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Biochemical properties of milk from machine-milked Holstein cows in early and late lactation period

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Key words
Machine milking, early and late lactation, milk biochemical properties

1 SUMMARY

In this study, 55 Holstein cows were used to study biochemical parameters of milk from machine-milked cows, comparing early and late lactation phases. The experiment started on the first day of lactation and lasted for 10 months. To determine milk composition, samples were obtained from each cow on the last day of the first week in month 1 and 2 (early lactation) and month 7, 8, 9 and 10 (late lactation). There was a decrease of milk fat content from the second month and a gradual increase after the 7 th month of lactation. The values for milk fat, pH and total solids were highest during the 9th and 10th months after delivery. The rate of decline of milk biochemical parameters was lower during the last months (between 7-10 months) than during the first months of lactation. In this study, the means of biochemical parameters in milk from machine-milked cows were different from those reported for hand-milked cows and the suckled dairy cows during lactation period. However, the curves followed the same trend regardless of the milking method. From the results, the stages of lactation have significant influence on the milk fat level. Accurate knowledge of lactation curves has an important relevance to management and research on dairy production systems. When definite goals become more clearly established, certain breeds or herds may be determined to be more desirable when selecting for increased total milk yield and biochemical milk parameters.

2 INTRODUCTION

Little is known about the factors affecting milk components and their interrelationships in the early and late lactation periods of machine-milked cows. Milk pH, total solids and protein contents have traditionally received more attention in machine milking process (Gonzalo *et al*., 1994). Lactation curves and knowledge about the pH, total solids and fat contents of milk are important for management of dairy animals (Wilmink, 1987). Component chemistry and relationships between them are also useful in studying the physiology of milk production. The machine milking process affects the metabolism and regulation of these parameters in dairy animals (Bruckmaier, 2001).

Lactation curves can be used to study the accuracy of estimation methods for lactation yield and biochemical parameters in milk (Coombera *et al*., 1997; Fuertes *et al*., 1998). It is therefore necessary to know the factors that influence milk components. This study compared the effect of early and late lactation

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stages on milk components of dairy cows milked by machine.

3 MATERIALS AND METHODS

In total, 55 Holstein cows selected at random from 80 cows belonging to the DIMES Company Animal Farm were studied during the experiment. The study started on the first day of lactation and lasted for 10 months. The cows were fed 4 kg per day of concentrate diet (2.5 Mcal Metabolisable Energy, 18% Crude Protein) and received grass silage *ad libitum* at 08.30 and 16.30 hours.

Samples were obtained from each cow on the last day of the first week of month 1 and 2 (early lactation phase) and months 7, 8, 9 and 10 (late lactation phase). Milk samples were composites of milk collected at consecutive morning and afternoon milking schedules. The samples of approximately 100 ml were collected into plastic milk sample vials (Capital Vials, Fultonville, NY), preserved with Microtabs (Control Systems, San Ramon, CA), stored at 4°C, and analyzed within 24 h.

The milk fat content was determined by Roese-Gottlieb Method (Hundrieser *et al*., 1984) and acidity was determined using a Xerolyt electrode (model HA 405; Ingold Electrode, Wilmington, MA). Total solids were determined by drying a 3-ml sample in a forced-air oven for 4 hr at 102 ^{o}C. All the data are indicated as mean ± SEM.

4 RESULTS AND DISCUSSION

There was a decrease of milk fat content on the second month and a gradual increase from the 7 th month of lactation (Table 1). The fat values of milk produced by Holstein cows of 3.5 and 2.9 % during the 1st and 2nd month of lactation in this study were low when compared to 4.2 % by similar breeds in similar early lactation period (Nielsen *et al*., 2003).

Table 1: Biochemical milk parameters in early and late lactation period.

Month of lactation	Biochemical parameter		
	pH	Fat (%)	Total solids (%)
1	6.3±0.5	3.5±0.1 ^{a}	11.4±0.4
2	6.4±0.3	2.9±0.1 ^{b}	11.0±0.3
7	6.4±0.3	3.4±0.2 ^{a}	11.2±0.4
8	6.3±0.4	3.6±0.2 ^{a}	11.2±0.5
9	6.5±0.4	3.7±0.3 ^{a}	11.5±0.3
10	6.5±0.3	3.7±0.2 ^{a}	11.6±0.4

^{a,b} Mean values with different superscript within columns, differ significantly at P<0.05.

In the reported study, the cows were fed on pasture, whereas in our study they were fed with concentrate diets. It would appear that the concentrate diets partly contributed to the reduced levels of milk fat in our study. Many theories have been postulated to explain the mechanism that causes milk fat depression when animals are fed with high grain diets (Jaquette *et al*., 1988; Cant *et al*., 2003). The peak milk fat level of the Holstein cows was observed to be in the 9th and 10th month which is in agreement with the findings of Graves and Drackley (2004).

In this study, the mean fat content in milk obtained using machine was low (3.5%) when compared to 4.2% reported by Thompson *et al.* (1982) from hand-milked cows in late lactation. The reason for the low fat content in milk is that the milking machine captures cisternal milk but not alveolar milk, where most of the fat is found (Thomas *et al.*, 2001). In addition, concentrate diet with high energy also causes low milk fat (Samuelsson, 1996).

The mean pH of milk in early lactation in this study was higher than that reported for cows milked by hand and suckled non-dairy cows during early lactation (Coulon *et al*., 1998). It was however not possible to tell why the pH was high in our study. Such contrasting results between our findings and what is documented in literature may be due to the fact that these studies were carried out on different breeds of cows which might have efficient or inefficient autocrine control of milk secretion, as suggested by Bencini (1993). The values for milk fat, pH and total solids contents of the cows were

highest on the 9th and 10th months. The milk fat was secreted at its highest rate at the start of lactation and then declined in the second month. As shown by the data, milk fat, pH and total solids were not stable during the lactation period.

The trends observed in our study are similar to those reported for dairy cattle (Walker & Elliot, 1970; Coombera *et al*., 1997) and non-dairy cows (Rajendran, 2007). Although the means of biochemical properties vary, the curves of biochemical parameters follow a similar trend for both machine-milked and hand-milked cows, as well as for suckled non-dairy cows (Heineman, 1947; Rajendran, 2007).

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