International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(3): 17-20

Received: 04-03-2017
Accepted: 05-04-2017

**Anamika Das**
PhD Scholar, Dairy Chemistry Division, National Dairy Research Institute, Karnal, India

**Raman Seth**
Dairy Chemistry Division, National Dairy Research Institut, Karnal, India

**Correspondence**
**Anamika Das**
PhD Scholar, Dairy Chemistry Division, National Dairy Research Institute, Karnal, India

# Studies on quality attributes of skimmed colostrum powder

**Anamika Das and Raman Seth**

**Abstract**
Bovine colostrum characterized by its high level of bioactive peptides plays a significant role in curing plethora of diseases in human. In the present study, bovine colostrum was collected within 24-36hours after parturition, pooled and stored at -20 $^0$C and the samples were analysed for total solids, fat, lactose, protein, ash, IgA, IgG, TGFβ1, TGFβ2, IGF1 and IGF2. Pooled samples were thawed and conditions for freeze drying were standardized. Physico-chemical attributes of freeze dried bovine colostrum powder was studied and microstructure of powder particles was observed with scanning electron microscope. Such powder can be used in formulating different food products like infant formula, fermented dairy products, sports drink and dietary supplements.

**Keywords:** Quality attributes, skimmed colostrum powder, lactose, physico-chemical attributes

## 1. Introduction
Colostrum, the first mammary secretion produced during the first 72 hours after parturition, provides nourishment and immunological protection to the newborn. It contains numerous immune factors, growth factors as well as essential nutrients, trypsin and protease inhibitors that protect it from destruction in the gastrointestinal (GI) tract. Colostrum is particularly rich in immunoglobulins (Ig), lactoferrin, lactoperoxidase and other bioactive molecules, including growth factors. It has antioxidant and anti-inflammatory properties and is a good source of many vitamins, minerals, enzymes and amino acids. During the past two decades, interest in the beneficial effects of these components and the possibility to utilize them have increased. The concentration of these bioactive compounds is the highest in colostrum and decreases gradually after 72 hours of parturition. The major differences between bovine colostrum and mature milk are that colostrum has higher levels of immunoglobulins, vitamins A and D, iron, calcium, and other vitamins and minerals (Kelly, 2003) [7]. In India, Ayurvedic physicians have used bovine colostrum for therapeutical purposes for thousands of years (Rona, 1998) [12]. In United States and throughout the world, conventional doctors used it for antibiotic purposes prior to the introduction of sulfa drugs and penicillin. In the early 1950, colostrum was prescribed extensively for the treatment of rheumatoid arthritis and also as a source for antibodies against polio (Sabin and Fieldsteel, 1962) [13]. Also colostrum has a therapeutic role to fight against AIDS, cancer, heart disease, diabetes, auto-immune diseases, allergies, herpes, bacterial, viral and parasitic infections, gingivitis and flu (Rona, 1998) [12].
Bovine colostrum and milk contain virtually all compounds of bovine cellular and humoral immune defence. For industrial scale production of immunoglobulins, colostrum represents an ideal source because of its ready availability and safety when compared with blood derived analogues. Because of its poor heat stability, colostrum is an unutilized product in the dairy industry. Knowledge concerning the influence of processing and isolation procedures on bioactive compounds in colostrum based products is, however, limited. Due to poor heat stability of colostrum, its addition in raw milk affects further processing. Colostrum addition to milk elevates protein and mineral content which might render milk unsuitable for certain dairy processing operations such as UHT or milk powder manufacture.
Clinical studies (Playford *et al.,* 1999) [11] suggest that colostral fractions or individual peptides present in colostrum might be useful for the treatment of a wide variety of gastrointestinal infections, including inflammatory bowel disease, nonsteroidal anti-inflammatory drug (NSAID)–induced gut injury, chemotherapy induced mucositis and Alzheimer's disease. The use of colostral based products as a dietary supplement has increased substantially over the past decade.

The aim of the present study is to prepare bovine skimmed colostrum powder from pooled colostrum by freeze drying method and to analyze the chemical composition with respect to moisture, fat, total protein, ash, lactose, IgG and IgA content of the colostrum powder.

## 2. Materials and methods

**2.1 Collection of bovine colostrum:** Colostrum samples were collected within 24 – 36 hours immediately after parturition from NDRI cattleyard. The samples were immediately frozen at-20 $^0$C. After thawing, the lipid portion was removed by centrifugation at 8000 g for 20min at 2 $^0$C using refrigerated centrifuge (Kubota high speed refrigerated centrifuge, model 6800) till further use.

**2.2 Heat treatment of colostrum:** Processing temperature of colostrum was determined by analyzing the IgG, IgA, loss as well as by visual observation for coagulation. The skimmed colostrum samples were heat treated at different temperature viz. 72 $^0$C /15 sec, 68 $^0$C/30 min, 65 $^0$C/30 min, 63 $^0$C/30 min, 60 $^0$C/45 min and at 60 $^0$C/ 60 min.

**2.3 Preparation of colostrum powder:** Heat treated (60 $^0$C/45min) skimmed colostrum samples was immediately frozen and stored at -20 $^0$C and subsequently freeze dried at -40 $^0$C under vacuum at 005 torr using freeze dryer (Labtech, Japan).

**2.4 Proximate composition Analysis:** Raw colostrum was analysed for pH, acidity, total solids and fat by gravimetric method (SP:18, Part XI, 1981), total protein by Kjeldahl method (AOAC method, 2000), ash and lactose by modified Lane Eynon method (SP:18, Part XI, 1981), IgG and IgA content by ELISA kit (KOMA BIOTECH), TGFβ1 and β2 by ELISA kit(USCN Life Science Inc., Wuhan), IGF1 and 2 by ELISA kit(USCN Life Science Inc., Wuhan), Growth hormone by ELISA test kit procured from Endocrine technologies, Inc. USA. Colostrum powder samples were analysed for moisture content (SP:18, Part XI, 1981), fat by gravimetric method (IS:11721, 1982), total protein by Kjeldahl method (AOAC method, 2000), ash and lactose by modified Lane Eynon method (SP:18, Part XI, 1981), IgG and IgA content by ELISA kit (KOMA BIOTECH), TGFβ1 and β2 by ELISA kit(USCN Life Science Inc., Wuhan), IGF1 and 2 by ELISA kit(USCN Life Science Inc., Wuhan), Growth hormone by ELISA test kit procured from Endocrine technologies, Inc.USA.

**2.5 Analysis of Physical parameters:** Flowability, as the angle of repose (as a static measure for flowability), was determined by the method of Sjollema, 1963 [14]. The wettability was measured by the method given by Muers and House (1962) [9]. Both loose bulk and packed bulk densities were estimated as described by Sjollema, 1963 [14]. Microstructure of BSCP was observed using Scanning Electron Microscopy (SEM) which was carried out as per the procedure of Caric and Kalab, 1987 [2].

Color of BSCP was measured using a Colorflex colorimeter supplied by Hunterlab (Hunter Associates Laboratory, Inc., Reston, VA, USA) alongwith the software version 4.10 and the results were expressed in terms of CIE LAB system. Before the test, the instrument was calibrated with standard black and white tiles as apecified by the manufacturers. The light source was dual beam xenon flash lamp. Data was received through the software in terms of L*(lightness) ranging from 0(black) to 100(white), a*(redness) ranging from +60(red) to -60(green) and b*(yellowness) ranging from +60(yellow) to -60(blue) values.

**2.6 Microbiological analysis:** Microbiological analysis of raw colostrum, skimmed colostrum powder were carried out according to Houghtby *et al.,* (1993) [5].

**2.7 Analysis of data:** Observations were recorded as mean ± S.E. Analysis of variance (ANOVA) at a confidence level of 95% was calculated using SYSTAT 6.01 for windows.

## 3. Results and discussion

**3.1 Time-temperature for heat treatment of bovine colostrum:** Colostrum samples were subjected to heat treatment using batch method at different temperatures and observed for coagulation. It was found that at 72 $^0$C/15 sec, 68 $^0$C/30 min and 65 $^0$C/30 min, the colostrum samples coagulated while at 63 $^0$C/30 min, 60 $^0$C/45 min and 60 $^0$C/60 min, there was no visual coagulation. After heat treatment at 63 $^0$C/30 min, 60 $^0$C/45 min and 60 $^0$C/60 min, IgG content was estimated and it was found that minimum reduction of 2.63% occurred at 60 $^0$C/45 min whereas a reduction of 15.81% at 63 $^0$C/30 min and 6.71% at 60 $^0$C/60 min was observed. After heat treatment at 63 $^0$C/30 min, 60 $^0$C/45 min and 60 $^0$C/60 min, IgA content was estimated and it was found that minimum reduction of 2.18% occurred at 60 $^0$C/45 min whereas a reduction of 2.54% at 63 $^0$C/30 min and 9.19% at 60 $^0$C/60 min was observed (Table1). Hence the temperature of 60 $^0$C/45min was selected for heat treatment of colostrum. Standard plate, coliform, *S.aureus* and Salmonella counts were performed before and after heat treatment at 60 $^0$C/45min. It was found that there was a significant reduction in the microbial count after the heat treatment at 60 $^0$C/45min. (Fig1). The standard plate, coliform, *Staphylococcus aureus*, *Salmonella* and yeast and mold count of bovine skimmed colostrum powder was also examined. The coliform, *Staphylococcus aureus*, *Salmonella* and yeast & mold count of bovine skimmed colostrum powder was found to be absent in first dilution. The mean standard plate count of bovine skimmed colostrum powder was found to be 6.12x102cfu/g respectively.

**3.2 Composition of Raw Colostrum and Skimmed Colostrum Powder:** The total solids, protein, total fat, lactose, ash, IgG, IgA, IGF 1 and 2, TGFβ1 and TGFβ2, growth hormone in all colostrum samples, collected during the first 48 hours after calving, is presented in Table 2. The moisture, protein, total fat, lactose, ash, IgG IgA, IGF 1 and 2, TGFβ1 and TGFβ2, growth hormone in skimmed colostrum powder samples, prepared from colostrum collected during the first 48 h after calving, is presented in Table 3.

**3.3 Physical properties of Bovine Skimmed Colostrum Powder (BSCP):** The physical properties of BSCP is important because it could affect the physical properties of food products in which it has been incorporated. The flowability, wettability, loose bulk density and packed bulk density of BSCP was investigated. The flowability of BSCP was measured in terms of the angle of repose and the cotangent of angle of repose for BSCP was found to be 0.84. The cotangent of angle of repose for SMP is 0.97, WMP is 0.45 and for instant SMP, it is 0.75 (Upadhyay, 1999) [16]. Wettability is measured as the time required in seconds by the powder particles to be wetted by water. The higher the

wetting time, the lower the wettability and the tendency of dried milks to form lumps upon addition of water indicates lack of wettability. The wettability of BSCP was found to be in the range of 130-160s. It is higher than that of SMP, WMP or instant powders (15-60s) (Upadhyay, 1999) [16]. The relatively high bulk density could be attributed to the composition of colostrum powder. The bulk density has pronounced influence on the volume requirement for the container and thus on the packaging cost of the dried products. The loose bulk density and packed bulk density of powder was found to be 0.61 g/cm$^3$ and 0.78g/cm$^3$ respectively. Hols and van Mil (1991) [4] reported a loose bulk density of 0.38 g/cm$^3$ and a packed bulk density of 0.41–0.43 g/cm$^3$ for spray dried powders.

The L*(lightness, ranging from 0-black to 100-white) for BSCP was found to be 79.85, a*(redness, ranging from +60 - red to -60 -green) was observed to be 6.87 and b*(yellowness, ranging from +60 -yellow to -60 -blue) values was found to be 55.45 suggesting that the powder has considerable yellowness because of the presence of carotene content.

The microstructure of the powder was investigated and the image of SEM (fig. 2) shows that the freeze dried powder particles showed a sponge-like internal microstructure with rough, porous surfaces.

**Table 1:** Selection of Time temperature combination for heat processing of bovine skimmed colostrum

| Time /temperature combination for heat treatment | 72ºC/15 sec | 68ºC/30min | 65ºC/30min | 63ºC/30 min | 60ºC/45min | 60ºC/60 min |
|---|---|---|---|---|---|---|
| Coagulation | + | + | + | - | - | - |
| Initial IgGconcentration% | 69.2 | 63.8 | 72.3 | 65.9 | 64.6 | 61.53 |
| Final IgG Concentration% | 50.23 | 49.2 | 58.89 | 55.47 | 62.99 | 57.4 |
| % Reduction in IgG | 27.41[a] | 22.87[b] | 18.54[c] | 15.81[d] | 2.63[e] | 6.71[f] |
| Initial IgAconcentration% | 0.97 | 0.94 | 1.08 | 1.01 | 0.97 | 0.92 |
| Final IgA Concentration% | 0.69 | 0.71 | 0.96 | 0.99 | 0.95 | 0.84 |
| % Reduction in IgA | 29.12 [a] | 24.33 [b] | 11.14 [c] | 2.54 [d] | 2.18 [e] | 9.19 [f] |

Values followed by different alphabets (a-f) coloumn wise differ significantly ($P$<0.05).

**Table 2:** Composition of raw bovine colostrum and bovine skimmed colostrum powder

| Constituents | raw colostrum (mean, range), n=12 | Constituents | bovine skimmed colostrum powder (mean, range), n=12 |
|---|---|---|---|
| Total solids% | 20.9-19.5 | Total solids% | 95.5-94.4 |
| Fat% | 5.9-4.5 | Fat% | 0.91-0.58 |
| Protein% | 15.2-11.4 | Protein% | 65.8-63.4 |
| Lactose% | 2.8-2.6 | Lactose% | 22.8-21.6 |
| Ash% | 2.3-1.1 | Ash% | 7.3-6.7 |
| IgG(g/L) | 90-40 | IgG(g/100g) | 65-40 |
| IgA(g/L) | 4.1-2.3 | IgA(g/100g) | 11-6.3 |
| IGF1(ng/ml) | 550-380 | IGF1(µg/100g) | 0.235-0.163 |
| IGF2(ng/ml) | 200-150 | IGF2(µg/100g) | 0.081-0.065 |
| TGFβ1(ng/ml) | 39.6-13.8 | TGFβ1(µg/100g) | 0.151-0.053 |
| TGFβ2(ng/ml) | 970-180 | TGFβ2(µg/100g) | 0.38-0.071 |
| Growth hormone(ng/ml) | 10-4 | Growth hormone(µg/100g) | 0.037-0.015 |

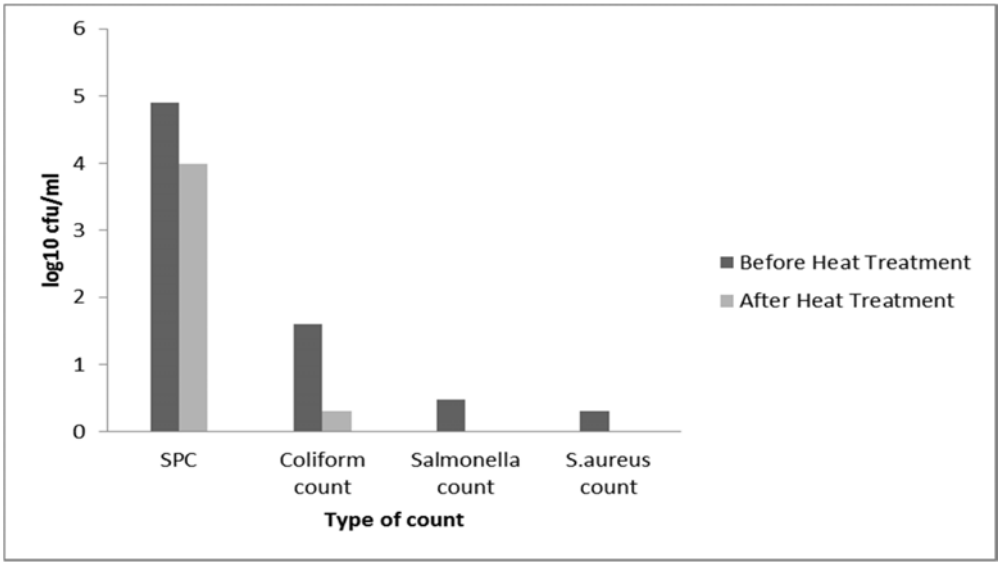


**Fig 1:** Microbiological count of colostrum before heat treatment and after heat treatment at 60 $^0$C/45 min.

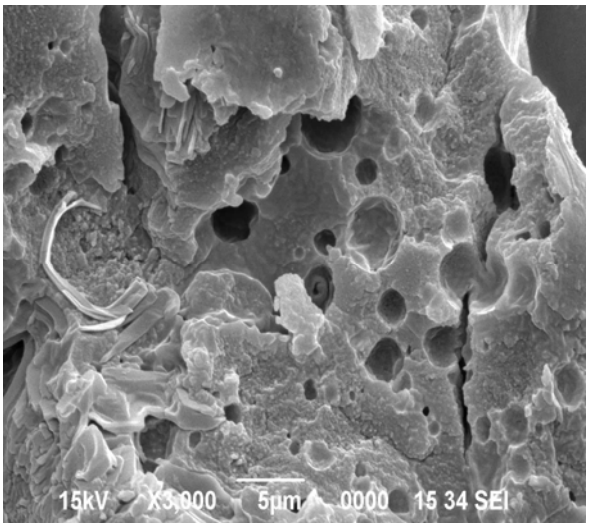


**Fig 2:** Internal microstructure of freeze dried bovine skimmed colostrum powder.

## 4. Conclusion

Bovine skimmed colostrum powder can be successfully prepared by freeze drying and such powders can be used as a constituent in beverages or infant formulas or it can be used as dietary supplement. Bovine colostrum can be subjected to heat treatment at 60 $^0$C/ 45 minutes with minimum damage to IgG, IgA, TGFβ1 and TGFβ2, IGF1 and IGF 2. The physical properties of freeze dried bovine skimmed colostrum powder is quite different from that of spray dried skim milk powder.

## 5. Acknowledgement

Fellowship from NDRI is greatly acknowledged.

## 6. References

1. AOAC. Official Methods of Analysis. Association of Official analytical Chemist. 2000. EUA.
2. Caric M, Kalab M. Effects of drying techniques on milk powders quality and microstructure: A review. Food Micros. 1987; 6:171-180.
3. Hay FC, Westwood OMR. Practical Immunology, Blackwell Science. 4th edition. 2002, 203-206.
4. Hols G, Vanmil PJJM. An alternative process for the manufacture of whole milk powder, J. Soc. Dairy Technol. 1991; 44:49-52.
5. Houghtby AG, Maturin LJ, Koenig KE. Microbiological Count Methods. Standard Methods for the Examination of Dairy Products. Ed. R.T. Marshall. 16th edition. American Public Health Association, 1993.
6. IS 11721:1986/ISO. Method for determination of fat content in milk powder and similar products (reference method). Bureau of Indian standards, New Delhi, 1736:1985.
7. Kelly GS. Bovine colostrum: a review of clinical uses. Alternative Medi. Rev. 2003; 8:378-394.
8. Laemmli UK. Cleavage of structural proteins during the assembly of the head of bacteriophage T4. Nature. 1970; 227:680-685.
9. Muers MM, House TU. A simple method for comparing wettability of instant spray dried separated milk powders. XVI International Dairy Congress Copenhagen, Denmark, 1962; 8:299-308.
10. Petrie L. Maximizing the absorption of colostral immunoglobulins in the newborn dairy calf. Vet. Rec. 1984; 114:157-163.
11. Playford RJ, Floyd DN, Macdonald CE, Calnan DP, Adenekan RO, Johnson W, Goodland RA, Marchant T. Bovine colostrum is a health food supplement which prevents NSAID induced gut damage. Gut. 1999; 44:653-658.
12. Rona ZP. Bovine colostrum emerges as immunity modulator. Am. Jr. Nat. Med. 1998; 19-23.
13. Sabin AB, and Fieldsteel AH. Antipoliomyelitic activity of human and bovine colostrum and milk. Pediatrics. 1962; 29:105-115.
14. Sjollema A. Some investigation on the free flowing properties and porosity of milk powders. Neth. Milk Dairy J. 1963; 17:245-253
15. SP:18. Handbook of food analysis. Part XI. Dairy Products. 1981; Bureau of Indian standards. New Delhi.
16. Upadhyay KG. Physico-chemical and functional properties of milk powders. Lecture compendium on advances in spray drying. NDRI. Karnal. 1999; 59-81.