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Original Research Article

Relation of milk parameters with postpartum reproductive efficiency in cattle

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Abstract

The high producing dairy cow is under high metabolic demand during the period immediately following parturition due to the metabolic demands of increased milk production. Negative energy balance probably acts similarly to under nutrition and may manifest in delayed ovarian activity by impinging on pulsatile secretion of LH. Recent studies revealed that certain milk parameters indicate the postpartum reproductive performance in exotic cattle. In the present study, milk parameters i.e. milk yield, lactose and milk urea nitrogen (MUN) were correlated with the day of first postpartum heat exhibition. Milk samples were collected from 25 lactating animals on 10th day of calving and after weekly intervals up to 12 weeks. Milk yield was recorded and the samples were analyzed for lactose and MUN. There was a significant positive correlation between milk yield and day of first heat. Animals with high milk yield took long time to exhibit the first postpartum heat. There was no significant difference in the milk yield between the groups of animals, which conceived within 3 months and the group of animals which conceived after 3 months. Non significant negative correlation was found between milk lactose concentration and day of occurrence of first postpartum heat. There was a significant positive correlation between MUN and day of occurrence of first heat but no significant difference was found in group of animals which conceived within 3 months and the group which conceived after 3 months.

Keywords: Metabolic demand, Milk urea nitrogen, postpartum, lactose and conception.

1. Introduction

An increased production has been associated with reduced conception rates. Negative energy balance probably acts similar to under nutrition and may manifest in delayed ovarian activity by impinging on pulsatile secretion of LH [1]. It is also postulated that dairy cattle selected for high milk production are not able to maintain a positive energy balance during early lactation and must mobilize body reserves. This in turn will led to increase in body weight losses as well as increase in number of days to attain first ovulation [2]. The high producing dairy cow is under high metabolic demand during the period immediately following parturition due to the metabolic demands of increased milk production largely achieved through breeding programmes that have emphasized increased yield [3]. An estimated 80 per cent of cows (high producing) experience negative energy balance in early lactation because the energy demands for milk yield are not met through the diet [4]. Selection of cows for high milk yield is based on increased blood concentrations of somatotropin and prolactin that act as stimulators of lactation but decreased levels of insulin, a hormone that is antagonistic to lactation and may be important for normal follicular development. These changes in hormone concentrations promote higher milk yield but may be detrimental to other physiological functions, such as reproduction, if the management is not adequate to meet the metabolic demands of lactation. Cows with the longest intervals from calving to first ovulation produced more milk and also had prolonged intervals to first estrus activity[5]. Cows with the greatest milk production will have the highest incidence of infertility. But, epidemiological studies indicate that in addition to milk production, other factors probably contribute to decreasing reproductive efficiency in dairy herds[6]. In the present study, an attempt was made to find the relation between various milk parameters with the postpartum reproductive efficiency in cattle.

2. Materials and Methods

This study was conducted at the Military Dairy Farm located in Bangalore city. Throughout the experimental period, cows were fed a diet to meet the maintenance, growth and lactation requirements. The farm has herd strength of around 600 cattle and has been maintained under strict veterinary care and management. The animals were regularly screened for Tuberculosis, Johnes disease and Brucellosis to eliminate the reactors and keep the herd free from above diseases, in addition to being periodically vaccinated against Rinderpest, Foot and Mouth disease, Haemorrhagic septicemia, Black quarter and Anthrax.

Twenty-five crossbred (12 HF and 13 Frieswal) cows were randomly selected among the animals calved between December 2006 and February 2007.

2.1 Experimental protocol

Periodical milk samples were collected from all the 25 cows after examining for the reproductive condition. Milk samples were collected from 10^{th} day postpartum period then onwards, every 7 days upto 12 weeks. These samples were stored at -20^0 C until analyzed. The estimation of various milk parameters like milk yield lactose and MUN was carried out according to standard procedures. With respect to observations on first postpartum heat, the cows were considered as the two groups i.e. 1)Cows which came to heat within two months postpartum and 2) Cows which came to heat after two months postpartum. And with respect to conception, the animals were considered as the two groups i.e. 1) the animals, which conceived within three months postpartum and 2) Animals, which conceived after three months postpartum.

2.2 Estimation of milk parameters:

Serum and milk urea nitrogen was estimated by the Diacetyl monoxime method [7]. The lactose content was estimated by using Lane Eynon method as given in Indian Standard Institution (ISI): 1479 (1961).

3. Results

3.1 Milk parameters:

3.1.1 Milk yield

The average milk yield during first 3 months of postpartum period is presented in Table 1.

There was a significant (P<0.01) positive correlation (r = 0.17) between milk yield and day of first estrus (Table 2). However, there was no significant difference (P>0.05) in the milk yield between the two groups i.e. the group which came to estrus before 2 months and the other group, which came to estrus after 2 months (13.89 ± 0.49 L vs 14.54 ± 0.38 L., respectively). There was a significant (P<0.001) negative correlation (r = - 0.24) between milk yield and blood cholesterol concentration. There was a non significant (P>0.05) positive correlation (r = 0.04) between the milk yield and day of conception. There was no significant difference (P>0.05) in the milk yield between the two groups i.e. the group of animals that conceived within 3 months and the other group that conceived after 3 months (13.60 ± 0.58 L. vs 14.33 ± 0.54 L., respectively).

3.1.2 Lactose

The average lactose concentration during first 3 months of postpartum period is presented in Table 1. There was no significant (P>0.05) difference in the blood lactose concentration between the two categories i.e those which came to estrus within 2 months postpartum and those which did not come to estrus after 2 months (4.00 ± 0.04 vs 3.98 ± 0.04 g % respectively). There was a significant (P<0.0001) positive correlation observed (r = 0.40) between lactose and blood cholesterol. There was a non significant (P>0.05) negative correlation (-0.05) between milk lactose concentration and day of occurrence of first postpartum estrus. There was a non significant (P>0.01) positive correlation (r = 0.24) between the lactose levels over the period of 3 months postpartum and day of conception. There was no significant (P>0.01) difference in the lactose levels over a period of first 3 months postpartum between the group of animals, which conceived within 3 months and the other group that conceived after 3 months (3.95 ± 0.04 vs 4.15 ± 0.04 g per cent).

3.1.3 Milk urea nitrogen

The average MUN concentration during first 3 months of postpartum period is presented in Table 1, 3. There was a significant (P<0.01) positive correlation (r = 0.20) between MUN and day of occurrence of first estrus. There was a highly significant (P<0.001) positive correlation (r = 0.88) between MUN and SUN levels. There was no significant (P>0.01) difference in the MUN level between the two categories i.e. the group, which came to estrus before 2 months and the other group, which came to estrus after 2 months (13.77 ± 0.20 vs 14.64 ± 0.25, mg per cent respectively). There was a non significant (P>0.05) positive correlation (r = 0.04) between the MUN and day of conception. There was no significant (P>0.05) difference in the MUN level between the group of animals, which conceived within 3 months and the other group that conceived after 3 months (14.12 ± 0.23 vs 14.36 ± 0.32 mg per cent).

Table 1: Mean ± SE values of blood and milk parameters during first 3 months of postpartum (n = 25)

Days postpartum	10	17	24	31	38	45	52	59	66	74	81
Blood parameters											
1) Glucose (mg %)	42.35 ± 0.96	47.37± 0.9	50.09 ± 1.03	53.65 ± 1.17	53.41± 0.65	55.02 ± 0.84	55.92 ± 1.06	56.10 ± 1.13	56.33 ± 1.11	54.17± 0.68	54.40 ± 0.69
2) Protein (g %)	5.73 ± 0.09	6.43 ± 0.11	7.35 ± 0.11	7.90± 0.09	8.67± 0.08	8.91± 0.08	9.38 ± 0.07	10.04 ± 0.07	10.54 ± 0.08	10.44 ± 0.08	10.84 ± 0.09
3) Cholesterol (mg %)	149.48 ±4.06	148.95 ± 2.86	159.78 ± 4.94	162.87 ± 4.84	165.72 ± 5.07	168.83 ± 4.42	175.25 ± 5.86	178.51 ± 5.4	180.82 ± 5.34	182.13 ± 5.45	185.21 ± 6.21
4) BUN (mg %)	11.28 ± 1.021	12.71± 1.05	14.01± 1.04	15.03 ± 0.91	16.28 ± 1.00	16.84 ± 1.08	16.92 ± 0.93	17.06 ± 1.01	16.62 ± 1.01	17.09 ± 0.96	17.23 ± 1.01
Milk Parameters											
1) MUN (mg %)	10.25 ± 0.42	11.44 ± 0.39	12.55 ± 0.37	13.50 ± 0.29	14.46 ± 0.35	15.15 ± 0.33	15.50 ± 0.30	15.60 ± 0.27	15.34 ± 0.24	15.98 ± 0.27	15.94 ± 0.25
2) Lactose (g %)	3.48 ± 0.0	3.54 ± 0.0	3.73 ± 0.05	3.78 ± 0.04	3.92 ± 0.06	4.04 ± 0.06	4.17 ± 0.05	4.22 ± 0.05	4.314 ± 0.05	4.34 ± 0.04	4.38 ± 0.05
3) Milk yield (L)	11.56 ± 1.02	12.86 ± 1.05	13.62 ± 1.04	13.34 ± 0.91	13.78 ± 1.00	14.14 ± 1.08	14.38 ± 1.08	14.28 ± 0.93	13.9 ± 1.01	13.84 ± 0.96	14.24 ± 1.01

Table 2: Mean ± SE values of physiological and biochemical parameters recorded during first postpartum period in crossbred cows

	Overall mean ± SE	Animals came to estrus within 2 months	Animals came to estrus after 2 months	Animals conceived within 3 months	Animals conceived after 3 months
BCS	3.00 ± 0.06	3.18 ± 0.04	3.17 ± 0.04	2.97 ± 0.03	3.12 ± 0.05
Serum parameters					
1) Glucose (mg %)	52.62 ± 1.31	55.49 ± 0.59	50.02 ± 0.59	54.22 ± 0.68	53.71 ± 0.79
2) Protein (g %)	8.75 ± 0.51	7.14 ± 0.09	7.08 ± 0.08	7.18 ± 0.09	7.09 ± 0.10
3) Total cholesterol (mg %)	168.9 ± 3.83	181.8 ± 2.80	159.9 ±1.78	177.0 ± 3.34	172.6 ± 3.96
4) Urea nitrogen (mg %)	15.56 ± 0.61	14.74±0.22	15.69±0.33	15.05 ± 0.24	15.77 ± 0.40
Milk parameters					
1) Milk yield (L)	13.63 ± 0.24	13.89 ± 0.49	14.54 ± 0.38	13.60 ± 0.58	14.33 ± 0.54
2) Lactose (g %)	3.10 ± 0.19	4.00 ± 0.04	3.98 ± 0.04	3.95 ± 0.04	4.15 ±0.04
3) MUN (mg %)	14.16 ± 0.51	13.77±0.20	14.64 ± 0.25	14.12 ± 0.23	14.36 ± 0.32

Table 4: Correlation coefficients of physiological parameters with postpartum fertility

	First estrus	Conception
BCS (loss of BCS at calving)	0.19	–
Serum parameters		
1) Glucose	-0.44*	0.011
2) Protein	-0.04	-0.11
3) Total Cholesterol	-0.36*	-0.11
4) BUN	0.24	0.12
Milk parameters		
1) MUN	0.20*	0.04
2) Milk lactose	-0.05	0.24
3) Milk yield	0.17*	0.04

* $P < 0.05$

4. Discussion

Shrestha *et al*[8] reported that in spite of similar milk production by different groups of cows, postpartum losses in BCS and BW were greater in delayed resumption Type II cows (First ovulation did not occur until ≥ 45 days after calving) than those in normal resumption cows; this suggested that cows with delayed resumption Type II were unable to consume the energy required and had prolonged negative energy balance (NEB) during the postpartum period. Cows with greater NEB have lower peripheral concentration of IGF-I and LH, which act synergistically to promote ovarian follicular development. Harrison *et al*[9] reported that greater loss of BW by the high yielding group during early lactation probably reflects greater mobilization of fat from both adipose tissue and muscle to support milk production. This loss may be an important part of the greater delay in expression of estrus for the high yielding group.

Digestion of dietary protein results in the production of ammonia. Ammonia is converted to urea primarily in the liver [7]. Urea is then excreted from the body primarily through urine, but is also excreted from the body through milk [10]. Milk urea nitrogen levels have been used to evaluate herd nutritional status, as well as to assess the nitrogen excretion to the environment [20].

Two reports indicated some relationship between MUN and reproductive traits on a within-herd basis [11][12]. Guo *et al*[13] reported that cows with higher MUN had reduced conception rates. Vallimont *et al*[12] found that cows with a very high and very low MUN within the 2 weeks period before insemination had reduced conception rates. But in our study there was non significant (P>0.05) difference in the MUN level between the group of animals which conceived within 3 months and the other group that conceived after 3 months (14.12 ± 0.23 vs 14.36 ± 0.32 mg %).

Milk urea nitrogen has been proposed as an indicator to evaluate the protein nutrition of the dairy cow [14][15]. Butler *et al*[16] suggested that high MUN concentrations are negatively associated with conception rate.

The high correlation of MUN and BUN was expected [17]. In the present investigation also there was a highly significant (P<0.001) positive correlation (r = 0.88) between MUN and BUN levels. Mean MUN concentration was 14.8 mg of N/dl but MUN concentration ranged from 3 to 28 mg/dl. In an earlier report BUN concentration ranged from 5 to 40 mg/dl. [12] Our values are also well within the range of these values. Guo *et al[13]* reported that negative association of MUN with CR at first service among cows within herds. This implies that within-herd negative association of MUN with probability of conception during early lactation could relate to the status or condition of individual cows. In our investigation there was a non significant (P>0.05) positive correlation (r = 0.04) between the MUN and day of conception. In the present study, there was a non significant (P>0.05) negative correlation (- 0.05) between milk lactose concentration and day of occurrence of first postpartum heat. These results are close agreement with McDonald *et al*[18]. If early postpartum DMI is low and if a cow produces more milk, then glucose supply to the ovary may not be sufficient for a cow to return to postpartum ovulation.

Milk lactose concentration has been shown to be associated with resumption of luteal function in second-parity Norwegian dairy cattle [19]. Buckley *et al[20]* reported higher 305-d lactose content was associated with an increased likelihood pregnancy.

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