Possibilities of Utilizing Protected Hazelnut Kernel Oil Meal in Growing Ruminants and Dairy Cow Diets*

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ABSTRACT : Growth and feeding studies were conducted to determine effects of hazelnut kernel oil meal (HKOM) on growth performance (as protein efficiency), and milk production and composition. In the growth study, 24 individually fed Karayaka lambs (4 mo. and 25.55 kg LW) were used to determine protein efficiency calculated using the Slope Ratio Technique. In the feeding trial, 4 Jersey cows were arranged in 4×4 Latin squares experiment to measure effects of diets containing HKOM, soybean meal (SBM) corn gluten meal (CGU) and urea (U) on milk production and composition. Protein efficiencies for HKOM, SBM and CGM were found as 1.342±0.499, 0.879±0.488 and 1.833±0.893, respectively. Milk production for the cows consuming concentrates, containing HKOM, SBM, CGM and U, were 13.97±0.99, 13.20±1.09, 14.86±0.68 and 13.06±1.23 kg/d ($p<0.01$), respectively. There were no differences ($p>0.05$) among diets for milk protein content were statistically different ($p<0.05$), although milk DM and fat percentage as well as milk solids-not-fat and lactose percentage ($p<0.01$). The highest DM intake was associated with the U diet, intake was intermediate with the SBM and HKOM diets, and the lowest with CGM diet ($p<0.05$). In conclusion, these data may indicate that the HKOM is useful in diets as a protein source for growing ruminants and lactating cows. *(Asian-Aus. J. Anim. Sci. 1999. Vol. 12, No. 7 : 1070-1074)*

Key Words : Hazelnut Kernel Meal, Protein Sources, Growing Ruminants, Lactating Cow

INTRODUCTION

High producing dairy cows require large amounts of protein and energy (Mielke and Schingoethe, 1981). High quality feed proteins may be utilized more efficiently for milk production if large proportions of proteins are less soluble in the rumen. This may allow proteins to be degraded more slowly or to by-pass degradation in the rumen and be digested in the lower digestive tract (Mielke and Schingoethe, 1981; Erdman and Vandersall, 1983; Klopfenstein et al., 1985; Ensminger et al., 1990).

Extent of feed protein degradation in the rumen has been the focal point of proposed protein evaluation systems for ruminants (Ørskov, 1988). These systems are based on the recognition that ruminal microbial protein synthesis is not adequate to meet the nitrogen (N) requirements of rapidly growing ruminants or lactating dairy cows. The duodenal amino acid needs of high producing ruminants are met by a combination of microbial protein and ruminal undegradable feed protein. Dietary protein requirements for ruminants, therefore, are best expressed in terms of undegradable protein and ruminal degraded protein (Loerch et al., 1983; Klopfenstein et al., 1985; Kirkpatrick and Kennelly, 1987). Several studies have shown improved production of cows fed diets containing less soluble proteins (Craig et al., 1984; Christensen et al., 1992; Keery and Amos, 1993).

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* This study was supported by TÜBITAK (VHAG-1135).

Received October 21, 1998; Accepted February 22, 1999

Grain proteins, primarily corn, are highly by-passed, and by-products of corn milling industries that are dried by heating have good by-pass characteristics. These by-products include corn gluten meal (CGM) and distillers grains. Generally, the higher the protein by-pass, the higher the protein efficiency value (Klopfenstein et al., 1985).

Hazelnut kernel oil meal (HKOM) have been shown to be an excellent protein source for ruminants due to the high digestibility (Akyildiz, 1970, 1986; Sarçiçek and Ocak, 1997) and the intermediate rumen degradability (Sarçiçek and Ocak, 1997). There is a little information available concerning protein efficiency value and utilization of HKOM in the diets of ruminants.

The purpose of this study was to determine the effects of HKOM on growth performance of lambs (as protein efficiency), milk production and composition of dairy cows.

MATERIALS AND METHODS

Lamb growth trial

A lamb growth trial (60 day) was conducted to evaluate the protein efficiency of HKOM, soybean meal (SBM) and CGM. Urea and CGM diets were included as negative and positive controls, respectively.

Basal diets (table 1), for each protein tested, were formulated to contain 61% TDN and 12% crude protein (CP) equivalent (NRC, 1984). Forty percent of the supplemental N requirement in the basal diet was supplied by a natural source and 10% by urea. All the supplemental N in the urea control diet was supplied by urea. These diets were combined with hay grass (1:1) at feeding time.

Twenty-four Karayaka lambs (average initial weight 25.55 kg and 4 mo. old) were weighed, after withholding feed and water for 12 h, once at the initiation and once at the conclusion of the trials. Animals were housed in an open front barn during the trial. Six lambs were allotted to each protein source and urea control group. Lambs had access to individual feed. The actual intake of complete diet and the amount of natural protein were calculated.

On the basis of NRC (1984) recommendations for maintenance (TDN), the maintenance energy requirement of each animal was calculated. With these calculations, all animals received the same amount of energy per day above maintenance (Rock et al., 1983). Intake adjustments and weighing were made at 7 day intervals throughout the trial.

Protein efficiency was defined as the daily gain observed above the urea control per unit of natural protein supplemented. Regression lines (Slope ratio technique) on which added gain and amount of natural protein added above the urea control were calculated (Rock et al., 1983; Klopfenstein et al., 1985; Goedeken et al., 1990). Furthermore, total and daily liveweight gains, daily feed intake DM conversion (kg DM/kg gain) and DM intake per 100 kg LW were determined.

Milk production trial

Hour Jersey cows at the peak of lactation and balanced as nearly as possible for age (80-84 mo), lactation stage (third lactation), duration (at the 1st mo of 3rd lactation) and milk production (average milk yield of 17.5 0.28 kg/d) were arranged in 4×4 Latin squares to evaluate effect of HKOM on milk production and composition. Each experimental period lasted 4 weeks in which the first 2 weeks served as adjustment for cows to adapt to the new dietary treatment, and the last 2 weeks constituted data collection. Cows were fed four experimental diets (16% crude protein and 75% TDN on DM matter basis) of HKOM, SBM, CGM and urea. Composition of the diets is shown in table 3. All diets were formulated according to NRC (1988) standards. Rations were offered in two equal feedings (at 800 and at 1600).

Intake of dry matter (DM) and milk production were recorded daily throughout the experiment. Milk samples were collected at both milkings for 2 consecutive days each week and sampled on basis of milk yield. Analyses for DM, crude protein (CP; N× 6.38) and ash were determined by Weende Analyze Method (AOAC, 1984). Fat was determined by Gerber Method, solids-non fat (SNF) and milk lactose were determined by calculation (Kurt, 1972) .

Data obtained in the lamb growth trial were analyzed as completely randomized designs by analysis of variance. Data obtained in the milk production trial were analyzed in a 4×4 Latin square. Comparison of treatment means (Protein source) for daily gain and feed conversion was by use of Duncan's Multiple Comparison Test.

RESULTS

Lamb growth trial

The chemical composition of feeds used in growth trials and the results of growth trial were given in table 1 and table 2, respectively.

Table 1. Composition of diets used in the lamb growth trial, % of diet DM

	Protein sources			
	Urea	HKOM	SBM	CGM
Hay grass	50.00	50.00	50.00	50.00
Urea	1.57	0.50	0.50	0.50
HKOM	-	10.80	-	-
SBM	-	-	10.45	-
CGM	-	-	-	8.93
Wheat bran	8.88	2.15	2.50	5.00
Corn	30.00	30.00	30.00	30.00
Wheat	8.00	5.00	5.00	4.02
Salt	0.25	0.25	0.25	0.25
Vit-Min. mix[1]	0.50	0.50	0.50	0.50
DCP	0.30	0.30	0.30	0.30
Limestone	0.50	0.50	0.50	0.50

[1] Supplies per kg of vitamin-mineral mix: 6,666,666 IU vitamin A, 666,666 IU vitamin D_3, 5,000 mg vitamin E, 150 mg Co, 300 mg I, 100 mg Se, 12,250 mg Fe, 5,000 mg Cu, 15,000 mg Zn, 12,500 mg Mn, 50,000 mg Mg and 250,000 mg Ca.

In this study, there were (p>0.05) no differences among treatment groups in terms of final weights (table 2). Total weight gain of CGM group (11.38 kg) was numerically higher (p>0.05) than that of HKOM group (10.08 kg), SBM group (8.83 kg), but significantly (p<0.05) higher than that of urea group (7.16 kg). Total weight gain of SBM group was not higher than that of urea group (p>0.05). DM intake was not different among experimental groups (p>0.05).

The urea group was different from CGM group (p<0.05) and there were no significant differences between the other groups(p>0.05).

Protein efficiency values for CGM, SBM and HKOM groups were calculated as 1.833±0.893, 0.879 ±0.488 and 1.342±0.499, respectively. Maximum LW gain above urea control group was higher for CGM

Table 2. Results obtained in the lamb growth trial

Item	Urea	HKOM	SBM	CGM	F	SEM[3]	CV
Initial weight, kg	25.82	25.62	25.53	25.23	0.033	1.34	12.88
Final weight, kg	32.98	35.70	34.36	36.61	1.018	1.63	11.39
Total liveweight (LW) gain, kg	7.16^{b}	10.08^{a}	8.83^{ab}	11.38^{a}	3.687*	0.94	24.60
Liveweight gain kg/d	0.119^{b}	0.168^{a}	0.147^{ab}	0.190^{a}	3.694*	0.02	24.59
DM intake, kg/d	0.995	1.038	1.067	1.014	0.351	0.05	12.50
DM, kg/100 kg LW	3.02^{b}	2.90^{ab}	3.05^{b}	2.71^{a}	2.746*	0.09	7.77
kg DM/kg LW	9.28^{b}	6.25^{a}	7.40^{ab}	5.47^{a}	3.301*	0.91	31.40
Protein intake, g/d[1]	-	150.05	155.03	147.34	0.234	8.06	13.09
LW gain>urea, g[2]	-	85.39	82.89	88.17	0.029	15.48	44.37

*p<0.05; ^{a,b}: Means in the same row with different superscripts differ (p<0.05).
[1] Intake of protein from protein supplement. [2] LW gain above urea control group. [3] Standart error of the mean.

(88.17 g) than HKOM (85.39 g) and SBM (82.89 g).

Milk production trial

The composition of feeds used in the milk production trial were given in table 3.

The effect of protein sources on milk yield and composition, as well as on DM intake and feed efficiency ratio are given in tables 4 and 5, respectively.

As seen in table 4 there were significant differences in milk production among treatments in terms of actual milk yield (p<0.01), however these differences were not significant when milk yield was standardized on a 4% fat basis (p>0.05). The highest non-corrected milk yield (p<0.01) was obtained from the CGM supplemented group (14.86±0.68 kg/d) whereas the lowest non-corrected milk yield was obtained from the urea supplemented diet (13.06±1.23 kg/d). Actual milk production was 13.97±0.99 and 13.20±1.09 kg/d for HKOM and SBM, respectively (p>0.05). There were significant differences among SBM, CGM and HKOM groups (p<0.01). Milk yield from animals receiving SBM was not different from that of animals receiving urea, both being significantly lower than that of cows fed CGM. Milk yields from HKOM fed animals were intermediate.

Protein sources had different effects on nutrient contents of milk. DM percentage was higher for HKOM group (14.07±0.27%) than for the other groups (CGM, SBM and urea groups) and there were no differences among these groups (12.65±0.18, 12.95 ±0.21 and 12.99±0.31, respectively). While HKOM group (8.57±0.03%) and CGM group (8.29±0.11%) were not different in terms of SNF, HKOM was (p<0.01) higher than SBM and urea groups (7.77± 0.18 and 8.36±0.17%, respectively). The numerically highest protein content was found for SBM (3.64± 0.04%). Milk fat percents of HKOM (5.50±0.26%) group were higher than those of urea (4.63±0.17) and CGM (4.36±0.13) groups. While the difference between milk fat yields of SBM and HKOM was found insignificant (p>0.05), the HKOM group was different from CGM and urea groups (p<0.05). The highest and the lowest lactose contents were obtained by feeding HKOM and SBM respectively (p<0.01).

As shown in table 5, DM intake was affected by N sources (p<0.05), so was DM conversion into actual milk yield and FCM (p<0.01). DM consumption per 100 kg LW was not affected by treatments (p>0.05). DM consumption was lower in HKOM (12.95±0.06 kg/d) and CGM groups (12.28±0.42 kg/d) (p>0.05) than in SBM (13.01±0.02 kg/d) and urea groups (13.08±0.03 kg/d). While the highest value in terms

Table 3. Composition of diets used in the milk production trial, % of DM of diet

	Protein sources[2]			
Feedstuffs	Urea	HKOM	SBM	CGM
Corn silage	30.00	30.00	30.00	30.00
Hay grass	10.00	10.00	10.00	10.00
Urea	1.98	-	-	-
HKOM	-	18.95	-	-
SBM	-	-	18.64	-
CGM	-	-	-	13.65
Wheat bran	15.00	6.32	6.63	9.00
Corn	31.00	30.00	30.00	30.00
Wheat	10.47	3.00	3.00	5.80
Salt	0.25	0.25	0.25	0.25
Vit-Min. mix[1]	0.50	0.50	0.50	0.50
DCP	0.30	0.30	0.30	0.30
Limestone	0.50	0.50	0.50	0.50

[1] Supplies per kg of vitamin-mineral mix: 6,666,666 IU vitamin A, 666,666 IU vitamin D_3, 5,000 mg vitamin E, 150 mg Co, 300 mg I, 100 mg Se, 12,250 mg Fe, 5,000 mg Cu, 15,000 mg Zn, 12,500 mg Mn, 50,000 mg Mg and 250,000 mg Ca.
[2] Protein sources supplied 50% of total nitrogen in the diet.

Table 4. Milk production and composition

Items	Urea	HKOM	SBM	CGM	F	CV
Milk yield (MY), kg/d	13.06±1.23^{B}	13.97±0.99^{AB}	13.20±1.09^{B}	14.86±0.68^{A}	8.17**	4.22
FCM, kg/d[1]	15.14±1.00	16.41±1.71	14.29±1.23	17.20±1.30	1.08	15.86
DM, %	12.99±0.31^{b}	14.07±0.27^{a}	12.95±0.21^{b}	12.65±0.18^{b}	6.00*	3.87
SNF, %[2]	8.36±0.17^{A}	8.57±0.03^{A}	7.77±0.18^{B}	8.29±0.11^{A}	9.06**	2.75
Protein, %	3.30±0.15	3.50±0.13	3.64±0.04	3.56±0.14	1.24	7.35
Fat, %	4.63±0.17^{b}	5.50±0.26^{a}	5.20±0.30^{ab}	4.36±0.13b	4.65*	9.80
Ash, %	0.74±0.02	0.78±0.02	0.74±0.01	0.76±0.02	0.86	5.95
Lactose, %	5.58±0.06^{A}	5.62±0.11^{A}	4.65±0.20^{B}	5.27±0.23^{A}	7.82**	6.08

* $p<0.05$; ** $p<0.01$; ^{a,b} ($p<0.05$); ^{A,B,C} ($p<0.01$). Means in the same row with different superscripts differ.
[1] FCM: fat corrected milk yield. [2] SNF: Solids not fat

Table 5. DM intake and feed efficiency

Item	Urea	HKOM	SBM	CGM	F	CV
DM intake, kg/d	13.08±0.03^{b}	12.95±0.06^{ab}	13.01±0.02^{b}	12.28±0.42^{a}	3.61*	3.05
kg MY/kg DM intake	1.00±0.09^{C}	1.08±0.08^{B}	1.01±0.08^{C}	1.22±0.06^{A}	70.75**	2.19
kg FCM/kg DM intake	1.16±0.08^{B}	1.27±0.12^{A}	1.10±0.09^{B}	1.40±0.10^{A}	16.93**	5.18
DM intake[1]	3.73±0.17	3.70±0.17	3.70±0.09	3.48±0.11	1.79	4.78

[1] kg/100 kg LW.
* $p<0.05$; ** $p<0.01$; ^{a,b}: ($p<0.05$); ^{A,B,C}: ($p<0.01$). Means in the same row with different superscripts differ.

of conversion of DM into actual milk production was obtained in CGM group (1.22±0.06), with the lowest value being obtained by urea group (1.00±0.09). Intermediate values were found for HKOM and SBM (1.08±0.08 and 1.01±0.08, respectively). Conversion of DM into FCM followed the same pattern as seen in the conversion of DM into actual milk production.

DISCUSSION

The differences between CGM group and the other two (HKOM and SBM) groups in terms of final weights, total and daily weight gains, DM conversion and protein efficiency values showed that CGM was more advantageous than the other nitrogen sources. HKOM was superior to SBM for the traits mentioned above. In studies where CGM and SBM were compared to each other (Rock et al., 1983; Abrams et al., 1983; Stock et al., 1983) CGM was superior to SBM. Coomer et al. (1993) reported that CGM and SBM+CGM complex increased undegradable protein intake compared to SBM alone. Because protein sources escaped from rumen degradation, it increased the animal performance by decreasing protein amount needed for production (Owens and Bergen, 1983).

The effects of protected proteins were observed during early lactation of dairy cows with high milk production. During this periods milk yield can be affected by the amount and the quality of the protein reaching the small intestine (Kung and Huber, 1983). The observation that there were no differences among treatments in terms of FCM lends additional support to some previous studies (Craig et al., 1984; Christensen et al., 1992; Keery and Amos, 1993). The same findings were previously reported by Klopfenstein et al., (1985). In our study actual milk yield was higher in the group consuming CGM with high undegradable protein content compared to the other groups.

While some researchers (Nelson and Yu., 1993) reported that milk composition was significantly affected by undegradable protein content, some of the other researchers reported that this effect was not significant (Craig et al., 1984; Wattiaux et al., 1994). There are some studies which report either that protein and fat percent were increased (Christensen et al., 1992; Nelson and Yu, 1993; Grummer et al., 1994) or that protein and fat yield were not affected (Christensen et al., 1992; Armetano et al., 1993; Keery and Amos, 1993; Wattiaux et al., 1994). In this study, while protein yield was not affected, fat yield was affected significantly. But, this effect was decreased due to undegradable protein content (in CGM group).

Keery and Amos (1993) reported that DM, SNF and lactose contents of milk were not affected by protein source or undegradable protein content. These findings contrast with the results of this study.

Although N sources were different in diets used in the present study, DM consumption per 100 kg LW was not different. Some studies lend additional support to this finding (Keery and Amos, 1993).

The difference between our results and some previous studies, as reported by Kung and Huber (1983), can be explained by various reasons: N sources could not supply enough N needed for maximum microbial fermentation. Or, degradabilities and amino acids profile of proteins reaching the small intestine were different, or undegradable protein content of control ration was adequate. Christensen et al. (1992) reported that protected proteins had no effect when the crude protein was supplied at adequate level.

As a result it can be said that HKOM is between SBM and CGM in terms of feeding value and it is a good protein source for growing ruminants and dairy cows.

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