



# Compositional Changes in Colostrum of Crossbred Dairy Cow

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## Research Article

### Abstract

The research was conducted to examine the day-to-day variation in colostrum composition at the udder quarter level. For this purpose, a total of 3 Holstein Frisian crossbred cows were selected from Bangladesh Agricultural University Dairy Farm. Colostrum samples were collected both as mixed and separately from different teats. The concentration of major colostrum constituents (fat, protein, lactose, total solids, solids-not-fat, ash, pH, specific gravity) changed significantly ( $p \leq 0.05$ ), the levels on day 4 were found similar to those of normal milk. The highest mean value of fat, protein, total solid, SNF, ash and specific gravity in colostrum was observed on 1st post-partum day as  $6.02 \pm 0.70$ ,  $14.20 \pm 0.18$ ,  $23.88 \pm 1.25$ ,  $17.94 \pm 0.42$ ,  $1.03 \pm 0.05\%$  and  $1.05 \pm 0.00$ , respectively and later on, decreased as postpartum days advanced. Minimum average fat, protein, total solid, SNF, and ash content in colostrum was observed on 5th postpartum days as  $3.75 \pm 0.11$ ,  $3.24 \pm 0.08$ ,  $12.00 \pm 0.20$ ,  $8.27 \pm 0.16\%$  and  $0.695 \pm 0.01$ , respectively. But lactose percent and pH showed an increasing trend from 1 to 5 postpartum days. Minimum average lactose and pH was observed on 1st and 5th postpartum days as  $2.42 \pm 0.06\%$ ;  $6.03 \pm 0.04\%$  and  $4.26 \pm 0.15$ ;  $6.30 \pm 0.04$ , respectively. The quality of colostrum produced by udder quarters was found significantly different ( $p < 0.05$ ). The rear quarters produced colostrum, which was significantly richer in fat, proteins, TS, pH compared to forequarters colostrum. The forequarters produced colostrum which was significantly richer in lactose, ash, SNF compared to forequarters colostrum. In conclusion, the results showed that colostrum composition was significantly changed up to 5 days post-partum.

**Keywords:** Colostrum, Physico-chemical, Holstein Frisian Crossbred, Postpartum

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## 1. Introduction

The nutritional and physiological requirements of the neonate during very early life are typically quite specialized. The composition of the maternal colostrum is tailored to meet these unique requirements (Tsioulpas et al., 2007; Chistiansen et al., 2010; Abd El-Fattah et al., 2012). During the transition from colostrum to normal milk, gradual, or sometimes sudden changes may occur in composition and properties (Abd El-Fattah et al., 2012; Morrill et al., 2012). The first six post-partum milking's, or the number of milking's it takes or the transition from colostrum to whole milk to occur, are considered colostrum. Of these six milkings, the first four reflect the majority of changes in composition. During this period, the level of total protein, fat, total solids, solids-not-fat, and ash decreases, lactose increases and cloistral Ig declines rapidly (Foley & Otterby, 1978). Colostrum is not only a source of nutrients such as proteins, carbohydrates, fat, vitamins, and minerals, but it also comprises numerous biologically active molecules that are vital for specific functions. Most of the biologically active constituents in complete bovine colostrum that can transfer important health benefits are proteins (Foley & Otterby, 1978).

Colostrum accounts for around 0.5% of a cow's annual milk output (Scammell 2001). Most of the healthy dairy cows produce colostrum far above the calf's requirements (Oyeniya and Hunter 1978), but, usually, milk collected during the colostrum period is considered unmarketable (Foley and Otterby 1978) and often is excluded from bulk milk collection (Lilius and Marnila, 2001). The high protein content of colostrum leads to numerous problems in industrial processings, e.g. poor heat stability, which impedes pasteurization (Lilius and Marnila, 2001). Similarly, the fermentation processes may be affected by the high content of antimicrobial components in colostrum (Lilius and Marnila, 2001). Regardless of this, colostrum has concerned significant interest as a functional food ingredient (Korohnen 1998).

As the lactation period progressed, all the components in the colostrum rapidly decreased, except for lactose. The concentration of the major colostrum constituents (milk protein, lactose, and solid not-fat extract) change significantly after birth, the levels on day 3 being similar to those of mature milk (Georgiev, 2005). After the colostrum period ceases, the fluid that is secreted by the cow is known as Normal milk or Whole milk. Milk differs widely in composition, the greatest differences being between different species of mammals, but within one species the composition depends on many factors (breed, lactation number, stage of lactation, type of feed, system of feeding, milking frequency, etc).

The changes in macro- and micro-elements concentration in colostrum occurred during the first five days and after 14 days of parturition. At calving, cow colostrum had higher concentrations of Mg, Na, K, and Zn and a lower concentration of P than buffalo colostrum. However, there were no differences between both colostrums in Ca, Fe, Cu, and Pb concentrations. The macro- and micro-elements concentration decreased gradually toward normality after five days of parturition. Similar differences in respect to Na during the experimental period (2-28 days of lactation) were reported by Ontsouka et al., (2003) for cow colostrum. The opposite trend with regards to K was found by Toshiyoshi et al., (1982) for cow colostrum, while did not find the remarkable change between the initial and final K concentration of cow colostrum.

Several studies have evaluated the changes in the chemical composition of cow colostrum after parturition & also buffalo colostrum, but no effective research has been done to determine the compositional changes of colostrum according to four different teats of the udder of Holstein Friesian cow, even though the topic remains of great importance mutually to milk producers and processors. Thus, the study was targeted to observe the 5 days post-partum changes in colostrum composition at the different teat quarter level of Holstein Friesian crossbred cows.

## 2. Review of Literature

### 2.1 Physical Properties of Colostrum

#### 2.1.1 Colour

Edelsten (1988) observed that colostrum has a reddish-yellow color, due mostly to the presence of carotenoids. It has been mentioned that the levels of carotenoids are high in the initial colostrum, in distinct the fat content, but decline quickly as the mammary secretions switch to normal milk. Parrish et al. (1948) stated that the concentration of the carotenoid's lutein, all-trans  $\beta$ -carotene, and cis-13  $\beta$ -carotene in colostrum were most eminent initially and reduced piercingly during the first week of lactation.

#### 2.1.2 pH and Buffering Capacity

McIntyre et al. (1952) stated that the pH of colostrum at parturition varied from 6.0 to 6.61, with a mean value of 6.32, and this increased with the advancement of time and ended up to pH 6.5 after 2 weeks. Madsen et al. 2004; Tsioulpas et al. 2007 and Jeong et al. 2009 noted that the pH of colostrum remains low initially and rises with the time proceed of post-partum. Sebela and Klicnik (1977) reported that the low pH of colostrum is induced by the increased concentration of protein, dihydrogen phosphate, citrate, and carbon dioxide. Tsioulpas et al. (2007) mentioned a logarithmic relationship between titratable acidity and the total protein level of colostrum. Nardone et al. (1997) also discerned a higher titratable acidity for colostrum than raw milk and recorded a positive correlation with protein content.

#### 2.1.3 Density and Specific Gravity

Madsen et al. (2004) stated the density of colostrum declined swiftly from 1048 to 1034 kg.m<sup>-3</sup> while the initial 2 days post-partum, accompanied by a longer continuous decrease to 1030 kg.m<sup>-3</sup> by 6 days post-partum. Strekozov et al. (2008) inspected the changes in the density of colostrum according to parity and calving season. On average, the density of colostrum of first-calf heifers was 1059 kg.m<sup>-3</sup>, related with 1068 kg.m<sup>-3</sup> for third- and fourth-calf cows. In these groups, the density of colostrum of cows which calved in fall was found highest, obeyed by winter, and then spring. Quigley et al. (1994) described that the specific gravity of colostrum is in the scale of 1.028 to 1.074, with an average of 1.052. Jeong et al. (2009) mentioned a comparable trend which is similar to Parrish et al. (1950), i.e. the specific gravity of colostrum reduces immediately within the first and fourth milking from 1.055 to 1.034 and extended to lower consequently at a short accelerated rate. Likewise, Kertz (2008) stated that the specific gravity of colostrum reduces from 1.056 to 1.033 through the first five milkings post-partum.

### 2.2 Chemical Constituents of Colostrum

#### 2.2.1 Lactose

Blum and Hammon 2000a, b; Uruakpa et al. 2002 stated that colostrum comprises less lactose and more fat, protein, peptides, non-protein nitrogen, ash, vitamins and minerals, hormones, growth factors, cytokines, and nucleotides compared to normal milk; except for lactose, the levels of these compounds decline quickly through the first 3 days post-partum. Tsioulpas et al. 2007; Stelwagen et al. 2009 stated that colostrum is portrayed by its extremely high density of immunoglobulin G (IgG), which is of critical significance to the neonate, whose gut, promptly after parturition, enables the passage of large immunoglobulins, thereby bestowing passive immunity.

### 2.2.2 Protein

The concentration of casein is higher in colostrum than in milk (Cerbulis and Farrell 1975; Madsen et al. 2004) and reduces at every milking post-partum (Parrish et al. 1948). Sobczuk-Szul et al. (2013) stated that initial post-partum milk comprised limited fractions of  $\alpha$ -casein, which progressed by time post-partum, and raised proportions of  $\kappa$ -casein, which declined with time post-partum when the proportion of  $\beta$ -casein persisted constantly.

In the immunoglobulins, there are three principal types in milk, i.e. IgG, IgM, and IgA, account for approximately 1% of the total milk protein preferentially around 6% of the total whey protein (Farrell et al. 2004). Colostrum comprises high degrees of IgG, IgA and IgM (Smolenski et al. 2007), and immunoglobulins obtain up 70–80% of the total protein in colostrum (Larson 1992), which is of critically important to the neonate, as the transfer of passive immunity to the calf happens by colostrum and not through the placenta (Zhang et al. 2011). Differences in the degree and comparable amounts of the immunoglobulins in colostrum associated with milk have been described by many authors (Quigley et al. 1994; Levieux and Ollier 1999; Korohnen et al. 2000; Elfstrand et al. 2002; Zhao et al. 2010). The concentration of immunoglobulins in the primary milk post-partum can differ in many ways, from 30 to 200 mg.mL<sup>-1</sup> (Larson 1992; Korohnen et al. 1995; Gapper et al. 2007). IgG1 contains above 75% of the Igs in colostrum, followed by IgM, IgA, and IgG2 (Butler 1974). It should be noted that different IgG subclasses change in their biological actions (Akita and Li-Chan 1998). The concentration of immunoglobulins in milk decreases immediately subsequent parturition (Korohnen et al. 2000).

### 2.2.3 Lipids

The composition and structure of milk fat have been studied widely (MacGibbon and Taylor 2006; Palmquist 2006), but comparably few works have been accomplished on variations in the composition and structure of milk fat during the transition from colostrum to milk. Usually, but not invariably, the fat content of colostrum is greater than that of whole milk (Parrish et al. 1950; Foley and Otterby 1978; Marnila and Korohnen 2002). Kehoe et al. (2007) and Morrill et al. (2012) stated a pretty extended variety of average fat content of colostrum; Abd El-fattah et al. (2012) observed a reduction in the fat content of colostrum from Holstein cows from parturition (8.04%) to 5 days post-partum (3.9%).

### 2.2.4 Minerals

Tsioulpas et al. (2007) stated that the concentrations of calcium and phosphate reduced from 2168 and 1635 mg.kg<sup>-1</sup>, sequentially, at parturition, to 1342 and 929 mg.kg<sup>-1</sup>, individually, after 15 days. A similar trend was observed by Jeong et al. (2009). Abd El-Fattah et al. (2012) noted a related trend for the calcium concentration during the transition from colostrum to milk, but the concentration of phosphate in colostrum and milk was significantly lower than that stated mean concentrations of calcium and phosphate in colostrum which were almost 4-fold and 5-fold greater than the concentrations observed in milk.

## 2.3 Colostrum Composition at Individual Teat

Berglund et al., 2007 found that the rear quarters produced more milk with higher fat, protein content than the front quarters. As far as urea content was concerned there was no difference between the front and the rear quarters. The quarters had similar milk production, fat, protein, urea, and lactose. The LR (left rear) and RR (right rear) quarters produced 3.42 and 3.47 kg while LF (left front) and RF (right front) quarters produced 2.63 and 2.71 kg of milk. Forsbäck et al. (2011) reported that front quarters produced 41.8% of the total yield, and rear quarters produced 58.2% ( $p < 0.001$ ). Similar proportions for the front quarters of 40%. Milk yield was significantly correlated with the length of both fore and rear teats ( $P < 0.01$ ). Das et al., (1982)

tabulated the teat measurements for 565 Black Bengal (BB), 64 Barbari, 21 Jamnapari, and 26.5 Saanen/0.5 Jamnapari (SJ) goats. BB goats had narrowest teats; distance between teats decreased in the order SJ<BB<Barbari and Jamnapari. Teat dimensions of BB goats were greater in 2nd than in 1st lactation ( $P<0.0.1$ ). Yakusevich and Bud-ko (1985) found for 34 Holstein-Friesian (HF), 28 Russian Black Pied (RBP) and 23 HF x RBP cows, front teat length 6.6, 6.0 and 6.3 cm, rear teat length 5.5, 5.3 and 5.4, front teat diameter 2.0, 2.2 and 1.97cm, rear teat diameter 2.0, 2.3 and 2.0, the distance between front teats 18.7, 15.9 and 17.8 cm and distance between rear teats 10.8, 8.1 and 10.2 cm, the differences of RBPs from the other groups being significant except for teat diameter. Baruah et al., (1991) studied on 120 crossbreds of Jersey cattle with local cattle. Teat length increased over the 4 lactations, the fore teats from 4.49 to 4.72 cm, and hind teats from 3.92 to 4.60 cm. There were significant correlations of milk yield with hind teats length in the 1st and 3rd lactations (0.34-0.40).

From the above discussion, it is clear that the composition of colostrum changes rapidly. No study has yet been carried out to observe these effects on compositional changes of colostrum of Holstein Friesian cows in the variation of quarter and teat together. For these reasons in order to fulfill the gap of knowledge, the present research was undertaken.

### 3. Materials and Methods

#### 3.1 Experimental Site

The experimental cows were selected from the Bangladesh Agricultural University (BAU) Dairy Farm and the research was carried out during the period from January 2018 to January 2019. The analysis of colostrum was conducted at the Dairy Chemistry and Technology Laboratory under the Department of Dairy Science, Bangladesh Agricultural University, Mymensingh.

#### 3.2 Animal, Diet, and Management

For this experiment, a total of 3 Holstein Friesian crossbred cows at different lactation were selected from Bangladesh Agricultural University Dairy Farm, Mymensingh. Initial body weight and body condition score of the animals were  $284.11\pm 7.28$ , and  $3.00\pm 0.00$ , respectively. Cows were housed in an individual maternity box stall for 60 days prepartum to 4 days of the postpartum period, and thereafter, shifted to the stanchion barn (double rowed, face out system). The diet supplied to the animals was in accordance with the similar diet of Islam et. al. (2020). Around 22 kg mixed roughage [Para (*Brachiariamutica*) and German grass (*Echinochloacrusgalli*) = 2:1] and 2.0 kg concentrate mixture (mix of 82.28, 13.72, 3.70 and 0.30% wheat bran, mustard oilcake, common salt, and DCP, respectively) were supplied daily. Clean water was provided *ad libitum*.

#### 3.3 Collection of Colostrum Samples

Colostrum samples were collected from calving to 5 days postpartum from four different teats of each animal both separately (teat-wise) and mixed. The samples were then transferred to the laboratory at 4°C for chemical analysis.

#### 3.4 Analytical Procedure

The samples were evaluated for Color, Specific Gravity, pH, fat, protein, total solids (TS), solids-not-fat (SNF), Ash. A specific gravity test was performed by using Quevenne Lactometer, cylinder, floating dairy thermometer according to the procedure described by Aggarwala and Sharma, 1961. Fat percent was determined by the Babcock method; protein percent was determined by the Kjeldhal method. The total solids and ash content of the samples were determined by Oven Drying method according to AOAC (2003). pH was measured by a digital pH meter (Hanna, Romania).

### 3.5 Statistical Analysis

The data obtained from the laboratory tests were analyzed in Microsoft Excell-2010 and p-value ( $p < 0.05$ ) was considered for the level of significance.

## 4. Results and Discussion

### 4.1 Variation in Day to Day Colostrum Composition (After Calving to 5days)

The average values of total solids (TS) content of colostrum of HF collected at different days after calving are shown in Figure 1. A gradual decrease was noticed in the fat concentrations such as  $23.888 \pm 1.253$ ,  $18.729 \pm 0.1578$ ,  $14.097 \pm 0.284$ ,  $12.576 \pm 0.192$ , and  $12.004 \pm 0.205$  at 1, 2, 3, 4, and 5 days postpartum, respectively. These results indicate that the highest value was found on day 1 and lowest on day 5. Similar results have been reported by Abd El-Fattah et al. (2012) who observed that the TS contents decreased irregularly with time after parturition. TS content at 1st day postpartum in the present study was higher than those reported by Kleinsmith (2011). Bar et al. (2010) found that the mean of TS contents in bovine colostrum were 27.6 and 23.6% with ranges 18.3 to 43.3 and 21.6 to 29.15%, respectively, while in mature milk (0.0.5H) were 12.7 and 12.9%; Walstra et al. (2006) and Kleinsmith (2011) found that the TS contents in bovine colostrum were 27, 20.5, 14.5, 12.8, 12.2 and 11.5% at 0, 6, 12, 24, 36 and 48 h postpartum, respectively. Also, AbdElFattah et al. (2012) stated that the mean of TS content in bovine colostrum at calving is 24.2%.

The average values of SNF content of colostrum of HF collected at different days after calving were decreased linearly. The means values of SNF were  $17.947 \pm 0.421$ ,  $13.428 \pm 0.1611$ ,  $9.605 \pm 0.108$ ,  $8.693 \pm 0.112$ , and  $8.273 \pm 0.161$  at 1, 2, 3, 4, and 5 days postpartum, respectively (Figure 1). These results indicate that the highest value was found on day 1 and lowest on day 5. According to APHA, milk contains a minimum of 8.5% solids not fat. Foley and Otterby (1978) reported that the average SNF content of cow colostrum at day 1, day 2, day 3, day 4 and day 5 were 160.70, 120.20, 90.80, 90.50 and 80.80 g/kg, respectively which is more or less similar to the present study.

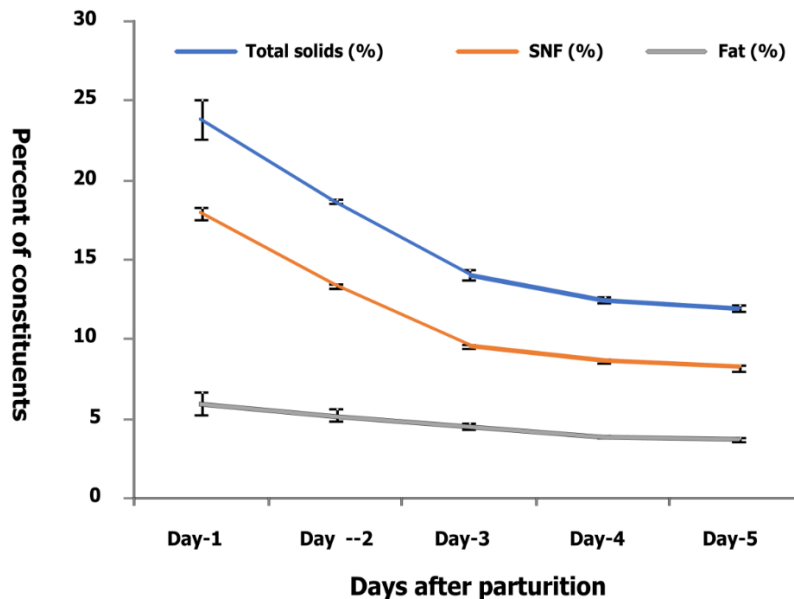
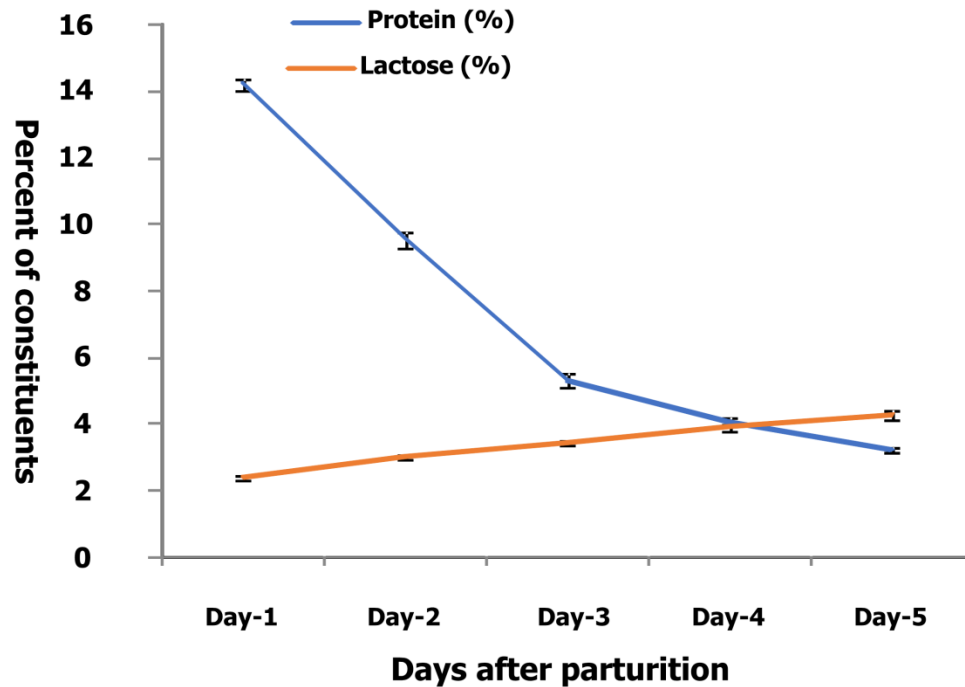


Figure 1. Changes of total solids, SNF and fat (%) in the colostrum up to 5 days post-partum

In the average values of the fat content of colostrum, a gradually decreasing was noticed where the fat content were  $6.025 \pm 0.705$ ,  $5.273 \pm 0.378$ ,  $4.567 \pm 0.232$ ,  $3.925 \pm 0.085$  and  $3.75 \pm 0.113$  % at 1, 2, 3, 4 and 5 days postpartum, respectively (Figure 1). These results indicated that the highest value was found on day 1 and lowest on day 5. Statistical analysis showed that there was a significant difference within the fat content at different days after calving. Also, the results are in agreement with those of Abd El-Fattah et al. (2012) who observed that the fat content decreased with time after parturition. The mean of fat contents in bovine colostrum was 6.7% with range 2.0 to 26.5% within 4 h of calving (Kehoe et al., 2007), 3.5 (4.6 to 5.8%) of first milked after calving (Bar et al., 2010), 8.0% at calving (Abd El-Fattah et al., 2012) and 7.9 (2.6 to 16.1%) after 2 to 3 days postpartum (Conte and Scarantino, 2013), while in mature milk, it was 3.7% (Jensen, 1995), 4.6% (Gopal and Gill, 2000), 4.5% (Fox and McSweeney, 2009b) and 4.0% (Walstra et al., 2006). Georgiev (2008) investigated that the fat content of colostrum changes very rapidly with time so that by 3rd day postpartum, it is already similar to that of normal milk. Conte and Scarantino, 2013 reported significant changes in the fat of colostrum from crossbred cows during different postpartum days which are similar to the present investigation. Tsioulpaset al. (2007) found no particular trend for the fat content of colostrum on 1st day postpartum as 14.0 % and 23.90 %, respectively.



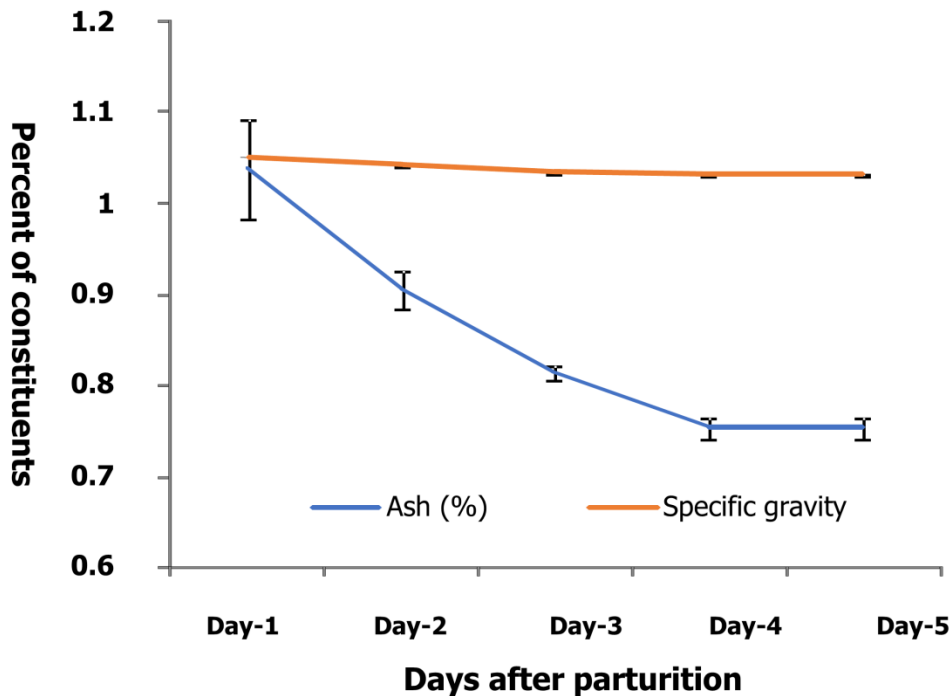
**Figure 2. Changes of protein and lactose (%) in the colostrum up to 5 days post-partum**

A progressively decreasing trend was noticed for protein content where the means values were at  $14.201 \pm 0.186$ ,  $9.527 \pm 0.214$ ,  $5.301 \pm 0.206$ ,  $4.089 \pm 0.101$  and  $3.248 \pm 0.086$  at 1, 2, 3, 4 and 5 days postpartum, respectively (Figure 2). These results indicated that the highest value was found on day 1 and lowest on day 5. These results are in agreement with those found by Tsioulpas et al. (2007); Kleinsmith (2011) and Abd El-Fattah et al. (2012) who found that the protein content decreases gradually with time after parturition. The mean of protein content in bovine colostrum was 14.92% with range 7.1 to 22.6% within 4 h of calving (Kehoe et al., 2007); 9.5% with range 6.6 to 11.7% at first milked after calving (Bar et al., 2010); 13.45% at calving (Abd El-Fattah

et al., 2012) and 12.2% with range 8.9 to 21.9% after 2 to 3 days postpartum (Conte and Scarantino, 2013),

while in mature milk, the protein contents were 3.4% (Gopal and Gill, 2000), 2.9% (Fox and McSweeney, 2003) and 3.3% (Walstra et al., 2006). According to Foley and Otterby (1978), the average fat content of cow colostrum at day 1, day 2, day 3, day 4 and day 5 was 140.00, 80.40, 50.10, 40.20 and 30.10g/kg, respectively which is more or less similar to the present study.

On contrary, a gradually increasing trend was recorded for lactose content, where the lactose content was  $2.426 \pm 0.061$ ,  $3.011 \pm 0.052$ ,  $3.459 \pm 0.072$ ,  $3.901 \pm 0.107$  and  $4.261 \pm 0.153$  at 1, 2, 3, 4 and 5 days postpartum, respectively (Table 3). These results indicated that the highest value was found at day 5 and lowest on day 1. These results are diligently similar to those of Kleinsmith (2011) and Abd El-Fattah et al. (2012) who observed that the lactose content increase with time after parturition. This difference is an advantage because lactose can induce the young to scour (diarrhea) with subsequent death or unthriftiness. In contrast with the study of Elfstrand et al. (2002) who found that the lactose contents were 3.0, 2.9, 3.5, 3.2, 3.5, 3.5 and 3.8% during 0 to 6, 7 to 10, 11 to 20, 21 to 30, 31 to 40, 41 to 50 and 51 to 80 h, respectively. Changes in lactose content of colostrum showed the opposite trend than the corresponding values in the mature milk, probably due to the mechanisms of lactose synthesis. Bar et al. (2010) and Conte and Scarantino (2013) showed that the mean of lactose contents in bovine colostrum was 2.49, 3.5 and 2.04% with ranges 1.2 to 5.2, 3.37 to 3.94 and 1.46 to 3.19%, in the same order, while in mature milk, it was 4.1 and 4.6% (Walstra et al., 2006).

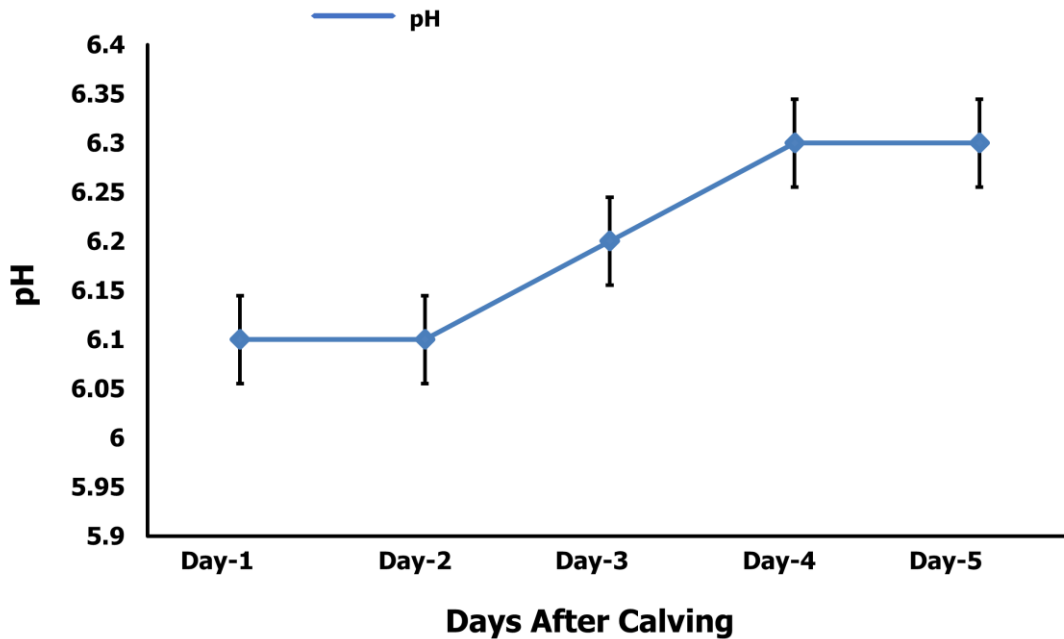


**Figure 3. Changes of ash (%) and specific gravity in the colostrum up to 5 days post-partum**

The average values of ash content were  $1.0383 \pm 0.055$ ,  $0.906 \pm 0.021$ ,  $0.815 \pm 0.008$ ,  $0.753 \pm 0.012$  and  $0.6951 \pm 0.012$  at 1, 2, 3, 4 and 5 days postpartum, respectively (Figure 3). These results indicate that the highest value was found on day 1 and lowest on day 5. Statistical analysis showed that there was a significant difference within the lactose content at different days after



calving. These results are in agreement with the previous reports by Tsioulpas et al. (2007) and Abd El-Fattah et al. (2012) who observed that the ash content decreased with time after parturition. Bar et al. (2010) showed that the mean values of ash content in bovine colostrum were 0.05 and 1.5% with ranges 0.02 to 0.1 and 1.10 to 1.3%, respectively, while in mature milk were 0.7 and 0.8% (Fox and McSweeney, 2003).



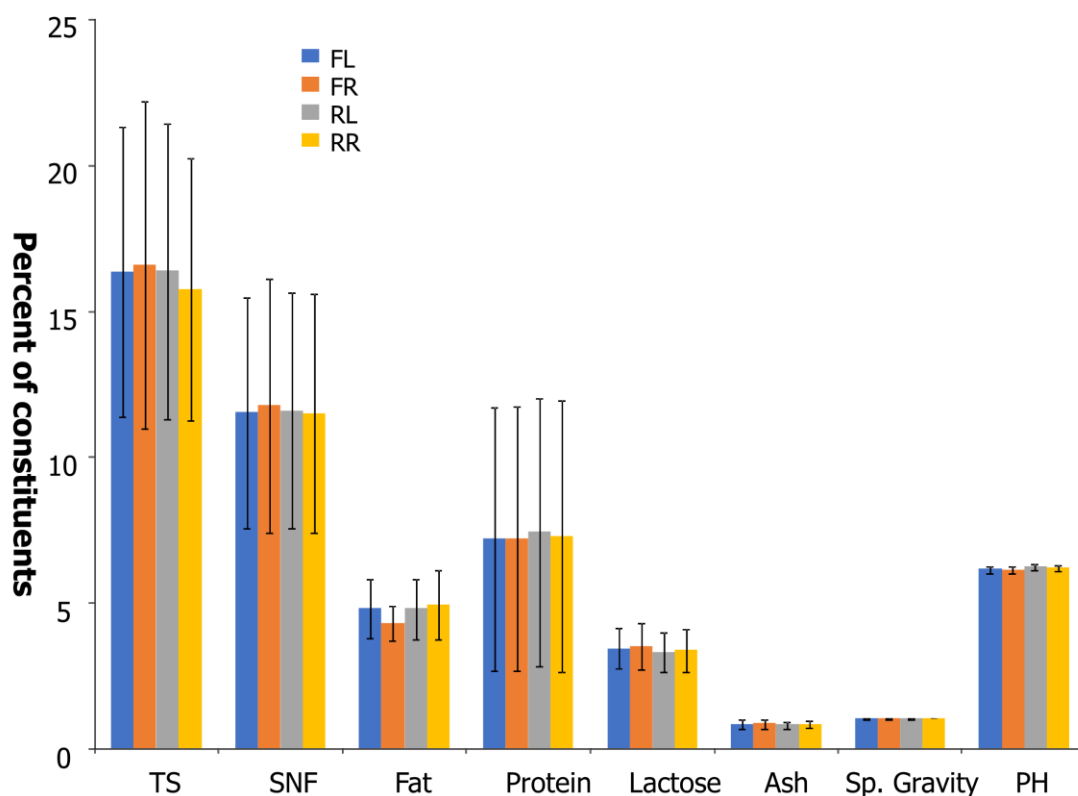
**Figure 4. Changes of pH in the colostrum up to 5 days post-partum**

The average values of sp. gr. of colostrum were found as  $1.052 \pm 0.00055$ ,  $1.043 \pm 0.00155$ ,  $1.035 \pm 0.00147$ ,  $1.032 \pm 0.00066$  and  $1.032 \pm 0.00094$  at 1, 2, 3, 4 and 5 days postpartum, respectively (Figure 3). These results indicated that the highest value was found on day 1 and lowest on day 5. Statistical analysis showed that there was a significant difference within the lactose content at different days after calving. Foley and Otterby (1978) reported that the average sp. gr. of cow colostrum at day 1, day 2, day 3, day 4 and day 5 were 1.040, 1.035, 1.033 and 1.033 g/kg, respectively. The average values of the pH content of the colostrum of HF collected at different days after calving are shown in Figure 4. The results indicated that the highest value was found at day 5 and lowest on day 1.

#### 4.2 Variation in Colostrum Composition from Different Udder Quarter

The data regarding compositional changes of colostrum at different udder quarter levels are presented in Figure 5. The average values of the total solids content of colostrum were  $16.341 \pm 4.953$ ,  $16.582 \pm 5.593$ ,  $16.359 \pm 5.061$ , and  $15.754 \pm 4.479$  % at FL, FR, RL, and RR, respectively. These results indicated that the TS content in rear quarters milk was a little lower than the front quarter's milk. The average values of SNF content of colostrum at different udder quarter were  $11.517 \pm 3.942$ ,  $11.762 \pm 4.341$ ,  $11.581 \pm 4.029$ , and  $11.496 \pm 4.080$  % at FL, FR, RL, and RR, respectively. The results indicated that the SNF content in front-right quarter's milk was slightly higher than the

rear quarter's milk. The mean fat concentrations from various udder quarters were  $4.8 \pm 1.0197$ ,  $4.308 \pm 0.590$ ,  $4.792 \pm 1.027$  and  $4.932 \pm 1.189\%$  at fore-left (FL), fore-right (FR), rear left (RL) and rear-right (RR), respectively. The figure indicated that the fat content in rear quarters milk was higher than the forequarters milk. The average values of the protein content of colostrum of HF collected from different udder quarter at different days after calving were found almost similar  $7.196 \pm 4.502$ ,  $7.205 \pm 4.521$ ,  $7.427 \pm 4.570$  and  $7.266 \pm 4.665$  at FL, FR, RL, and RR, respectively. The means of lactose concentrations from different udder quarter were  $3.437 \pm 0.697$ ,  $3.501 \pm 0.791$ ,  $3.314 \pm 0.676$ , and  $3.392 \pm 0.733\%$  at FL, FR, RL, and RR, respectively (Figure 5). These results indicated that the lactose content in the front quarter's milk was a tiny higher than the rear quarter's milk. The average values of ash content were shown similar values at different quarters. The means and SD of ash concentrations from udder quarter were  $0.853 \pm 0.141$ ,  $0.859 \pm 0.159$ ,  $0.816 \pm 0.118$ , and  $0.838 \pm 0.123\%$  at FL, FR, RL, and RR, respectively. The average values of specific gravity were  $1.039 \pm 0.0088$ ,  $1.038 \pm 0.0087$ ,  $1.038 \pm 0.0083$ , and  $1.039 \pm 0.0084\%$  at FL, FR, RL, and RR, respectively. These results indicate that the sp. gr. content in front quarters and rear quarter is more or less similar. The average values of pH content of colostrum of HF collected from udder quarter at different days after calving from udder quarter were  $6.147 \pm 0.117$ ,  $6.133 \pm 0.105$ ,  $6.233 \pm 0.097$  and  $6.193 \pm 0.109\%$  at FL, FR, RL, and RR, respectively.



**Figure 5. Changing of Physico-chemical components of colostrum from at different udder quarter**

## 5. Conclusion

There is an accelerated change in cow colostrum composition from the first milking until the fifth day of parturition. The study was taken to find out: day to day changes in colostrum

composition, compositional changes at udder quarter level also the transitional period from colostrum to milk. It is observed that colostrum fat, protein, TS, SNF, ash, and specific gravity decrease gradually with the increase of days after calving. At the first day fat, protein, TS, SNF, ash and specific gravity were higher than any other days and at day 4 these constituents were near about similar to the composition of normal milk. The most significant changes were those in the concentration of milk protein that on day 5 was more than four times lower as compared to the first portion of colostrum. According to a different quarter of udder, it was found that colostrum of rear quarters produced more fat, proteins, TS, pH compared to forequarters colostrum. Colostrum of rear quarters produced more lactose, Ash, SNF compared to forequarters colostrum.

**Conflicts of Interest:** The authors declare no conflict of interest.

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