PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
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Pakistan Journal of Nutrition 7 (2): 303-307, 2008
ISSN 1680-5194
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Heat Stability and Quality Characteristics of Postpartum Buffalo Milk

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Abstract: Study was carried out to evaluate the heat stability and quality characteristics of buffalo colostrum during its transition to normal milk. A total of 140 postpartum milk samples of 20 buffaloes (in seven postpartum milking) were collected to observe the heat stability at boiling temperature during transition period. Gradual change (coagulation/precipitation) was observed up to sixth postpartum milking when heated at boiling temperature. The heat stability of first postpartum milk was ≤ 5.5 min and gradually increased in consequent milking i.e. second (≤ 8.75min), third (≤ 15 min), fourth (≤ 20.25), fifth (≤ 24 min) and sixth (≤ 30min). No coagulation/precipitation was occurred in 7th postpartum milk heated for 1h at boiling temperature. Average acidity, specific gravity and viscosity of first postpartum milk was 0.39 ± 0.01%, 1.061 ± 0.001 and 6.80 ± 0.05cP, respectively and significantly declined to 0.26 ± 0.004%, 1.037 ± 0.0002 and 1.64 ± 0.01cP, respectively in sixth postpartum milk. Average pH value of colostrum was 6.30 and significantly inclined to 6.46 in sixth postpartum milk. TS, SNF, total protein, casein, ash and chloride contents of colostrum averaged 28.52 ± 0.33%, 23.08 ± 0.31%, 18.75 ± 0.30%, 5.06 ± 0.31%, 1.64 ± 0.04% and 0.20 ± 0.01%, respectively and significantly declined to 17.63 ± 0.18%, 11.75 ± 0.16%, 6.90 ± 0.12%, 4.16 ± 0.10%, 0.89 ± 0.004% and 0.121 ± 0.002%, respectively in sixth postpartum milk. Fat and lactose content of colostrum after initiation of lactation were 5.41 ± 0.21% and 2.70 ± 0.05%, which significantly increased to 5.88 ± 0.95% and 3.97 ± 0.08%, respectively in sixth postpartum milk.

Key words: Colostrum, heat stability, composition

Introduction

Postpartum milk (colostrum) is unsuitable and unprocessable milk which differs considerably in composition and properties from normal milk (Johnson, 1978; Walstra and Jennes, 1984). During transition from colostrum to normal milk gradual or some times sudden changes may occur in composition and properties. Thus, it is not marketable product. The sole purpose of colostrum is to serve as a feed for offspring to provide a much higher nutrition to the new born calf (Prasad, 1997). While the excess of this either has been mixed to normal milk fraudulently or sold to confectioneries and/or disposed off as a waste.

Nevertheless, the inclusion of colostrum in normal milk affect the market milk industry due to denaturation of immunoglobulin and tend to gel during heating at home level or processing at dairy plant (Haggag *et al*., 1991; Harding, 1995). In later case, the denatured immunoglobulins burn on in evaporator or on heat exchanger and deposited inside the plant. This could reduce the heat transfer and significantly increase the cleaning cost (Harding, 1995). Keeping the above views in mind, present study was designed to appraise the heat stability and quality characteristics of buffalo colostrum during transition to normal milk.

Materials and Methods

Postpartum milk samples (140) were collected from 20 freshly calved buffaloes (in seven postpartum milking) maintained at Livestock Experiment Station, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University, Tando Jam and surrounding areas. Each sample (450 ml) was obtained in a sterilized sample bottle, of which 10ml was heated (at boiling temperature) to observe length of time for coagulation/precipitation. The rest of the quantity of the sample was used to analyze the physico-chemical characteristics except those which were not coagulated/precipitated (20 samples of seventh postpartum milking). The acidity, specific gravity, viscosity, casein, total solids, ash and chlorides were analyzed according to the method of Association of Official Analytical Chemists (AOAC, 2000) while protein and fat as described by British Standards Institution (BSI, 1990) and James (1995), respectively. SNF (Harding, 1995) and lactose contents were determined by difference [i.e. SNF (%): subtracting the percentage of fat from total solids content (%) and Lactose %: subtracting sum of percentage of Protein, Fat and Ash from total solids content (%)] and pH values by using pH meter (Hanna Instrument HI8417, Italy).

Results and Discussion

Change (i.e. coagulation/precipitation) in secretion of udder (colostrum) of buffalo up to sixth postpartum milking was observed when heated at boiling

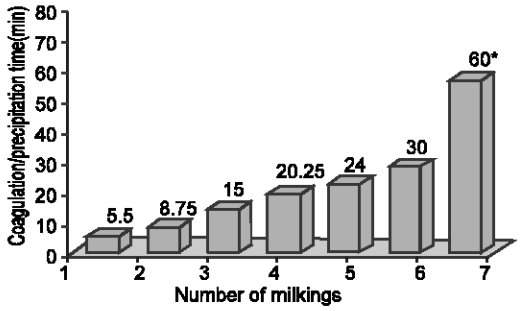

Fig. 1: Trend of heat stability of buffalo colostrum at boiling temperature. Data are the average of duplicate samples for each postpartum milk of 20 buffaloes. *No coagulation/precipitation was observed when heated at boiling temperature for 1h.

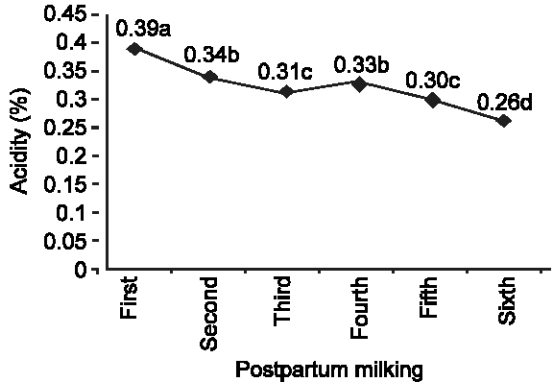

Fig. 2: Acidity (%) of Buffalo colostrum during its transition to normal milk. Data are the average of duplicate samples for each postpartum milk of 20 buffaloes. SE (±) = 0.01, 0.004, 0.003, 0.01, 0.004 and 0.004 for 1st, 2nd, 3rd, 4th 5th and 6th postpartum milk, respectively. Values bearing a, b, c, d differ significantly (P<0.05).

temperature (Fig. 1). Coagulation/precipitation time of first postpartum milk was noted as 5.5 min. which was increased to 30 min. on sixth milking. Whilst no change (coagulation/precipitation) was observed in seventh postpartum milk heated at similar temperature (boiling temperature). The reason could be the high level of globular protein in first milking colostrum transited to low level up to sixth milking that cause the colostrum to coagulate and/or precipitate in similar fashion (Walstra and Jennes, 1984). However, variation with regards to coagulation/precipitation time of colostrum was also observed among buffaloes that could be considered in some extent on the individuality of buffaloes (Maher, 2000).

Titrable acidity of first milking colostrum was observed as 0.39±0.01% which was decreased to 0.34±0.004%, 0.31 ± 0.003%, 0.33 ± 0.01%, 0.30 ± 0.004% and

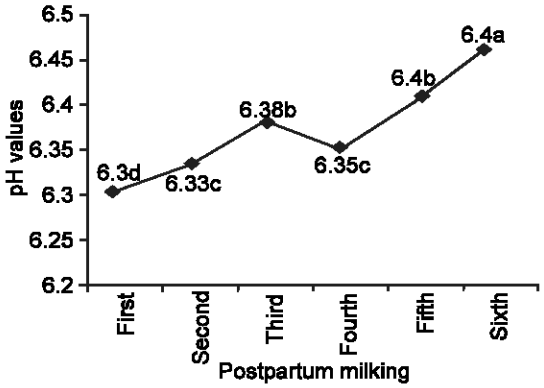

Fig. 3: pH values of Buffalo colostrum during its transition to normal milk. Data are the average of duplicate samples for each postpartum milk of 20 buffaloes. SE (±) = 0.01 for each of 1st, 2nd, 3rd, 4th 5th and 6th postpartum milk. Values bearing a, b, c, d differ significantly (P<0.05).

0.26±0.004% in second, fourth, third, fifth and sixth milking colostrum, respectively (Fig. 2). Results observed were within the range as reported by Prasad (1997), whilst not in line with the result of Ferrerio *et al.* (1980) who reported 0.24% and 0.15% acidity of colostrum milked after 6h and 54h postpartum, respectively.

pH value of first postpartum milk was inclined from 6.30 to 6.33, 6.35, 6.38, 6.4 and 6.46 after second, fourth, third, fifth and sixth postpartum milk, respectively (Fig. 3). These observations were similar to that of reported by Ferreiro *et al.* (1980) and Faul and Hughes (1987). From the foregoing results it could be argued that the variation in pH and acidity of buffalo colostrum during first six postpartum milking took opposite trends as expected. However, both acidity and pH values gradually changed to more or less their levels in normal milk after sixth postpartum milking. Similar trend in change of acidity and pH values were observed by Haggag *et al.* (1991). Specific gravity of buffalo colostrum (1.061±0.001) was decreased markedly in second, third, fourth, fifth and sixth postpartum milking (i.e. 1.040±0.0005, 1.039±0.0005, 1.038±0.0003, 1.041±0.0003 and 1.037±0.0002, respectively) (Fig. 4). These results indicate a general resemblance to the reported results of different workers (Haggag *et al.*, 1991; Prasad, 1997). Change in viscosity of buffalo colostrum throughout first six postpartum milking was observed in present study (Fig. 5). It was high shortly after parturition (6.80±0.05cP) and then dropped markedly up to the sixth milking (i.e. 3.37±0.06cP, 1.87±0.02cP, 1.98±0.03cP, 1.67±0.02cP and 1.64±0.01cP in second, third, fourth, fifth and sixth milking, respectively). Present result is remarkably higher than that of reported by different workers (Singh and Fox, 1989; Prasad, 1997). However, the change in viscosity of colostrum could be correlated with

Table 1: Chemical quality of Buffalo colostrum during its transition to normal milk

Postpartum milking	Total solids (%)	SNF (%)	Fat (%)	Protein (%)	Casein (%)	Lactose (%)	Ash (%)	Chlorides (%)
First(4h)	28.52±0.33^{a}	23.08±0.31^{a}	5.41±0.21^{bc}	18.75±0.30^{a}	5.06±0.31^{a}	2.70±0.05^{d}	1.64±0.04^{a}	0.20±0.01^{a}
Second(12h)	21.98±0.31^{b}	16.20±0.30^{b}	5.78±0.18^{ab}	12.01±0.29^{b}	4.59±0.28^{ab}	3.12±0.06^{c}	0.97±0.01^{b}	0.174±0.01^{b}
Third(24h)	18.87±0.30^{c}	12.92±0.22^{c}	5.95±0.09^{a}	8.56±0.23^{c}	4.21±0.12^{b}	3.42±0.06^{b}	0.95±0.003^{bc}	0.154±0.01^{bc}
Fourth(36h)	18.58±0.18^{d}	12.75±0.18^{c}	5.84±0.08^{a}	8.30±0.13^{c}	4.29±0.20^{b}	3.54±0.08^{b}	0.92±0.003^{bc}	0.142±0.004^{bc}
Fifth(48h)	18.27±0.18^{cd}	12.43±0.18^{c}	5.84±0.11^{a}	7.41±0.14^{d}	4.09±0.17^{b}	3.99±0.07^{a}	0.98±0.056^{b}	0.132±0.003^{bc}
Sixth(60h)	17.63±0.18^{d}	11.75±0.16^{d}	5.88±0.95^{a}	6.90±0.12^{d}	4.16±0.10^{b}	3.97±0.08^{a}	0.89±0.004^{d}	0.121±0.002^{d}

Data are the average of duplicate samples for each postpartum milk of 20 buffaloes. ±Standard error of difference of mean. Values bearing a, b, c, d and e superscripts in a column differ significantly (P<0.05)

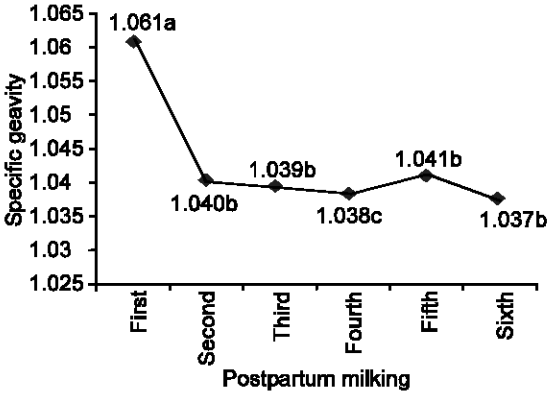

Fig. 4: Specific gravity of Buffalo colostrum during its transition to normal milk. Data are the average of duplicate samples for each postpartum milk of 20 buffaloes. SE (±) = 0.001, 0.0005, 0.0005, 0.0003, 0.0003 and 0.0002 for 1st, 2nd, 3rd, 4th 5th and 6th postpartum milk, respectively. Values bearing a, b, c differ significantly (P<0.05).

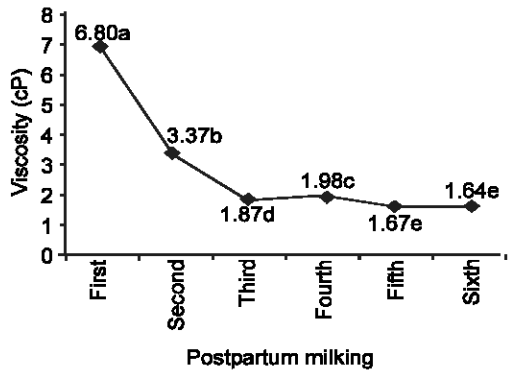

Fig. 5: Viscosity (cP) of Buffalo colostrum during its transition to normal milk. Data are the average of duplicate samples for each postpartum milk of 20 buffaloes. SE (±) = 0.05, 0.06, 0.02, 0.03, 0.02 and 0.01 for 1st, 2nd, 3rd, 4th 5th and 6th postpartum milk, respectively Values bearing a, b, c, d, e differ significantly (P<0.05).

concentration of total solids content of colostrum (Sing and Singh, 1980) which was appeared in higher percentage in the present study (Table 2).

Chemical composition of colostrum was different from normal milk (Prasad, 1997) and changed significantly in successive milking in the present study (Table 1). It became relatively normal up to seventh (72h) postpartum milking, whilst 5 to 6 days had been reported the transition period by different workers (Prasad, 1997).

Total solids content of first postpartum milk of buffalo was analyzed as 28.52 ± 0.33% contrast to normal milk of buffalo which ranged between 14.73 and 23.11% (Malhi, 2000; Chaudhry, 2002). The greatest differences in the total solids content of colostrum contrast to normal milk could be the result of elevated content of antibodies of colostrum (Nickerson, 1995). Relatively similar values of total solids content (i.e. 23.9%) of colostrum was reported by McGuirk (1989).

While the values of colostrum analyzed in the present study were higher than reported by others workers (Nickerson, 1995; Prasad, 1997) i.e. in between 24.71% and 26.99%. However, gradual significant decrease in total solids content of colostrum was observed up to sixth postpartum successive milking which appeared to be related to change in total protein content, albumin, globulin fraction, and ash (Singh *et al.*, 1982).

The average percentage of SNF content (23.08±0.31%) was high shortly after parturition and dropped steadily in successive milking (i.e. 11.75±0.16%, sixth milking colostrum) in the present study. Decline trend in SNF content of colostrum during its transition to normal milk was reported up to 6 to 12 weeks, and then increased slowly to sixth month lactation (Nickerson, 1995). A wide variation in SNF content of colostrum from different buffaloes was also observed during present study which could be the evidence of individuality of buffaloes (Andrew, 2001).

Average fat percentage of buffalo colostrum at initiation of lactation was observed as 5.44±0.21, which was inclined to 5.88±0.10% up to sixth postpartum milking. While declined trend in fat content of cow colostrum was reported by different workers during its transition to normal composition (Ghionna *et al.*, 1987; Maria *et al.*, 1990). However, the concentration of fat in colostrum observed in the present study was not within the range of normal buffalo milk as reported in different studies (Prasad, 1997; Malhi, 2000; Chaudhry, 2002).

Total protein content of first milking colostrum was observed very high (18.75 ± 0.30%) in the present study, which could be due to higher concentration of globulin that serve as the carrier of antibodies for suckling calf against disease producing organism (Nickerson, 1995). However, the values observed were in line with studies conducted by Sodhi *et al.* (1996). While these were lower than the studies conducted by Ghionna *et al.* (1987) i.e. 18.83%, and higher than reported by Prasad (1997) and Singh *et al.* (1982) (i.e. ranged between 16.42 to 17.8%). Moreover, the total protein content of colostrum was significantly declined during its transition to normal milk. For example, protein content in second postpartum milk was observed as 12.01±0.29 which was 1.6 fold lower than first milking colostrum and continued to decrease in third, fourth, fifth and sixth milking. The corresponding values were 8.56 ± 0.23%, 8.30 ± 0.13%, 7.41 ± 0.14% and 6.90 ± 0.12%, respectively. Even though the protein content was declined to 6.90 ± 0.12%, but it was still higher than normal buffalo milk as reported by Sukumar (1980); McGuirk (1989); Prasad (1997) and Chaudhry (2002) i.e. 3.7%, 3.88% and 5.25%, respectively.

Casein content of first milking colostrum was analyzed as 5.06 ± 0.31%, which dropped to 4.59 ± 0.28%, 4.21 ± 0.21%, 4.29 ± 0.20%, 4.09 ± 0.17% and 4.16 ± 0.10 in second, third, fourth, fifth and sixth milking, respectively. Similar trend of change in casein content of colostrum was reported by different workers (Nickerson, 1995; Prasad, 1997). However, higher casein content of first milking colostrum was the results in increase in alpha and beta casein in the first day of lactation over that of normal one and those were decreased gradually to reach the level of normal one after 2nd or 3rd day of lactation.

Lactose content of buffalo colostrum in first postpartum milking was observed as 2.70±0.05%. The concentration level of lactose in the present study was lower than the values of normal buffalo milk (i.e. 3.67% to 5.2%) as reported by different workers (Sukumar, 1980; Prasad, 1997; Chaudhry, 2002). While inclined trend of lactose content of colostrum was resulted in subsequent postpartum milking. These results were in line with the result of Nickerson (1995) and Prasad (1997).

Ash content in first milking colostrum of buffalo was analyzed as 1.64±0.04% in the present study. This was higher than the range of normal milk i.e. in between 0.70% to 0.87% as reported by different workers (Sukumar, 1980; Prasad, 1997; Chaudhry, 2002). However, declined trend in ash content of colostrum was observed in others postpartum milking i.e. second (0.97±0.01%), third, fourth, fifth and sixth milking (0.89±0.004%). These results were in agreement with the results of different workers in the past (Nickerson, 1995; Prasad, 1997).

Chloride content of buffalo colostrum was higher in first postpartum milking (0.20±0.01%), which was significantly declined to 0.17±0.01% in second postpartum, 0.15±0.01% in third postpartum, 0.14 ±0.004% in fourth postpartum, 0.13±0.003% in fifth postpartum and 0.12±0.002% in sixth postpartum milking in the present study. Where ever, ups and down in the values of chlorides of colostrum up to 5 days of postpartum was reported in the past (Prasad, 1997).

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