

# Effect of Levels of Nutrient on the Growing Performance and Nutrient Intake of Holstein Heifer as Influenced by Source of Roughage

Sang Gi Yun, Hyeun Shup Kim, Woo Sung Kang and Jong Hwangbo\*

## 조사료 급여원과 영양수준이 홀스타인 육성우의 성장 및 양분 섭취량에 미치는 효과

윤상기 · 김현섭 · 강우성 · 황보종\*

### 적 요

홀스타인 암소 육성우에 옥수수사일리지와 볏짚을 급여하면서 영양수준을 80, 100 그리고 120% (NRC 요구량 대비)로 급여할 때 육성우의 증체량 및 영양소 섭취량을 조사하기 위하여 육성우 30두를 각 처리당 5두씩 완전임의 배치로 공시하여 체중 400kg까지 시험을 수행한 결과는 다음과 같다.

1. 옥수수사일리지 및 볏짚급여시 육성기 최대 일당증체량은 각각 체중 200과 250kg일때였다.
2. 체중이 증가할수록 DM, CP 및 TDN 요구량은 증가되었으며 체중 250~300kg일때 이들 영양소 요구량이 가장 높았다.
3. 체중 250~300kg일때 체중(X)과 DM, CP, TDN 섭취량(I)과의 관계는 다음과 같다.

$$DMI = 8.0168X - 0.0209 \quad (r=0.7986^{**})$$

$$CPI = 1.1428X - 0.0145 \quad (r=0.5787^{**})$$

$$TDNI = 6.7620X - 0.3702 \quad (r=0.6877^{**})$$

### I. INTRODUCTION

Feeding of well-balanced diet to the young calves is no doubt very important. Of the nutrients, protein and energy are required more than others. Although many publications dealt with protein and energy requirement on Holstein heifers (ARC, 1980; NRC, 1978, 1988, 1991), it is still believed that there are marked variations in the protein and energy requirement of calves. These requirements are influenced by rate of gain, body size, age, diet or environmental conditions. However, dairy cattle in Korea have been reared mostly according to feeding standards established by ARC or NRC.

Growing calves require energy to form tissues

and make a physiological and biochemical reactions that are necessary to perform various metabolism. Thus, growth of growing calves requires more energy in addition to maintenance. The increased weight gain needs more protein, minerals and relatively less fat (Blaxter, 1962). Increase of body weight during growth largely consists of protein and fat. The theoretical minimum protein requirement for growth is far below the actual requirements because of the wastage in digestion and metabolism.

In general, the protein required by young calves or heifers is substantially higher than by old dairy cattle (NRC, 1991). As a calf grows, the percentage of protein needed declines quite rapidly (Broster et al., 1969; Jahn and Chandler, 1976).

축산시험장(Livestock Experiment Station, RDA, Suwon 441-350, Korea)

\* 경상대학교(Gyeong Sang National University, Chinju 660-701, Korea)

The objective of this study was to determine nutrient requirement of Holstein heifers fed corn silage or rice straw under feeding conditions in Korea.

## II. MATERIALS AND METHODS

Thirty growing Holstein heifers weighing 102.0 ± 1.1kg (average 100 days old) were used in the feeding trial. Animals were fed to gain average 0.8 kg per day according to NRC feeding standard until animals reached to 400kg of body weight. Experi-

mental period lasted for about 400~580 days. Animals were fed on diets of 3 treatments (80, 100 and 120% of NRC requirement) with 2 different roughage sources (corn silage and rice straw). The chemical compositions of roughage and concentrate are presented in Table 1.

Table 2 shows the ratio of roughage and concentrate at each class of body weight. Animals were fed individually, and their feed intake was measured at the time of every 50kg gain of body weight. A completely randomized design was used with 5 replications.

Table 1. Chemical composition of feed used.

Feed	DM	CP	EE	NFE	CF	Ash	TDN
	..... % .....						
Corn silage	24.9	2.3	0.9	14.8	5.5	1.4	16.7
Rice straw	88.0	4.5	2.1	38.0	28.3	15.1	37.5
Concentrate	88.0	16.0	3.2	50.3	8.7	9.8	72.0

Table 2. The ratio of roughage and concentrate at each growing stage of heifer.

Body wt. (kg)	Corn silage		Rice straw	
	Roughage	Conc.*	Roughage	Conc.*
100~150	50	50	30	70
150~200	60	40	30	70
200~250	70	30	40	60
250~300	70	30	40	60
300~350	80	20	50	50
350~400	80	20	50	50

\* Concentrate.

## III. RESULTS AND DISCUSSION

Table 3 shows days required for 50kg gain and daily weight gain at each level of nutrient by roughage source. In animal fed corn silage at 120 % level of NRC requirement, period required to gain 50kg from 100kg body weight was 50 days, but that in animal fed rice straw at the same level required 80 days to reach the same body weight. At this time, the highest daily weight gain was

obtained when corn silage was fed at 120% level of NRC requirement (0.82kg day<sup>-1</sup>), while rice straw at 80% level promoted the lowest 0.53kg of daily gain.

Animals fed corn silage at 80, 100 and 120% level required 70~80 days to reach from 150 to 200kg body weight and gained 0.67~0.81kg per day during this period, while heifers fed rice straw at 80~100% of NRC requirement required 90~100 days and gained 0.53~0.58 kg per day. And also,

heifers fed rice straw at 120% level required 80 days to gain 50kg from 150kg body weight, which is similar to those fed corn silage at 80% level.

Time required for 50kg weight gain from 200 kg body weight of heifers fed corn silage at 80~100% level and rice straw at 100~120% level was the same days(70 days). Although daily weight gain during this period was the highest in corn silage at 120% level and the lowest in rice straw at 80% of NRC requirement, that in corn silage at 80~100% level and in rice straw at 100~120% level was the similar (0.62~0.70kg day<sup>-1</sup>).

Feeding corn silage at 80, 100 and 120% level from 250 to 300kg of body weight promoted 0.67, 0.71 and 0.74kg gain per day, respectively, while rice straw 0.50, 0.60 and 0.65kg per day, respectively. And also, during the growth stage of 300~350kg, daily gain at 80% level with corn silage and rice straw was 0.64 and 0.51, at 100% level 0.68 and 0.58, and at 120% level 0.72 and 0.60kg, respectively. Days required to gain 50kg from 250 and 300kg body weight in feeding corn silage were 70~80 and 60~70 days, respectively, but those in rice straw 70~100 and 80~100 days, respectively.

Table 3. Days required for 50kg gain and daily weight gain at each level of nutrient by roughage source.

Body wt.		Corn silage			Rice straw		
		80*	100	120	80	100	120
100~150	duration(day)	84	70	50	89	90	80
	wt. gain (kg)	51.3	49.5	41.0	47.3	49.7	50.5
	Daily gain (kg)	0.61	0.71	0.82	0.53	0.55	0.63
150~200	duration(day)	80	70	70	100	90	80
	wt. gain (kg)	53.7	52.5	56.5	53.0	52.0	52.0
	Daily gain (kg)	0.67	0.75	0.81	0.53	0.58	0.65
200~250	duration(day)	70	70	60	90	70	70
	wt. gain (kg)	44.3	49.0	48.3	48.5	43.7	48.5
	Daily gain (kg)	0.63	0.70	0.81	0.54	0.62	0.69
250~300	duration(day)	80	70	80	90	100	70
	wt. gain (kg)	53.6	49.8	59.5	45.0	60.0	45.4
	Daily gain (kg)	0.67	0.71	0.74	0.50	0.60	0.65
300~350	duration(day)	70	70	60	100	80	90
	wt. gain (kg)	45.1	47.8	43.0	51.0	46.0	54.0
	Daily gain (kg)	0.64	0.68	0.72	0.51	0.58	0.60
350~400	duration(day)	90	90	80	110	90	90
	wt. gain (kg)	55.3	58.4	56.4	55.5	49.3	53.1
	Daily gain (kg)	0.61	0.65	0.71	0.51	0.55	0.59
100~400	duration(day)	470	440	400	580	520	480
	wt. gain (kg)	303.3	307.0	304.7	300.3	300.7	303.5
	Daily gain (kg)	0.65	0.70	0.73	0.52	0.58	0.63

\* of NRC requirement.

Among those periods, days required to gain 50kg from 250kg body weight in animal fed rice straw at 120% level were 70 days, which is similar to those in corn silage at 80~120% level(70~80 days).

Days needed to gain 50kg body weight in heifers fed corn silage and rice straw were 60~70 and 80~100 days respectively. Daily weight gain obtained by feeding 80, 100 and 120% level with rice straw was 0.51, 0.58 and 0.60kg day<sup>-1</sup>, respectively, but that with corn silage 0.64, 0.68 and 0.72kg day<sup>-1</sup>, respectively. In final feeding period, days required to gain 50kg from 350kg body weight with corn silage and rice straw were similar(80~90 days), except for feeding 80% level with rice straw (110 days).

Judging from the results of the present studies, it was apparent that animals fed corn silage showed the fastest weight gain in the growth stage of 150~200kg body weight, while those fed rice straw in 200~250kg body weight. Similar result was observed by Andrews et al. (1972), who reported that straws can be utilized by growing animals above 250kg

body weight.

Table 4 showed feed intake data during the experimental period. Daily dry matter intake of animals fed rice straw at 120% level of NRC requirement was the highest of all treatments (7.094kg day<sup>-1</sup>), while that of heifers fed corn silage at 80% level the lowest (4.597kg day<sup>-1</sup>). As animals grow, the TDN intake in corn silage was increased from 3.149 to 4.683 kg/day, while that in rice straw 2.955 to 4.438 kg day<sup>-1</sup>. These results were similar to those of Journet & Remond(1976) and Huth(1968), who indicated that feed intake increased with increased body weight, but this trend was affected by the type and quality of roughage.

Correlations between body weight and dry matter intake at different body weight are presented in Table 5. As body weight increased, dry matter requirement increased(p<0.01). This is in good agreement with reports of Holmes and Jones(1964) and Curran et al. (1970), but differs from the results of Copposk et al. (1974), who observed no relationship between dry matter intake and body weight.

Table 4. Effects of roughage sources on feed and nutrient intake.

Items	Corn silage			Rice straw		
	80	100	120	80	100	120
	..... kg/day .....					
Concentrate	1.400	1.737	2.040	2.904	3.612	4.402
Roughages	12.977	16.209	19.658	2.487	3.087	3.660
DM	4.597	5.565	6.690	4.744	5.894	7.094
CP	0.503	0.627	0.743	0.526	0.653	0.791
TDN	3.149	3.903	4.683	2.955	3.673	4.438

Table 5. Correlation between weight gain (X, kg) and DM intake (Y, kg).

Body weight (kg)	Equations	r
100~150	Y = 4.6776X + 0.2812	0.7775**
150~200	Y = 4.5458X + 1.1744	0.6895**
200~250	Y = 8.0168X + 0.0209	0.7986**
250~300	Y = 6.4453X + 1.8799	0.6246**
300~350	Y = 4.6023X + 3.9570	0.6694**
350~400	Y = 3.5644X + 6.0957	0.7984**

\*\* Significant at P<0.01.

The results of regression analysis between body weight gain and crude protein intake showed high significance ( $P < 0.01$ ) as shown in Table 6. As was in ARC(1980) and NRC(1988), requirement for crude protein increased with increased body weight. TDN intake, as presented in Table 7, was highly related to body weight gain ( $P < 0.01$ ), which is showing the same trend as that in dry matter and protein requirement.

In conclusion, NRC requirement on daily gain in growing heifer was 0.6~0.8kg per day. When based on this NRC requirement, animal fed corn silage could normally grow at all treatment levels, but those fed rice straw at only 120% level. And also, the growth stage of the highest daily gain in feeding corn silage and rice straw was at 200 and 250kg body weight, respectively.

Table 6. Correlation between weight gain (X, kg) and CP intake (Y, kg).

Body weight (kg)	Equations	r
100~150	$Y = 0.7960X - 0.0114$	0.8407**
150~200	$Y = 0.8012X + 0.0793$	0.5330**
200~250	$Y = 1.2766X + 0.1233$	0.6377**
250~300	$Y = 1.1428X + 0.0145$	0.5787**
300~350	$Y = 1.1050X + 0.0738$	0.6436**
350~400	$Y = 1.1383X + 0.0766$	0.6918**

\*\* Significant at  $P < 0.01$ .

Table 7. Correlation between weight gain (X, kg) and TDN intake (Y, kg).

Body weight (kg)	Equations	r
100~150	$Y = 3.6438X + 0.0427$	0.8071**
150~200	$Y = 4.0437X + 0.2728$	0.7261**
200~250	$Y = 6.4718X - 0.7282$	0.8938**
250~300	$Y = 6.7620X - 0.3702$	0.6877**
300~350	$Y = 6.5490X + 0.3428$	0.6304**
350~400	$Y = 3.4011X + 2.9048$	0.7401**

\*\* Significant at  $P < 0.01$ .

#### IV. SUMMARY

This experiment was carried out to determine the body weight gain, days required to be grown from 100 to 400kg body weight and nutrient intake of thirty growing Holstein heifers fed three different levels of nutrient (80, 100 and 120% of NRC requirement) by two different sources of roughage (corn silage and rice straw). The experiment was arranged as a completely random block design with 5 replications.

The results obtained are summarized as follows:

1. Average daily weight gain of heifers fed corn silage and rice straw was the highest at 200 and 250kg body weight, respectively.
2. As body weight increased, DM, CP and TDN requirement increased-especially requirement of those nutrients being the highest at about 250~300kg body weight.
3. At 250~300kg body weight, correlations between body weight(X) and DM, CP and TDN intake(I) requirement are the following.

DMI = 8.0168X - 0.0209 (r=0.7986\*\*)

CPI = 1.1428X - 0.0145 (r=0.5787\*\*)

TDNI = 6.7620X - 0.3702 (r=0.6877\*\*)

## V. LITERATURE CITED

1. Andrews, R.T., M.K. Curran and W. Holmes. 1972. The influence of supplements of energy and protein on the intake and performance of cattle on cereal straws. *Anim. Prod.* 15:167.
2. ARC. 1980. The nutrient requirements of ruminant Livestock Commonwealth Agricultural Bureaux, England.
3. Blaxter, K.L. 1962. The energy metabolism of ruminants. Hutchinson Sci. Tech. London.
4. Broster, W.H., V.J. Tuck, T. Smith and V.W. Johnson. 1969. Experiments on the nutrition of the dairy heifer. *J. Agri. Sci.* 72:13.
5. Coppock, C.E., C.H. Noller and S.A. Wolfe. 1974. Effect of forage concentrate ratio on complete feeds fed ad libitum on energy intake in relation to requirements by dairy cows. *J. Dairy Sci.* 57:1371.
6. Curran, M.K., R.H. Wimble and W. Holmes. 1970. Prediction of the voluntary intake of food by dairy cows. I. Stall-fed cows in late pregnancy and early lactation. *Anim. Prod.* 12:195.
7. Holmes, W. and J.G.H. Jones. 1964. The efficiency of utilization of fresh grass. *Proc. Nutr. Soc.* 23:88.
8. Huth, F.W. 1968. Futteraufnahme Vermogen und Nahrstof Verwertung bei schwartzbunter Kuhen. *Schriftenr Max, Planck Inst., Tierzucht.* 34:1-354.
9. Jahn, E. and P.T. Chandler. 1976. Performance and nutrient requirements of calves fed varying percentages of protein and fiber. *J. Anim. Sci.* 42:724.
10. Journet, M. and B. Remond. 1976. Physiological factors affecting the voluntary intake of feed by cows. *Livestock Prod. Sci.* 3:129.
11. NRC. 1978. 1988 and 1991. Nutrient requirements of dairy cattle. National Academy of Science. Washington. D.C.