

*Review Article***Colostrum- Immunomodulator and Health Promoter for Dairy Calves**

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Abstract

Colostrum is the early milk secreted at the time of parturition which is rich in antibodies and acts as an immune booster for post-natal calves' health. Cow's colostrum contains the basic alimentary constituents; fat, protein, carbohydrate, minerals and vitamins, in addition to an immunoglobulin, biological factors, hormones and other biological particles. Colostrum constituents are very crucial for immunity as calves born with weak immunity and very susceptible to infection in early age. Colostrum feeding enhances immunity of calves, so quality and quantity of colostrum should be optimized for better growth and health of calves.

Key words: Colostrum, Calf Mortality, Immunoglobulin, Immune System

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Introduction

Calves born with poor immunity and very prone to infectious diseases until they acquire active immunity against the diseases through exposure to the disease organisms in their surroundings, they totally depend on the passive immunity acquired by drinking colostrum from their dam. For a profitable dairy farm maintenance of health is very important. The most common health problem in calves in early age is diarrhoea which is caused by infectious organisms *E. coli*. Many authors indicate that the mortality in cattle and buffalo calves ranged from 29.1 % to 39.8% (Afzal *et al.*, 1983), whereas Martin and Wiggan (1973) estimated that 20 % calf mortality resulted in a reduction of 38 % profit of a livestock farm. Across the globe, immunity related diseases of calves are major causes of morbidity and mortality. Along

the transfer of passive immunity, colostrum has other functions such as providing nutrients for the metabolism of the newborn (NRC, 2001). Fat acts as a source of energy for neonates, which represents approximately 6.7% of colostrum (Foley and Otterby, 1978) and is required for heat production and maintenance, as well as for providing fatty acids for glucose homeostasis via gluconeogenesis (Hammon *et al.*, 2012).

Colostrum

Colostrum is the first milk of dam containing the maternal immunoglobulin provides protection to neonates from invading pathogens (Larson *et al.*, 1980). Some ingredients as proteins, vitamins and minerals are more in colostrum as compared to milk (Table 1, 2 and 3).

Table 1: Composition of colostrum and milk constituents (Petersen, 1950)

Constituents	Colostrum (%)	Milk (%)
Total solids	28.30	12.86
Ash	1.58	0.72
Fat	0.15 to 12.0	4.00
Lactose	2.50	4.80
Casein	4.76	2.80
Albumin	1.50	0.54
Globulin	15.06	-
Total protein	21.32	3.34

The immunoglobulins present in colostrum are absorbed through the neonate's gastrointestinal tract and provide passive immunity to young calves. After 48 hrs of birth, there is a reduction in immunoglobulin concentration in colostrum and also permeability of colostrum through the gut. Ingredients like (lactalbumins, lactoglobulins and immunoglobulins), fat, minerals (iron, magnesium and sodium) and vitamins (A, E, D, B) are more in colostrums as compared to the normal milk, while the concentration of lactose is lower (Jain *et al.*, 2007 and Georgiev, 2008). Colostrum also contains 3 to 5 times more concentration of both water soluble as well as fat soluble vitamins and somewhat higher concentration of minerals and trace elements than normal milk (Table 2 and 3).

Table 2: Major mineral content of bovine colostrum and mature milk

Mineral	Ca	P	Na	K	Fe	Mg	Zn	Cl
Bovine Colostrum^a								
Kehoe, 2007 ^b	4999	4719	1122	3017	5.33	777	40.3	-
Mature Bovine Milk^a								
Webb, 1974	1230	950	580	1410	0.45	120	3.9	1190
Jensen, 1995	1180	930	597	1442	0.2 – 0.6	120	4	1071

^aAll values in mg/L; ^bmg/kg values converted to mg/L assuming 1.06 g/ml for 27.6%

Table 3: Trace mineral content of bovine colostrum and mature milk

Mineral	Cu	I	Mn	Se
Bovine Colostrum^a				
Kehoe, 2007 ^b	360	-	106	-
Mature Bovine Milk^a				
Webb, 1974	130	43	22	40 – 1270
Jensen, 1995	50 - 200	70 - 219	21	10 – 1270 ^c

a. All values in mcg/L; b. mg/kg values converted to mg/L assuming 1.06 g/ml for 27.6% T.S c. Range of three studies cited for U.S.

The iron concentration is also on the higher side than the normal milk. Colostrum contains 22% solids as compared to 12% solid present in normal milk (Sjaastad *et al.*, 2003). Colostrum also provides nutrients for the metabolism of the newborn (NRC, 2001). Approximately 6.7% of colostrum (Foley and Otterby, 1978) provide fat (the main energy source for newborns) which is important for heat production and maintenance; also maintain homeostasis via gluconeogenesis (Hammon *et al.*, 2012). The recent emphasis of immune-biochemical studies on the first weeks of calves' lives was obviously increased. Immunoglobulin plays the key role against infections occurring during early age period of calves which may lead to death. Umbilical infections and pneumonia are among the most important diseases that threaten calves. Calves mortality in dairy farms is most important irrespective of the dairy farms modernizations and reasons worldwide (Weaver *et al.*, 2000). Of the main reasons that lead to increased mortality rates were insufficient birth cares during suckling and rearing periods (Jahnke, 2002).

A number of hormones are detected in colostrum and milk, whose concentrations in the colostrum are many times higher than in milk (Levieux, 1999) (Table 4). The content of oestrogens (oestrogen, oestradiol-17 β) in colostrum is similar to that of plasma and almost twice higher than that of milk. The levels of somatotropin\ and thyroxine, however, are higher in milk than in colostrum (Blum & Hammon, 2000).

Table 4: Concentration of Hormone (ng/ml) in colostrum and milk

Hormone	Concentration (ng/ml)	
	Colostrum	Milk
Insulin	4.2–34.4	0.042–0.34
Total cortisol	4.4	0.35
Free cortisol	1.8	0.30
Prolactin	150	50
Progesterone	2.6	0.8

Mechanism of Immunoglobulin Proteins Absorption

The epithelial cells of the intestine especially in the ileum and jejunum regions in newly born calves contain the ability to absorb the immunoglobulins molecules directly without changes. Colostrum is

known to contain trypsin-inhibitor which prevents digestion of immunoglobulin proteins, in addition to the fact that at day one post-partum, abomasums produces a low quantity of mineral acids which do not greatly affecting immunoglobulin proteins. It has been noticed that in 10 hours after birth the percentage of the transferred immunoglobulins from stomach epithelial cells to the blood and lymph reach about 25%. Kolb and Seehawer (2002) declared that absorption in the epithelial cells of the intestinal villi takes place in accordance with cellular absorption (pinocytosis) and the percentage of the absorbed immunoglobulins were correlated with the time of colostrum feeding after birth. Kruse (1970) describes the percentage of absorbed immunoglobulins increased with early feeding of colostrum.

Quantity and Quality of Colostrum

The concentration of immunoglobulins in colostrum is a common indicator of colostrum quality. Colostrum containing greater than 50 gm Ig/L is considered to be high quality. The diet of the mother is very important to colostrum production. Colostrum containing less than 100gm Ig is at risk for failure of passive transfer. Dam on low energy diets produces less colostrum than the one with adequate nutrition. Younger females tend to produce less colostrum than mature females. Inadequate nutrition during late pregnancy can reduce the quantity and quality of colostrum (Rodastitis *et al.*, 1994). Consumption of colostrum in an amount sufficient to meet the energy requirement of the neonate is a major determinant for survival. Since most neonatal losses occur in the first 2 days of life, before the acquisition of a maternal IgG for immune protection becomes important for survival. There are reports showing a direct correlation between low Ig levels and susceptibility to and/or morbidity and mortality of calves from infections. Newborns that do not receive colostrum have greater difficulty emptying the intestine of its content of dead epithelial cells and remnants of swallowed amniotic fluid called meconium than animals that receive colostrum. Animals receiving an inadequate amount of colostrum usually grow more slowly than animals that receive adequate amounts and the former often suffer from diarrhoea (Sjaastad *et al.*, 2003). Colostrum supplies the newborn animal with antibodies persist in the newborn animal for 4-6 weeks after birth.

Importance of Colostrum in Safety and Health of Newborn Calves

Calves are born virtually without Igs; therefore the colostrum Igs are essential for survival (Marnila and Korhonen, 2011). Shortage or delayed colostrum feeding play a significant role in decreasing immunoglobulin proteins in calf blood (Hypogammaglobulinemia) (Kolb, 1981; Levieux and Ollier, 1999). It has been noticed that delay in colostrum feeding will lead to shortening the period of immunoglobulin absorption in the intestine (Baumrucker and Bruckmaier, 2014). It is known that calves consumed the insufficient amount of colostrums when subjected to difficulty in birth accompanied with a

decrease in brain oxygen (Hypoxia). It was advised in such a case to offer colostrum at a rate of 2 Liters two hours after birth, then after 12 hours using stomach tube (Kolb and Seehawer, 2002). Early feeding of colostrum is considered to be the basic source of immunoglobulin (Rajala and Castren, 1995) and in the calf, the absorption is non-selective during the first 12–36 h after the parturition (Marnila and Korhonen, 2011).

Rearing and nourishing cows during pregnancy are most important for the health and life of the newborn. Shortage of energy and protein will lead to retard the growth and development of the newborn immune system (Thymus, spleen and lymph glands), which remain weak and that will lead to either early mortality of the calf or remain alive with weak performance and consume little colostrum. It was also noticed that such calves benefit a little from Vitamins A, D3 and E in colostrum and that will lead to retard the development of the immune system (Kolb and Seehaer, 2002). Healthy pregnant cows normally produce calves with a low level of immunoglobulin in blood and will acquire immunoglobulin during the first three weeks after delivery and continually through feeding colostrum. Feeding and absorption of colostrum in appreciable quantities is more important in activating the immune system and destruction of the diseases causal agents in the first weeks after birth (Baumrucker and Bruckmaier, 2014). Presenting colostrum immediately after birth will prevent the calf from diseases like *E. coli* infection and others. Besser et al. (1991) indicated that feeding colostrum in the first 24 hours after birth was not sufficient and offering colostrum at a rate of 2.84 L/animal immediately after birth using stomach tube or in a rate of 1.9 L/animal immediately after birth, 12 hours and 24 hours using bottle feeding elevated the immunoglobulin (IgG1) in blood serum to 100% compared to those suckled without assistance. The study indicated that colostrum should be fed immediately after birth at a rate of 2 L and 2 L after 12 hours using stomach tube (oro-esophageal intubation) or bottle feeding. The absorbed immunoglobulin from colostrum reaches 200 mg until 12 hours after birth and 400 mg 24 hours after birth (McGuirk, 1998). The level of IgG of 10 mg/L or more in blood plasma during the first 24 hours after birth is a good indicator of the consumed immunoglobulin (Quigley and Drewry, 1998). The study of Perino *et al.* (1995) showed that in standard calves rearing stations, 11 to 31% of them the level of immunoglobulin in blood plasma was low. In such calves were 9 times at risk of infections, compared to healthy ones. In addition to that mortality rate was increased 5 times. It was also noticed that immunoglobulin was low in 18.3% of calves fed colostrum with a concentration of IgG less than 100 mg in the first 12 hours (Levieux and Ollier, 1999).

Diseases Transmitted through Colostrum

Some diseases are transferred from the dam to the offspring via the colostrums (OPP), Caprine Arthritic Encephalitis (CAE), interstitial mastitis and Johne's disease are the diseases transmitted through

colostrum. To prevent the transmission of diseases the offspring should not be allowed to nurse positive dam. They should be fed pasteurized colostrum or colostrum from another dam.

Conclusion

Rations rich in energy, protein, vitamins and minerals should be fed to pregnant cows, which could directly affect the growth of newborn and composition of colostrum that contains appreciable quantities of immunoglobulin. Colostrum should be fed immediately after birth to ensure feeding the required quantity.

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