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Impact of Different Qualities of Colostrum at Different Times on Karadi Calves' Performances

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Abstract

Colostrum gives the newborn calf maternal antibodies that help it fight disease. A calf that does not receive colostrum has a higher risk of illness until it develops antibodies of its own at around 6 weeks of age. This study aims to evaluate the immunity background of Karadi calves, measuring physiological responses to different qualities of colostrum and testing Karadi calves for survival in the herd. Twelve females local Karadi calves (0-day olds) were divided into two treatments with two levels for each. Using low and high colostrum quality before 6 hours and after 6 hours from parturition. Regarding calf body weight, withers height, immunoglobulin G concentration, and dry matter intake, there is no significant difference between low- and high-quality colostrum feed. However, our results show that calf body weight, withers height, and respiration rate were higher ($P < 0.01$) when colostrum was fed six hours after birth compared to those fed six hours after birth. However, there is no significant difference in the rectal temperature of the calf fed before six hours and six hours after birth. Results show that the total white blood cells, lymphocyte, neutrophil, eosinophil, and basophil numbers were unaffected by treatment, time and the interaction between treatment and time. Monocyte numbers have a tendency toward significant by treatment. Total plasma protein was not affected by treatment and time, but it tends significant treatment over time.

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Introduction

Colostrum is the first lacteal secretion generated by mammals within 24 to 72 hours after parturition. Because ruminants lack the immune factor exchange in utero, colostrum is crucial for ruminants (Angulo *et al*., 2015; Ramya *et al*., 2016). The concept is colostrum, milk, and the mammary gland play important roles in immune defense (Wheeler *et al*., 2007; Nordi *et al*., 2012). Colostogenesis occurs many weeks before parturition, during which time immunoglobulins from the dam's circulation are transferred to mammary secretions and, as a result, the transmission of IgG stops just before giving birth (Dunn *et al*., 2017). Cow's colostrum is a thick, sticky, yellow, and slightly acidic (pH 6.4) liquid, according to the most basic definition (Puppel *et al*., 2019). Colostrum is high in nutrients and biologically active non-nutrient components such as carbohydrates, proteins, growth hormones, enzymes, enzyme inhibitors, nucleotides, and peptides. With nucleosides, cytokines, lipids, minerals, and vitamins, colostrum is a vital source of nutrients for the newborn calf's nutrition (McGee and Earley, 2019). Colostrum is rich in antibodies that give the newborn passive immunity and includes more lactalbumin and protein. You can either get the colostrum raw (directly from the mother) or preserved (Either refrigerated or frozen) (Ramya *et al*., 2016). Increasing IgG intake reduces mortality and morbidity during the preweaning period improves growth and increases future milk production (Ahmed, 2017). The concentration of IgG in colostrum varies among cows and may range from 9 to 186 g/L. A few days after parturition, immunoglobulin concentrations in milk decrease to a total of ~0.6 g/L (Saldana *et al*., 2019). Failure of passive transfer (FPT) is defined as the presence of less than 10 mg/mL of calf serum IgG in calves between the ages of 24 and 48 hours (Godden, 2008). Immunoglobulins are monomeric or polymeric proteins that are made up of two light and two heavy polypeptide chains linked by disulfide bonds to form a Y-shaped particle. The physicochemical, biological, and immunologic features of immunoglobulins are categorized into classes (Puppel *et al*., 2019). The Ig classes include IgA, IgD, IgE, IgG, and IgM; nevertheless, most of them are only weakly present in colostrum and circulating immunoglobulins, particularly immunoglobulin G (IgG), play an important role in overall host defence against environmental antigens (Derbakova *et al*., 2020). Factors affecting first colostrum IgG content that affect colostrum quality include the time between calving and milking, the dam's age, the length of the dry period, the metabolic status of the dam and the calving season (Zwierzchowski *et al*., 2020). The timing of colostrum offering to a newborn calf is critical since research has shown that absorption efficiency diminishes as the period between birth and first colostrum feeding increases (Lopez and Heinrichs, 2022). The objectives of this study were to evaluate the immunity background of Karadi calves, measure physiological responses to different qualities of colostrum, and test Karadi calves for survival in the herd.

Materials and methods

Ethics Approval

Experimental animal: all applicable national and international guidelines for the care and use of animals were followed.

Animals care and experimental design

This study was conducted in the Animal Science Farm, College of Agricultural Engineering Sciences, University of Sulaimani, from March to July 2022, by using 12 female newborns local Karadi calves, directly after birth until 8 weeks of age (weaning). Karadi calves were taken from their dam and bottle-fed, study day 0 was the day of birth, and on day 1; all the calves were transferred to the calf unit and kept in individual pens (1.2 x 1.2 m) during the experimental period, which contained bedding on the solid floor with wood shavings, and fresh bedding was added each day.

Treatments (colostrum)

Before the experiment started, the colostrum was collected from the Karadi farm located near the Sulaimani and then pooled by mixing all the individual samples in a large container, then pooled colostrum was kept in fresh, individual, 2-litre bottles of polyethene, and colostrum was then frozen (−20°C) until use. A brix refractometer was initially used to categorize colostrum’s quality on farms. Then different pools of colostrum were used during the experiment and were evenly distributed to high-quality and low-quality colostrum. The high-quality colostrum treatment was collected from first-milking colostrum the amount of (IgG) was about (11.8 mg/ml) while the low-quality colostrum treatment was collected from second- and third-milking colostrum and the amount of (IgG) was about (8 mg/ml) in our study. In a warm water bath (not above

40°C), the colostrum was defrosted. Before feeding, the colostrum's temperature was about to ideal temperature which was close to 39°C. Pasteurized milk was given to calves twice daily at 0800 and 1700h at a rate of 1L per feeding, rising to 1.5 L per feeding depending on the calves' body weights (10% milk feeding per body weight).

Measurement of body weight and withers height

In the production of animals, cattle body weight (BW) is an important and frequently utilized factor that significantly affects feed intake, breeding potential, social behaviour, and overall farm management, before receiving colostrum feedings, calves were weighed in the study, and subsequently, body weight (BW) and withers height (WH) were measured every week until day 60, using the scale for body weight measurement and using measure tape for withers height.

Blood sample collection and analysis

Soon after delivery, before feeding colostrum the first blood samples were taken, then once every two weeks, via jugular venipuncture with the use of ethanol for sterilizing and keeping the blood from contamination, a 10mL disposable syringe with the 22-gauge hypodermic needle by using a non-vacuum EDTA K3 blood collection tube was used for measuring hematocrit that includes (White blood cell 'WBC' Eosinophil's 'ESO' Lymphocytes 'LYM' Monocytes 'MON' Basophils 'BAS' Neutrophils 'NEU' by (Orphee mythic-22 5-part differentiation), also total plasma protein concentrations by (Cormy accent-200). Also, IgG levels were taken by using the clot and gel activator non-vacuum. One hour after the morning meal, blood sampling was completed until clotted then centrifuged at 3000×rpm for 10 min at 4°C to have the serum, then it was aliquoted and kept frozen (−20°C) until the time of the analysis, by using ELISA Kit (Cattle PRL 'prolactin,' cat: ELK8218, ELK Biotechnology) and with (BioTek Microplate Reader ELX800 and BioTek Microplate Strip Washer ELX50).

Health care

Using a standardized scoring system, daily health scores were recorded thrice weekly for eye discharge, ear disposition, nasal discharge, coughing, and fecal score, with a score of (0) representing normal and (3) being severely abnormal. Respiration rate was calculated by counting the number of times the animal's abdomen muscles extended and relaxed while the calf was in the prone position during the measurement period and body temperature was recorded thrice weekly (Sunday, Tuesday, and Thursday) by a GLA M900 (San Luis Obispo, CA digital rectal thermometer).

Statistical analysis

Body weight, wither height, respiration rate, rectal temperature, dry matter intake, five differential total for WBC, level of IgG and total plasma protein data were analyzed by least squares ANOVA using SAS (2016) PROC GLM (version 9.4; SAS Institute Inc., Cary, NC). The cow was considered a random variable. Fixed effects included treatment, time, and treatment × time. In addition, the PDIFF means separation test of SAS was employed to compare low- and high-quality colostrum during different times at each point if there was a treatment × time interaction. The data is shown as least squares means ± standard error of the mean. A probability of 5% (P<0.05) was used to determine significance, whereas P < 0.10 was used to determine tendency.

Results and discussion

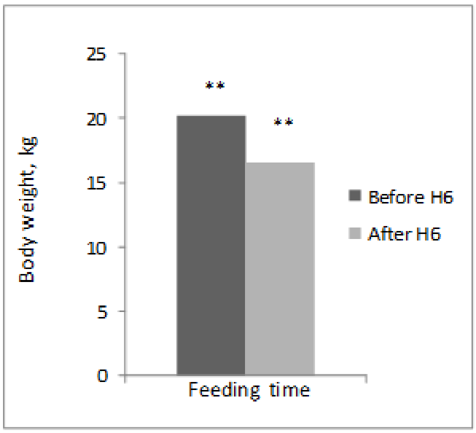
Regarding calf body weight, we notice there is no significant difference between low- and high-quality colostrum fed (P = 0.50) as well as for calf withers height (P = 0.70) (Table 1). Rectal temperature and respiration rate showed no significant difference across the treatments (P = 0.89) and (*P* = 0.19), respectively. Also, there is no significant difference between the treatments for IgG concentration (*P* = 0.39) and dry matter intake (*P* = 0.85) (Table 1).

Our results show that calf body weight and calf withers height were higher (*P* < 0.01 and *P* < 0.001, respectively) when colostrum was fed during six (6) hours from the birth compared to those fed after (6) hours from the birth (body weight: 20.17 vs. 16.61 kg; withers height: 65.69 vs. 61.69 cm) (Table 1, Figure 1). However, there is no significant difference in the rectal temperature between calves fed before six hours and after six hours from birth (*P* = 0.19) (Table 1, Figure 2). There is a significant difference in the respiration rate for the calf fed colostrum before six hours (30.79 breath/min) compared to those fed after six hours from the birth (35.08 breath/min) (*P* < 0.01) (Table 1, Figure 2). However, there are no significant differences between the calf-fed colostrum before six hours to those fed after six hours from the birth for IgG concentration (*P* = 0.62) and dry matter intake (*P* = 0.50) (Table 1, Figure3).

Table 1. The body characteristic of calves fed different quality of colostrum during different times

Variable	Low colostrum		High colostrum		SEM	*P* value		
	B6	A6	B6	A6		Trt	Time	Trt*Time
Initial BW, kg	15.5	13.67	15.93	12.2	1.42	0.73	0.09	0.52
BW, kg	19.53^{ab}	16.54^{b}	20.81^{a}	16.68^{b}	1.05	0.50	< 0.01	0.59
WH, cm	65.78^{a}	61.94^{b}	65.59^{a}	61.44^{b}	0.89	0.70	< 0.001	0.86
RT, °C	38.89	38.97	38.87	38.97	0.06	0.89	0.19	0.87
RR, breath/min	30.71^{a}	37.00^{b}	30.88^{a}	33.16^{a}	1.37	0.20	< 0.01	0.16
IgG (mg/ml)	9.49	9.39	9.69	10.81	0.80	0.32	0.53	0.45
DMI, g/week	1441.89	2285.52	1936.46	1635.05	401.90	0.85	0.51	0.17

^{a,b} Means with different superscripts in a row show statistically significant (*P* < 0.05) differences.
BW = body weight; WH =withers height; RT =rectal temperature; RR = respiration rate; IgG =immunoglobulin; DMI =dry matter intake; B6 = before six hours; A6 =after six hours; SEM =standard error of the mean; Trt =treatment.



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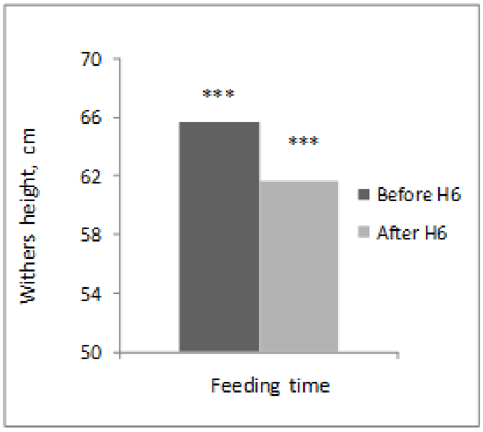
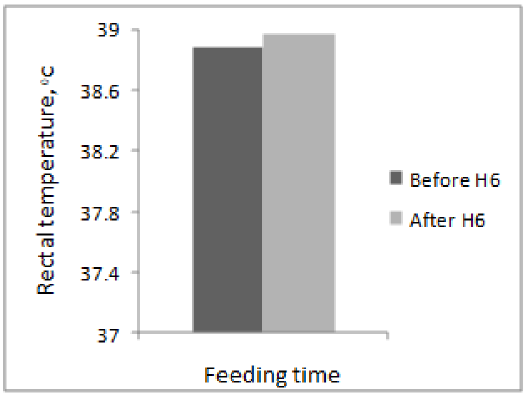


B

**Significant differences between the groups (*P* < 0.01).
***Significant differences between the groups (*P* < 0.001).

Figure (1. A) Body weight of calf-fed colostrum during different times; (1. B) wither height of calf-fed colostrum during different times; Before H6 = before six hours; After H6 = after six hours

In the production of animals, calves body weight is important and has economic features for determining animal growth. Growth is one of the most essential processes that occur in the life of an animal. It is impacted by genetic potential, nutrition, and environmental factors. When we talk about Karadi cows there is little research focusing on this local breed. The size of Karadi cows is small; the body weight of Karadi is about 208 kg under ideal conditions, while the average newborn weight is around 15 kg (AlKudsi and Elia, 2010). The effectiveness of the low-quality colostrum before and after six (6) hours from birth to the high-quality colostrum before and after six hours from birth for newborn calf was verified by greater body weight and withers height for calf fed before 6 hours when compared with those fed after 6 hours, because of colostrum IgG absorption is time-dependent (Desjardins-Morrissette *et al*., 2018). Reported that weight gain is positively related to body weight, which has a high growth rate, and produces more size of muscle (Saeed *et al*., 2022). Also, it has been observed that growth rate and wither height are positively correlated with first-lactation milk yield (Van De Stroet *et al*., 2016).



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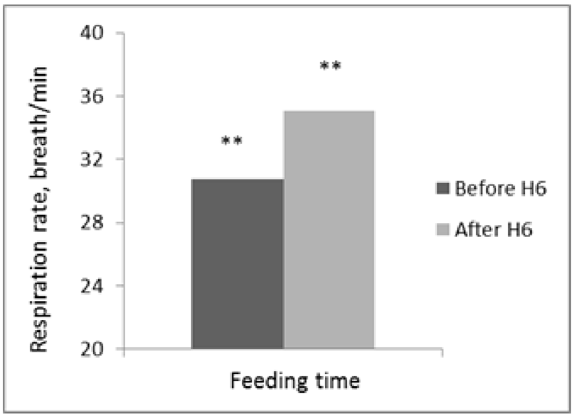


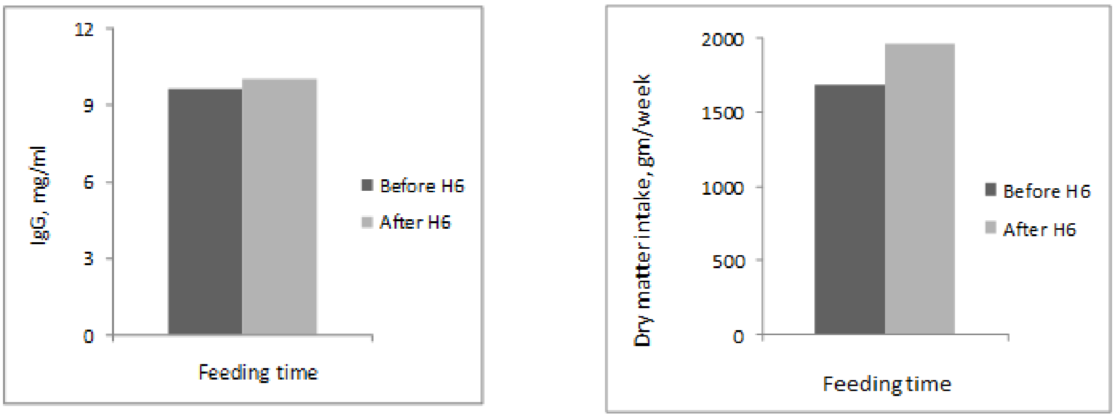
B

**Significant differences between the groups ($P < 0.01$).

Figure (2.A). Rectal temperature of calf feed colostrum during different times; (2.B) respiration rate of calf feed colostrum during different times; Before H6 = before six hours; After H6 = after six hours

The preweaning period of a calf's life is essential. In terms of health and survival, the physiological state of neonates is critical. The effect of quality colostrum during different times has no significant impact on the calf's rectal temperature (RT). And RT is an essential physiological performance. Calves' body temperatures normally vary from 38.1 to 39.2 ^{o}C, however, they might change according to metabolic and physiological changes, stress from the environment, and high humidity (Dado-Senn *et al*., 2020). Neonatal calves have immature metabolic mechanisms for controlling body temperature, furthermore, ambient temperature has a significant impact on calf performance, and temperature extremes can harm calf immunity (Hill *et al*., 2016).

The wellbeing and survival of this population of calves, however, may be impacted by additional factors, including perinatal conditions and herd-level management techniques. Rectal temperature and RR generally show that the calves remain healthy and exhibit no sign of distress or illness (Zhao *et al*., 2021). The lower respiration rate for calves fed colostrum before six (B6) hours from birth than six (A6) hours after birth may show slight function and calf well-being. Furthermore, despite significant differences between the groups, the health status data in the study were all in the normal ranges.



A **B**

Figure (3.A). IgG =Immunoglobulin of calf-fed colostrum during different times; (3.B) Dry matter intake of calf fed colostrum during different times; Before H6 = before six hours; After H6 = after six hours

Immunoglobulins are innate immune system components found in animals without prior antigen exposure and have a broad specificity. Calves, unlike most newborn animals, are born immunoglobulin emic and consequently strongly rely on the immunoglobulins in cow's mammary secretions to protect them from sickness and infection. Fortunately, colostrum has significant levels of IgG and can provide up to 9 g of immunoglobulins per 100ml of colostrum (Saldana *et* *a*l., 2019). Immunoglobulins in mammary secretions arise from a variety of sources and represent a history of the mother's antigen exposure and immune system response (Hurley and Theil 2011). Our study showed that the calves have approximately the same amounts of serum IgG regardless of whether they were subjected to low or high colostrum during different times.

Results show that the total white blood cells (WBC), lymphocyte, neutrophil, eosinophil, and basophil numbers were not affected by treatment, time or the interaction between treatment and time. Monocyte numbers tends increasing with treatment (P = 0.08), the number of monocytes is higher in calves fed low quality colostrum compared to those fed high quality colostrum. Total plasma protein was not affected by treatment and time, but it tends significant interaction of treatment by time (P = 0.07) (Table 2).

Table 2. Blood characteristic of calves fed different quality of colostrum during different times

Variable	Low colostrum		High colostrum		SEM	*P* value		
	B6	A6	B6	A6		Trt	Time	Trt*Time
Total WBC (cells/ml)	9.97	9.98	9.80	9.42	0.99	0.72	0.85	0.85
Lymphocytes (cells/ml)	4.62	4.88	4.88	5.09	0.44	0.63	0.64	0.97
Monocytes (cells/ml)	0.19^{ab}	0.27^{a}	0.19^{ab}	0.15^{b}	0.09	0.12	0.69	0.10
Neutrophils (cells/ml)	4.92	4.65	4.55	4.04	0.85	0.57	0.65	0.89
Eosinophils (cells/ml)	0.02	0.03	0.04	0.04	0.01	0.32	0.93	0.93
Basophils (cells/ml)	0.11^{ab}	0.22^{a}	0.10^{b}	0.11^{b}	0.03	0.12	0.11	0.21
Total plasma protein (cells/ml)	4.97^{a}	5.92^{ab}	6.19^{b}	5.84^{ab}	0.35	0.11	0.40	0.07

[a–b]Means with different superscripts in a row show statistically significant ($P < 0.05$) differences.
B6 = before six hours; A6 = after six hours; SEM =standard error of the mean; Trt =treatment.

The result observed shows that lymphocyte, neutrophil, and eosinophil percentages were not affected by treatment, time, and interaction treatment by time. Monocyte percentage tends significant by treatment (P = 0.10), monocyte percentage in both quality colostrum before (six) hours from birth was greater than after (six) hours from birth. Basophil percentage has been affected significantly by treatment (P = 0.02) (Table 3).

Table 3. Blood characteristic percentage of calves fed different quality of colostrum during different times

Variable	Low colostrum		High colostrum		SEM	*P* value		
	B6	A6	B6	A6		Trt	Time	Trt*Time
Lymphocytes, %	42.99[a]	51.83[ab]	51.95[ab]	56.03[b]	4.28	0.15	0.15	0.60
Monocytes, %	2.32	2.33	2.19	1.72	0.71	0.23	0.46	0.44
Neutrophils, %	49.71	43.0	44.63	40.64	4.38	0.40	0.23	0.76
Eosinophil, %	0.40	0.33	0.50	0.52	0.09	0.16	0.82	0.67
Basophils, %	1.52[ab]	1.84[a]	0.95[b]	1.09[ab]	0.28	0.02	0.41	0.76

[a,b]Means with different superscripts in a row show statistically significant ($P < 0.05$) differences.
B6 =before six hours; A6 = after six hours; SEM =standard error of the mean; Trt =treatment.

Further information on the variations in WBC variables with different colostrum fed at different times. More than $1x10^6$ cells/ml of immunologically active leukocytes, including macrophages, T and B lymphocytes, and neutrophils, are seen in normal bovine colostrum. At least some colostral leukocytes are absorbed in their entirety across the intestinal barrier. Early evidence suggests that colostral leukocytes boost lymphocyte reactivity to nonspecific mitogens, increase phagocytosis and bacterial killing capabilities, and activate humoral immune responses (IgG production) in the calf. While there is clear evidence that the entire critical immunological component discovered is present in the newborn baby calf at birth, at least (2-4) weeks after birth, they do not appear to be fully functional (Reber *et al*., 2006). The number of WBC and neutrophils were not different, regardless of the number of monocytes that differed between treatments for calf-fed low colostrum (B6). Lymphocyte and eosinophil numbers were not changed. But basophil tended to be different among the treatments. Total plasma protein is frequently used to determine circulating IgG concentrations and to predict vulnerability to newborn illness. It has been hypothesized that a total protein concentration of ≥5.2 g/dl indicates appropriate passive transfer (Quigley *et al*., 2002). Total plasma protein has tendency to be treated over time.

Conclusion

In terms of measuring calf growth, there is not much variance between various colostrum quality types; nonetheless, the timing of colostrum feedings is the most important factor. Regarding the calf's immune system, there are generally no significant differences between various colostrum quality levels or feeding timings. This might occur because of the native Karadi cows' adaptation to the hot, dry climate of northern Iraq.

Conflict of interest

Regarding the publication of this manuscript, the authors declare that there are no conflicts of interest.

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