Seasonal Variations in L-carnitine Levels in Colostrum and Milk of Holstein Cows

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Summary: In this study, we observed the seasonal variations in L-carnitine levels in the colostrum and milk of Holstein strain cows. Milking for L-carnitine analysis was conducted on days 2, 6, and 30 after calving. Because milk composition varies with each cow udder, mixed milk from each cow was prepared for this study. In the chronological variations of L-carnitine values after calving, the highest values were recognized in the colostrum and decreased to their lowest levels in milk. The seasonal variations in L-carnitine levels for each day after calving showed specific patterns, respectively. The L-carnitine level in colostrum increased mildly at the start of summer, and on day 6 after calving at the start of autumn, it increased suddenly. The L-carnitine level in milk remained stable. Differences in these variations in L-carnitine levels during the lactation stage appear to indicate differences in heat stress damage.

Key words: L-carnitine, colostrum, milk, seasonal variation

Introduction
L-carnitine supports the transport of long-chain fatty acids across the mitochondria membrane to produce energy. Although it is synthesized with lysine and methionine in the liver and/or kidney, an animal being nursed depends on milk for its supply. In previous studies (Sato et al. : 2009, Harmeyer : 2003, Roos et al. : 1992), L-carnitine levels in the colostrum were found to be higher than that in the milk. The level of L-carnitine decreased chronologically with the level of milk. Harmeyer (2003) reported that the plasma level of L-carnitine showed the highest value during the dry period and it decreased in accordance with the increase in milk yield. Therefore it appears that the stock level of L-carnitine in cows affects its level in the milk. Environmental temperature affects various biological responses in the whole body, and so accordingly, L-carnitine synthesis action in cows is also affected. There have been no reports from studies on the seasonal variations in L-carnitine level in milk. In this study, we observed the seasonal variations in L-carnitine levels in the colostrum and milk of Holstein strain cows.

Materials and Methods
Colostrum and milk came from TANAKA Dairy Farm (Hiratsuka-shi, Kanagawa Prefecture). They were stripped from 16 cows in different seasons in accordance with the calving schedule, as follows: 2 cows in May, 2 cows in June, 3 cows in July, 1 cow in August, 3 cows in September, 3 cows in October, and 2 cows in November. They had various calving numbers, with 6 primipara cows included. They were fed with customary farm feed. Milking for L-carnitine analysis was conducted on days 2, 6, and 30 after calving. Because there is a difference in milk composition with each cow udder, mixed milk from each cow was prepared for this study. L-carnitine analysis was entrusted to the Haute Ecole Specialisee de Suisse Occidentale, applying liquid chro-
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Significant difference (P < 0.05) was recognized between different letter.

In the chronological variations of L-carnitine values after calving, the highest value was recognized in the colostrums, and it decreased to its lowest level in milk (Fig. 1). This tendency was reported in other studies (ERFLE et al. 1974, ROOS et al. 1992, HRMEYER 2003, CARLSON et al. 2007, and SATO et al. 2009). It was reported that the serum L-carnitine level in cows increased during the dry period and decreased in accordance with milk secretion (HARMEYER 2003). The synthesis of L-carnitine is stimulated by various stress factors, i.e. calving, reduction of energy intake, and environmental conditions. TSUNEISHI et al. (2005) reported that grazing by aged beef cows accumulated high L-carnitine levels in the muscle and deduced that this phenomenon was due to the decrease in energy intake. In the feeding of milk cows, the dry period is necessary for the renewal of mammary glandular cells, therefore energy intake was reduced for milk secretion reduction. CARLSON et al. (2007) reported that starvation stress increased L-carnitine synthesis. Therefore this treatment during the dry period induces starvation stress and stimulates L-carnitine synthesis in milk cows. On the other hand, the colostrum is the best source of L-carnitine for calves. They cannot synthesize L-carnitine themselves, because the function of liver and/or kidney has not yet developed during the early period of nursing. The high level of L-carnitine stimulates energy production with the high level of milk fat in the colostrum. ROOS et al. (1992) reported the positive correlation of L-carnitine level and milk fat. Although the present data for each cow indicated a similar tendency noted in the above-mentioned reports, the seasonal variations of L-carnitine levels for each day after calving showed a specific pattern, respectively. The L-carnitine level in colostrum increased mildly at the start of summer (Fig. 2), and on day 6 after calving at the start of autumn it increased suddenly (Fig. 3). The environmental temperatures are shown in Fig. 2. The L-carnitine level in
the milk remained stable (Fig. 4). The difference in these variations in L-carnitine levels during the lactation stage appears to indicate differences in heat stress damage, i.e. cows secrete higher L-carnitine levels on day 6 after calving having undergone heat stress and starvation stress at the same time. Furthermore the calving number was not affected by the secretion of L-carnitine in the milk. The seasonal variation of L-carnitine level in the milk might have resulted in the change of accumulated level of L-carnitine in their muscle. It was deduced that L-carnitine was required to play its role in the reduction of heat stress and it was released from muscle to milk in accordance with decreasing of environmental temperature. L-carnitine levels during the winter season remain to be studied and will be investigated in the near future.

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References


ホルスタイン種乳牛の初乳および乳中
L-カルニチン含量の季節変動
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要約：本試験はホルスタイン種乳牛の初乳および乳中L-カルニチン含量の季節変化について検討することを目的とした。L-カルニチンの分析に供する乳汁の検乳は分娩後2日、6日および30日とした。乳牛の各乳房から泌乳される乳汁成分は異なることが知られているが、本試験では合乳として処理をした。分娩後のL-カルニチンの経時的な変動は、初乳で最も高く、徐々に乳中の最も低い値まで低下していった。分娩後同日の乳汁中L-カルニチン含量の季節変動は、各採乳日で特異な変動を示した。初乳中の季節変動は初夏に緩やかに上昇し、分娩後6日のL-カルニチン含量は秋に急激に上昇した。乳中のL-カルニチン含量は安定していた。このような泌乳ステージにおける変動の違いは、暑熱ストレスの違いを示すものと考えられた。

キーワード：L-カルニチン、初乳、乳、季節変動

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