Research and Reviews: Journal of Dairy Science and Technology
ISSN: 2319-3409(online), ISSN: 2349-3704(print)
Volume 5, Issue 3
www.stmjournals.com

Current and Future Prospects of Colostrum—Indian Ethnic Food Supplement

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Abstract

Traditional foods of India are called as 'Functional Foods' because they contain components such as body healing components, dietary fibres and growth promoters. Colostrum is the first secretion from mammary gland of an animal after parturition, which contains high amount of many nutrients such as proteins, vitamins, minerals and biologically active substances like immunoglobulins, enzymes, hormones and growth factors. This physicochemical composition makes it highly useful food substance as nutraceuticals to promote growth and increase performance of athletes. Immunological and physiological considerations of bovine colostrum can be exploited more to explore their uses to its full potency and should be easy to use. Indigenous method of preparation of colostrum-based food products differs in various parts of India; accordingly, the composition may also vary. Two main growth factors namely, TGFα and TGFβ and IGF1 and IGF2 has significant muscle and cartilage regeneration, so colostrum proves to be an ideal regenerative material for growth of body cells.

Keywords: *colostrum, functional foods, nutraceutical and regenerative material*

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INTRODUCTION

Indian traditional foods are considered as the 'Functional Food' because it promotes growth and prevents the diseases occurrence. Traditional Indian foods are prepared by various methods throughout the country for many years. Preparation methods of our native food items follow the method called 'Shodhana therapy' which eliminates the toxic substance present in the food [1]. Colostrum or foremilk is the yellowish liquid which is rich in immune factors, secreted by female mammals a few days before and after parturition. Before invention of all artificial antibodies, colostrum was used as a key to unlock all mechanisms to prevent the microbial infections. In the early 20th century, only the higher concentration of antibody level in the colostrum was identified and now it is used as a nutraceutical. The present paper was aimed to review the available information in the composition of cow colostrum and its nutraceutical properties to the humans.

PHYSICOCHEMICAL COMPOSITION OF COLOSTRUM

Colostrum content varies according to its day of production. It contains various types of immunological substances, growth promoting factors, essential amino acid, hormones and antimicrobial factors. Comparison of nutritive components of human and bovine colostrum is made in Table 1. The composition of colostrum is shown in Figure 1.

Immune Milk–Colostrum

The colostrum contains various types of immunoglobulins such as IgG1, IgG2, IgM, IgA; among these IgG1 is the principle immunoglobulin [2]. Composition of this immunoglobulin in human and bovine colostrum is depicted in Table 2. Concentration of immunoglobulins will decrease when the number of milking is increased, i.e., time after parturition. When comparison between concentration of IgG1, IgG2, IgM, and IgA in milk and colostrum (collected after 80 h of postpartum) was done, it was found to be 24, 7, 5 and 7 times higher, respectively [3].

Amino Acid Composition

Bovine colostrum contains the amino acids such as lysine, methionine, phenylalanine, threonine, isoleucine, valine, cystine, leucine and tryptophan. The concentration of these

amino acids is given in Table 3. Among these amino acids phenylalanine, valine, isoleucine, leucine and threonine are considered as essential amino acids [4].

Growth Factors

Various growth factors such as insulin-like growth factors (IGFs), transforming growth factors (TGF), epidermal growth factors (EGF), etc. are present in the colostrum which are essential for repair and growth of various tissues. They help in promoting growth in general and specific tissues by particular growth factors. They indirectly influence metabolism also [2].

Insulin-like Growth Factor (IGF)

The bovine colostrum contains insulin-like growth factors (IGF-1 and IGF-2) that are identical to that of human forms [5, 6]. Concentration of these growth factors in human and bovine colostrum is compared in Table 4. IGF-1 and IGF-2 are acid and heat stable proteins with single chain polypeptide of approximately 7.6 kDa molecular weight; this single polypeptide chain has four polypeptide domain denoted as A, B, C, D. Hence, they can be pressure cooked and supplemented orally [7]. Bovine IGF-1 has the amino acid sequence identical to humans, but IGF-2 differs in three amino acid sequence [5, 6].

Transforming Growth Factors (TGF)

Three types of isoforms of TGF (TGF-β1, TGF-β2, and TGF-β3) are identified in bovine colostrum and they act as pleiotropic growth factors mainly with different functions such as embryogenesis, tissue repair, formation of bone and cartilage, and control of immune system [7].

Epidermal Growth Factor (EGF)

Family of EGFs include actual EGF, TGF-α and amphiregulin. Most of this EGF is to regulate the growth of the epidermis and causing angiogenesis. EGF and TGF-α act on the same receptor of the cell surface glycoprotein [8].

Enzymes

Colostrum also contains variety of antimicrobial enzymes such as lactoferrin, lysozyme and lactoperoxidase. Lactoperoxidase is the major antimicrobial factor present in the bovine colostrum which is homologous to human myeloperoxidase, thyroperoxidase and eosinophil peroxidase; its concentration is about 11–45 mg/l [9]. Lactoferrin identified in the bovine colostrum was identical to human forms like human lactoferrin (68%), human transferrin (60%) and other iron binding proteins [10, 11]. It acts against *Giardia lambia in vitro* [12], *Herpes simplex* virus type-1 [13] and human cytomegalovirus *in vitro* [14]. Lysozyme is another important enzyme that exerts antimicrobial property by its cationic and hydrophobic activities. The concentration of lysozyme in the bovine colostrum is about 0.14–0.7 mg/l [9].

Other Components of Colostrum

Colostrum also contains the hormones such as insulin, cortisol, prolactin and progesterone [15]. Apart from these, they also contain the cellular contents such as macrophages, polymorphs, lymphocytes, epithelial cells [16]. Proline-rich polypeptide or PRP is the immunomodulator substance which is also present in the colostrum; they stimulate the T-cell maturation process [17].

INDIGENOUS COLOSTRUM PRODUCTS

Ginna

Ginna is the colostrum-based Indian food product also called as *Junnu* or *Posu* in various parts of India. Ginna is prepared by cooking first day colostrum with sugar/saggery powder and cardamom in a closed vessel that can be taken with *roti*, *dosa* or *idly* [1].

Kharwas

Kharwas is another colostrum-based Indian product, but the method of preparation varies. In the North-Eastern part of India, equal amount of first day colostrum is mixed with normal milk, sugar, saffron, cardamom powder and cooked in pressure cooker (no direct heat should be applied).

In the parts of south India, method followed is, first day colostrum is taken in a vessel and mixed with sugar (required amount), then this vessel is kept in idly making vessel filled with water up to its one fourth volume (i.e., no direct heat should be applied). After cooking, the colostrum is taken out, which is now made as solid cake. It can be cut into pieces and consumed.

COLOSTRUM PRODUCTS: AN ANCIENT FOOD FOR MODERN TIMES

Booster for Athletes

Growth factors such as IGF-1, IGF-2, and growth hormone (GH) helps in the production (or) increase of lean muscle mass and reduce the adipose tissue, because these growth factors causes 'shift in the fuel utilization of carbohydrate to fat'. So, this colostrum can be given to increase the strength, endurance to build lean muscle mass and burn body fat. These factors are needed for athletes so it can be highly helpful natural substance [18]. In athletes, the body core temperature increase by 2 degree due to stress; there is an increase in the leakiness of the gut mucosa occurring for about two to three fold. This is called 'runner trots'. But supplementation of colostrum two weeks prior to exercise decreases this problem because of its growth factors [19]. Improvement in the performance of athletes was identified by a study conducted on cyclers in cycling completion. Colostrum supplementation was given before eight weeks of completion and the performance was found to be increased by 158 sec faster than previous [20]. This finding was presented in pre-Olympic sports medicine conference in Brisbane. NSAIDs-induced leaky gut syndrome is also reduced by taking colostrum [21].

Cancer Preventing Food

Conjugated linoleic acid in colostrum stimulates the production of interleukin-2 and lymphocyte by 29% and 32%, respectively. Also, it lowers immunosuppressive substance concentration such as Leukotriene's and prostaglandins [22]. They act as anticarcinogenic substance by inducing apoptosis through inhibition of eicosanoids synthesis [21].

Functional Food Supplement for Infants

Immunoglobulins present in the colostrum provides prevention or protective function to infants from diarrhoea and act as immunological supplement [23]. Colostrum has the ability to prevent rota virus, *Salmonella typhi* infections by the help of lactoferrin [24]. Bovine colostrum has large amount of IgA that protects against polio virus, Influenza A, *Herpes simplex* virus, *E. coli*, Streptococcus, and *Shigella flexneri* [25]. Colostrum can also elevate severe eye dryness and problematic eye lesions by tropical application [26].

Colostrum—A Magic Wound Healer

Two types of important growth factors such as TGF-α and β, IGFs-1 and 2 has remarkable muscular–skeletal repair and growth capacities. These properties of colostrum are physiologically outstanding. This anabolic effect of colostrum is a breakthrough in wound healing studies [27–29].

Colostrum–A Promising Candidate in Cell Culture Medium

Normally foetal bovine serum (FBS) is mainly used in cell culture medium. Colostrum has the ability to support the cell growth and production of monoclonal antibodies (MAb) of IgG hybridoma cell lines [30, 31]. The complexity, limited availability and high cost of production are the major drawbacks of FBS. Colostrum is the promising candidate, as best alternative for FBS [31].

EFFECT OF PROCESSING ON COLOSTRUM DURING PREPARATION OF FOOD PRODUCTS

Scientists conducted an experiment with whole colostrum, colostrum whey and concentrated colostrum (after removal of fat, casein, salts and lactose). They subjected all these three types of materials to same processing procedure (heat treatment) and their immunoglobulin concentration was analysed. The results showed that concentrations of immunoglobulin in whole colostrum and colostrum whey were unaffected when compared to the concentrated colostrum. This experiment proves that the above-mentioned factors in colostrum protect the immunoglobulin from processing damage and also they protect growth factors and growth hormones [32].

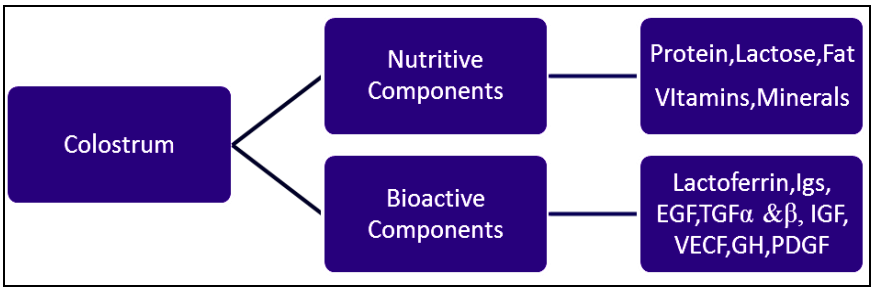

Fig. 1: *Composition of Colostrum.*

Table 1: *Comparison of Nutritive Components of Colostrum in Human and Bovines.*

Nutritive components	Human colostrum	Bovine colostrum
Energy (Kcal)	5.8	~130
Protein (g)	3.7	~14.9
Lactose (g)	5.3	~2.6
Fat (g)	2.9	~6.7

**Per 100 ml of colostrum.*
Source: Guthrie AH. (1989) [33] and Kehoe et al. (2007) [34].

Table 2: *Comparison of Immunoglobulins in Human and Bovine Colostrum.*

Immunoglobulins	Human colostrum (mg/ml)	Bovine colostrum (mg/ml)
IgA	17.35	3.9
IgG1	0.43	47.6
IgG2	-	2.9
IgM	1.59	4.2

Source: Stelwagen et al. (2009) [35], Playford et al. (2001)[19], Elfstrand et al. [36].

Table 3: *Comparison of Amino Acids in Colostrum and Milk of Jersey and Holstein Friesian Cattle Breeds.*

Amino acids	Jersey		Holstein Friesian	
	Colostrum[a]	Milk[b]	Colostrum[a]	Milk[b]
Thr	1.263±0.270	0.178±0.008	1.237±0.071	0.143±0.008
Cys	0.310±0.080	0.029±0.001	0.300±0.044	0.023±0.003
Val	1.347±0.241	0.237±0.011	1.373±0.061	0.214±0.009
Met	0.387±0.051	0.105±0.004	0.043±0.040	0.083±0.001
Ile	0.690±0.098	0.211±0.008	0.730±0.092	0.160±0.003
Leu	1.570±0.262	0.390±0.013	1.640±0.132	0.309±0.009
Try	0.907±0.144	0.201±0.009	0.970±0.069	0.151±0.006
Phe	0.777±0.127	0.196±0.007	0.817±0.076	0.153±0.006
Lys	1.327±0.216	0.345±0.011	1.387±0.090	0.258±0.011

[a] First day colostrum (g amino acid per 100 g sample), [b] Average values of three milking sessions on the third, fourth and fifth month of lactation (g amino acid per 100 g sample).

Table 4: *Comparison of Growth Factors in Human and Bovine Colostrum.*

Growth factors	Human colostrum	Bovine colostrum
EGF	200 µg/l	30–50 µg/l
TGFα	2.2–7.2 µg/l	2.2–7.2 µg/l
TGFβ	20–24 mg/l	1–2 mg/l
IGF	18 mg/l	10 mg/l
VEGF	75 µg/l	NA
GH	41 ng/l	<0.03 ng/l

Source: Stelwagen et al. (2009) [35], Playford et al. (2001)[19], Elfstrand et al.[36].
Abbreviations: EGF, Epidermal Growth Factor; TGF, Transforming Growth Factor; IGF, Insulin-like Growth Factor; VEGF, Vascular Endothelial Growth Factor; GH, Growth Hormone, Ig- Immunoglobulin.

CONCLUSION

The nutritional composition of colostrum proves it as an ancient food for modern times and as nutraceutical. Many commercially available colostrum-based products are also used but the traditional homemade way of preparation of colostrum is safe and hygienic, without any additives causing side effect to humans. So in the era of globalization and international food trading, health conscious citizens will be benefited by using our traditional food product—colostrum.

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Cite this Article

Rajamanickam K, Gogoi J, Leela V, *et al*. Current and Future Prospects of Colostrum—Indian Ethnic Food Supplement. *Research & Reviews: Journal of Dairy Science and Technology*. 2016; 5(3): 23–28p.