The Effect of Different Flaked Lupin Seed Inclusion Levels on the Growth of Growing Korean Native Bulls

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ABSTRACT : Seventy-two Korean native bulls, with an average initial body weight of 247.2±2.34 kg, were used to determine the effect of different flaked lupin seed inclusion levels (0%, 15% and 30%; Control, LS15, LS30, respectively) on growth with a 3×3 randomized complete block design at the experimental farm of TS Corporation in Korea for 150 days. There were no significant differences in average daily gain (ADG) and feed:gain among treatments. However, LS30 increased concentrate intake and total feed intake ($p<0.05$) and decreased rice straw intake compared with Control and LS15 ($p<0.05$). With inclusion of flaked lupin seeds, concentrate intake and total feed intake increased ($p<0.01$) and rice straw intake decreased ($p<0.05$) compared with Control. There were no specific changes in the health status of animals used in this experiment with inclusion of flaked lupin seeds in concentrates. Inclusion of flaked lupin seeds in the concentrates showed a tendency of reduced average daily total feed cost per kg weight gain compared with Control by 1.6% and 3.4%, respectively, in LS15 and LS30. *(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 8 : 1129-1132)*

Key Words : Flaked Lupin, Inclusion Levels, Growth, Korean Native Bulls

INTRODUCTION

Lupins have been cultivated as a grain crop for over 3,000 years, primarily in the Mediterranean, parts of the Middle East and in South America. However, in the past, the extreme bitterness of the seed has generally made lupins unsuitable for human or animal consumption without prior treatment to remove toxic alkaloids (King, 1990).

The type of lupins being produced today for export markets bears little resemblance to its predecessors. After extensive non-GMO plant breeding efforts, the composition of the present day varieties is far superior to those grown originally. Around 1.2 million tonnes of the sweet (i.e. low-alkaloid) lupins, *Lupinus angustifolius*, were traded on world markets annually with approximately 85% originating from the Western Australia (Godfrey, 1998). It also could be estimated that about 550,000 tonnes of sweet lupins were used annually for cattle (personal communication with R. Nelson). Conversely most of the lupins produced in Europe are varieties from the cultivars *Lupinus albus*, which is poorly tolerated by pigs, even at low inclusion levels (King, 1981; Batterham et al., 1986; Edwards and van Barneveld, 1998).

In ruminants, lupins are commonly used as a supplement of dairy cows, but they are not widely used for feedlot cattle. However lupins probably demonstrate their greatest value when supplemented with low quality pasture or roughage such as rice straw where their energy and protein can be employed concurrently to good effect (Edwards and van Barneveld, 1998).

The objective of this experiment was to evaluate the effect of inclusion levels of flaked Western Australian sweet lupin seed (*L. angustifolius*) on the growth of growing Korean native bulls fed rice straw as a sole roughage source.

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MATERIALS AND METHODS

Experimental design and animal management

Seventy-two Korean native bulls, with an average initial body weight of 247.2±2.34 kg, were used in a 3×3 randomized complete block design for 150 days from 29 February, 2000 to 28 July, 2000 at the experimental farm of TS Corporation in Korea. Animals were divided into nine pens with 8 bulls per pen, and assigned three pens per treatment. Animals were weighed at initiation, every 30 days after initiation and at the end of experiment. Feed intake was checked every 3 days to calculate ADG and feed:gain.

Feed

Raw lupin seeds were flaked to a thickness of 3.0 to 3.2 mm after 1 hour treatment in a steam chamber (Ferrell-Ross, USA) at 95°C. The experimental diets were designed in a 6.4 mm pellet form mixed with 25% flaked corns using the flaked lupin seeds as follows; 1) 0% of flaked lupin seed (Control), 2) 15% of flaked lupin seed (LS15), 3) 30% of flaked lupin seed (LS30) in the concentrate of beef grower diets with the same specifications mainly in crude protein and energy, while inclusion levels of rye and soybean meal were decreased by about 20% and 40%, respectively, in LS15 and LS30 compared with Control. Rice straw was fed as roughage. Experimental diets including rice straw were fed *ad libitum*. The formulations and chemical composition of lupin seed and experimental diets are shown in tables 1 and 2.

Chemical analysis and statistical treatment

The chemical compositions of experimental diets were analyzed using AOAC (1990) procedures. Statistical treatment was performed by Duncan's multiple range test, using General Linear Model (GLM) procedures of SAS (1989) for a randomized complete block design. Effect of lupin seed inclusion was analyzed by orthogonal contrast to compare growth with Control.

Table 1. Chemical composition of lupin seed used in experimental diets (*as-fed basis*)

Item	%
Chemical composition	
Moisture	10.50
Crude protein	30.50
Crude fat	5.50
Crude fiber	14.20
Crude ash	2.70
Calcium	0.25
Total phosphorus	0.60
Alkaloid	0.002
Net energy for beef (Mcal/kg)[1]	2.00

[1] Calculated from CVB (1998).

Table 2. Ingredients and chemical composition of experimental diets for Korean native bulls

Item	Treatment[1]		
	Control	LS15	LS30
Ingredient composition (%)			
Flaked corn	25.00	25.00	25.00
Rye	28.00	18.65	9.80
Flaked lupin seed	-	15.00	30.00
Wheat bran	12.30	16.00	19.20
Wild oat	10.00	10.00	10.00
Soybean meal	19.00	9.50	-
Molasses	2.00	2.00	2.00
Limestone	1.80	1.95	2.10
Salt	0.40	0.40	0.40
Sodium bicarbonate	1.00	1.00	1.00
Premix	0.50	0.50	0.50
Chemical analysis (%)			
Moisture	11.42	11.39	11.34
Crude protein	16.00	16.00	16.00
Crude fat	2.43	3.14	3.84
Crude fiber	4.20	6.10	7.95
Crude ash	6.62	6.39	6.21
Net energy for beef (Mcal/kg)[2]	1.78	1.78	1.78
Calcium	0.88	0.88	0.88
Phosphorus	0.44	0.44	0.44

[1] Control=0% of flaked lupin seed, LS15=15% of flaked lupin seed, LS30=30% of flaked lupin seed.

[2] Calculated from CVB (1998).

RESULTS AND DISCUSSION

Table 3 shows the effect of different flaked lupin seed inclusion levels on the growth of growing Korean native bulls, which showed 1.20 kg of ADG on an average that was above the average of normal by 30% in Korea (Paek et al., 1993). Throughout the total period, LS15 did not affect average daily gain (ADG), concentrate intake, rice straw intake, total feed intake and feed:gain compared with the Control group. However, LS30 increased concentrate and total feed intake and decreased rice straw intake ($p<0.05$) without any effect on ADG and feed:gain compared with Control and LS15. With the inclusion of flaked lupin seed in the concentrates, ADG and feed:gain did not differ, but concentrate and total feed intake increased ($p<0.01$) and rice straw intake decreased ($p<0.05$) in comparison with Control.

It is not clear why there were some changes in the pattern of feed intake in this experiment with inclusion of flaked lupins, but the result of this experiment was similar to the study conducted by Dixon et al. (1992) and Paduano et al. (1995). They reported that total dry matter intake and live weight increased with increasing levels of lupin supplement for sheep fed low quality roughage, while roughage intake decreased. Angela et al. (1997) also observed that there were no significant effects on forage or total dry matter intake, animal live weight gain or overall feed conversion efficiency when soybean meal in the diets of growing bulls (6 month old, 182 kg initial live weight) was replaced on an isonitrogenous basis by lupin seeds. This is in contrast to the findings of Murphy and McNiven (1994) who reported that the live weight gain of growing steers (234 kg live weight) was significantly lower when soybean meal was replaced by lupin seed, although this difference was removed when the lupin seeds were roasted. Singh et al. (1995) also reported that there was no significant difference in milk production when soybean meal was isonitrogenously substituted by raw lupins in lactation diets, but cows fed roasted lupins produced more milk than those fed raw lupins. Improved performance of cattle fed heat treated versus raw lupins was probably due to more sustained release of protein in the rumen, increased undegraded protein supply, and increased energetic efficiency (Singh et al., 1995; Goelema et al., 1998).

It is not clear why LS15 decreased concentrate and total feed intake compared with Control and LS30 ($p<0.05$) during the last 30 days of this experiment. ADG and concentrate intake also decreased dramatically during this period in all treatments. It may have been caused by the high maximal mean ambient temperature of 31.3°C and average mean humidity of 75% recorded during this period at Suweon. close to the experimental farm (Korea Meteoro logical Administration, 2000). Voluntary food intake can be

Table 3. Effect of flaked lupin seed inclusion level on the growth of Korean native bulls

Item	Treatment[1]			SEM[2]	Contrast[3]
	Control	LS15	LS30		
	----------	Feb. 29 ~ Mar. 30	----------		
Initial BW, kg	249.5	246.4	245.7	2.34	-
Final BW, kg	295.0	291.8	289.3	2.56	-
ADG, kg	1.52	1.51	1.45	0.03	-
Daily feed intake, kg					
Concentrate	7.15^{b}	7.26^{ab}	7.52^{a}	0.07	-
Rice straw	0.90	0.90	0.85	0.02	-
Total	8.05	8.16	8.37	0.07	-
Feed:gain, kg/kg	5.31^{b}	5.41^{ab}	5.76^{a}	0.09	-
	----------	Mar. 31 ~ Apr. 29	----------		
Final BW, kg	333.2	330.4	333.6	2.76	-
ADG, kg	1.28^{b}	1.29^{b}	1.48^{a}	0.03	*
Daily feed intake, kg					
Concentrate	7.90^{b}	7.80^{b}	8.13^{a}	0.05	**
Rice straw	0.98^{a}	0.97^{a}	0.89^{b}	0.01	**
Total	8.88^{ab}	8.77^{b}	9.02^{a}	0.05	*
Feed:gain, kg/kg	6.97	6.85	6.12	0.19	-
	----------	Apr. 30 ~ May 29	----------		
Final BW, kg	370.5	365.1	369.9	2.67	-
ADG, kg	1.24	1.16	1.21	0.04	-
Daily feed intake, kg					
Concentrate	8.07	8.03	8.25	0.05	-
Rice straw	1.18^{a}	1.16^{ab}	1.10^{b}	0.01	-
Total	9.25	9.19	9.35	0.05	-
Feed:gain, kg/kg	7.43	8.04	7.82	0.28	-
	----------	May 30 ~ Jun. 28	----------		
Final BW, kg	402.3	403.3	407.2	3.18	-
ADG, kg	1.06	1.27	1.24	0.34	-
Daily feed intake, kg					
Concentrate	8.21^{b}	8.02^{b}	8.56^{a}	0.05	**
Rice straw	1.12^{a}	1.10^{ab}	1.07^{b}	0.01	-
Total	9.33^{b}	9.12^{c}	9.63^{a}	0.05	**
Feed:gain, kg/kg	8.84	7.34	7.79	0.36	-
	----------	Jun. 29 ~ Jul. 28	----------		
Final BW, kg	427.8	423.0	431.3	3.20	-
ADG, kg	0.85	0.65	0.80	0.04	-
Daily feed intake, kg					
Concentrate	7.87^{a}	7.47^{b}	7.88^{a}	0.05	**
Rice straw	1.13	1.13	1.11	0.01	-
Total	8.99^{a}	8.60^{b}	8.99^{a}	0.05	**
Feed:gain, kg/kg	10.59	14.56	11.34	1.21	-
	----------	Feb. 29 ~ Jul. 28	----------		
Initial BW, kg	249.5	246.4	245.7	2.34	-
Final BW, kg	427.8	423.0	431.3	3.20	-
ADG, kg	1.19	1.18	1.24	0.02	-
Daily feed intake, kg					
Concentrate	7.84^{b}	7.71^{b}	8.07^{a}	0.03	**
Rice straw	1.06^{a}	1.05^{a}	1.01^{b}	0.01	*
Total	8.90^{b}	8.76^{b}	9.07^{a}	0.03	**
Feed:gain, kg/kg	7.48	7.45	7.35	0.07	-

[1] Control = 0% of flaked lupin seed, LS15 = 15% of flaked lupin seed, LS30 = 30% of flaked lupin seed.

[2] SEM; Standard error of mean.

[3] Control vs LS15 and LS30 ; GLM and orthogonal contrast; - Not significant, * $p<0.05$, ** $p<0.01$.

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

significantly affected by the environment, particularly with ambient temperatures outside the thermoneutral zone of

Table 4. Economic evaluation of flaked lupins substituted for soybean meal in concentrates

Item	Treatment[1]		
	Control	LS15	LS30
ADG, kg	1.19	1.18	1.24
Average daily total feed cost, won/head	2,368	2,311	2,384
Average daily concentrate, won/head[2]	2,188	2,133	2,212
Average daily rice straw, won/head[3]	180	179	172
Average daily total feed cost /ADG, won/kg	1,990	1,959	1,922

[1] Control=0% of flaked lupin seed, LS15=15% of flaked lupin seed, LS30=30% of flaked lupin seed.

[2] Material cost of concentrates were calculated with won 244/kg of soybean meal , won 170/kg of raw lupin seed and additional manufacturing cost of lupin flaking by won 3.3/kg compared with pelleting process as follows; Control=won 279.1/kg, LS15=won 276.6/kg, LS30=won 274.1/kg.

[3] Calculated by won 170/kg of rice straw.

15°C to 25°C in cattle. With high temperature and humidity, intake may be depressed by up to 30% (NRC, 1987; Kwak and Ha, 1996).

Health status of the animals used in this experiment was not affected by flaked lupin inclusion. This demonstrates that flaked lupin can be used up to 30% in concentrates without any detrimental effect on animal health.

In table 4, LS15 and LS30 showed a tendency of reduced average daily total feed cost per ADG kg compared with Control by 1.6% and 3.4%, respectively. These savings are partially attributed to low rice straw intake and reduced concentrates cost by about 1.0% and 2.0%, respectively, in LS15 and LS30 compared with Control, which is caused by their substitution for expensive soybean meal.

CONCLUSION

It can be concluded that flaked lupin (*L. angustifolius*) can be included up to 30% in a commercial beef grower diet without any detrimental effects on the growth performance. It is also suggested that soybean meal can be economically replaced by flaked lupin. Flaked lupins can also demonstrate their good value when supplemented with low quality roughage such as rice straw.

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