

Effects of Flaxseed Diets on Fattening Response of Hanwoo Cattle :

1. Performance and Carcass Characteristics

C. M. Kim, J. H. Kim, T. Y. Chung and K. K. Park*

Animal Resources Research Center, College of Animal Husbandry, Konkuk University, 1 Hwayang-dong
Gwangjin-gu, Seoul, 143-701, Korea

ABSTRACT : Two separate trials were conducted to determine effects of dietary level of whole flaxseed (WFS; 0, 10 and 15%) on feed intake, weight gain, and carcass yield and quality of Korean Hanwoo cattle. The daily gains of bulls (Trial 1) were not different among treatment groups, but those of cows (Trial 2) fed WFS 15% were higher ($p < 0.01$) than others. Feed intake of both bulls and cows tended to decrease as dietary level of WFS increased. However, feed conversion ratio (feed/gain) of bulls tended to be improved by dietary inclusion of WFS and was significantly improved ($p < 0.01$) in cows by increasing level of WFS. Neither carcass weight nor dressing percentage were affected by WFS level. Back fat thickness of bulls was decreased ($p < 0.01$) by dietary inclusion of WFS and the same trend was observed in cows without statistical significance. Loin-eye area of bulls was not different among treatment groups but was significantly higher ($p < 0.01$) in cows fed WFS. Carcass yield and quality were not improved by WFS addition. The results indicate that WFS is an acceptable fat source in diets of finishing beef cattle to increase energy density without any adverse effects. (*Asian-Aust. J. Anim. Sci.* 2004, Vol 17, No. 9 : 1241-1245)

Key Words : Hanwoo Cattle, Flaxseed, Performance, Carcass Characteristics, Oilseeds, Fat Supplementation

INTRODUCTION

Addition of fat to finishing diets of beef cattle can increase energy density and enhance meat quality by increasing fat deposition (Garrett et al., 1976; Rule et al., 1989), but may have negative effects on fiber digestibility (Johnson and McClure, 1973). Although decreased fiber digestibility is not a major concern in finishing diets of beef cattle, fat sources with minimal effects on fiber digestibility or microbial growth would nonetheless be advantageous in terms of quantities of both energy and amino acids absorbed.

Attention has been directed towards the feeding of protected fat to ruminants (Kita et al., 2002; Sarwar et al., 2004; Wang et al., 2004). Whole oilseeds, with a natural fiber coating surrounding the oil, can be used as naturally occurring protected fat sources for ruminant diets (White et al., 1987). Furthermore, unprocessed oilseeds can spare any processing cost and be stored for a long period without the oxidation problem of unsaturated fatty acids that are high in oilseeds.

The composition of whole flaxseed (WFS) is similar to other oilseeds, high in fat (38%), protein (25%), and fiber (47% neutral detergent fiber; NDF), but different in that WFS seed is relatively small in size and the seed coat is hard. If energy density of diets could be elevated by addition of WFS with minimal or no effects on ruminal fermentation, levels of animal performance and carcass characteristics can be increased with cost of gains being reduced.

Limited research has been carried out on WFS for swine (Romans et al., 1995; Enser et al., 2000), for poultry (Scheideler and Froning, 1996; An et al., 1997), and for dairy (Petit, 2002; Ward et al., 2002; Petit, 2003), but little information is available for beef cattle. Therefore, two trials were conducted to determine the effects of dietary level of WFS on feed intake, weight gain, and carcass yield and quality of Hanwoo bulls and cows.

MATERIALS AND METHODS

Animals and diets

Trial 1 was conducted at a farm located in the southeast (Gyeongsangbuk-Do) of Korea. Twenty-one Hanwoo bulls (mean initial weight $485 \text{ kg} \pm 17$) were allotted randomly to one of three dietary treatments: 1) WFS 0% (control), 2) WFS 10%, and 3) WFS 15%. Bulls were housed by treatment group in three $4.3 \text{ m} \times 7.4 \text{ m}$ pens with concrete floor in an enclosed barn. Diets were fed for 130 days starting in October.

Trial 2 was conducted at a farm located in the northeast (Gangwon-Do) of Korea. Fifteen Hanwoo cows (mean initial weight $418 \text{ kg} \pm 14$) were randomly assigned to the same dietary treatments used in Trial 1. Each treatment group was placed in a $3.8 \text{ m} \times 7.0 \text{ m}$ pen with a concrete floor. Cows were offered their assigned diets for 156 days starting in mid-July.

Within each trial, diets were formulated to contain equal levels of protein and Ca. All animals had *ad libitum* access to concentrates for the entire experimental period, whereas roughage (rice straw) intake was set at $1.0 \text{ kg/animal/day}$.

* Corresponding Author: Keun-kyu Park. Tel: +82-2-450-3661, Fax: +82-2-455-1044, E-mail: kkpark@konkuk.ac.kr
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Table 1. Ingredient and chemical composition of concentrate diets fed to Hanwoo bulls and cows

Item	Bulls			Cows		
	Control	WFS 10%	WFS 15%	Control	WFS 10%	WFS 15%
Ingredients, %						
Ground corn	37.50	36.50	35.50	39.50	37.50	37.50
Wheat grain	29.50	27.50	27.00	30.00	28.00	26.00
Wheat bran	5.00	5.00	5.00	4.50	4.50	4.50
Cottonseed meal	5.50	5.50	5.50	5.00	5.00	5.00
Rapeseed meal	4.00	4.00	4.00	4.00	4.00	4.00
Flaxseed meal	10.50	3.50	-	9.00	3.00	-
Flaxseed	-	10.00	15.00	-	10.00	15.00
Molasses	5.00	5.00	5.00	5.00	5.00	5.00
Limestone	1.00	1.00	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Ca-phosphate	0.50	0.50	0.50	0.50	0.50	0.50
Premix ²	1.00	1.00	1.00	1.00	1.00	1.00
Chemical composition						
Dry matter, %	87.46	87.11	87.73	88.44	88.77	92.09
----- % of DM -----						
Crude protein	18.63	18.23	18.34	17.63	17.71	17.95
Ether extract	2.53	4.38	4.96	2.32	3.39	5.58
Crude ash	8.14	8.01	7.86	8.18	8.09	7.66
Neutral detergent fiber	39.19	42.43	44.08	47.49	47.86	50.08
Acid detergent fiber	11.84	15.75	16.52	15.84	15.95	16.90

¹ Whole flaxseed.

² Contains the following in kg of mixture: Vit. A 2,000,000 IU; Vit. D₃ 400,000 IU; Vit. E 1,500 IU; Mn 12,000 mg; Fe 12,000 mg; Zn 8,000 mg; Cu 1,000 mg; Co 1,000 mg; I 150 mg.

Table 2. Chemical composition of whole flaxseed(WFS) and rice straw fed to Hanwoo bulls and cows

Item	Bulls		Cows	
	WFS	Rice straw	WFS	Rice straw
Dry matter, %	90.81	88.74	92.35	89.88
----- % of DM -----				
Crude protein	25.18	5.38	24.80	5.46
Ether extract	37.94	1.64	38.37	1.59
Neutral detergent fiber	47.43	74.62	46.93	75.92
Acid detergent fiber	36.94	50.91	36.41	50.93

Animals in both trials were gradually adapted to their diets for the first 10 days and were fed equal portions twice daily, at 07:00 and 17:00. Amounts of feeds offered were recorded and refused feed was weighed back once every 2 wk to determine daily intake and feed/gain ratio. Feed samples were mixed throughout the feeding period and were ground through a 1 mm screen before analyses. Concentrates, rice straw, and WFS were analyzed for DM, ash, crude protein, ether extract (AOAC, 1990), NDF, and ADF (Goering and Van Soest, 1970). Amylase was used to determine the NDF content of concentrates (Cherney et al., 1989). Nutrient composition of concentrates used in Trials 1 and 2 is presented in Table 1; composition of WFS and rice straw is shown in Table 2.

Carcass characteristics

Initial and final weights of each trial were the averages

of two consecutive early-morning weights. All cattle were slaughtered at a commercial abattoir; carcass measurements were obtained after chilling for 24 h at 2°C. Carcass yield and quality were determined at the 13th rib section from the left side of each carcass and graded by meat graders using the criteria provided by the Korean carcass grading system (NLCF, 1999). Carcass yield index (YI) was calculated from the following equation as described by the grading system:

$$YI = 65.834 - (0.393 \times \text{backfat thickness, mm}) + (0.088 \times \text{longissimus muscle area, cm}^2) - (0.008 \times \text{carcass wt., kg})$$

A score of carcass yield A represents "high (YI over 69.0)", a B "medium (YI between 66.0-69.0)" and a C "low (YI under 66.0)". Carcass quality (1=high, 2=medium, 3=low) was determined by the following factors:

- i) marbling score (1=devoid, 7=very abundant marbling);
- ii) meat color (1=very light cherry red, 7=very dark red);
- iii) fat color (1=white, 7=bright lemon yellow);
- iv) texture (1=good, 3=bad);
- v) maturity (1=youthful, 3=mature).

Statistical analyses

Performance and carcass trait data were analyzed by General Linear Models procedure of the SAS (1990). Data from two trials were analyzed independently because of differences in sex, body weight, farm location, nutrient

Table 3. Effects of dietary whole flaxseed (WFS) on BW, daily gain, feed intake and feed/gain ratio of Hanwoo bulls and cows

Item	Bulls				Cows			
	Control	WFS 10%	WFS 15%	SE	Control	WFS 10%	WFS 15%	SE
Initial body wt, kg	484.0	483.0	488.0	6.84	414.8	422.0	415.6	7.54
Final body wt, kg	599.6	597.1	608.4	8.35	484.0	485.0	486.0	6.35
Daily gain, kg	0.89	0.88	0.91	0.02	0.52 ^B	0.57 ^B	0.64 ^A	0.01
Daily feed intake, kg	7.92	7.74	7.69	0.03	7.39	7.29	7.27	0.03
Feed/gain ratio	8.91	8.80	8.45	0.08	14.21 ^A	12.78 ^B	11.36 ^C	0.37

^{A, B, C} Means in a row within same animal group followed by an uncommon letter differ ($p < 0.01$).

composition of diets, and feeding period. Differences among means were determined by Duncan's multiple range test when F values were significant ($p < 0.05$ or $p < 0.01$).

RESULTS AND DISCUSSION

Performance

Body weight change, daily weight gain, feed intake, and feed/gain ratio in Hanwoo bulls and cows fed the experimental diets are shown in Table 3. The daily gains of cows were much lower than those of bulls. The daily gains of bulls (Trial 1) were not different among treatment groups, but those of cows (Trial 2) fed WFS 15% were higher ($p < 0.01$) than others. These results may be related to the difference in fat content of the diets. Chemical analyses (Table 1) indicate that 1.9 and 2.4% fat were supplied by WFS in WFS 10 and 15% diets of bulls, and comparable values for cows were 1.1 and 3.5%, respectively. Thus, the relatively high content of fat in the WFS 15% diet of cows may have led to increased daily gain. In addition, the difference in sex may have contributed to the different responses of the two genders. For example, NRC (2000; beef cattle) suggests a 15% greater maintenance energy requirement for intact males compared with castrates and females.

Feed intake of both bulls and cows tended to be decreased as dietary level of WFS increased. Considering the relatively long experimental period of both trials (130 d for bulls and 156 d for cows), these results might be associated with the negative effect of fat addition on fiber digestion and (or) ruminal microbial populations (Henderson, 1973; Johnson and McCulre, 1973). Palmquist and Jenkins (1980) summarized that fat at 5 to 10% of the diet reduces intake and digestion. Rule et al. (1989) also reported that dry matter intake is often depressed when diets contain more than 8% fat. With diets containing lower levels of fat, Huerta-Leidenz et al. (1991) reported that dietary whole cottonseed levels of 15 or 30% (3.3 and 6.6% additional fat) did not influence daily gain, intake, or feed conversion ratio. In the present study, fat concentrations of the experimental diets were 4.38 and 4.96% in WFS 10 and 15% diets of bulls and 3.39 and 5.58% in WFS diets of cows, respectively. Considering the additional amount of fat that was derived from intact flaxseed, it is unlikely that these

levels of fat influenced feed intake. Similarly, feeding 10% (Petit, 2002) and up to 15% of the total DM as whole flaxseed (Kenelly and Khorasani, 1992) had no negative effect on DM intake by dairy cows. In addition, Hussein et al. (1996) noted that a diet containing 9.87% fat with crushed canola seed at relatively low forage percentage (30% of DM) had no negative effect on intake by steers. The authors suggested that crushing rather than grinding canola seed results in slower release of the oil in the rumen and, thereby, minimizes potential for adverse effect on feed intake. Therefore, it is doubtful that addition of WFS at 10 or 15% of the diet may lead to slight depression in intake.

Feed conversion ratio (feed/gain) of bulls tended to be improved, and the ratio for cows was significantly improved ($p < 0.01$) by increasing dietary level of WFS. Feeding soybean oil, tallow, or yellow grease at 3.5% of dietary DM increased daily gain and feed efficiency of finishing steers without impacting DM intake (Brandt and Anderson, 1990). Bock et al. (1991) suggested that improved feed utilization with dietary fat addition was related to increased energy density. Most research concerning fat addition to ruminant diets has been conducted with sheep or dairy cows and, therefore, cannot be extrapolated directly to finishing beef cattle settings. For example, with high-concentrate diets lipolytic and biohydrogenating activities of the ruminal microbes are inhibited (Latham et al., 1972), which suggest that effects of dietary fat addition may differ from ones with diets high in forage (Brandt and Anderson, 1990). Based on the animal performance data, WFS can be an acceptable fat source to increase energy density in finishing beef cattle without any adverse effects.

Carcass characteristics

Carcass weight, dressing percentage, backfat thickness, loin-eye area, and yield grade of Hanwoo cattle fed diets containing 0, 10 or 15% WFS are shown in Table 4. Both carcass weight and dressing percentage were not significantly influenced by the dietary treatments.

Backfat thickness for bulls was decreased ($p < 0.01$) by dietary inclusion of WFS, and for cows tended to be decreased by WFS diet with increasing level of WFS. These results are unexpected because feeding fat generally increases backfat thickness (Garrett et al., 1976; Bock et al.,

Table 4. Effects of dietary whole flaxseed (WFS) on carcass yield of Hanwoo bulls and cows

Item	Bulls				Cows			
	Control	WFS 10%	WFS 15%	SE	Control	WFS 10%	WFS 15%	SE
Carcass wt, kg	342.6	345.0	351.1	3.77	287.0	288.2	292.0	3.45
Dressing, %	57.1	57.8	57.7	1.04	59.33	59.44	60.11	1.05
Backfat thickness, cm	0.61 ^A	0.51 ^B	0.53 ^B	0.07	0.80	0.72	0.66	0.08
Loin-eye area, cm ²	80.6	81.9	80.7	2.32	68.6 ^B	74.4 ^A	74.6 ^A	1.83
Yield grade ¹	2.29	2.29	2.29	0.31	2.08	2.24	2.40	0.32

^{A,B} Means in a row within same animal group followed by an uncommon letter differ ($p < 0.01$).

¹ A grade (yield index ≥ 69.0)=3, B grade ($66.0 \leq$ yield index < 69.0)=2, C grade (yield index < 66.0)=1.

Table 5. Effects of dietary whole flaxseed (WFS) on carcass quality of Hanwoo bulls and cows

Item	Bulls				Cows			
	Control	WFS 10%	WFS 15%	SE	Control	WFS 10%	WFS 15%	SE
Marbling score ¹	2.75	3.07	3.36	0.31	4.50	4.44	4.10	0.27
Meat color ²	3.70	4.29	4.29	0.29	5.40	5.40	5.40	0.37
Fat color ³	3.10	3.29	3.57	0.11	3.40	4.00	3.80	0.11
Firmness ⁴	2.10	2.00	2.00	0.08	2.72	2.50	2.50	0.15
Maturity ⁵	1.50	1.50	1.50	0.02	1.30	1.30	1.40	0.09
Quality grade ⁶	1.73	1.86	2.00	0.26	2.42	2.59	2.42	0.18

¹ Marbling score standard: 1=devoid, 7=very abundant. ² Meat score standard: 1=very light cherry red, 7=very dark red.

³ Fat color standard: 1=white, 7=bright lemon yellow. ⁴ Firmness: 1=firm, 3=soft.

⁵ Maturity: 1=youthful, 3=mature. ⁶ 1st grade (good)=4, 1st grade=3, 2nd grade=2, 3rd grade (bad)=1.

1991; Lee et al., 2003). However, high-fat diets have not always increased backfat thickness (Rule et al., 1994), which is more related to energy intake rather than dietary energy concentration (Solomon et al., 1992). In this regard, Brandt and Anderson (1990) summarized seven experiments involving more than 1,000 yearling cattle fed diets with 0 vs. 3.5 or 4% supplemental fat. Fat supplementation did not influence dressing percentage or consistently increase backfat thickness.

Loin-eye area was not different among treatment groups of bulls but was higher ($p < 0.01$) in cows fed WFS. Cows had greater backfat thickness than bulls (0.54 vs. 0.73 cm), and loin-eye area was greater for bulls (81.7 vs. 72.9 cm²). Dietary WFS did not affect carcass yield or grade.

Marbling score of bulls tended to increase as dietary level of WFS increased, but for cows marbling score tended to decrease (Table 5). The reason for this discrepancy between bulls and cows is unclear. Although not measured in this study, bulls may deposit supplemental fat from WFS to as intramuscular fat and cows in subcutaneous and(or) internal depots (kidney, pelvic and heart). Further study to clarify these effects is required.

The subjective score for meat color was not influenced by dietary treatment. However, meat color for cows was comparably darker than that of bulls (4.09 vs. 5.40). This is probably due in part to ambient temperature and a seasonal effect. Kim et al. (2003) reported that, regardless of gender, Hanwoo cattle slaughtered at average daily temperature of 5°C (winter season) produced the darkest beef; temperatures of more than 25°C produced intermediate and ones 5 to 25°C produced the lightest color. In this study, bulls were slaughtered on Feb. 27 with average daily

temperature between 5 to 25°C, whereas cows were slaughtered on Dec. 25 when temperature was than 5°C. Other pre-slaughter conditions such as various stress factors may have affected the results as well. Fat color, firmness, maturity, and quality grade were not affected by dietary WFS level. Therefore, dietary WFS did not induce any noticeable change in carcass quality.

IMPLICATIONS

Feeding whole flaxseed at 10 and 15% of diets had minimal or no negative influences on *ad libitum* intake, with slight or significant improvement in feed conversion ratio for Korean Hanwoo bulls and cows. However, feeding whole flaxseed at the levels reported herein only had minor effects on carcass quality and yield. These results indicate that whole flaxseed is an acceptable fat source to increase energy density without any adverse effect for finishing beef cattle.

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