e heart girth, withers height and length of the body were measured with inch tape every 15 days up to the period of 60 days.

Statistical analysis

To determine the passive transfer of immunity and compare it between the groups, we used one-way ANOVA with the IgG concentration in serum as response to the treatment. The following parameters were also analyzed using a one-way ANOVA. The difference in growth rate, body weight, body height, body length and heart girth with the response to the treatment. All the statistical analyzes were performed using JMP 7.1 version statistical software. p-values <0.05 were considered statistically significant.

RESULTS AND DISCUSSION

Serum IgG level

Serum IgG means ± SD for different methods of colostrum feeding in calves (stomach tube, nipple and suckling) was found significantly different ($p < 0.05$) among the groups (Fig. 1). Serum IgG Mean ± SD values in ST feeding group was recorded as 15.74±0.29 mg/ml, for NF as 11.52±0.72mg/ml and for NS group as 10.36±0.36mg/ml in calves.

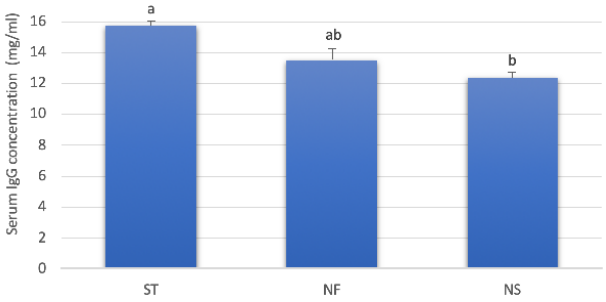

Fig. 1. Effects of various colostrum feeding methods on serum IgG level in Holstein-Friesian calves. Different alphabets on means in colostrum show significant differences at P<0.05. IgG, Immunoglobulin G; ST, stomach tube feeding; NF, nipple feeding; NS, natural Suckling.

The method and volume of colostrum were the factors determining FPT at 24 hours of age. This was expected because each calf received colostrum with similar immunoglobulin concentration, but the method and volume among the groups were differed. A total of 150 to 200 g/litter of colostral IgG have been recommended for adequate transfer of colostral immunity in dairy bull calves (Chigerwe *et al.,* 2008a). The results of this study revealed that the Serum IgG levels in ST feeding group were higher as compared to NF and NS methods. These results are in agreement with the earlier studies of Chigerwe *et al.* (2008b), Beam *et al.* (2009) and Brignole *et al.* (1980).

Body weight

The mean body weight of calves fed different levels of colostrum on 15th, 30th, 45th and 60th day by ST, NF and NS showed significant differences ($p < 0.05$) between the groups during the entire experimental period and results are mentioned in Table I.

The difference in body weight of different groups recorded during this study could be attributed to the different colostrum feeding method and similarly morbidity percentage among the groups. Similar results were also reported by Chigerwe *et al.* (2009) that the different colostrum feeding methods i.e. NF, ST feeding had effect on the body weight of calf. However, other researcher described non-significant effect of various colostrum feeding methods on body weight gain (Godden *et al.,* 2009a).

Wither height (cm)

The mean wither height of calves fed different levels of colostrum on 15th, 30th, 45th and 60th day by stomach tube, nipple and natural suckling showed non-significant difference ($p > 0.05$) among the groups during entire experimental period and present in Table I. Calf height may not be as useful a parameter for measuring growth and development as weight. In this study, height varied depending on the surface the calf was standing on, even when efforts were made to ensure the measuring stick was level with the bottom of the calf's hooves. Girth measurements had more consistency compared to height. The challenge with measuring height is also described in another studies (Furman *et al.,*1994; Veissier *et al.,* 2013). The results of this study regarding effect of various colostrum feeding techniques on growth performance and immunity of HF calf have been discussed in light of the available literature (Veissier *et al.,* 2013).

Heart girth (cm)

The mean heart girth of calves fed different levels of colostrum on 15th, 30th, 45th and 60th day by ST, NF and NS showed non-significant difference ($p > 0.05$) between the groups during the entire experimental period and presented in Table I. The Similar findings were recorded by the Chigerwe *et al.* (2008b), Furman *et al.* (1994) and Veissier *et al.* (2013). The heart girth is not only depending upon the body weight gain but also on the feeding and housing of calves (Quigley, 2013). The similar findings have been reported by Godden *et al.* (2008) stated that the median of heart girth found non-significant when calves were fed colostrum through different methods and stated that there is no correlation of heart girth and colostrum feeding methods.

Body length (cm)

The mean body length of calves fed different levels of colostrum 15th, 30th, 45th and 60th day by ST, NF and NS showed non-significant difference ($p > 0.05$) between the groups during the entire experimental period and mentioned in Table I. The results are in agreement with those of Chigerwe *et al.* (2008a), Furman *et al.* (1994)

Table I. Effects of various colostrum feeding methods on mean body weight (kg), wither height (cm), hearth girth (cm) and body length (cm) of Holstein-Friesian calves.

	Natural suckling	Nipple feeding	Stomach tube feeding	P- Value
Body weight				
day 15	35.19±1.74b	37.17±0.57ab	38.13±1.26a	0.011
day 30	43.94±1.31b	45.96±0.48a	46.12±0.51a	0.003
day 45	53.66±1.55b	54.92±1.17ab	56.28±0.73a	0.016
day 60	65.12±1.14b	66.7±1.03ab	67.76±0.94a	0.006
Wither height (cm)				
day 15	69.60±0.64	69.77±0.25	70.21±0.76	0.2827
day 30	74.27±0.69	74.24±0.20	74.63±0.84	0.5832
day 45	79.35±0.53	79.12±0.13	79.43±0.66	0.6137
day 60	84.63±0.56	84.94±0.74	85.09±0.84	0.6045
Heart girth (cm)				
day 15	72.52±1.50	73.05±0.94	72.90±1.19	0.7824
day 30	78.94±1.04	79.10±0.64	79.15±0.89	0.9294
day 45	81.94±0.56	82.09±0.41	82.40±0.58	0.4019
day 60	86.61±0.84	86.74±0.48	86.82±0.94	0.9177
Body length (cm)				
day 15	59.08±0.58	59.39±0.64	59.49±0.69	0.5875
day 30	63.68±0.41	63.68±0.61	63.73±0.51	0.9841
day 45	69.04±0.51	68.99±0.71	69.32±0.79	0.728
day 60	74.02±0.86	74.07±0.58	74.32±0.91	0.8156

Different alphabets on means± S.D in a row/column show non-significant differences at $p<0.05$

and Veissier *et al*. (2013) who could not detect difference ($p > 0.05$) in body length among the groups of colostrum feeding techniques stomach tube feeding and nipple feeding. Similarly, Chigerwe *et al.* (2008b) reported non-significant difference in body length among the groups of various colostrum feeding methods. On the contrary some workers indicated that the body length of calf ultimately depends upon the body weight gain and feeding management (Quigley, 2013) and reported that the significantly different of body length of calves fed by different methods of colostrum techniques but in present study the disease condition is not related to the body length.

Morbidity and mortality

The morbidity of calves fed colostrum by ST, NF and NS was observed every week; diarrhea was found 40%, 80% and 60% among the groups respectively during the entire experimental period (Fig. 2). The respiratory illness in ST, NF, and NS was recorded 20%, 40% and 60% among the groups, respectively during the entire experimental period. Meanwhile no mortality was recorded among the all groups. The results of present study are in line with Godden *et al.* (2009a) who reported that the morbidity occurs more in calves which were fed colostrum by natural suckling among the groups. The cause of the increased morbidity in the natural suckling group is due to the failure of passive transfer of immunity.

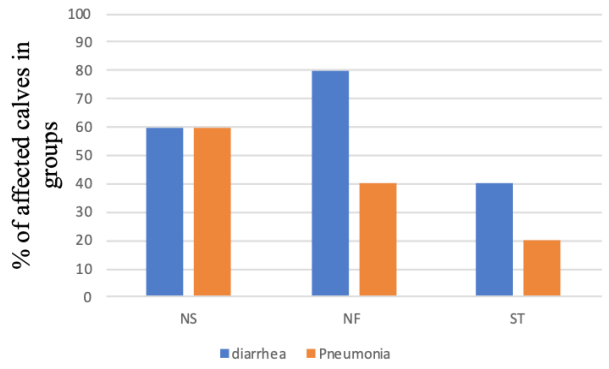

Fig. 2. Effect of different methods of colostrum on morbidity rate of Holstein-Friesian calves. NS, natural suckling; NF, nipple feeding; ST, stomach tube feeding.

CONCLUSSION

The concentration of serum IgG following administration of colostrum by stomach tube method increases at a rate to that in calves fed by natural suckling and nipple bottle and reaches a level consistent with high calf survival. It is also concluded from the study that the body weight gain is increased by stomach tube feeding and from present study it is recommended to use the stomach tube feeding in farms to improve the health status and performance of calves.

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Statement of conflict of interest

Authors have declares that there is no conflict.

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