Utilization of Faba Bean (*Ficia faba*) By-Products as Feed Ingredients for Lactating Cows

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ABSTRACT : Sixteen Friesian Cows were allocated equally into 4 groups in a 4 × 4 Latin square design to evaluate the effects of utilizing bean by-products on the feed intake and milk production. Cows were fed on 4.5% of their body weight fresh alfalfa; the remainder of their requirements were covered by one of 4 experimental concentrate treatments: 1) commercial concentrate (CC), 2) 70% CC+30% bean hulls (BH), 3) 70% CC+30% Polished bean (PB) and 4) 70% CC+15% BH + 15% PB. Results showed that the inclusion of bean hulls at 30% improved ($p<0.05$) milk yield, 4% fat corrected milk yield, feed conversion ratio and fat percent of the milk over the other treatments. Feeding cows on a commercial concentrate plus 30% BH or 30% PB or 15% from each of BH and PB decreased the cost of feed per kg milk by 13.6, 2.5 and 1.3 %, respectively, lower than those fed on the commercial concentrate.

(**Key Words**: Dairy Cattle, Bean By-Products, Milk Production)

INTRODUCTION

A shortage of high quality protein sources within Saudi Arabia limits the profitability of animal production systems. One possible solution to this problem is the importation of protein concentrates, for example the bean (*Ficia faba*).

The bean a leguminas crop, is widely used in the diets of various farm animals (Allam, 1979; McDonald et al., 1981; Hassan, 1989; Tag El-Din et al., 1992). In addition, the bean is an important human food source in Arab countries. As a consequence, large amount of bean by-products such as straws, hulls and pollished bean are produced. Information concerning the nutritional value of bean hulls and pollished bean in the diets of farm animals is limited. The aim of this study was to examine the effects of inclusion of bean by-products in the diet on the performance of lactating dairy cattle.

MATERIALS AND METHODS

This trial was conducted at the livestock experimental farm, King Saud University, Saudi Arabia. Sixteen lactating Friesian cows, approximately 8-10 weeks postpartum, were used to study the effect of utilizing bean by-products as feed ingredients on their performances. Cows were allotted equally (multiparous cows according to the average adjusted milk yield of the previous lactation) into 4 groups, each group contained one cow at the 1st, one at the 2nd and two cows at the 3rd lactation. Thereafter, cows of each group were assigned randomly to one of 4 diets in a 4 × 4 latin square design; period length was 25 days. Each group of cows was confined separately and offered fresh alfalfa (*Medicago sative*) twice daily at level equivalent to 4.5% of their body weight. The remainder of the animals nutrient requirements (NRC, 1989) were met through the 4 experimental concentrates as follows: 1) commercial concentrate, 2) bean hulls replacing 30% of the commercial concentrate mixture, 3) pollished bean replacing 30% of the commercial concentrate mixture, and 4) 30% of the commercial concentrate replaced by an equal percentages of bean hulls and pollished bean. Replacements undertaken on a dry matter basis. The commercial concentrate offered in this trial consisted of 65% corn, 20% wheat bran, 14.4% soybean meal and 0.6% trace mineral salts. Samples of all experimental diets were taken approximately every 3 weeks, dried at 60℃ for 72 hr. and grounded using a 1-mm screen in a Willey mill (Arther H. Thomas, Philadelphia, PA). Samples were subjected to all or some of the following analysis: ash, Kjeldahl N (AOAC, 1984), neutral detergent fiber, Acid detergent fiber content of feed was determined according to the procedure of van Soest et al. (1991). Chemical analysis of all experimental feed

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ingredients are presented in table 1. Drinking water was freely available, while animals had access to a salt lick.

Cows were milked twice daily at 06:30 and 18:30 h, with yield being recorded at each milked. A composite milk sample from two consecutive milking during the final two days of each period was also collected for each cow. Milk total solids, protein and ash were analyzed according to AOAC (1984), milk fat by the Gerber's method (Atherton, H. V., and Newlander, 1982), while non-fat solids and lactose were calculated by difference. Four-percent fat corrected milk and milk energy concentration were calculated using the equations of Gaines (1928). and Tyrrell and Reid (1965) respectively.

Data for all variables were subjected to analysis of variance using the general linear model (GLM) procedures of the statistical analysis system (SAS, 1988).

RESULTS AND DISCUSSION

Ingredient composition and chemical analysis of the experimental diets are shown in table 1. The results indicated that the addition of bean hulls only or with pollished bean to the commercial concentrate in diets 2 and 4 decreased the percentages of CP and EE, and increased the percentages of CF, ADF and NDF in comparison to diets 1 and 3. The addition of pollished bean in diet 3 increased the percentages of CP, CF, ADF and NDF, and decreased the percentages of EE, ash and NFE in comparison to the commercial concentrate (diet 1). All the above effects were significant at $p < 0.05$. Physical examination of bean by-products showed that pollished bean was not pure product and it contained some remains of bean hulls.

Mean values of dry matter intake, milk yield and feed conversion ratio of the friesian cows as influenced by the experimental diets are shown in table 2 and figure 1. There were no significant differences in daily dry matter intake for the cows fed on the various experimental diets. Feeding cows on 30% bean hulls in replacement of commercial concentrate improved ($p < 0.05$) their daily milk yield, 4% fat corrected milk yield (FCM) and feed conversion ratio over the other groups fed on diets contained pollished bean. Inclusion of pollished bean decreased milk yield and fat corrected milk significantly ($p < 0.05$) than bean hulls or commercial concentrate. This may be due to some antinutritional factors like trypsin inhibitors which can be destroyed by heating or autoclaving of bean or soybean meal Kakada et al. (1979), McDonald et al. (1981), Santrum et al. (1987). On the other hand, plant protein, like barley, soybean, beanut, bean, sunflower seed and cotton seed are highly degradable in the rumen (Miler, 1973) resulting in high concentration of free ammonia. Addition of 30% untreated pollished bean increased the solubility of protein in the rumen which increased the level of ammonia in blood converted to urea in the liver and excreted with urine, may be one of the reasons of decreasing milk production. The results of Higginbotham

Table 1. Ingredient composition and chemical analysis of the experimental concentrates

Trait	Ingredients			Experimental concentrates			
	bean hulls	pollished bean	fresh alfalfa	1	2	3	4
Ingredients (%):							
Bean hulls	100				30		15
Pollished bean		100				30	15
Commercial Concentrate				100	70	70	70
Fresh alfalfa (FA)			100				
Composition (%)							
Dry matter	96.2	95.8	20.3	91.9	91.8	91.8	91.9
Crude protein (CP)	5.2	28.4	19.6	18.1	15.4	19.9	17.7
Crude fiber (CF)	–	–	30.8	5.8	19.5	8.7	12.4
Ether extract (EE)	–	–	2.4	5.0	3.3	4.1	3.5
Ash	–	–	13.0	8.1	6.4	6.6	6.9
NFE	–	–	34.2	63.0	55.4	60.7	59.5
ADF	64.6	9.5	37.8	7.4	24.8	13.1	17.9
NDF	69.8	16.7	44.4	22.0	34.1	25.3	28.6

– not determined.

Table 2. Dry matter intake, milk yield, feed efficiency and milk compositions of Friesian cows fed the experimental diets

Trait[1]	Experimental diets				
	1	2	3	4	SEM
Dry matter intake (kg/day)	13.88	13.98	14.14	13.78	0.00
Milk yield (kg/day)	11.15[ab]	11.38[a]	10.65[b]	10.06[c]	0.71
4% FCM (kg/day)	9.36[ab]	9.76[a]	8.89[bc]	8.75[c]	0.62
Feed conversion (kg Dm/kg FCM)	1.67[b]	1.55[c]	1.85[a]	1.90[a]	0.08
Milk Composition (%)					
Total solids	12.38	12.33	12.28	12.38	0.39
Fat	3.03[bc]	3.08[ab]	2.93[c]	3.22[a]	0.17
SNF	9.35	9.28	9.34	9.16	0.39
CP	3.38[a]	3.24[b]	3.33[a]	3.24[b]	0.08
Ash	0.71	0.72	0.70	0.70	0.01
Lactose[2]	5.27	5.29	5.32	5.21	0.36
Milk energy value (kcal/kg)	1,500	1,503	1,481	1,519	25.59

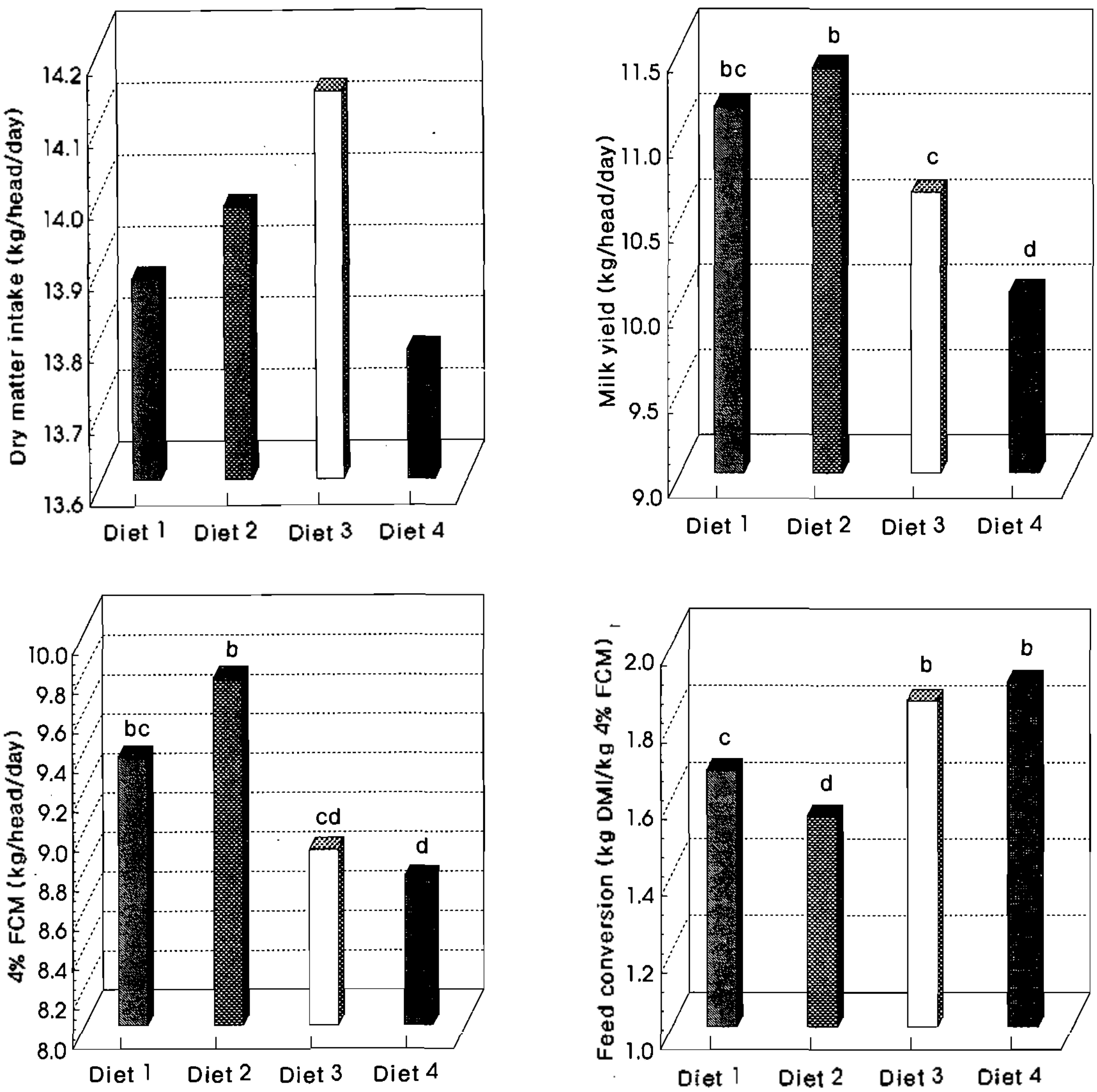
[1] Each mean is an average of 16 cows.
[a,b,c] Means in the same row with different superscripts are different ($p < 0.05$).
[2] calculated by difference.

(1987) showed lower milk yields on a diet of 19% CP and high degradability than on a diet of 19% CP of lower degradability or a diet 16% CP at either degradability. However, Higginbotham et al. (1989) reported that milk yields of midlactation high producing cows subjected to moderate environmental temperatures were not significantly affected by percent protein (between 15 and 18%) or by protein degradability, but milk fat was lower at lower degradability. However, 15.4% CP in diet was adequate for the lactating cows, hence, it improved their milk productivity. Similar results were obtained by Van Horn (1982) who reported that, response of milk production to dietary CP was curvilinear, the greatest improvement had been observed when dietary CP was increased from lower than 10% to approximately 14%. Increasing dietary CP above this percent did not improve the milk production (Clark and Daves, 1979; Stern et al. (1983), Ha and Kennelly (1984). Edward et al. (1980) reported that 15% CP in the diet was adequate for cows producing 29 kg milk/day. In the same connection, Satter (1982) indicated that optimum ruminal NH_3-N concentration for maximum microbial protein synthesis was close to 5 mg/100 ml ruminal fluid which could be equivalent to 13-14% CP in the diet.

The addition of bean hulls to the diet (diet 2) significantly ($p < 0.05$) increased fat percent and lowered ($p < 0.05$) milk protein percent. However, a reverse relationship was observed when pollished bean was included in the diet (diet 3). Increasing fat percent of the milk was probably due to the higher percentage of fiber in the bean hulls, which fermented by the rumenal cellulytic bacteria and produced higher amounts of acetic acid for milk fat production. There were no significant differences in calorivic value of cow's milk amongest the experimental diets; the calorivic value ranged between 1,481 and 1,519 kcal/kg milk.

The effect of feeding experimental diets on the feeding cost of milk production from Friesian cows are shown in table 3. The daily cost of feeding each group on the diet which contained 30% bean hulls was 1.04, .41 or .07 Saudi Riyals (SR) lower than feeding cows on commercial concentrate, concentratate which contained 30% poillished bean or concentrate which contained 15% bean hulls + 15% pollished bean, respectively. When daily milk production from each group was considered in the calculation, the corresponding values of feeding cost per Kg fresh milk were 15.7, 12.9 and 14.3%, respectively higher than those cows fed on 30% bean hulls.

Generally, the present work showed that bean hulls was better feed ingredient if it mixed at 30% with commercial concentrate and more economically efficient in term of cost of feeding per kg milk produced than pollished bean or the common used commercial concentrate in Saudi Arabia. The obvious improvement in milk production caused by bean hulls probably due to its lower content of CP which decreased the total CP of the commercial concentrate to about 15%.



[b,c,d] Means in the same histogram with different superscripts are significantly different at ($p < 0.05$).

Figure 1. Dry matter intake, milk yield, fat corrected milk and feed conversion ratio of the Friesian cows fed the experimental diets.

Table 3. Feeding cost of milk production from Friesian cows fed the experimental diets

Trait	Experimental diets			
	1	2	3	4
Cost of experimental concentrate (SR/ton DM)[1]	598.5	479.3	516.9	500.6
Feeding cost (SR/cow/day) :				
Experimental concentrate	5.44	4.38	4.81	4.47
Alfalfa	3.57	3.59	3.57	3.57
Total	9.01	7.97	8.38	8.04
Feeding cost (SR/kg milk)	0.81	0.70	0.79	0.80
% improvement	–	13.60	2.90	1.30

[1] Market price of one ton of commercial concentrate=550 SR, bean hulls=200 SR, polished bean=300 SR and fresh alfalfa=150 SR. $=3.7542 Saudi Riyal (SR).

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