COLOSTRUM FEEDING: THE SCIENCE AND ART OF SAFEGUARDING NEWBORN CALVES FROM ILLNESSES

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ABSTRACT

The success of dairy cattle rearing depends on methods that enhance the health and growth efficiency of neonates, which in turn affect replacement rates and the financial viability of dairy production systems. Ensuring adequate colostrum intake with a minimum of 50 mg IgG/mL is vital to prevent FPT and safeguard the calf's health. Colostrum feeding is an example of early-life nutrition that can significantly affect calf's overall performance, including average daily gain (ADG), health status, and survival rates.

Keywords: gut closure, passive immunity, immunoglobulins

INTRODUCTION

Colostrum, the mammary gland's first secretion following parturition, is a vital source of immunity and sustenance for the newborn (Giammarco et al., 2021). Colostrum is the first milk secreted by the mammary glands after giving birth, and it is unique in that it contains vital nutrients, immunological components, and oligosaccharides that benefit the baby. Colostrum is vital for passive immunity in neonatal calves and has an impact on metabolism, endocrine systems, and nutritional status (Blum and Hammon, 2000). Colostrum is known as 'liquid gold' because it includes maternal antibodies that protect newborns from diseases. Colostrum has a high content of energy, protein, vitamins, and minerals. Colostrum contains maternal immunoglobulins which give a passive defence to newborns against invading infections. Within the first few hours of life, producers must regularly feed sufficient high-quality colostrum to calves. These compounds are essential for boosting passive immunity while supporting the development of the newborn's digestive system. In addition to being high in IgG, colostrum is also a rich source of nutrients and non-nutrient components that support intestinal maturation and immune system development.

SYNTHESIS AND SECRETION MECHANISM OF COLOSTRUM

Colostrogenesis refers to the process of transferring immunoglobulins (Igs) from the maternal bloodstream into mammary secretions before birth. This process is finite, and the mechanisms involved in the synthesis and secretion of colostrum are illustrated in Figure 2. The primary method for the secretion of proteins, water, lactose, oligosaccharides, phosphate, calcium, and citric acid by alveolar cells is through the exocytosis pathway. Colostrum lipids, mainly phospholipids and triacylglycerols, are produced in the smooth

endoplasmic reticulum at the basal region of the cell, utilizing precursor fatty acids and glycerol. These lipids form cytoplasmic lipid droplets that travel to the apical membrane, where they are secreted as milk fat globules encased in a membrane. IgG is absorbed from the blood by endocytosis at the basolateral membrane, then transported across the cytosol to the apical membrane of the lactocyte, where it is released directly into the alveolar lumen.

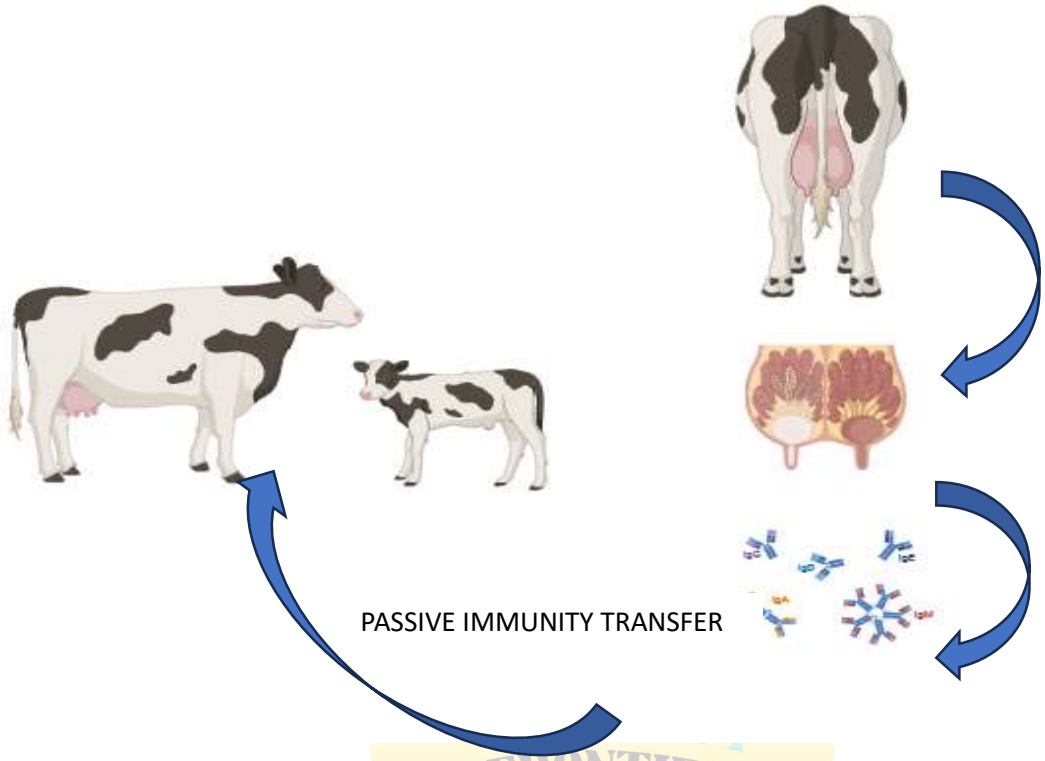

Fig 1. Transfer of immunoglobulins through colostrum in calves

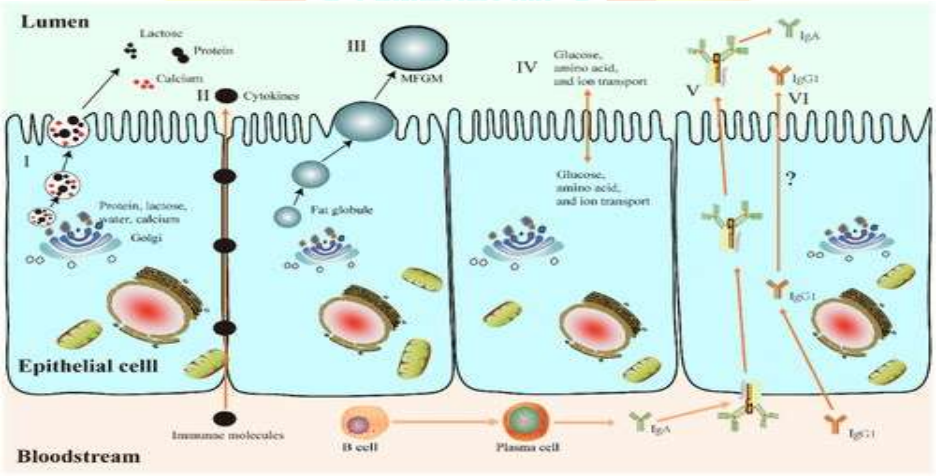

Fig. 2: Synthesis and secretion mechanism of colostrum in the mammary epithelial cells. Adapted from Hernandez-Castellano et al.

IMMUNOGLOBULIN-THE ESSENTIAL COMPONENT FOR IMMUNITY

Ig is an important component of globulin with highly efficiency of absorption in colostrum. The content of Ig of calves before eating colostrum is very low in serum, but increases significantly after sucking colostrum. Colostrum Ig content fell sharply during postpartum 48h in line with the change trend of protein content. It may be associated with mammary gland function, which allowed Ig transported from blood to in mammary gland in the early lactation, at the same time also it proved that the difference between colostrum and mature milk mainly because of the difference of Ig content. The types of Ig mainly include IgG, IgM, and IgA.

COLOSTRUM INTAKE: KEY TO PREVENTING FAILURE OF PASSIVE TRANSFER (FPT)

Calves are agammaglobulemic at birth and rely heavily on the uptake of maternal Ig from colostrum until their immune system matures (Godden, 2008). The placenta's syndesmochorial form prevents the mother's immunoglobulins from being transferred to the fetus because of which calves are immunodeficient at birth. To avoid the FPT of immunoglobulins, which has been related to an increased risk of sickness and mortality in the early stages of life, the neonatal calf relies on the timely delivery of high-quality colostrum. FPT is defined as a low IgG concentration in the serum between the ages of 24 and 48 hours. When IgG serum concentrations fall below 10 g/L within the first 24 hours after birth, FPT is diagnosed. Early detection of colostrum quality and the degree of developed immunity is required for successful newborn treatment on the farm. Calves with FPT are more sensitive to infectious illnesses, with greater rates of morbidity and death, as well as diarrhoea and respiratory sickness (Giammarco et al., 2021). Failure of Passive Transfer can be avoided by feeding adequate amounts of colostrum with at least 50 mg of IgG/ mL (Giammarco et al., 2021).

THE CRITICAL TIMING OF COLOSTRUM FEEDING AND GUT CLOSURE

The composition of colostrum changes hour by hour and its nurturing value diminishes with time. Regarding providing colostrum to calves, time is crucial. As a result, it is critical to administer colostrum after birth as soon as possible, likely within 0.5–1 hour. After 6 hours, the ability of immunoglobulin absorption from colostrum drops by one-third, then by two-thirds after 12 hours, and an intestinal barrier seems to appear after 24 hours (Puppel et al., 2019).

Colostrum should be consumed after birth as soon as possible to ensure efficient and adequate absorption of immunoglobulins as well as necessary and non-essential fatty acids, as well as fat-soluble vitamins such as b-carotene, retinol, and a-tocopherol (Blum and Hammon, 2000). Colostrum, which serves as the sole nutrition for newborn calves, is directed to the abomasum through the esophageal furrow reflex. The period between birth and the closure of the gut is crucial for the absorption of intact immunoglobulins (Igs). Since calves lack digestive enzymes in their gastrointestinal tract and colostrum contains high levels of trypsin inhibitors, most of the proteins, including IgG, are able to pass through the digestive system to the small intestine without being broken down. The jejunal epithelium plays a key role in the absorption process, and noted that the duodenum of newborn calves did not have enterocytes containing colostrum-filled vacuoles.

At birth, calves are capable of absorbing immunoglobulins from maternal colostrum through their small intestine. However, as the calf ages beyond 12 hours, the intestinal permeability to these proteins gradually decreases, and by 24 hours postpartum,

absorption completely ceases. The absorption of IgG from epithelial cells into the bloodstream significantly diminishes after 12 hours of age, with full closure occurring at 24 hours. Additionally, it has been demonstrated that the efficiency of absorption declines as the time between birth and the first colostrum feeding increases, emphasizing the importance of timely colostrum administration.

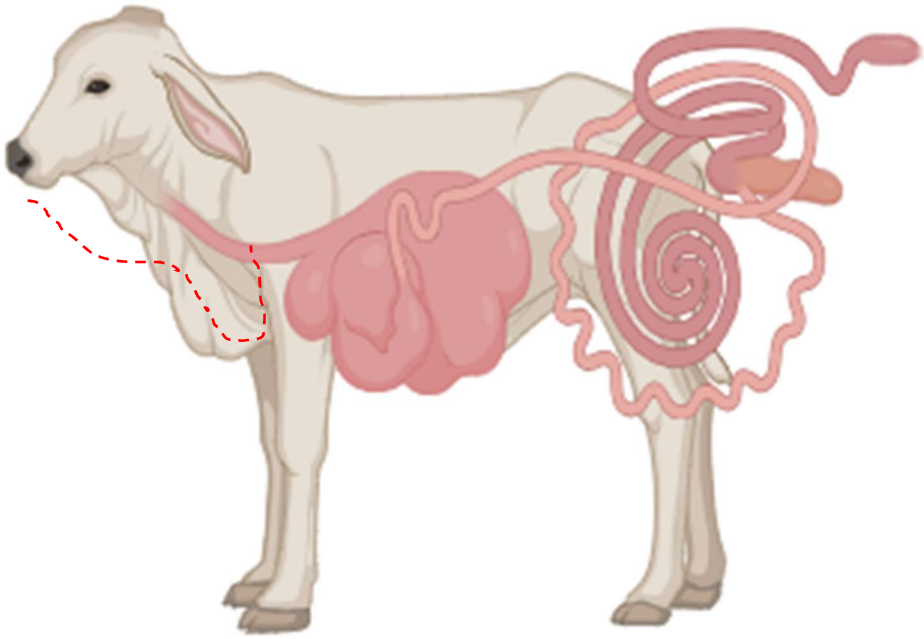

Fig 3. Esophageal groove in calves

More recently, Fischer et al. (2016) found that delaying colostrum feeding beyond 6 hours after birth resulted in reduced IgG transfer compared to calves that were fed immediately after birth, reinforcing the need for prompt colostrum feeding. Despite this, studies show that calves can still absorb IgG even if colostrum feeding is delayed up to 48 hours.

Gut closure refers to the point when the intestine is no longer able to absorb large molecules and transfer them into the bloodstream. Colostrum feeding stimulates pinocytosis, the process by which immunoglobulins are transported. In calves, gut closure serves as a protective mechanism to limit the absorption of macromolecules after colostrum intake. Although the precise mechanism behind this permeability closure remains unclear, it is generally believed to result from the depletion of pinocytotic activity or the replacement of enterocytes by mature epithelial cells.

KEY DIFFERENCES IN THE COMPOSITIONAL DIFFERENCE OF COLOSTRUM AND COW MILK

Colostrum contains fatty acids (essential and non-essential) and numerous fat-soluble vitamins and has higher fats, proteins, and peptides as well as fat-soluble vitamins, growth factors, immunological components (IgG, IgA, and Ig M) enzymes, hormones, cytokines, and

minerals and these compounds, except lactose, rapidly decline during the first three days of lactation in comparison to those found in milk (Arslan et al., 2021). Colostrum appears to be the only natural source of four important growth factors: transforming growth factors alpha and beta, as well as Insulin-like growth factors 1 (IGF-1) and 2 (IGF-2). Immune components present in colostrum include immunoglobulins, and antimicrobial factors such as lactoferrin, lysozyme, etc (Arslan et al., 2021). In addition to having a high IgG content, goat colostrum is rich in fat, protein, and other vital elements such vitamins, growth factors, hormones, enzymes, antimicrobials, and neuroendocrine peptides.

CONCLUSION

The scientific understanding of colostrum's composition, the gut closure mechanism, and the timing of feeding are essential in ensuring the health and survival of newborn calves. By adhering to these principles and ensuring timely colostrum feeding, farmers can reduce the risk of disease and promote the long-term health and productivity of their herds.

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