Effects of Substituting Concentrates with Dried Leftover Food on Growth and Carcass Characteristics of Hanwoo Steers

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ABSTRACT : This study was conducted to determine the optimum substitution level of dried leftover food (DLF) in formula feed for Hanwoo (Korean Native Cattle) steers. A total of forty growing steers were assigned to 5 treatments based on substitution level of DLF (at 0, 25, 50, 75 and 100% level of formula feed). The experiment was carried out with growing steers from 6 months of age to 24 months of age. Average daily gain (ADG) was not affected by DLF substitution level up to 75% of formula feed. However ADG decreased at 100% substitution level. Daily feed intakes were similar among treatments but the amount of feed per 1 kg gain increased with increasing substitution level of DLF. Dressing percentage was around 62% in all treatments without any significant differences. Proportion of quality beef higher than grade 1 was the greatest from animals fed 25% substitution level of DLF. Economic efficiency for Hanwoo steer operator was the highest with 50% substitution level of DLF. ***(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 2 : 209-213)***

Key Words : Hanwoo, Dried Leftover Food, Growth Performance, Feed Intake, Carcass Characteristics

INTRODUCTION

The amount of food leftovers generated in 1998 in Korea was estimated to be 4.2 million tons and 4.4 million tons are expected to be generate in 2002 (Cho et al., 2004a, b). Various methods are proposed to use the leftover food as animal feeds. Those include drying, wet feeding, fermentation, cooking, and frying. Wet feeding and drying are the most favored method in Korea. Heat-sterilized leftover food generally contains 30-40% of moisture which is used as wet feeding method (Tadtiyant et al., 1988; Myer et al., 1994; Rivas et al., 1994). Fermented wet feed has excellent palatability and may control putrefaction. Leftover foods in pellet forms treated with heat or in ground dry forms had been compared as whole feed or as feed ingredients (Yu, 1998). Recently, researches have been performed to improve the efficiency of degradation using microbes, which has broad range of activity on degradation of leftover food (Gijen et al., 1988; Lee et al., 1997). McClure et al. (1970) reported that when 50% of dried leftover food was substituted for commercial feed for ruminant, nutritional quality of final feed was good enough to meet nutrient requirement of ruminant although feed intake was decreased (NRC, 1994). And feeding leftover food to beef cattle and sheep *ad libitum* was similar in feed intake to feeding commercial formula feed (McClure et al., 1970; NRC, 1994). Summers et al. (1980) reported that sheep were easily adapted to 30% substitution of formula feed with leftover food when feed intake was around 4.5% of body weight. The feed containing leftover food had good nutritional value, favorable digestibility without any harmful bacterial infection. However, Karalazos and Swan (1976) reported that if great amount of ingredient such as molasse were supplied to ruminant, fermentation pattern of rumen could be changed to increase the level of butyric acid. In such case, animal could not use ketone body generated in the rumen inducing Ketosis. Kil et al. (1999) also reported that if leftover food was supplied to ruminant, nitrogen absorption through stomach walls and nitrogen evacuated into urine could be increased due to excessive ammonia generated in reticulo-rumen. Therefore, supplementation of soluble carbohydrate to leftover food as a feed for ruminant is essential. McKnight et al. (1979) reported that the crude fat content of leftover food was 9.5% of dry matter which was higher than that of formula feed. However, the carbohydrate content of leftover food was lower than that of formula feed.

There are, however, a lot more researches on physical, chemical or biological treatment methods required to improve quality of leftover food as animal feeds. Therefore, the objective of this study was to determine the optimal substitution level of dried leftover food in formula feed for Hanwoo steers.

MATERIALS AND METHODS

Animals and feeding

Forty calves (Hanwoo) aged between 3-4 months with an average weight of 100 kg were purchased at local cattle market in Pyeongchang, Kangwon-Do. All the calves were castrated using a surgical operation and tamed for 60 days before the experiment started. The experimental diets were fed from 6 months to 24 months of age.

Five treatments were substitution levels of formula feed

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Received September 19, 2003; Accepted Jun 16, 2004

Table 1. Chemical composition of dried leftover food

Item	Average	Range
Chemical composition (%)		
Dry matter	85.3±1.3	79.39-92.64
Crude protein	20.1±1.2	18.21-22.05
Crude fat	9.1±1.0	7.70-10.91
Crude fiber	9.7±2.1	6.04-12.32
Crude ash	11.4±1.1	9.88-12.70
NaCl (%)	2.07±0.4	1.48-2.45
Gross energy (kcal/g)	4.0±0.3	3.68-4.39
Hg (mg/kg)	0.019±0.01	0.002-0.045
Vitamin A (IU/g)	22.9±0.8	22.28-24.15

with dried DLF at 0%, 25%, 50%, 75% and 100%. Eight heads of steer calves were randomly assigned to each treatment with some adjustment on the bases of body weight and age.

Calves were group fed in loose barns constructed with reinforced concrete (pen size, 5 m×10 m). Commercial formula feed was used as a concentrate to be substituted with DLF. And rice straw was used as roughage. Formula feed was supplied in the amount set to 1.5-2.0% of body weight. All the steers had free access to rice straw. Mineral supplements in salted mineral blocks and water were also supplied *ad libitum*.

Dried leftover food

Dried leftover food was collected from residential apartment complexes. Processing of DLF was rinsing out with water → grinding (hammer cruller)→dehydration (screw press) → vacuum dehydration (steam) → mixing with rice bran → removing foreign substances (drum screen) → removing metals (magnet separator) → removing fine alien substances (shaking sorter) → storage → packaging. Nutrient contents of dried leftover food were measured by chemical analysis every month.

Carcass evaluation

Upon termination of experiments, all the steers were slaughtered at slaughter house of the meat science lab of National Livestock Research Institute (NLRI), located in Suwon, Korea. Fasted animals were weighed and slaughtered. And after an overnight chilling process, beef yield and quality grades were assessed by a trained evaluator by observing at the vertical surface of loin eye area between the last thoracic vertebrae and the first lumbar vertebrae. Marbling scores were assessed in scores from 1 (no marbling) to 7 (high marbling) with final quality grades from 3 (low quality) to 1+(very high quality) considering colors, maturity and texture as well as marbling. Carcass yield grades from C (low yield) to A (high yield) were calculated by an index that considers carcass weight, back fat thickness and loin eye area according to the standard of Korean Meat Evaluation System. Crude fat contents in the loin eye area were analyzed by ether extraction in the meat science lab of NLRI by taking samples from cold carcasses where the carcass evaluation had been made.

Table 2. Nutritional composition of experimental diets

Item	Dry matter	Cruds protein	TDN[1]
Concentrate (%)			
Grower	88.9	15.0	71.0
Finisher I (early)	88.0	13.0	72.0
Finisher II (late)	88.4	11.2	73.0
Dried leftover food (%)	85.3	20.1	51.4
Rice straw (%)	88.0	4.5	37.5

[1] Calculated value.

Measurements and statistical analysis

Body weights were measured every 15 days from the beginning to the end of experiment at 2:00-3:00 pm. On the day of beginning and end of experiment, body weights were measured twice on 2 consecutive days and the average weight of two measurements were takene. Feed intake was calculated by weighing feed residue remained in the feeder before feeding every morning. Chemical composition of feed was analyzed by the method of AOAC (1990). TDN contents of formula feed and rice straw were calculated according to digestion coefficients estimated by RDA (1988) and Lee (1998). Data analysis was performed using SAS package (1995). Treatment means were separated by Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Nutritive value of dried leftover food as a feed

Chemical composition and calories of dried leftover food used in this study are shown in Table 1. NaCl concentration of DLF was about twice as those of commercial feeds for Hanwoo or dairy cattle (RDA and NLRI, 1999). NaCl concentration of DLF did not exceed toxic level (>5.0%) set by feed regulation. Any special disease or poisoning symptoms associated with NaCl toxicity were not found.

According to the Feed Regulation Act. 12, acceptable limits of toxic minerals in the feed are 20 ppm Pb, 2.5 ppm Cd, 0.5 ppm Hg and 50 ppb aflatoxins. Among these toxic substances, only Hg was detected in the range of 0.002-0.045 ppm, still lower than the limit. Table 2 shows nutritional composition of experimental diet components used in this study.

Feed intake and utilization

Table 3 shows the amount of feed intake and nutrient utilization by experimental diets during the growing phase (6 months to 12 months of age). Average daily intakes of

Table 3. Effects of substitution levels of dried leftover food (DLF) for formula feed on the feed efficiency during the growing phase (6 mo-12 mo)

Item	Substitution levels (%) of DLF				
	0	25	50	75	100
Feed intake (kg/day)					
Concentrate	3.9	3.3	2.1	1.1	-
DLF	-	2.2	4.2	6.3	5.5
Rice straw	2.8	2.5	2.1	1.9	2.1
Feed intake per kg gain					
DM	5.8	7.0	7.3	8.1	6.6
CP	0.70	1.08	1.28	1.55	1.24
TDN	3.78	4.46	4.46	4.73	3.63

Table 4. Effects of substitution levels of dried leftover food (DLF) for formula feed on the feed efficiency during the finishing stage (13 mo-24 mo)

Item	Substitution levels (%) of DLF				
	0	25	50	75	100
Feed intake (kg/day)					
Concentrate	9.7	7.2	4.6	2.8	-
Food waste	-	2.6	4.8	7.9	10.1
Rice straw	2.0	2.0	2.0	2.2	2.1
Feed intake per kg gain					
DM	11.5	12.6	12.4	14.8	15.6
CP	1.37	1.86	2.07	2.73	3.25
TDN	8.63	9.03	8.28	9.21	9.96

Table 5. Body weight and average daily gain of Hanwoo steers fed different levels of dried leftover food (DLF)

Item	Substitution levels (%) of DLF				
	0	25	50	75	100
Body weight (kg)					
6 month of age	145.4±36.2	145.6±26.7	141.6±24.6	144.5±25.6	146.1±43.2
12 month of age	288.1±48.2[b]	319.3±38.6[ab]	325.6±37.4[ab]	340.8±40.3[a]	310.8±43.4[ab]
18 month of age	448.3±49.6	457.8±34.0	473.3±50.8	494.0±39.3	453.5±45.8
24 month of age	610.8±50.9	600.3±73.1	608.5±72.7	611.4±37.0	558.4±41.8
ADG (kg)					
Growing stage	0.80±0.08[c]	0.97±0.16[ab]	1.03±0.13[a]	1.09±0.15[a]	0.88±0.12[bc]
Finisher stage I	0.89±0.11	0.77±0.20	0.82±0.13	0.80±0.09	0.79±0.07
Finisher stage II	0.89±0.15[a]	0.79±0.25[ab]	0.74±0.14[ab]	0.65±0.09[bc]	0.58±0.07[c]
Overall period	0.86±0.06	0.84±0.16	0.87±0.12	0.85±0.07	0.75±0.06

[a, b, c] Mean in the same row with different superscripts differ (p<0.05).
Growing stage: from 6 mo. to 12 mo. of age; Finisher stage I: from 13 mo. to 18 mo. of age; Finisher stage II: from 19 mo. to 24 mo. of age.

formula feed, rice straw and DLF were 0-3.9 kg, 1.9-2.8 kg and 0-6.3 kg, respectively. Total feed intake was increased with increasing substitution level of DLF and was the most at 75% substitution. However, feed intake of rice straw showed opposite pattern to total feed intake pattern. The DM, CP and TDN intake per kg body weight gain were 5.8-8.1 kg, 0.70-1.55 kg and 3.78-4.73 kg, respectively. The DM, CP and TDN intake for 1 kg body weight gain reached peak at 75% substitution level of DLF. Relative digestion efficiency of DM, CP and TDN at 75% substitution level of DLF as compared to non-DLF diet (control) were estimated to be 72%, 45% and 80%.

Table 4 shows amount of feed intake and nutrient utilization during finishing stage (13-24 months). The average daily feed intake of formula feed, rice straw and DLF ranged 0-9.7 kg, 2.0-2.1 kg and 0-10.1 kg, respectively. Unlike growing stage, total feed intake and rice straw intake did not differ among treatment groups.

DM, CP and TDN intake per kg body weight gain were 11.5-15.6 kg, 1.37-3.25 kg and 8.63-9.96 kg, respectively. The DM, CP and TDN intake for kg body weight gain reached peak at 100% substitution level of DLF. According to the observations at growing and finishing stages, increasing substitution level of DLF tends to decrease feed efficiency.

McClure et al. (1970) reported that feed intake was decreased at 50% substitution level of DLF for formula feed. But feed efficiency did not decrease up to 75% substitution level of DLF for formula feed. This result could partly be explained by good nutritive quality of DLF due to its stern manufacturing process.

Growth and weight gain

The effects of substitution level of DLF for formula feed on body weight gain for Hanwoo steers are shown in Table 5. Daily weight gain during the growing stage (6-12 months) was significantly lower in groups fed 100% formula feed (control) than the other groups (p<0.05). According to nutrient analysis, nutritional value of DLF-containing diet was lower than that of control diet. Therefore, feed intake of DLF-fed groups should be higher than those on control (2.5% of body weight) to maintain the nutritional balance. For this reason, average daily gain during the growing stage was significantly higher in DLF-fed group than that in control group (p<0.05). However, concentrate feed was supplied in standard ratio based on body weight during finishing stage. ADG of control groups (0.89 kg) tended to be higher than those of DLF-fed groups (0.58-0.82 kg), but without any significant differences. During finishing stage II when concentrate feed was supplied *ad libitum*, ADG of control group was significantly higher than those of DLF-fed groups (at 75

Table 6. Effects of substitution levels of dried leftover food (DLF) for formula feed on carcass characteristics of Hanwoo Steers

Item	Substitution levels (%) of DLF				
	0	25	50	75	100
Slaughter weight (kg)	618.9±55.1	603.0±41.0	631.3±60.6	605.9±30.2	551.9±23.7
Carcass weight (kg)	386.4±39.3[a]	378.6±26.7[a]	398.2±36.9[a]	378.6±16.9[a]	338.8±20.7[b]
Dressing (%)	62.4±0.9	62.8±1.5	63.1±1.6	62.5±1.6	61.4±2.0
Retailed cuts (%)	63.8±2.2[b]	62.8±3.0[b]	63.5±1.5[b]	61.6±0.8[b]	66.5±1.4[a]
Fat (%)	24.2±2.8[a]	25.2±2.8[a]	24.7±2.0[a]	26.0±0.9[a]	20.2±2.2[b]

[a, b, c] Mean in the same row with different superscripts differ ($p<0.05$).

Table 7. Effects of substitution levels of dried leftover food (DLF) for formula feed on carcass quality and yield traits of Hanwoo steers

Item	Substitution levels (%) of DLF				
	0	25	50	75	100
Carcass yield traits					
Carcass wt. (kg)	386.4±39.3[a]	378.6±26.7[a]	398.2±36.9[a]	378.6±16.9[a]	338.8±20.7[b]
Loin eye area (cm^2)	81.4±5.5	82.9±7.7	79.5±4.5	75.7±10.6	73.3±11.7
Back fat thickness (mm)	10.0±4.8	9.8±3.0	10.5±2.6	10.1±4.3	7.6±3.2
Yield grade (A:B:C)	4:3:1	3:5:0	1:7:0	3:3:1	5:3:0
Quality traits					
Marbling score	3.3±1.4	4.8±1.5	3.4±1.5	3.8±1.7	3.7±2.1
Meat color	4.4±0.5	4.3±0.5	4.1±0.4	4.1±0.4	4.4±0.5
Fat color	2.9±0.4	3.0±0.0	3.0±0.0	2.9±0.4	2.9±0.4
Firmness	1.3±0.0	1.3±0.0	1.3±0.0	1.3±0.0	1.3±0.0
Maturity	1.9±0.2[a]	1.6±0.3[b]	1.9±0.2[a]	1.8±0.2[ab]	1.8±0.3[ab]
Meat quality grade (1^+:1:2:3)	0:2:5:1	2:4:2:0	0:3:3:2	0:4:2:1	2:1:3:2

[a, b, c] Mean in the same row with different superscripts differ ($P<0.05$).

and 100% substitution level). Increased level of DLF in the concentrate decreased ADG because of low nutritive quality of DLF, particularly, in TDN level (see Table 3).

Hong et al. (1996) reported that ADG of Hanwoo steers ranged 0.63-0.71 kg for growing stages when they fed concentrate diets at 1.5% of body weight with free access to rice straw. ADG shown in this study was higher than those from Hong et al.'s result maybe due to higher feed intake (2.0% BW) in our experiment.

Carcass characteristics

Table 6 shows the effects of DLF substitution level on carcass characteristics of Hanwoo steers. Average carcass weight and slaughter weight of 100% DLF feed groups were significantly lower than the other groups ($p<0.05$). Dressing percentage was the highest from groups of 50% substitution level of DLF for formula feed and the lowest in 100% substitution level of DLF. But any significant differences were not found between treatment groups. Average retail cut percentage in 100% substitution level of DLF was significantly higher (66.5%) than those of the other treatment groups ($p<0.05$). Fat content in animal body was significantly lower in 100% substitution level of DLF for formula feed compared to the other treatments ($p<0.05$).

Table 7 shows the effects of substitution level of DLF for formula feed on carcass quality and yield traits. Average loin eye areas were not significantly different between treatment groups. However, increasing substitution levels of DLF tended to produce carcasses with slightly less loin eye area. Back fat thickness was around 10 mm in all treatment groups except groups of 100% substitution level of DLF for formula feed whose back fats were some thinner than the others. This might be due to lower energy content of DLF than commercial formula feed. Marbling score was highest in 25% substitution level of DLF for formula feed (4.8) but without any significant difference. There were no significant differences among treatments in meat color or fat color.

Animals were observed 1-2 times a day during the experimental period to investigate disease occurrence. But any pathological symptoms were not observed in DLF-fed groups and no clinical signs were detected from meat products after slaughter.

Economic analysis

Economical efficiencies of substituting formula feed for finishing Hanwoo steers with DLF at different levels were analyzed (data not shown). The results showed that income per head was highest in 50% substitution level of DLF for formula feed and lower in groups fed DLF over 75% substitution level than that of control.

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