Chapter 1

FORWARD TO THE PRESENT WORK
1.1 Introduction

Colostrum is the first milk produced by female mammals immediately after parturition to nourish their young ones. Colostrum supplies immune and growth factors and a perfect combination of vitamins and minerals to ensure the health, vitality and growth of the newborn. It has high-energy value and balance of nutrients to protect and satisfy the young in the early critical period of life. This first meal transmits natural immune and growth factors capable of not only acting quickly but in some cases of giving life long assistance.

Conventional medical doctors were at one time, enthusiastic about using colostrum for antibiotic purposes. This was prior to the introduction of sulpha drugs and penicillin. In 1950s, prior to the wide scale use of corticosteroids as anti-inflammatory agents, colostrum was used for the treatment of rheumatoid arthritis. Polio-vaccine developer, Dr. Albert Sabin discovered that colostrum contained antibodies against polio and recommended it for children susceptible to the disease. Colostrum has an especially important role in baby's gastrointestinal tract. A newborn's intestine is very permeable. Colostrum seals the holes by 'painting' the gastrointestinal tract with a barrier, which mostly prevents foreign substances from penetrating and possibly sensitising a baby to the food, the mother has eaten.
Chemically colostrum contains more casein, albumin, globulin chlorine, minerals etc. than normal milk. The most striking difference between normal milk and colostrum is the globulin which often reaches 12 to 14 percent in colostrum.

The average composition of bovine colostrum reported by Henry and Harry (1966) is as follows.

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>71.69</td>
</tr>
<tr>
<td>Butter fat</td>
<td>3.37</td>
</tr>
<tr>
<td>Casein</td>
<td>4.83</td>
</tr>
<tr>
<td>Globulin</td>
<td>13.68</td>
</tr>
<tr>
<td>Albumin</td>
<td>2.20</td>
</tr>
<tr>
<td>Lactose</td>
<td>2.45</td>
</tr>
<tr>
<td>Ashes</td>
<td>1.78</td>
</tr>
</tbody>
</table>

Colostrum has a reddish yellow colour, an unpleasant odour, is very slimy, viscous and has a decidedly acidic nature. Because of its high total solid content, 28.31% colostrum has a higher specific gravity than normal milk, approximately 1.079. Colostrum shows a large number of colostral cells. These cells are leucocytes enlarged by absorption of fat globules. The higher ash content is due to raised contents of iron (10%), calcium, magnesium, phosphorus, and chlorine. Vitamin A content is ten times that of normal milk and vitamin D is three times higher. Usually the first milk secreted after calving contains sixteen times more albumin and globulin than normal milk. This amount decreases rapidly to normal during the
first few milkings. The mineral content, which is high in colostral milk, decreases to a level that is constant for most of the lactation period and increases again towards the end of lactation period.

Colostrum contains over 37 different important natural immune and growth factors, which trigger several processes in a newborn, ranging from the development of an immune system to growth of all body cells (Clark and Wyatt, 1996). The concentration of immune factors is much higher in colostrum than in mature milk. The immune factors include the following reported components:

Immunoglobulins IgA, IgD, IgE, IgG and IgM neutralise toxins, viruses, and the bacteria in the lymph and circulatory system.

Lactoferrin is an antiviral, antibacterial, anti-inflammatory and iron binding protein with therapeutic effects in cancer, HIV, cytomegalovirus, herpes, chronic fatigue syndrome and other infections. Lactoferrin modulates cytokine release and its receptors have been found on most immune cells including lymphocytes, monocytes, macrophages and platelets.

Proline-Rich Polypeptide (PRP), a hormone that regulates the thymus gland, stimulates an underactive immune system or dampens an overactive immune system, as seen in autoimmune diseases.

Leukocytes are the white blood cells that stimulate the production of interferon which slows viral reproduction and virus penetration of cell wall.

Enzymes – Lactoperoxidase, thiocyanate peroxidase and xanthine oxidase destroy bacteria through their ability to release
hydrogen peroxide. Lysozyme is a hydrolysing agent and immune system booster, capable of destroying bacteria and viruses on contact.

Cytokines are composed of interleukins that regulate the duration and intensity of immune response. They are responsible for cell-to-cell communication, boosting of T cell activity and the production of immunoglobulins.

Trypsin and other protease inhibitors prevent the destruction of immune and growth factors in colostrum from being broken down in the gastrointestinal tract. They prevent *Helicobactor pylori* from attaching themselves to the stomach wall and have a beneficial role in the treatment of peptic ulcers.

Lymphokines, hormone-like peptides produced by activated lymphocytes mediate the immune response. Oligo-polysaccharides and glycoconjugates attract and bind to pathogens like *Escherichia coli*, *Salmonella*, *Shigella*, *Cryptosporidia*, *Giardia* and *Entamoeba* preventing them from attaching themselves to or entering the body's mucous membrane.

Other immune factors include orotic acid, secretory IgA, IgA specific helper, β-Lactoglobulin, Lactalbumin, Albumin, Pro-albumin, Alpha 1-antitrypsin, Alpha 1-fetoprotein, Alpha 2-macroglobulin, Alpha-2AP-Glycoprotein, C₃, C₄ and orosomucoids. Sulphur is a mineral with multiple uses in metabolism and is part of many structural body proteins found in colostrum.
Several studies show that the growth factors are capable of increasing T cell production, accelerate healing, balance blood glucose levels, reduce insulin need, increase muscle and bone growth and repair, while metabolising fat for fuel. The growth factors found in colostrum boost cell and tissue growth by stimulating DNA and RNA formation (Bricker, 1991).

Colostrum growth factors include: Epithelial growth factor (EgF) Insulin like growth factor I and II (IGF-I and IGF-II), Fibroblast growth factor (FgF) Platelet derived growth factor (PDgF), Transforming growth factors A and B (TgFA and TgFB) and Growth hormone (GH).

IgF-I is required by the body to metabolise fat for energy through the Krebs cycle. Adequate levels of IgF-I are associated with an increased incidence of Type II diabetes and difficulty in losing weight despite proper nutritional intake and adequate exercise. Colostrum provides a good source of IgF-I as a complementary therapy for successful weight loss. IgF-I and GH in colostrum can lower low density lipid cholesterol while increasing high density lipid cholesterol concentrations. A recent American Journal of Natural Medicine concluded that TgFA and TgFB, in colostrum were involved in normal cellular activities such as cell proliferation and tissue repair. It also reported that it promotes the synthesis and repair of DNA and the mix of immune and growth factors in colostrum can inhibit the spread of cancer cells (Rona and Zoltan, 1998).

Athletic stress, exhaustive workouts and athletic competition can temporarily depress the immune system, decreasing the number
of T lymphocytes. Athletes are therefore more prone to develop infections including chronic fatigue syndrome. Many of immune factors in colostrum can help significantly to reduce the number and severity of infections caused by both physical and emotional stress. EGF, TGF and IgF-1 stimulate skin growth, cellular growth and repair by direct action on DNA and RNA. These growth factors facilitate the healing of tissues damaged by ulcers, trauma, burns, surgery or inflammatory diseases.

Hundreds of studies indicate that colostrum is a safe and effective agent for both the prevention and treatment of common viral illnesses (Clark and Wyatt, 1996).

Heart diseases of all kinds can be checked by colostrum's ability to regenerate heart muscles via its growth factors. The interferon and lymphokine components of colostrum fight cancer, while diabetics can benefit from colostrum's growth factors.

Colostrum benefits over 60 known immune and auto-immune diseases including the following: AIDS, allergies, attention deficit disorder, bacterial infections, chronic fatigue syndrome, candidiasis, crohn's disease, depression, fibromyalgia, multiple sclerosis, rheumatoid arthritis etc.

1.2 Lactoperoxidase

Lactoperoxidase (LP) has been identified as an antimicrobial agent in milk, saliva and tears. LP is a natural bacterial defence system through the oxidation of thiocyanate ions (SCN⁻) by
hydrogen peroxide, producing a weak oxidising agent, the
hypothiocyanite ions with antimicrobial properties (Klebanoff et al.,
1966; Hamon and Klebanoff, 1973). Both these are present in
biological fluids and together with lactoperoxidase are termed the
lactoperoxidase system (LP-S). LP-S has proven to be both
bactericidal and bacteriostatic to a wide variety of micro-organisms
(Ekstrand et al., 1985).

The most widely recommended industrial application of the
LP-S in food processing is in the dairy industry for the preservation
of raw milk during transportation to the processing plants. Further,
if LP-S is activated immediately prior to the application of approved
thermal processes, the shelf life of dairy products may get extended
significantly and high temperature processes may be replaced with
more economical lower temperature treatments. In addition to
energy savings low temperature thermal processes may provide
better retention of nutrients and quality of food. (Pruitt and Reiter,

Biological application of LP-S can be found in cosmetics,
ophthalmic solutions, and dental and wound treatment for antiseptic
purposes (Lumikari et al., 1993; van Steenberghe et al., 1994). It
also functions as an antitumor and antiviral agent (Pourtois et al.,
1990). In view of the growing applications of LP in biological and
industrial field, more in-depth investigations of the enzyme is highly
significant. This significant factor motivated the author in selecting
sheep lactoperoxidase (sLP) which is one of the least studied among
the LP of plentiful sources as the area of the research study.