West Japan J. Anim Sci. 44 101～105 ,2001

Original paper [Research Note]

Intake of Milk Constituents in Japanese Brown Calves on Pasture

Chinobu OKAMOTO, Kiyotaka KABATA, Norifumi HATTORI,
Takashi KOUTAKA and Masatake KIKUCHI

School of Agriculture, Kyushu Tokai University

(Received March 31, 2001/ Accepted May 24, 2001)

Introduction

In the Aso region of Kyushu District, about 10,000 head of Japanese Brown beef cows are kept [1]. The calving operation is a major component of the agricultural production of the region [1,2], which includes some 23,000 hectares of grassland [3]. About 60% of the grassland area is used for grazing the cows and their calves [4], and it is very common in this region for cattle to be fed on pasture in order to reduce feeding costs and labor. Techniques of yearlong grazing are also enjoying greater use among the farmers of the region [1]. Improvements in the feeding management of cattle on pasture must be considered in light of its effects on calf production.

The authors have reported on the herbage intake of dams and the fetal growth of Japanese Brown cattle grazed on pasture [2,5-8], as well as on the growth of calves of this breed under grazing conditions [9-12]. The management of suckling calves is important because their suckling condition is closely related to their future growth [11,13]. Many researchers have studied the growth and milk intake of Japanese Black calves [14-17], however, studies of Japanese Brown calves are rare [18]. In order to achieve effective management of suckling calves on pasture, it is necessary to determine the changes in intake of each milk constituent during the suckling term. In our previous studies [9,12], we investigated the characteristics of milk composition and milk intake and its retention in Japanese Brown cattle. The present paper describes the intake of milk constituents in suckling Japanese Brown calves on pasture.

Materials and Methods

1. Animals and feeding methods

For this experiment, conducted from 1993 to 1995, we used 21 calves (12 male and 9 female) and their dams selected from the herd of Japanese Brown cattle kept in the Biotechnical Center of Kyushu Tokai University. The calves were born in January or February of each experimental year. A herd of the cow-calf pairs were reared in a stable (0.03 hectares) until the end of March of each experimental year and fed ***ad libitum*** with hay mown from the pasture where the animals were to be grazed from April onward. The dams were given a supplemental formula diet (Nikuyougyu-Hansyokugyu, ZEN-NOH, Tokyo, Japan) in the amount of 0.3% of their live weight, but the calves received no such supplement. Beginning in April of each experimental year, after the calves had reached 60 days of age, the herd was rotationally grazed on a pasture of 2.03 hectares, which was partitioned into three areas, each containing tall fescue (***Festuca arundinacea*** Schreb.), orchard grass (***Dactylis glomerata*** L.) and white clover (***Trifolium repens*** L.). No supplemental feed was given to the animals during grazing. The male calves were castrated at about 100 days of age. All calves were weaned at 180 days of age.

2. Measurement of milk intake

The milk intake of the calves was measured nine times at intervals of 10-30 days during the suckling term. For each measurement, the calves were separated from their dams at 9:00 a.m. and were suckled at 4:00 p.m. and 11:00 p.m. on the same day, and at 7:00 a.m. the next morning. We decided on this schedule according to the results of our previous study [10]. The calves were weighed at both the beginning and the end of each suckling time. Their daily milk intake was calculated by summing the differences in their live weigh before and after each of the three suckling times.

The milk intake was measured in the stable when the calves were from 0 to 60 days of age, and in the pasture during the grazing period from 90 to 180 days of age. During the grazing period, the measurement of milk intake was carried out as follows: the calves were separated from their dams and placed in a 0.04-hectare paddock for a day where they were given fresh herbage mown from the pasture ***ad libitum***. The times and methods of measuring milk intake were otherwise the same as the above.

3. Analytical methods

Two hundred ml of milk per day was collected at each suckling so that its constituents could be analyzed and the collected milk was homogenized prior to analysis. The total solids content was measured according to AOAC procedure [19]; the protein and fat contents were analyzed using the Kjeldahl method [19] and the Rose-Gottlieb method [19], respectively; and the lactose content was measured by an enzymatic analysis using a food analysis kit (Boehringer Mannheim Inc., Mannheim, Germany). We conducted this experiment simultaneously with another study [9] investigating the milk composition; the changes in milk composition were the same as the study [9].

Results and Discussion

The live weight of the calves showed a linear increase during the suckling term (Fig. 1).The changes in live weight of both males and females can be expressed by the following equations:

$LW_M = 0.8864\,t + 35.2893$; ($r$=0.965, P<0.001),

$LW_F = 0.7480\,t + 30.0969$; ($r$=0.962, P<0.001),

where LWM and LWF are the live weights (kg) of the males and of the females, respectively. t is the age of the calf during the suckling term (t=0-180 days). Both slope (*i.e.*, daily gain) and intercept (*i.e.*, birth weight) were significantly higher (P<0.001) in the males' equation than in that of the females. Growth of both males and females was similar to the standard growth rate reported for Japanese Brown calves [20].

The relationship between the daily intake of milk constituents per live weight (g (kg LW)$^{-1}$ day^{-1}) and the days of age in both males and females are shown in Table 1. Significant negative correlations (P<0.001) were observed in exponential regressions in each relationship between milk constituent intake and days of age. The correlation coefficients of the exponential regressions were higher than those of both linear and quadratic regressions for all constituents. There were no differences between the sexes of the calves in the regression equations in the intake of any constituent. It has been shown that the difference in milk intake per calf among males and females is not due to any difference in milk intake per live weight be-

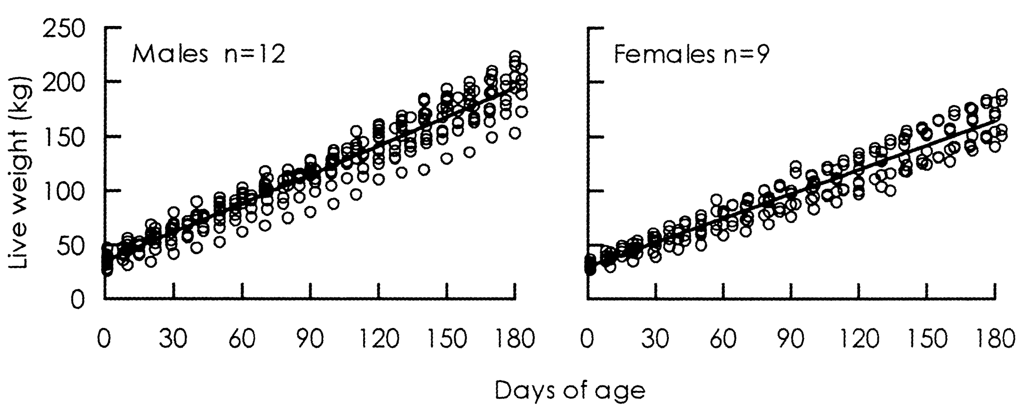

Fig.1. Changes in the live weight of the experimental calves during suckling term.

Table 1. Comparison of the regression of the days of age and the intake of milk constituent between sexes of calves.

	Constituents											
$I = b \exp(a\,t)$ [1)]	Whole milk		Protein		Fat		Total solids		Solid-not-fat		Lactose	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Slope (a)	-0.0110	-0.0105	-0.0117	-0.0115	-0.0097	-0.0108	-0.0109	-0.0107	-0.0112	-0.0107	-0.0110	-0.0104
t-test	P=0.472		P=0.781		P=0.424		P=0.759		P=0.470		P=0.399	
Intercept (b)	168.5930	157.5036	7.1365	6.8507	3.0472	3.1802	20.4757	19.4563	17.1471	16.0358	8.6819	8.0770
t-test	P=0.413		P=0.524		P=0.594		P=0.372		P=0.407		P=0.522	
Correlation coefficient (r)	-0.936***	-0.913***	-0.936***	-0.918***	-0.709***	-0.812***	-0.930***	-0.926***	-0.942***	-0.918***	-0.920***	-0.911***

1) where I is the intake of each milk constituent (g (kg LW)$^{-1}$ day^{-1}), and t is the days of age.

*** significant at 0.1% level.

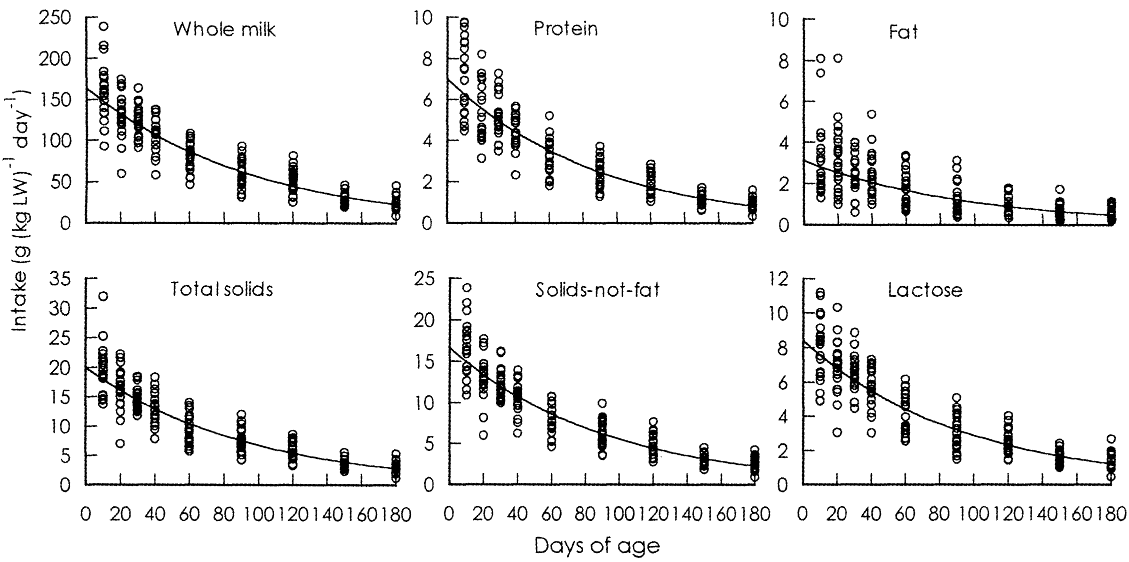

Fig.2. Changes in the intake of milk constituents.

tween the sexes, but rather corresponds to the difference in body size between the sexes [9,21]. The data of both sexes was analyzed together (Fig. 2)

because the data of the males and the females, adjusted for body size, shows no significant difference between the sexes. The following equations express the rate at which the daily intake (g (kg LW)$^{-1}$ day^{-1}) of each constituent decreased with age:

I_{WM} = 163.66424 exp (-0.01080 t); (r=-0.929, P<0.001),

I_{PRO} = 7.01009 exp (-0.01163 t); (r=-0.928, P<0.001),

I_{FAT} = 3.10339 exp (-0.01021 t); (r=-0.752, P<0.001),

I_{TS} = 20.02312 exp (-0.01083 t); (r=-0.928, P<0.001),

I_{SNF} = 16.65313 exp (-0.01100 t); (r=-0.931,P<0.001),

I_{LACT} = 8.41301 exp (-0.01070 t); (r=-0.916, P<0.001),

where I_{WM}, I_{PRO}, I_{FAT}, I_{TS}, I_{SNF} and I_{LACT} are intake of whole milk, protein, fat, total solids, solids-not-fat and lactose, respectively. t is the age of the calf in days during the suckling term (t=0-180 days). In order to compare reduction rates of the intake during the suckling term among the milk constituents, differences in slopes of the above regression equations were analyzed using the t-test (Table 2). There were no differences in the slopes (reduction rates) of the exponential regression equations among the constituents. The changes in intake of the milk constituents seem to be closely related to the whole

Table 2. *P*-values in the t-test for slopes of the regression equations.

Milk constituents	Milk constituents				
	Whole milk	Protein	Fat	Total solids	Solids-not-fat
Lactose	0.848	0.061	0.497	0.798	0.545
Solids-not-fat	0.670	0.177	0.280	0.718	
Total solids	0.947	0.091	0.393		
Fat	0.417	0.056			
Protein	0.082				

milk intake. However, the slope in the protein intake was the steepest among all the constituents, and the *P*-values in the t-test with the other constituents were low (*P*=0.056-0.177). Our previous study [9] on the milk of Japanese Brown cows shows that the protein content decreases significantly with days after calving, although other constituents remain almost uniform. This decrease in protein intake may be the cause not only of the decrease in whole milk intake, but also of the change in protein content as well.

The changes in whole milk intake found in the present study were similar to those found in the calves of Angus-Hereford F_1 dams [22]. In comparison with Japanese Black calves, the initial amounts (*i.e.*, the intercept of the equation) of both whole milk [15] and total solids [14] intakes in Japanese Black calves were higher, and the reduction rate (*i.e.*, the slope of the equation) found in Japanese Black calves was also higher than in the present results. In addition, we observed in our previous study [12] that Japanese Brown calves begin to eat herbage voluntarily at a later time than Japanese Black calves. The dependence upon milk intake for calf growth in the later part of the suckling term seems to be higher in Japanese Brown breed than in the Japanese Black.

Acknowledgments

The authors wish to thank the staff of the Biotechnical Center of Kyushu Tokai University.

References

1) Aso Secretariats, Kumamoto Prefecture. Stockbreeding of Aso. 1-18. 1999. **
2) Okamoto C, Kabata K, Kikuchi M. Estimation of secondary production of grazing pasture by Japanese Brown cows. West Japan J. Anim. Sci., 33: 23-28. 1990.*
3) The Council of Kumamoto Rakuza, The Kumamoto Nichinichi Shimbun, The Incorporated Foundation of Aso Greenstock. Situational Survey of Grassland and Pastoral Association in Aso County. 1-57. 1999.***
4) Nasu R. Present state and problem of grassland farming in the Aso region. J. Kyushu Br. Japan. Grassl. Sci., 23(1): 20-25. 1993. ***
5) Okamoto C, Kabata K, Kikuchi M. Productivity of grazing pasture comprising both native and improved areas in Aso area of Kyushu district. 1. Seasonal changes in herbage allowance and herbage intake. J. Japan. Grassl. Sci., 38: 26-35. 1992.
6) Okamoto C, Kabata K, Kikuchi M. Productivity of grazing pasture comprising both native and improved areas in Aso area of Kyushu district. 2. Grazing behavior of cows among both areas. J. Japan. Grassl. Sci., 40: 52-60. 1994.*
7) Okamoto C, Kabata K, Hattori N, Kikuchi M. Productivity of grazing pasture comprising both native and improved areas in Aso area of Kyushu district. 3. Estimation of digestibility of herbage grazed in the pasture. Grassland Science, 41: 42-47. 1995.*
8) Okamoto C, Kabata K, Tsuji K, Kikuchi M. Productivity of pasture consisting of both unimproved and improved areas in Aso Region of Kyushu District. Proc. XVIII Inter. Grassl. Congr., Vol.3(21): 47-48. 1997.
9) Tsuji K, Okamoto C, Kabata K, Hattori N, Koutaka T, Kikuchi M. Characteristics of milk and milk production in Japanese Brown cows. Proc. Sch. Agric. Kyushu Tokai Univ., 16: 33-38. 1997. *
10) Okamoto C, Tsuji K, Kabata K, Koutaka T, Kikuchi M. Behavior of suckling Japanese Brown calves on pasture. J.

Kyushu Br. Japan. Grassl. Sci., 27(2): 30-35. 1997. ***
11) Okamoto C, Tsuji K, Kabata K, Hattori N, Koutaka T, Kikuchi M. Factors affecting weight gain of suckling Japanese Brown calves. Proc. Sch. Agric. Kyushu Tokai Univ., 17: 29-34. 1998.
12) Okamoto C, Kabata K, Hattori N, Koutaka T, Kikuchi M. Energy intake and retention of suckling Japanese Brown calves on pasture. Grassland Science, 47: 16-20. 2001.
13) Willham RL. Beef milk production for maximum efficiency. J. Anim. Sci., 34: 864-869. 1972.
14) Kyuma T, Kikuchi T, Takahashi M, Takizawa S. Ingestive behavior and nutrient intake of suckling beef calves on pasture. Bull. Tohoku Natl. Agric. Exp. Stn., 52: 145-159. 1976.*
15) Noda M, Kibushi M, Fukushima M. Effect of Cow Milk Yield on Growth of Calves in Tajima Beef Cattle. Bull. Beef Cattle Sci., 67: 14-18. 1999.**
16) Terada T, Yoshida S, Onodera T. Some variation factors and practical estimation method of cow milk yield in beef cattle. Bull. Chugoku Natl. Agric. Exp. Stn., B24: 23-36. 1979. *
17) Shimada K, Lin EC, Ohshima K, Takenouchi N, Takahashi M. Relationship between breeding value of maternal genetic effect on calf growth and actual milk yield in Japanese Black cattle (Wagyu). Anim. Sci. Technol. (Jpn.), 67: 175-180. 1996.*
18) Hattori N, Tobioka H, Kinugawa K, Fujiwara N, Yamamoto T, Nishi R. Preliminary application of nursing facilities for calves separated from grazing cows. Suckling milk yield, composition and body weight of calf. Proc. Sch. Agric. Kyushu Tokai Univ., 16: 25-32. 1997.*
19) The Association of Official Analytical Chemists. Official methods of analysis, 14th Ed. The Association of Official Analytical Chemists. Arlington. 1984.
20) The Aso Branch of Kumamoto Station, National Livestock Breeding Center. Investigative Report of the Aso Branch of Kumamoto Station, National Livestock Breeding Center. 8: 22-47. 1981.***
21) National Research Council Secretariat of Agriculture, Forestry and Fisheries, Ministry of Agriculture, Forestry and Fisheries (Ed.). Japanese Feeding Standard for Beef Cattle. Central Association of Livestock Industry, Tokyo. 1987.**
22) Sowell SD, Wallac JD, Branine ME, Hubbert ME, Fredrickson EL, Bowman JPG. Effects of restricted suckling on forage intake of range calves. J. Range Manage., 49: 290-293. 1996.
* : In Japanese with English summary.
** : In Japanese only.
*** : In Japanese only. Title translated by the authors.