

Quality Assessment of Bovine Colostrum and Possible Applications in the Dairy Industry

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Abstract

Colostrum is a mammary gland fluid that is produced and secreted throughout the last trimester of pregnancy and the first few days following calving. Colostrum aids in the growth, development, and protection of the new-born calves' immune system. In order for the immunoglobulins to be effective, colostrum it must be given to the new-born within the first few hours of life. Lab tests for IgG levels may be quite precise, but they are time-consuming and not always accessible to farmers. Colostrometer and refractometers could be foreseen as promising tools in the estimation of IgG for distinguishing colostrum of high quality. This paper describes quick methods for evaluating colostrum quality and prospective uses of colostrum in the dairy industry.

Keywords: bovine colostrum, dairy industry, physico-chemical properties, rapid methods.

1. Introduction

The mammary gland's first secretion after calving is called colostrum and is regarded as a "Liquid Gold" [1] been utilized for hundreds of years in veterinary medicine as a conventional or supplementary therapy for a wide range of illnesses [2].

Bioactive components and bacteriostatic compounds found in colostrum include enzymes, hormones, polyamides, nucleic acid derivatives, and amino acids [3]. Immunoglobulins, lactoperoxidase, lactenins, lactoferrins, lysozymes, and leukocytes are some of the molecules that are bacteriostatic.

Proteins, particularly immunoglobulins, which are the primary source of innate immunity against bacterial infections, are the ones among the aforementioned components that have received the most attention [4]. Additionally, it has higher

concentrations of lipids, proteins, minerals, and vitamins [2,5].

During the first two days of the calf's life, it is advisable to provide colostrum frequently —3 feedings each day to obtain a minimum of 6 L/day n that [6], because studies have shown that administration of 3 L of colostrum with Ig concentration >40 mg/mL within 6 h after calving can minimize failure of passive immunity transfer in new-born calves.

Colostrum needs to be milked and given to the calf as soon as possible because its composition will vary over the next several hours. The IgG level in colostrum can be determined in a variety of ways. The simplest technique to evaluate the quality of colostrum is to look at its density because density and Ig content are related. One tool used for this is the colostrometer. It is among the most fundamental and simple methods for determining the quality of colostrum [7]. The colostrometer gauges the liquid's density, allowing one to determine the number of immune proteins, or immunoglobulins, that are assigned to a particular density. Experts claim that a

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refractometer is a more accurate instrument than a colostrometer. It enables aqueous solution concentration to be determined based on the refractive index. Optical and electronic tools have been used to process the light refraction index through the Brix scale referred to be a useful indicator for differentiating between high-quality and low-quality colostrum [8]. The concentration in of IgG from colostrum may vary, ranging between 20 mg/mL and 100 mg/mL depending on the time of year, the season, and the variation of the physico-chemical parameters of the colostrum from the collected samples.

2. Materials and methods

Bovine colostrum; Distilled water; Graded cylinder; Refractometer; Colostrometer, Combiscope FTIR.



Figure 1. Illustration Refractometer



Figure 2. Illustration Colostrometer

Colostrum was collected from Holstein dairy cows at second and third lactation, immediately after calving. Afterwards, the colostrum was evaluated from a physico-chemical point of view to establish its quality.

Methods for measuring the concentration immunoglobulin and physico-chemical composition of Colostrum

The IgG concentration in colostrum may be measured both directly and indirectly. At basis for the indirect methods are the physical and chemical characteristics of colostrum, such as its specific gravity, density, or viscosity which change depending on the IgG content. The physicochemical composition of colostrum was determined by infrared methods.

Combiscope FTIR - uses special kits both for determining the physico-chemical composition of milk (basic compounds: protein, fat, dry matter, lactose, casein) [11]. On the colostrometer's scale, different colours are used to indicate different levels of colostrum quality: green is commonly used for good quality, yellow for average, and red for poor quality colostrum. If the colostrometer shows the colour green, the calf should receive colostrum in an amount equivalent to 10% of its body mass. This colour indicates that the colostrum contains more than 50 mg/mL of antibodies [3]. The usage of a refractometer is significantly simpler and more accurate. Its benefits include the need for only a tiny amount of the tested materials and a few drops of colostrum.

3. Results and discussion

High-quality colostrum management and feeding may lower calf mortality, boost immunity, and lengthen animal life. Delaying colostrum consumption decreases passive Ig transfer and delays the delivery of crucial nutrients that help the bovine neonate's inadequate reserves.

The composition of colostrum differs markedly from milk, reflecting a difference in the biological function of the two secretions. Every hour, the colostrum's composition changes and it loses its biological and nurturing qualities.

Table 1 shows the evaluation of the quality of bovine colostrum with a refractometer and colostrum, and table 2 shows the ranges of variation of the physico-chemical parameters of the colostrum from the collected samples.

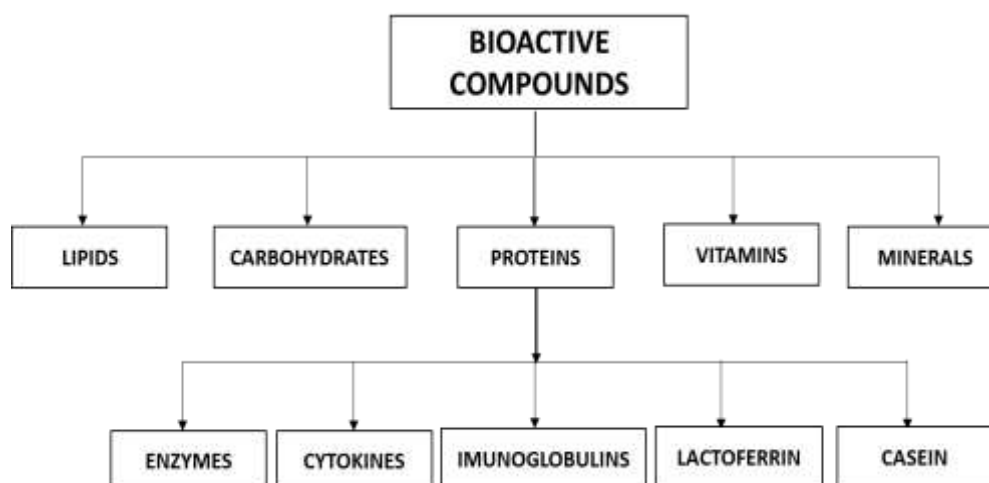
Colostrum has a low lactose concentration and fluctuates inversely with other components like fat, protein and ash. The preservation of high-quality colostrum that is free from microbial contamination is one of the main challenges to producing colostrum-based products for human consumption [12]. The main sources of contamination are the surrounding environment, people working there, and infected equipment. Due to unsanitary circumstances during milking, processing, packaging, transit, and storage, microbes may infect cow colostrum. Regulations in the European Union state that in order to prevent the rapid formation of high bacterial counts, bovine colostrum must be quickly cooled below 8 °C, stored separately, and transported at a temperature below 10 °C [2].

Table 1. Evaluation of the quality of bovine colostrum with refractometer and Colostrometer

No.	Values Brix %	Concentration IgG (g/L)	Quality
1.	< 18 - 20	0 – 25	Low
2.	22 - 25	50 - 75	Good
3.	27 - >29	100 - >125	Excellence

**Table 2.** Compositional analysis of colostrum from samples collected

Physico-chemical Characterization of bovine colostrum					
Fat (%)	Protein (%)	Lactose (%)	Solids (%)	Casein (%)	IgG (mg/mL)
6.70 -11.27	14.7 - 19.45	2.50 - 2.2.72	25.05 - 34.02	11.5 - 15.90	24.5 - 35.0

**Figure 3.** Compounds present in the bovine colostrum

The destruction of bacteria caused by diseases, the inhibition of enzymes, the reduction of the product's pace of degradation, and the prevention of nutrients in the food are the goals of processing bovine colostrum. Bovine colostrum is made suitable for human consumption through the use of pasteurization, sterilization, spray drying, and freeze-drying. These procedures offer both benefits and drawbacks, but they all attempt to maintain the colostrum's high level of bioactive proteins, such as IgG, which is essential for human health. Consequently, maintaining the positive effects of bovine colostrum requires guaranteeing the stability of these proteins. Due

to its low processing temperature, freeze drying is the preferred dehydration technique for biological samples that are sensitive to heat. Using this technique can help produce a final product of great quality while minimizing nutritional loss. According to some research, freeze-drying protects bioactive proteins in colostrum from cows, improving its quality and shelf life in comparison to spray drying.

Colostrum IgG concentration and serum IgG levels are unaffected by freezing, or are only marginally impacted. It's preferable to thaw using the au bain-marie method up to 40°C [13].

Applications of bovine colostrum in the dairy industry

In recent years, the study of bovine colostrum has been a popular issue among academics, researchers, food producers, and healthcare professionals [13]. The bioactive components in bovine colostrum have the ability to treat and prevent a wide range of illnesses and dysfunctions involving the digestive and respiratory. Consumable forms of colostrum are liquid, powder, pills, and capsules [2, 14]. Several dairy products, including cheese, kefir, yoghurt, ice cream, and milk-based beverages, contain liquid bovine colostrum as a component. High-end functional food products can be created using bioactive ingredients.

Bovine colostrum contains a wide range of bioactive substances, including enzymes, growth factors, and immunoglobulins. Because of its high-quality proteins and low lactose content, this is a potential and appealing source from a nutritional standpoint [2]. Lactoferrin, lysozyme, lactoperoxidase, immunoglobulins, and growth factors are just a few of the physiologically active compounds found in bovine colostrum that have

been shown to have the ability for modulation the human immune system.

These characteristics have attracted the interest of the pharmaceutical industry to bovine colostrum components and their applications in human health. Many investigations have been conducted to ensure its appropriateness for human consumption.

The incorporation of bovine colostrum into dairy products is supposed to result in a better and healthier product for humans. In the context of yogurt manufacture, the addition of bovine colostrum reflected high sensory approval [15, 16], found that adding bovine colostrum to yogurt boosted the total protein content, total solids, IgG, lactoferrin, and minerals compared to regular yogurt. There are dairy products that contain bovine colostrum as an addition (Figure 4). The researchers pointed out that colostrum is very important for its beneficial impact on human health and the food industry [10].

In addition to these procedures, is used cutting-edge technologies, such as liposomal and nanotechnology through encapsulate bovine colostrum to distribute it in a finished product.

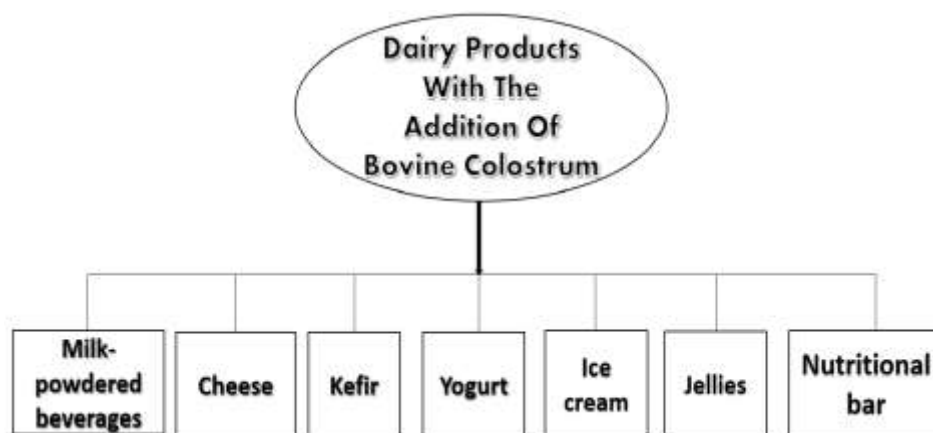


Figure 4. Applications of bovine colostrum in the dairy industry

4. Conclusions

Brix refractometer offers a reliable measurement of IgG in cow colostrum. It is a quick, low-cost procedure that needs minimal equipment's or expertise.

The colostrimeter has some disadvantages that can limit its adoption on the farm: it is made of glass, fragile and must be thoroughly cleaned before each use and the colostrum sample must be at 22°C to obtain a correct measurement.

It has recently been suggested that the Brix refractometer is a reliable tool for determining the IgG content of bovine colostrum and values above 23% Brix is an appropriate or good quality colostrum. The use of bovine colostrum in several food products is becoming more popular, and it is regarded as a unique functional food.

These results suggest that even though colostrum management and quality have improved, there is still a need to educate farmers about the need of storing and administering colostrum at the right

time to increase passive transfer and lower the rate of calf morbidity and mortality.

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