

The Importance of Colostrum on Neonate Development in Ruminants

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Abstract

Colostrum or first milk is a life elixir, which is produced by mammary glands within 2-3 days following parturition and contains immunoglobulins, enzymes, growth and biological factors besides nutrients for neonate. Ruminants are unable to transmit antibody substances during the pregnancy due to the nature of the epitheliochorial placenta. It is stated that if neonates do not take colostrum within the first few hours following birth, there will be a delay in the establishment of the mother-neonate relationship, a decline in growth performance and an increase in morbidity and mortality rates. Colostrum also plays a vital role in the regulation of both the digestive system and the body cell division, which is termed second programming in the neonatal life; first programming takes place at embryonal life. Colostrum intake is important for morphological and functional developments of intestinal epithelium in ruminants. So, colostrum consumed in the first few days of life strengthens the defense mechanism of the newborn against diseases and it is a regulatory factor on the survivability, productivity and healthy during the postnatal period. In this review, the importance of the colostrum will be emphasized.

Keywords: Colostrum, growth performance, immune resistance, mother-offspring bond

Ruminantlarda Yeni Doğan Gelişimi Üzerine Kolostrumun Önemi

Öz

İlk süt olarak bilinen kolostrum, doğumdan sonraki 2-3 gün içinde meme bezleri tarafından üretilen ve yeni doğanlar için ihtiyaç duyulan besinlerin yanı sıra immünoglobulinler, enzimler, büyüme ve biyolojik faktörler içeren bir yaşam iksiridir. Ruminant hayvanlar gebelik boyunca epitelyokoriyal plasantanın yapısı nedeniyle antikorları fetüse ulaştıramazlar. Yeni doğan yavrunun doğumdan sonraki ilk birkaç saat içerisinde kolostrumu yeteri düzeyde alamaması anne yavru bağının oluşumunda gecikme, büyüme performansında düşüş, hastalığa yakalanma ve ölüm oranlarında artış ile sonuçlanmaktadır. Kolostrum aynı zamanda sindirim sistemi ve vücut hücre bölünmesinin düzenlenmesinde hayati rol oynamaktadır. Kolostrumun tüketimi, ruminantlarda bağırsak epitelinin morfolojik ve fonksiyonel gelişimi için önemlidir. Bu nedenle yaşamın ilk birkaç gününde tüketilen kolostrum yeni doğanın hastalıklara karşı savunma mekanizmasını güçlendirmekte ve doğum sonrası dönemde hayatta kalabilme, üretkenlik ve sağlıklı olma konusunda düzenleyici rol oynamaktadır. Bu derlemede, kolostrumun önemine değinilecektir.

Anahtar Kelimeler: Kolostrum, büyüme performansı, bağışıklık direnci, anne-yavru bağı

1. Introduction

The mammalian neonate is unable to collect, chew, or digest solid food, relying entirely on the colostrum of its mother and subsequently on milk for its survival (Stelwagen et al., 2009). The formation of colostrum, an excellent potion, occurs slowly during 3-4 weeks prenatal period. Furthermore, colostrum formation is highly variable among mammalian dams in total volume, immunoglobulin concentrations and its first-time milking amount (Baumrucker et al., 2016; Dzik et al., 2017). Colostrum is an unrivalled source of nutrients that allow the life and development of a newborn creature (Furman-Fratczak et al., 2011; Przybylska et al., 2007). Recent work has suggested that a rapid transfer of

immunoglobulin G (IgG), which is very important for postnatal survival, to secretions may occur if animals are milked prepartum (Baumrucker et al., 2016) and just to near postpartum. It is known that the colostrum also contained enzymatic and non-enzymatic antioxidants in addition to nutrients and immune substances in order to be able to defend against the stress conditions of the neonate (Przybylska et al., 2007; Elbera and Konkofer, 2009). Therefore, it is emphasized that in the first hours after birth, the mother-offspring bond is weak when sufficient amount of colostrum is not consumed. If colostrum is not consumed by neonates within 12 hours after birth, they need to be assisted by the outside caretakers for their suckling, and neonate's death rate increases in cattle and sheep (Çam et al., 1999; Kehoe, 2006). Cummins et al. (2017) reported that colostrum not only contains nutrients and immune substances but also biological factors that contribute to the development of tissue and physiological functions for the newborn individual.

Ruminants have an epitheliochorial type of placenta. This type of placenta has complete intact epithelial layers of epithelium in both maternal and fetal components. Also, sow and mare have the same placental type. The nature of this type of placenta do not allow antibody substances to cross from dam to fetus, although in a hemochorial and an endotheliochorial placenta immunoglobulin can be transported from the maternal to the fetal side (Senger et al., 2003). Colostrum has a pivotal role in the establishment of maternal-offspring bond (Çam et al., 1999; Kehoe, 2006). Delayed and inadequate colostrum feeding can result in increased morbidity and mortality (Zanker et al., 2000; Abdou et al., 2014; Yang et al., 2015). In this review, it is aimed to re-emphasize the importance of the colostrum on the different aspects of life in the light of the last literatures.

2. Immune System and Colostrum

After parturition, the mammary glands begin to synthesize and secrete immune substances such as immunoglobulins to protect newborn and itself from external attacks. Milk and colostrum contains a range of factors, which contribute to the protection of the neonate and the mammary gland from disease. Antibodies are an important component of the disease resistance function of mammary secretions (Yang et al., 2015; Hurley, 2003; El-Loy, 2007; Marziali et al., 2018). Considerable diversity exists among mammalian species in the transport of immunoglobulin from mother to neonate, as well as in the implications of that transport (Hurley, 2003).

The colostrum immunoglobulins, in conjunction with the ability of the ruminant neonatal gut to absorb the large immunoglobulin molecules, provide passive immunity for young animals. However, both the concentration of immunoglobulins in colostrum and the permeability of the gut decrease rapidly and progressively over the first 48 h after birth (Stelwagen et al., 2009; Dzik et al., 2017; Moore et al., 2005). Therefore, an adequate supply of colostrum, with abundant immunoglobulins, is essential during this brief period of time for the young ruminant to gain sufficient passive immunity to be able to survive until its own immune system is fully developed (Stelwagen et al., 2009). The emerging immune system is vulnerable to insult not only during fetal life, but also through colostrum transfer of maternal factors with immunomodulatory functions. Early life nutritional imbalances may impact on immune system function in later life due to programming effects (Chadio et al., 2016). Delaying intake of colostrum in dairy calves not only decreases transport of immunoglobulins but also fat-soluble vitamins. Dairy calves that receive colostrum 12 to 25 h after birth have lower plasma concentrations of beta-carotene, retinol and alpha-tocopherol for almost a month after birth compared to calves that receive colostrum within 7 h (Zanker et al., 2000). These vitamins play a role in immunity, and their absence may predispose neonates to enteric infections, thereby reinforcing the importance of proper colostrum

feeding. It is stated that calves should receive at least 150-200 g IgG within 2 hours after birth in order to develop a strong immune system. If these quantities are not taken at sufficient level with maternal colostrum or not supplied with colostrum substitution, it is stated that lower live weights were obtained from weaning time and death rates were increased in calves (Lago et al., 2018).

3. The Role of Colostrum in the Development of Digestion System

Colostrum contains many bioactive compounds, such as insulin-like growth factors and transforming growth factors. Prolonged feeding of colostrum to calves has been reported to have an effect on small intestinal development due to these growth factors compared with calves fed milk replacer. Feeding colostrum causes hyperplasia of the intestinal epithelium, resulting in a decrease in crypt depth: villus height ratios in calves (Bühler et al., 1998), indicating an increase in differentiated cells. Absorption of xylose, a marker used to evaluate enterocyte function, is higher in calves fed colostrum for 6 times than in calves fed colostrum only once or only milk replacer, suggesting an increase in absorptive capacity due to increased numbers of differentiated enterocytes and greater intestinal surface area (Bühler et al., 1998; Sauter et al., 2004). It was reported that there are many stressor factors to neonate gut such as temporary starvation and exposed to microbiota of colostrum. However, Oxytocin contained in the colostrum reduces this type of stressor (Klein et al., 2017).

Insulin-like growth factors (IGF) are part of the insulin family of hormones and growth factors, and include IGF-I, IGF-II and relaxin. In the report of Sparks et al. (2003) the concentration of IGF-I ranged from 289 to 909 $\mu\text{g/L}$. IGF are heat and acid stable allowing them to be ingested and to reach the small intestine intact (Baumrucker and Blum, 1993).

Transforming growth factor- β s (TGF- β) are found in 3 forms, including TGF- β 1, TGF- β 2, and TGF- β 3. Most mature cells are able to produce one of the isoforms of TGF- β s during tissue repair and inflammation (Urashima et al., 2000). Concentrations of TGF- β 1 in first milking colostrum are 12.4 to 42.6 ng/ml. Cells have three receptor types (I, II, and III) that are capable of binding all three TGF- β s in mammals and increase circulating levels of TGF- β s in calves after colostrum consumption. Therefore, colostrum enhances growth performance of neonates in later life (Kehoe, 2006).

4. Conclusion

The high-quality colostrum establishes a strong immune system and antioxidant mechanism as soon as possible after birth. This strong defense system and antioxidant mechanism could support in reducing the effects of harmful microorganisms, promoting intestinal development, and as a result decrease morbidity and mortality in neonates. Therefore, colostrum should be thought of as a divine elixir in order for the newborn offspring to survive and live healthy in the mammalian species, and neonates should not be deprived of this elixir substance in their early life feeding.

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