*J. Agric. Sci., Tokyo Univ. Agric., 53 (4), 317-321 (2009)*
**東京農大農学集報**, 53 (4), 317-321 (2009)

# Effect of L-carnitine Supplementation on Growth Performance of Beef Calves

By

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(Received July 25, 2008/Accepted December 12, 2008)

**Summary** : The present experiment aimed to estimate the effect of dietary supplementation of L-carnitine to calves on their growth performance. L-carnitine plays a role in the shuttling process of long-chain fatty acids into a mitochondrial matrix that eventually promotes lipid catabolism to produce ATP. Immature animals cannot synthesize it by themselves and depend on milk for the intake of L-carnitine. Six Japanese Black cattle calves were used in this study. The animals were randomly classified into two groups of 3 calves each, a normal control group and an L-carnitine supplemented experimental group. After one week of drinking colostrum, they were separated from their dam and artificially given 500 g/2 L commercial milk replacer twice a day. The milk in the experimental group contained additional 0.1 g L-carnitine. Artificial nursing was conducted for 1 month and the animals were weaned after this period. Determination of body weight and body measurement (withers height, body length, chest depth, chest girth, and height at hip cross) was conducted every week. Enlargement percentage was calculated for the initial size for each calf at the starting point. Although body weight gain and enlargement of chest girth in the experimental group showed a tendency for improved growth performance, there was no significant difference in any factor. The number of animals used in this study may be somewhat small, but the present results suggest that L-carnitine supplementation to the milk replacer supported the growth performance of calves.

***Key words*** : L-carnitine, growth performance, beef calves

## Introduction

In the feeding of dairy cattle, early weaning, or cow separation, is carried out for milk production. Recently early weaning has been carried out in the feeding of beef calves. Calves were given synthetic milk under definite variables, i.e. definite time and volume (Japanese Feeding Standard for Beef Cattle, 2000). The growth performance of calves depends on the nutrients supplied from milk, and good performance during the nursing period anticipates good fattening performance. Therefore the ingredients in synthetic milk are important for growth performance. It was reported that dietary supplementation of L-carnitine supports good performance in piglets (MUSSER *et al.*, 1997, EDER *et al.*, 2001). L-carnitine ingested by sows was given to piglets through their milk and this supported growth performance. In a previous study (IKEDA *et al.*, 2008), the authors found that dietary supplementation to sows tended to increase the daily gain of nursing piglets. L-carnitine stimulates the transport of long-chain fatty acids across the inner mitochondria membrane to produce energy. It was reported that L-carnitine administered to ruminants was quickly degraded by rumen microbes (LACOUNT *et al.*, 1996). The rumen of calves, despite being ruminants, never develops during the nursing period. Their digestive mechanism is similar to those of monogastric animals. Dietary supplementation of L-carnitine to calves may hide or preserve the possibility of good growth performance. The present experi-

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**Table 1** Chemical composition (%) of milk replacer

| | | |
|---|---|---|
| Crude protein | more than | 24.0 |
| Ether extracts | more than | 25.0 |
| Crude fiber | less than | 1.0 |
| Crude ash | less than | 8.0 |
| Calcium | more than | 0.6 |
| Phosphorus | more than | 0.4 |
| Total digestible nutrients | more than | 114.0 |
| L-carnitine[1] (mg/100g) | | 19.0 |

1: L-carnitine concentration was analyzed by HPLC after modification to FMOC amino acid type.
Other values were guaranteed by a synthetic milk maker.

**Table 2** Guaranteed composition of synthetic milk (%)

| | | |
|---|---|---|
| Crude protein | more than | 17.0 |
| Ether extracts | more than | 2.0 |
| Crude fiber | less than | 10.0 |
| Crude ash | less than | 10.0 |
| Calcium | more than | 0.4 |
| Phosphorus | more than | 0.3 |
| Total digestible nutrients | more than | 74.0 |
| Feeding amount (g/head/day) | | |
| 1–10 days | | 1,200 |
| 11–20 days | | 2,000 |
| 21–30 days | | 2,800 |

Feeding was twice a day, but calves did not always consum.

ment aimed to estimate this hypothesis.

## Materials and Methods

Six Japanese Black cattle calves, 3 bulls and 3 heifers were used in this study. They were born at Fuji Farm at the Tokyo University of Agriculture between July and September in 2007. The animals were randomly divided into two groups of 3 calves each, a normal control group and an L-carnitine supplemented experimental group. Therefore the control group included two bull calves and a heifer calf and the experimental group included the opposite ratio. After a week of drinking colostrum, they were separated from their dam and artificially given 500 g/2L commercial milk replacer twice a day. Chemical composition of basal commercial milk replacer is shown in Table 1. This milk was used for both groups, while 0.1 g L-carnitine was added to the milk of the experimental group. Artificial nursing was conducted for 1 month and the animals were weaned after this period. Determination of body weight and body measurement (withers height, body length, chest depth, chest girth, and height at hip cross) was conducted every week. During the nursing period, calves were given synthetic milk (commercial type) *ad libitum*. Feeding amount increased chronologically (Table 2).

Body weight gain and enlargement percentage of each measurement were calculated for the initial size for each calf at the starting point. Data was treated using one-way analysis of variance at significant level of $P<0.10$.

Furthermore, the chronological variation of L-carnitine concentration in the milk of dairy cattle was determined as fundamental data. The milk was collected from a commercial farm and milking was conducted on days 2,6, and 30 after farrowing. The concentration of L-carnitine in milk was quantitatively analyzed by HPLC after modification to FMOC amino acid type.

Experimental protocol was approved by the Animal Experiment Committee of the Tokyo University of Agriculture.

## Results and Discussion

There are fewer studies on L-carnitine for cattle in Japan than in some other countries. TSUNEISHI *et al.* (2004, 2005) reported that the L-carnitine content in cattle beef increased with grazing and that also beef is valuable as functional food for humans. Furthermore, it is well known that synthetic activity of L-carnitine in the liver of cattle is weak and that the synthetic activity of L-carnitine is weak in immature animals. The authors recognized that increasing L-carnitine content in milk supports growth in piglets (IKEDA *et al.*, 2008). Therefore, supplementation of L-carnitine to the milk for calves seemed to be useful to their growth. Concentration of L-carnitine in the milk replacer presently used is shown in Table 1. Addition of 0.1 g L-carnitine to milk replacer, corresponds to the same volume ordinarily contained in milk replacer, by the following calculation : additional amount/original amount in milk replacer$=(0.1\times2)/(0.019\times5\times2)$. A final intake/day was 390 mg $[(0.1+0.095)\times2]$ during nursing (4,000 g/day), and this value was about 2 times higher than that (205 mg) for the same volume of colostrum, it contains 6.63 mg/100 g (determined value in this study as shown in Fig. 3). The *ad libitum* of synthetic milk may have had no effect on the L-carnitine intake, because it was prepared with plant material, which contains very little L-carnitine. The present results showed only the effective tendencies of L-carnitine addition, with no negative effect on the growth performance of calves (Table 3 and Fig. 1 and 2). Although enlargement percentages of body length, withers height, and chest depth in the experimental group were less than

**Table 3** Percentage of body weight gain and enlargement of body size for initial size

| | Control | | | | Experiment | | | |
|---|---|---|---|---|---|---|---|---|
| | bull 1 | bull 2 | heifer 1 | means | bull 3 | heifer 2 | heifer 3 | means |
| Body weight gain | 30.4 | 38.1 | 14.6 | 27.7±6.9 | 44 | 32.3 | 16.9 | 31.1±7.9 |
| Withers height | 10.7 | 5.2 | 6.9 | 7.61±1.6 | 4.1 | 10.7 | 6.4 | 7.06±1.9 |
| Body length | 10.6 | 14.5 | 8.0 | 11.0±1.9 | 11.3 | 11.8 | 6.8 | 9.95±1.6 |
| Chest depth | 10.5 | 11.5 | 11.7 | 11.2±0.4 | 9 | 9.5 | 3.3 | 7.3±2.0 |
| Chest girth | 9.0 | 7.0 | 4.5 | 6.84±1.3 | 12.1 | 11.5 | 1.4 | 8.34±3.5 |
| Height at hip cross | 5.1 | 1.9 | 5.3 | 4.11±1.1 | 2.3 | 7.1 | 5.6 | 4.98±1.4 |

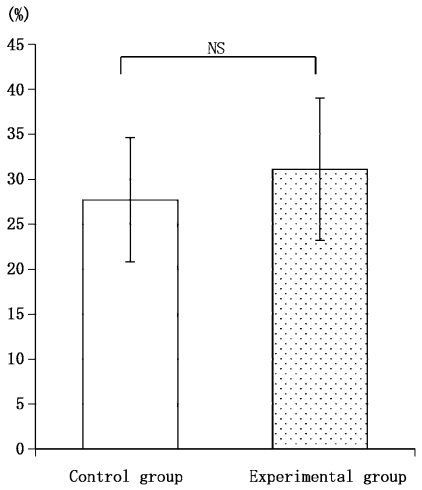


**Fig. 1** Body weight gain percentage for the initial weight of starting point
Contorol group : ♂2, ♀1, Experimental group : ♂1, ♀2

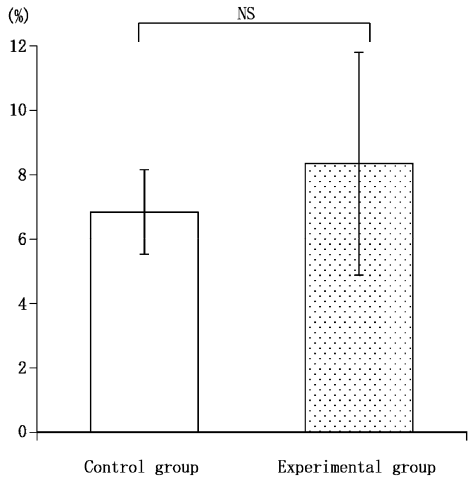


**Fig. 2** Enlargement percentage of chest girth for initial size of starting point
Contorol group : ♂2, ♀1, Experimental group : ♂1, ♀2

those in the control group, these values were shown as a reference data, because it was difficult to determine with exactitude. Body weight gain and the enlargement of chest girth suggest the development and meatiness of the body.

In growth performance factors for calves, the bull calf is generally stronger than the heifer calf. Furthermore, the pedigree of the seed parent, especially in breeding bulls, also affects the growth performance of calves. The expected ability of breeding bulls in the control group is good beef quantity, although that for the experimental group is good beef quantity and quality. This condition occurred unexpectedly, but the experimental group showed a better tendency for growth performance. This result suggests that L-carnitine supplementation to synthetic milk supported the growth performance of calves.

It was reported that L-carnitine concentration in the blood of cows decreased daily with the onset of lactation and that this decrease was induced by the sudden excretion of L-carnitine into the milk (HARMEYER *et al.*,

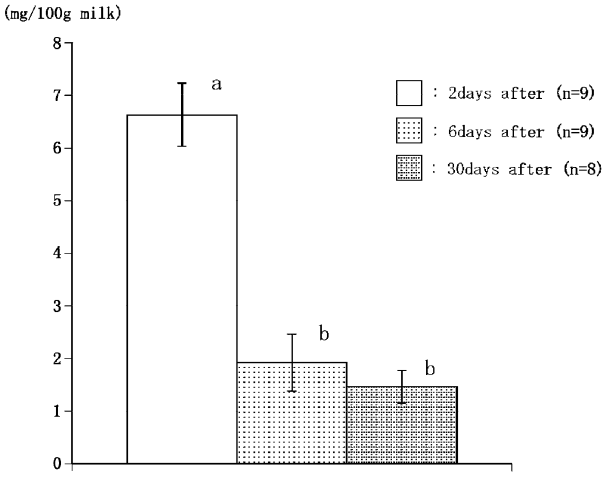


**Fig. 3** Chronological variation of L-carnitine concentration in milk after farrowing
Significant difference ($p < 0.01$) was recognized among the different letters.

2003). Furthermore, ROOS *et al.* (1992) reported that there is a positive correlation between the concentrations of milk fat and L-carnitine. These reports suggest that the growth of calves depends on L-carnitine excretion through the milk from cows, because calves require a period of time before they can synthesize adequate amounts of L-carnitine. The present data of chronological variation of L-carnitine concentration in the milk (Fig. 3) decreased in accordance with time spent after farrowing, and this phenomenon was similar to those tendencies found by ROOS *et al.* (1992). Colostrum contains high milk fat concentration, with low milk-yield mammals especially showing this strong tendency. Nursing animals require a metabolic pathway for effective energy production, and L-caritine supplementation might support this.

## Acknowledgement

Authors thank Mr.K.HAMASUNA for his helpful work in this study.

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# 肉用子牛の発育成績に対するL-カルニチン添加の効果

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（平成20年7月25日受付/平成20年12月12日受理）

要約：本試験は子牛の飼料へのL-カルニチン添加が発育成績に及ぼす影響を評価する目的で実施した。L-カルニチンはATP生産に係わる脂肪代謝を促進するべくミトコンドリア内に長鎖脂肪酸を取り込む上で重要な役割を果たしている。 未成熟な動物は体内でのL-カルニチン合成が未発達であり，L-カルニチンの摂取は乳成分に依存している。本試験では黒毛和種子牛6頭を用いた。6頭の子牛は通常飼育の対照区とL-カルニチンを給与した試験区の2区に3頭ずつ無作為に配分した。1週間初乳を授乳させた後，母牛から分離して市販代用乳（500g/2L）を1日当たり2回給与した。試験区の代用乳には0.1gのL-カルニチンを添加した。人工哺乳を1カ月間行い，この期間終了後離乳させた。体重測定と体尺（胸囲，体長，胸深，十字部高）は期間中毎週行った。各項目において開始時の初期値に対する伸張率を算出し，比較した。試験区の増体量と胸囲の伸張率は大きくなる傾向を示したが，いずれの項目でも有意な差は認められなかった。本試験では供試頭数が少なかったが，L-カルニチンを代用乳に添加給与することは子牛の発育を高める事が示唆された。

キーワード：L-カルニチン，発育成績，肉用子牛

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