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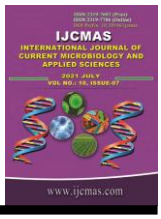

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Colostrum – A Boon for Immunity: A Brief Review

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A B S T R A C T

Colostrum, also known as fore-milk, beestings or bisnings, is the mammary secretion that all mammals offer as first feed to their newborns during the initial 24–48 hr post-parturition. The human also secretes colostrum at the time of parturition that creates the foundation of lifelong immunity. It lasts for 2-4 days after initiation of the lactation. Colostrum is an essential constituent of breast milk. It is different from milk secreted in the following weeks. Both human and bovine colostrum (BC) is thick in consistency, gluey and yellowish fluid full of several antibodies at a higher percentage than ordinary milk. Bovine colostrum (BC) contains higher lactalbumin concentration, lactoprotein, protein, immunoglobulin, lactoferrin, and growth factors. These immunoglobins provide passive immunity to the newborn and give power to fight many diseases. Immunoglobulin and growth factors constituents of colostrum can help in the treatment of autoimmune disorders**.** The high mortality rate in the world is due to immunity-related infections. BC is enriched with immunity, growth, and antimicrobial factors. It promotes tissue growth and the maturing of the gut and immune function in neonatal animals and humans. So, Bovine colostrum is a boon for body immunity and is a complete diet for neonates**.** In ruminants, colostrum is the source of initially acquired immunity for offspring and plays a vital role in mammalian host defence. Bovine colostrum is a complete diet that provides essential nutrients. It helps food industries to gain financial gains. This creates a responsibility for both scientists and the food industry to provide scientific evidence and transparency regarding the production and quality so that the benefits do not come second to financial gain. Considering the wide utility of colostrum for human heath, a brief literature review is presented about the immune factors in colostrum and its benefits.

Introduction

Mammals provide antibodies, immunocytes, and humoral constituents to their newborns before birth or shortly after birth. Until a mammal newborn develops its pathogen acknowledgement and removal systems, this "borrowed immunity"(passive immunization) protects the newborn against ecological pathogens. The colostrum, the first milk after

birth, provides immunoglobulins in animals neonates and enhances their immunity. The major effect of bovine colostrum intake on the growth of calves' immune system has led to the use of bovine colostrum-based products in humans (Natalia Główka *et al.,* 2020). In the human being, the newborn obtains immunoglobulins from the mother by placental transport in the weeks before parturition (Struff, W. G., & Sprotte, G,.2007). Thus, colostrum and human milk are a complete diet for neonates. In ruminants, the progeny's immunity is gained through colostrum and plays a dynamic role in mammalian host defence. In the ruminant's colostrum, IgG immunoglobins are high, whereas, in human milk, IgA is high. In both, mammary receptors help in the secretion of immunoglobulins. Both colostrum and dairy also have neutrophils and macrophages, which secrete cytokines, lactoferrin, defensins, and cathelicidins, which act as antimicrobials peptides (Stelwagen K *et al.,* 2009). The amount of colostrum is about 50 ml, which is sufficient to fill neonates' small stomach.

It is yellow or orange due to the high quantity of carotene and called 'Yellow Gold". It helps in the expulsion of meconium and decreases bilirubin's initial level, thus controlling neonatal jaundice. Colostrum satisfies neonates' appetite and therefore calms the satiety centre, helping in deep sleep in neonates.

BC encourages tissue growth and the digestive tract's maturation and immune function in neonatal animals and humans. BC is considered safe and well tolerant, as lactose intolerance is relatively less compared to milk. BC provides growth and immunological benefits to the calf in its first days of life as it has more protein than standard milk (13.0% vs 3,3%). Immunological benefits have also been recognized in adults, with consumption leading to reduced damage to the gastrointestinal tract induced by high doses of non-steroidal anti-inflammatory drugs. Colostrum supplementation is useful to reduce subjective upper respiratory symptoms in athletes (Bagwe, S. *et al.,* 2015). The colostrum intake supports the start of anabolic processes in several tissues, stimulating postnatal body growth and organ development. (H.M.Hammon[1] *et al.,* 2020)

A recent literature review is presented about the immune factors in colostrum and its benefits.

Bovine colostrum composition

Colostrum composition varies from mature milk because it consists of a higher concentration of macronutrients, protein, immunoglobulins for passive immunity, fat, and growth factors, as shown in Fig-1(Marnila, P *et al.,* 2011).

Bovine colostrum and mature milk are different from each other, and the compositions of these two fluids have different biological functions (McGrath, B. A. *et al.,* 2016). Colostrum composition varies by species, as shown in Table1(Gregory, S. K. 2003). Table -2 shows the concentration of growth factors in Human and Bovine Colostrum (Godhia ML. *et al.,* 2013), Table-3 showing water-soluble vitamins and Table-4 showing minerals in different colostrum.

No doubt serum IgA concentration is (2-3 mg/mL) less than IgG (12 mg/mL)in colostrum; however, IgA production by the organism is 5 times faster than IgG. Salivary immunoglobulin (A S-IgA) plays a defensive role in mucosal areas such as the respiratory tract, genitals, and gastrointestinal tract. It is vital in the defence against pathogenic invasion. (Woof, J. M.*et al.,* 2006). Lactoferrin (LF) is an iron-binding protein mainly found in milk, colostrum, and most

mammalian species. It is one of the types of glycoprotein. It contains numerous biological properties, such as antioxidative, anti-inflammatory, anticancer, and immune regulatory properties. It augments the body's immune system against microbial infections and eradicates free oxygen radicals. It increases the sensitivity of bacteria for certain antibiotics, such as penicillin, vancomycin, and cephalosporins. Iron–chelation–related antioxidative property and immunoregulatory and anti-inflammatory functions help LF for its anticarcinogenic activity. The lactoferrin controls both humoral and cellular immune systems by;-1) initiation of monocytes, macrophages, natural killer cells, and neutrophils; 2) stimulation of proliferation of lymphocytes; 3) encouragement of intestinal and peripheral antibody response; 4) initiation of cytokine and nitric oxide production (Agarwal P *et al.,* 2016).

The colostrum and breast milk contain lactoferrin, and it is considered the main protein found in all mammals' milk serum. (Buttar, H. S., 2017). It prevents lung, bladder, colon, oesophagus, and tongue cancer by improving the immune system. Lactoferrin has antineoplastic actions that act differently depending on the type of cancer; it can affect cell cycle arrest, apoptosis action, inhibition of metastasis, and cellular necrosis. It is extracted from colostrum or shaped by recombinant DNA technology. It is mixed with standard formulas because it is considered a safe food supplement by the Food and Drug Administration (FDA).

The lactoferrin favours infant intestinal health benefits by reducing the pathogenic microbial load (Manzoni, P. *et al.,*.2016). The lactoferrin inhibits several viruses' growth. Its oral administration in animals and humans saves from various viral infections like the common cold, influenza, viral gastroenteritis, and herpes (Wakabayashi, H. *et al.,* 2014). Lactoferrin reduces tumours' size as it has cytotoxic activity against cancer cells (Eliassen, L. *et al.,* 2002). Colostrum contains lysozyme (an enzyme), which acts as a bactericidal barrier. It destroys the integrity of the bacteria cell wall, together with other bactericidal agents present in the colostrum (Ribeiro, K. D. S. *et al.,* 2016). The epithelial cells and leukocytes produce lysozyme enzyme and kill bacteria by the hydrolysis of the peptidoglycans present in the cell wall of Gram-positive and Gram-negative bacteria and result in complete cellular breakage (Rainard, P. *et al.,* 2006, Emerson Gabriel dos Santos Oliveira SILVA *et al.,* 2019).

Hyperimmune Bovine Colostrum

Recently, scientists have produced a different type of bovine colostrum called "hyperimmune bovine colostrum." Cows are vaccinated with specific disease-causing organisms resulting in hyperimmune bovine colostrum production with particular kinds of antibodies. Thus, antibody levels in bovine colostrum can be 100 times higher than regular cow's milk levels. Immune milk products preparations are made of such hyperimmune colostrum or antibodies augmented from it. These preparations are utilized to provide adequate specific protection to calves and suckling pigs against different enteric diseases. Bovine colostrum-based immune milk products are quite useful in prophylaxis against various infectious diseases in humans caused by rotavirus, Shigella Flexner, Escherichia coli, Clostridium difficile, Streptococcus mutans, Cryptosporidium parvum, and Helicobacter pylori. Immune milk is useful in balancing gastrointestinal microbial flora, becoming health-promoting functional foods or nutraceuticals (Korhonen H. *et al.,* 2000).BC is given to patients in blend with standard therapies and hence named as balanced, supportive diets.

Benefits of Colostrum in human

Due to its great bioactive component concentration due to its value in body development by growth factors, colostrum is an immunity booster and a food supplement**(**Godhia ML. *et al.,* 2013**)**. However, the researchers and the food industry have a moral duty to protect consumers from misinformation and false claims**(**Siddhi Bagwe. *et al.,* 2015).

Historically, India uses bovine colostrum since its domestication and has utilized it in medical and spiritual rituals(Agarwal P *et al.,* 2016). The colostrum can be used as a medicine against influenza in older adult patients(Conte, F. *et al.,* 2013). The eyes were irrigated with bovine colostrum during ocular surgeries, as mentioned in Ayurveda's ancient Indian medicine (Buttar, H. S *et al.,* 2017).

Since the 18th century, colostrum is being used in the medicinal form in Western World also. Colostrum was useful in the fight against bacterial diseases until the development of penicillin. No doubt, bovine colostrum is too helpful for human health. Still, bovine colostrum is unutilized entirely due to lack of cooling storage facilities, oxidation sensitivity and lipid components (Struff, W. G., & Sprotte, G. 2007).

BC helps improve the immune system, intestinal flora balance, and tissue regeneration due to the presence of various bioactive compounds (Kabała-Dzik, A. *et al.,* 2017). Also, bovine colostrum is helpful in some therapeutic processes of cardiovascular diseases, allergies, autoimmune diseases. It presents beneficial actions against bleeding, decreased flow, and ischemia resulting from certain drugs (Bagwe, S., 2015).

Due to bioactive components in bovine, colostrum can neutralize the endotoxins in the gastrointestinal tract, decrease intestinal inflammation, and help repair tissue lesions (Saad, K. *et al.,* 2016). As preterm newborns have a reduced digestive function, low bacterial colonization, and a dysregulated immune system, colostrum is beneficial in them(Sty, A. C. *et al.,* 2016).

Benefits in GI Disorders

GI tract contains lots of microbiological organisms, antigens, food ingredients. These can act directly on the gut by the immunological process stimulation. Colostrum has immunological factors that protect against microorganisms. Colostrum contains trypsin inhibitors, and the whole colostrum goes down the GI tract and maintains the healthy epithelium linings and immune system. This way, colostrum protects against GI disorders (F. O. Kaducu *et al.,* 2011). The hyperimmune bovine colostrum produced against a particular infection is very specific to the tract and prevents the infection host (Claes-Henrik Flore ´N. *et al.,* 2006).

Non-steroidal anti-inflammatory drugs (NSAIDs) can cause gastric gut ulceration. It affects the gut and causes increased permeability with protein and blood loss and rarely stricture formation. Acid suppressants and prostaglandin analogues are usually effective in reducing gastric injury induced by NSAIDs but are less effective in preventing small intestinal damage. Therefore, novel therapies are essential for this. The human and bovine colostrum consist of various growth factors like α IGF 1, β IGF 1, and transforming growth factor (TGF). These growth factors stimulate gut repair and result in gut growth. Bovine colostrum is useful to control the side effects of NSAIDs on GI mucosa. Bovine colostrum containing a protein content of approximately 43%, helps prevent NSAIDS induced GI dysfunction (Antonius C.M. *et al.,* 2000).

Autoimmune Disease/ Leaky Gut Syndrome (Aldredge DL *et al.,* 2013)

Over-reaction of an immune system and mistakenly attacks on own body tissues can cause the autoimmune disorder. These disorders can disturb one organ in the body (organ-specific), or multiple organs or systems may be affected (non-organ specific). Leaky gut syndrome, also known as bowel (intestinal) permeability, is an ailment in which the intestines' lining is more permeable than usual. In leaky gut syndrome, there are large pores or spaces between the cells of the intestinal wall. This damaged intestinal barrier means compromised immunity since infectious pathogens (including bacteria, viruses, yeasts, and fungi), as well as allergens, can transfer through these enlarged holes within the intestinal wall and cause infection in the body. As the damaged intestinal wall pours more and more of these substances into the body, autoantibodies are made by the body, and thus inflammation becomes chronic. Such autoimmune disease that can develop depends on the chronic inflammation's location, deciding the site of autoimmune disease. For example, inflammation that disturbs a joint can result in rheumatoid arthritis, and when it involves the blood vessels, vasculitis may occur. It is becoming apparent in recent research that there is a relationship between gastrointestinal health and autoimmune diseases. Colostrum is full of immunoglobulins and lactoferrin (immune factors), regulating the immune response, repair damaged cells, and reducing inflammation, a characteristic of autoimmune disorders. Colostrum contains proline-rich peptides (PRPs), also known as Colostrinin, a potent immune modulator that can slow the intense immune response in autoimmune diseases. It acts by stopping the overproduction of lymphocytes and stimulating the production of helper and suppressor T cells. Lactoferrin restores the humoral immune response, an immune response mediated by T and B cells.

Leaky gut syndrome has a significant negative role in autoimmune diseases like lupus, rheumatoid arthritis, multiple sclerosis, diabetes, fibromyalgia, scleroderma, etc. Approximately 70% of the population has it. Suppose we consume substances that damage the intestinal lining due to antibiotics, steroids, soft drinks, alcohol, NSAIDs or alcohol, chemical hardeners used in canned foods, wheat proteins that contain gluten, or refined foods. There are high chances for some degree of the leaky gut syndrome, as shown in Fig-2.

Immune deficiency and diarrhoea

Diarrhoea is well-defined as the condition of having three or more loose or liquid stools per day. It is due to infection and malfunction in the gut mucosa with increased permeability. The common cause of diarrhoea is bacteria, viruses, microbes, or other enteric pathogens. As severe diarrhoea results in dehydration and malnutrition so, they are the primary threat to human diseases. Whenever there is a breach in the mucosal integrity, diarrhoea can be part of several other conditions (WHO 2017).

Bovine colostrum is an essential dietary supplement to help in the improvement of Diarrhoea (Playford, R. J. *et al.,* 2000, Kelly, G. S.2003, Struff, W. G. *et al.,* 2008, Elfstrand, L. *et al.,* 2010, Feasey, N. A *et al.,* 2011, Marchbank, T *et al.,* 2011, Rathe, M. *et al.,* 2014). This action is due to various bioactive factors like immunological, antibacterial, -viral, and –microbial in colostrum(Pakkanen, R. *et al.,* 1997). Bovine colostrum is reasonably effective against bacterial gastrointestinal infections, oral infections, viral infections, cryptosporidium infections (Korhonen H *et al.,* 2000). Chronic diarrhoea is due to immune deficiency syndromes due to the enteric pathogen

Cryptosporidium parvum, and this diarrhoea benefits from the intake of bovine colostrum. Supplementation decreases stool frequency and increased stool volume. Also, in some immune-compromised persons, supplementation resulted in the complete resolution of previously non-responsive Diarrhoea (Playford, R. J. *et al.*, 2000, Kelly, G. S.2003).

HIV infections lead to loss of CD4+ cells from the gut mucosa, compromising its epithelial barrier function, thereby enabling microbial translocation, resulting in gastrointestinal and systemic immune activation and diarrhoea. HIV-associated diarrhoea thus, not only results in discomfort, dehydration, and malnutrition but may also affect the patients' immunological and inflammatory status (Rathe, M. *et al.,* 2014). BC is useful in patients infected by HIV who often suffer from chronic Diarrhoea (Rump, J. A 1992). This is due to direct colostrum effects on antimicrobial and endotoxin neutralizing effects by suppressing gut inflammation and promoting mucosal integrity and tissue repair (Elfstrand, L. *et al.,* 2010, Feasey, N. A *et al.,* 2011).

Bovine colostrum is beneficial against diarrhoea in immune-compromised individuals, such as AIDS patients (Korhonen H, 2000; Kelly, G. S, 2003). BC helps lower the daily stool frequency and normalize the gut for a long time (Rump, J. A. *et al.,* 1992).

In pediatric patients with bloody diarrhoea, oral colostrum reduces stool frequency and improves life quality (Fernandez, L. B. *et al.,* 1973). When antibiotics fail to control diarrhoea, bovine colostrum is a safe therapy (Korhonen H *et al.,* 2000, Struff, W. G. *et al.,* 2008, Thapa, B. R., 2005). Athlete's diarrhoea" is caused by the combination of extreme physical stress and increased body temperature(Lambert, G. P. 2008), and gut permeability may increase as much as two- to threefold during intensive training. Therapy with BC stabilizes the gut, controls gut permeability, and reduces diarrhoea's tendency to significantly counteract this (Marchbank, T *et al.,* 2011).

Colostrum Anticancer Role

The milk-derived bioactive peptides include antithrombotic, antihypertensive, immunomodulating, antioxidative, mineral carrying, antimicrobial, anticancer, and growth-promoting properties. The conjugated linolenic acid (CLA) in colostrum has shown anticancer properties in breast cancer cells. As BC either inhibits the cyclooxygenase-2 pathway or the lipo-oxygenase pathway or induces the expression of apoptotic genes, it possesses the anticarcinogenic property of CLA in the mammary glands of females. It reduces immunosuppressive substances like leukotrienes and prostaglandins. CLA also inhibits carcinogens by inducing apoptosis through a mechanism that involves the inhibition of eicosanoid synthesis, as shown in Fig-3 (Agarwal P. *et al.,* 2016).

Utility in Preterm Baby

Preterm newborns need extra nutrition and immune protection compared to full-term newborns. Surprisingly, the preterm mother's milk has high quantity proteins and higher amounts of many immunobiological factors, such as cytokines, growth factors, TGF-β2, and SIgA. As lymphoid tissues of the oropharynx can absorb the immunoprotective components of the maternal colostrum, this route can be used to treat premature neonates.

Table.1 Colostrum characterization of different species.

Constituent	Bovine Colostrum	Buffalo Colostrum	Sheep Colostrum	Human Colostrum
Fat (%)	6.7%	7.6 - 11.31	4.1	3-5%
Protein (%)	14.9%	4.3%	3.4	0.8-0.9%
Lactose (%)	2.5%	7.4%	4.7	6.9-7.2%
IgG1 mg/mL	35.0	NA	NA	NA
IgG2 mg/mL	16.0	NA	NA	NA
IgA mg/mL	1.7	NA	NA	NA
IgM mg/mL	4.3	NA	NA	NA
Lactoferrin mg/mL	0.8	NA	NA	NA

(Bagwe, S. *et al.*, 2015), (Czerniewicz, M., 2006), (Gapper, L. W *et al.*, 2007)

Table.2 Showing Growth Factor in Human and Bovine Colostrum (Godhia ML. *et al.*, 2013).

Growth Factors	Human Colostrum	Bovine Colostrum
Epidermal growth factor (EGF)	200mcg/L	30- 50 mcg/L
Transforming growth factor(TGF α)	2.2–7.2 mcg/L	2.2–7.2 mcg/L
TGF β	20–40 mg/L	1–2 mg/L
Insulin like growth factor (IGF)	18 mg/L	10 mg/L
Vascular endothelial growth factor (VEGF)	75 mcg/L	NA
Growth hormone (GH)	41ng/L	<0.03ng/L

Table.3 A comparison of the water-soluble vitamin content of human, cow, buffalo and goat colostrums

Constituents	Human Colostrum mg/100ml	Cow colostrum Microgram/ml	Buffalo colostrum Microgram/ml	Goat colostrum
Niacin	0.02	0.34	---	Approximately0.64 microgram/ml water-soluble vitamins are present
Thiamin	0.017	0.90	---	---
Rivoflavin	0.04	4.55	3.4	---
Vitamin B12	0.03	0.60	1.59	
Pyridoxal	--	0.15	---	---
Pyridoxamine	--	0.21	----	---
Pyridoxine	---	0.04	3.25	

Table.4 A comparison of the mineral content of human, cow, buffalo and goat colostrums

Constituents	Human Colostrum mg/100ml	Cow colostrum mg/kg	Buffalo colostrum mM	Goat colostrum gm/kg
Calcium	33	4716	47.1	0.65
Phosphate	13-16	4452	27.7	0.36
Magnesium	04	733	7.3	-
Sodium	50	1058	20.3	1.44
Potassium	74	2845	28.7	3.38
Zinc	0.53	38	147-728	--
Iron	0.15	5.3	42-152	--
Copper	0.04	0.3	7	--
Sulphur	--	2595	15700	0.2
Manganese	--	0.1	38.2	--

Fig.1 showing the composition of colostrum

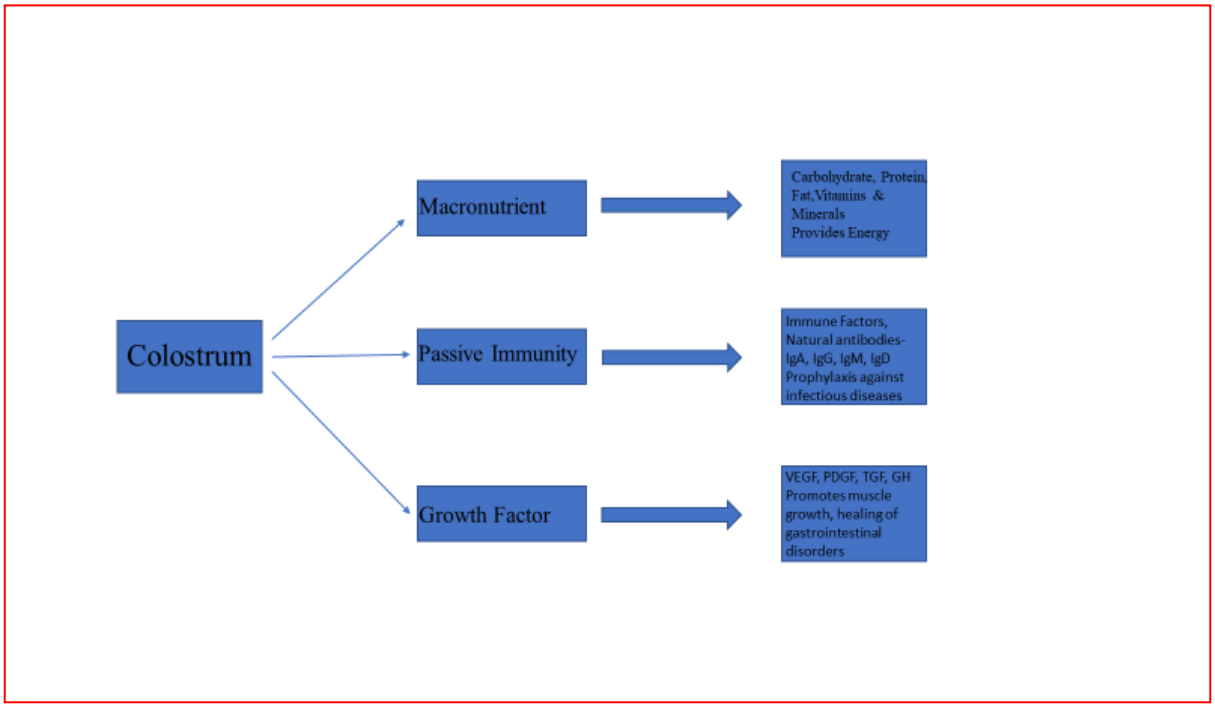


Fig.2 showing factors affecting the immune system causing intestinal barrier dysfunction

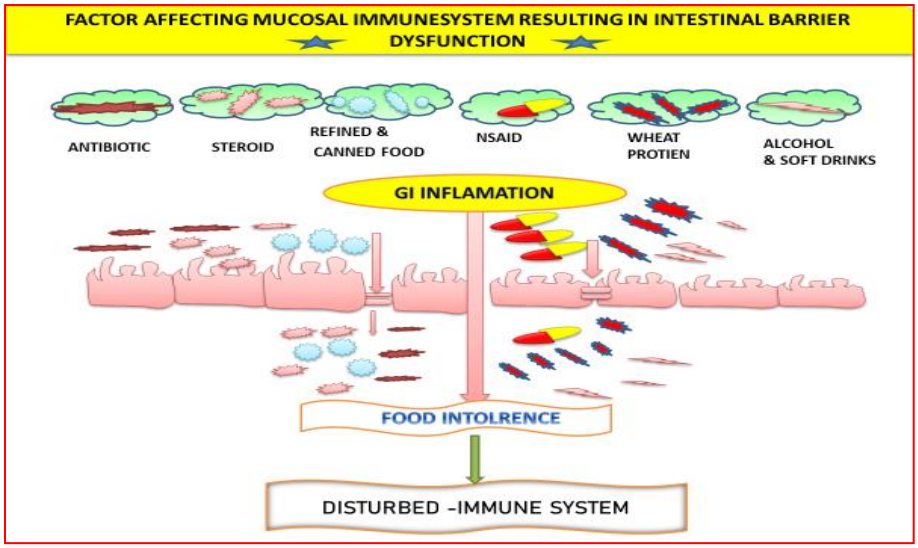
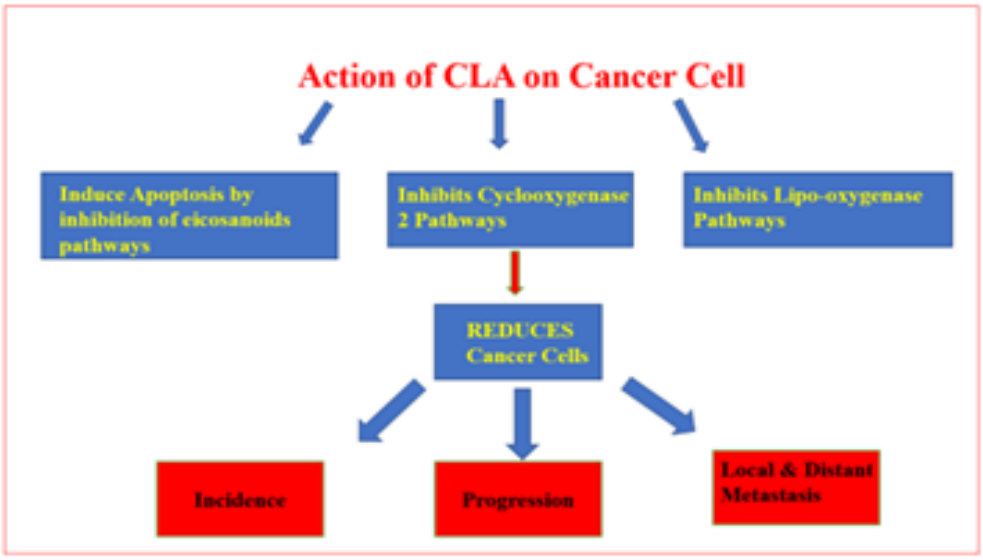


Fig.3 showing the action of conjugated linolenic acid



This factor imitates the bioprotective function of amniotic fluid in extrauterine life (Camilla da Cruz Martins *et al.*,2020; Garofalo NA *et al.*, 2019).

As a nutraceuticals

Nutraceuticals or functional foods are defined as substances that help in enhancing overall health and defend against non-communicable diseases. Usually, nutraceuticals are products that are isolated or extracted from fruits and dairy products. These are sold in the market as health supplements as non-pharmacological products and do not require doctors prescription. These are mostly cost-effective, reasonably priced substitute treatments for controlling and managing musculoskeletal abnormalities, diabetes, obesity, and some cancers. Being non-pharmacological, these are not prescribed by allopathic physicians. However, these are not scientifically proved supplements for various diseases as there are no evidence-based studies with a limited number of randomized, placebo-controlled studies and unresolved controversy about the role of nutraceuticals in treating non-communicable diseases. So, manufacturers should produce these functional foods (colostrum) under good manufacturing practices (GMPs) and high-quality control standards. Post-sale scrutiny should be conducted carefully for the tolerability of BC supplements and bioactive components. Hygienic conditions should be used by dairy farmers and manufacturers while collecting and producing BC. BC contains a higher amount of immunoglobulins than human colostrum; it can treat immunodeficiency diseases and infections along with conventional medicines (Bagwe S, 2015; Butter HS, 2017; Siddhi Bagwe Parab, 2020).

Utility for Athletes

Colostrum is the most important natural substance (growth Factors-GF), helping professional athletes attain their wanted results in games. BC colostrum enhances strength and stamina, builds lean muscle mass, burns body fat, and boosts immune function, usually decreasing after strenuous exercise. BC

shortens recovery time and thus accelerates the healing of injuries in athletes. Colostrum contains the growth factors that help in building lean muscle. Colostrum contains many GFs, including insulin-like growth factors (IGF-I & IGF-II) and growth hormone (GH); IGF-Iis the only natural hormone capable of helping muscle growth by itself. The IGFs in humans and cows are equal. Still, bovine colostrum contains a greater concentration of IGF-I than human colostrum. Thus, bovine colostrum is useful to bodybuilders, athletes, and others interested in mass muscle gain. Protein synthesis is induced by IGF-1, resulting in increased lean muscle mass without a corresponding increase in fat tissue as GF helps shift fuel utilization on fat instead of carbohydrates. Thus, the body burns fat to produce fuel more efficiently, including fat produced by consuming carbohydrates and protein (Schwade, S 1992). The IGF-1 in the colostrum increases blood glucose uptake and facilitates glucose transport to the muscles to maintain energy levels. Together with growth hormones, IGF-1 slows down the protein breakdown due to a vigorous workout. It speeds up protein synthesis, which forms lean muscle mass without fat addition to the body. A last-minute illness is a real fear for athletes, and colostrum seems to give the immune system a boost that can reduce such risk of a last-minute breakdown in athletes.

Colostrum improves the integration of nutrients, enhances energy levels in the body, and thus improve performance. Also, colostrum's immune factors help athletes minimize their susceptibility to infections, thus keeping up with their training schedules. IGF 1 in bovine colostrum is structurally identical to that found in humans (Lambert, G. P. 2008). Since IGF 1 has an anabolic effect and is useful in the monitoring feedback of growth hormone. When athletes are in an intense training period, many athletes develop gut problems – runner diarrhoea caused by stress and raising their body's core temperature by about two degrees, which seems to increase gut permeability. There is a tendency to leakiness rises 2- 3fold during intense training like the Olympics. However, bovine colostrum supplements prevent gut leakiness if consumed by athletes for two weeks before exercise. This is possible due to the growth factor present in the colostrum. It strengthens the gut lining (Raymond J Playford *et al.*, 2000).

The platelet-derived growth factor (PDGF) present in colostrum stimulates other growth factors, including IGF-1. The growth hormone (GH) present in the colostrum accelerates bone regeneration. TGF α and TGF β control cellular migration, proliferation, and fibroblast growth factor (FGF) and act as potent stimulators of angiogenesis and regulator of cellular migration and proliferation. Cytokines in bovine colostrum are useful in tendon repair as they accelerate tendon tissue growth (Jolanta Artym *et al.*, 2004, Michelle Chen *et al.*, 2008, Macdonald, Helen B 2000)

BC Safety in Human

Based on the recent literature, BC supplementation is considered well-tolerated and safe for the human population. Reported side effects include only mild complaints, like nausea, Diarrhoea, flatulence, unpleasant taste, abdominal discomfort, which may disappear with time. Unfortunately, there is no existing data for the long-term use of BC to make any conclusions.

The dietary benefits of colostrum are a boon for human immunity. As reviewed, colostrum can be used to maintain the integrity of GI mucosa, the permeability of gut mucosa, local immunity, systemic immunity, and antigen handling. Colostrum supplements can play an essential role in autoimmune disorders like rheumatoid arthritis. As an immune

modulator, BC has the scope in maintenances of growth in children due to growth factors. However, further research is needed for a recommendation for clinical use in human beings. Research is required for dosages, frequency etc. A systematic review and meta-analysis have shown that immunity enhancement may occur through other mechanisms, which are unclear and should be investigated further with more specific and clinically significant biomarkers.

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