The Determination of Metabolizable Protein of Untreated and Treated Sun Flower Meal with Urea and Microwave Using Nylon Bags Technique

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ABSTRACT

This study was carried out to determine the nutritive value of sun flower meal treated and untreated with 0.5% urea and microwave using nylon bags technique in Gizel sheep. Two fistulaed Gizel sheep with average BW 45±2 kg were used in a complete randomized design. The treatments were as following: A: sun flower, B: sun flower treated with 0.5% urea, C: sun flower treated with microwave. The ruminal dry matter and crude protein disappearance were measured at 0, 2, 4, 6, 8, 12, 16, 36 and 48 h. Sun flower meal treated with 0.5% urea (156.117 g/kg DM) and sun flower (89.89 g/kg DM) had the highest and lowest effective ruminal degradable protein, respectively. The subjects in this experiment, the metabolizable protein of sun flower treated with 0.5% urea (300.947 g/kg DM) accounted for the highest value than the other treatments. Results show that increased metabolizable protein by processing meals with urea and microwave.

Keywords: *In situ,* Metabolizable protein, Microwave, Sun flower, Urea

INTRODUCTION

Sun flower meal is an appropriate source of protein in the dairy cow's diet and is considered as a section of the high degradation protein in the rumen [1]. Sun flower meal is derived from sun flower seed oil extraction. Having said that, by varying the extent of the cortex, the nutritional value will be very different [2]. Sun flower meal is a high-protein byproduct. The palatability of sun flower is somewhat less than that of soybean meal but is rich of sulfur-containing amino acids, i.e. methionine and cysteine. Sun flower meal contains high levels of methionine compared to soybean meal but the lysine level is lower. Sun flower meal contains phenolic compounds including tannin and cyanidin. Tannins are complex groups of plant secondary metabolites that are soluble in the polar solutions and have been recognized as polyphenol compounds [3]. Apparently these compounds do not have any functions in the plant metabolism such as biosynthesis and energy exchange but exhibit various biologic activities, i.e. toxicity or protecting plants from vegetarians [4]. Although the sun flower meal possesses a good potential in livestock industry, it is used with restriction in the diet due to anti-nutritional factors and the variation in the nutritional value of the meal. In order to obtain the best performance from grain and meal, their digestibility should be determined [5]. Fermentation and digestion patterns can affect the nature of the available nutrients for the use in animals significantly. In ruminants, the meal processing can influence the digestibility and the rate of digestion [6]. The present study was conducted to identify the degradability rate and

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determine the digestion coefficients of sun flower meal and increase and optimize its use in animal feed and prevent wasting them and polluting the environment.

MATERIALS AND METHODS

Canola meal collection

Examples of meals were obtained randomly sampled from oil extracted reputable manufacturers and sun flower meal productive companies, Iran. The experimental treatments were: A: sun flower meal, B: sun flower meal treated with 0.5% urea, C: sun flower meal treated with microwave that was prepared in the laboratory. Besides, 3 parts of solution and 1 part of sun flower meal were mixed in plastic containers and were kept in room temperature and away from sunlight for 60 days; samples were taken out of the containers and dried in the sunlight and milled in a 2 mm size to be used in other phases of the experiment. Animals used in this experiment were fed at maintenance level. The animals were fed with a mixture of 60% forage and 40% concentrate diet [7].

Chemical composition

Feedstuffs dry matter (DM, method ID 934.01), ash (method ID 942.05), ether extract (EE, method ID 920.30), and crude protein (CP, method ID 984.13) were determined by procedures of AOAC [8]. The neutral detergent insoluble fiber (NDF) and acid detergent fiber (ADF) concentrations were determined using the methods of Van Soest et al. (1991), without sodium sulphite. Neutral detergent insoluble fiber was analyzed without amylase with ash included [9].

Measured In Situ

To estimate the degradability of the nylon bag technique, the feed samples were milled with a special mill and 2-mm sieve [10]. 5 grams of each nutrient were poured into bags made of synthetic polyester fiber as 6 × 12 cm and pore diameter of 50 mm. Two fistulated sheep with average BW 45±2.5 kg were used in a complete randomized design. Incubation times were 0, 2, 4, 6, 8, 12, 16, 36 and 48 h. After each incubation time, the bags were removed and rinsed with cold water until the water is completely cleared out. After washing, bags were incubated for 24 h at a temperature of 65 °C to evaporate and for 24 h at 105 °C in oven [10]. Degradation parameters (soluble, insoluble, and fixed rate of degradation) were calculated with Naway. For matched degradation data used from $P=a+b\ (1-e^{-ct})$ that a=The degradation of soluble fraction (%), b=The degradation rate of insoluble fraction (%), c=The constant degradation rate (%/h), t=The incubation time (h), e=The constant factor (2.718) and P=The degradation rate at the time t. Effective degradability was calculated at $ED=[a+(b\times c)]\div(c+k)$ that k is passage rate which were considered in this study 0.02 [9].

Statistical analysis

The obtained data from in situ study was analyzed according to a completely randomized design with 4 replicates by the GLM procedure [11]. The treatment means were compared by the Duncan test.

RESULTS AND DISCUSSION

The chemical composition of treatments is presented in table 1. The data show that treatment B had the most (94.61%) and treatment A had the least (92.90%) amount of dry matter ($P<0.05$).

Regarding the percentage of crude protein treatment B (39%) and treatment A (34.7%) had the highest and the lowest amount of crude protein (P<0.05). According to table 1, there were significant differences in crude protein, acid detergent fiber, and neutral detergent fiber in tested feed (P<0.05). According to the results reported in tables 2 at different times of incubation, treatments B and C are the highest and lowest DM disappearance values, respectively.

Table 1. The chemical composition (% DM)* and the parameters estimated from the metabolizable protein (g/kg DM) of feeds.

Treatments	DM	CP	OM	NDF	ADF	ash	ADIN	QDP	SDP	ERDP	DUP	UDP	MP
A	92.90^{c}	34.7^{c}	93.36^{a}	40.71^{c}	30.37^{c}	6.64^{a}	2.33^{a}	11.37^{c}	80.76^{c}	89.89^{c}	229.25^{a}	254.87^{a}	286.77^{b}
B	94.61^{a}	39^{d}	93.19^{ab}	43.16^{b}	32.84^{b}	6.81^{a}	2.11^{b}	53.96^{a}	116.77^{a}	156.11^{a}	197.22^{b}	219.27^{b}	300.94^{a}
C	93.62^{ab}	36.56^{b}	93.39^{a}	45.31^{a}	35.03^{a}	6.6^{a}	1.74^{c}	25.23^{b}	87.07^{b}	107.51^{b}	227.62^{a}	253.03^{a}	296.43^{a}
SEM	0.354	0.313	0.114	0.373	0.356	0.1308	0.04	1.1156	2.068	2.43	1.99	2.215	2.686

*DM=dry matter, CP=crude protein, OM=organic matter, NDF=neutral detergent fiber, ADF=acid detergent fiber, ADIN=acid detergent insoluble nitrogen, ERDP=Effective ruminal degradable protein, DUP=Digestible undegradable protein, MP=Metabolizable protein. A: sun flower meal, B: sun flower meal treated with 0.5% urea, C: sun flower meal treated with microwave. a,b,c = Within a column, means without a common superscript letter differ (P< 0.05). **Standard error means of the difference amount three treatments means.

Table 2. Means of dry matter degradation and dry matter degradability coefficients of feeds by incubation at different times in the *in situ* method (% DM).

	Incubation times (h)									Degradation coefficients				
Treatment	0	2	4	6	8	12	16	36	48	a	b	c	ED	RSD
A	15.75^{c}	19.66^{c}	23.07^{b}	26.05^{b}	28.65^{a}	32.9^{a}	36.14^{a}	43.84^{a}	45.22^{b}	15.75^{c}	30.77^{b}	0.068^{a}	39.53^{b}	0.91^{b}
B	17.99^{b}	20.54^{b}	22.89^{b}	25.06^{c}	27.07^{b}	30.65^{b}	33.72^{c}	43.51^{a}	46.61^{a}	17.99^{b}	33.79^{a}	0.039^{c}	40.36^{a}	0.95^{b}
C	19.75^{a}	22.34^{a}	24.83^{a}	27.06^{a}	29.07^{a}	32.5^{a}	35.27^{b}	42.92^{b}	44.82^{b}	19.57^{a}	27.37^{c}	0.053^{b}	39.29^{b}	1.47^{a}
SEM**	0.283	0.223	0.191	0.175	0.168	0.164	0.166	0.193	0.248	0.2724	0.536	0.00138	0.189	0.166

a=Dry matter solution at zero time (%), b=Fermentable material (%), c=Constant degradability coefficients at time t (%/h), ED=Effective degradation (The passage of time r=0.02), RSD= Residual standard deviation. A: sun flower meal, B: sun flower meal treated with 0.5% urea, C: sun flower meal treated with microwave. a,b,c = Within a column, means without a common superscript letter differ (P< 0.05). **Standard error means of the difference amount three treatments means.

Also, according to the results obtained at 0 h of incubation, treatment A (15.75%) had the lowest and treatment C (19.75%) had the highest rate of dry matter disappearance that there were significant differences among treatments (P<0.05). The data shows that sun flower meal processed

with microwave had initially higher value of degradability of dry matter than the other treatments. However, after 36 hours of ruminal incubation, the rate of degradability of dry matter of sun flower meal processed with 0.5% urea was higher than the other treatments. Degradation of all treatments has increased trend in during incubation in the rumen of sheep. Treatments C (19.57%) and A (15.75%) had the highest and lowest (a) coefficient value for DM, respectively, that due to the high solubility of urea, these results are predictable and justifiable. Treatment B (33.79%) and C (27.37%), had the highest and lowest fermentable material (coefficient b), respectively. The results reported in this study revealed that the coefficients a and b indicated significant differences among treatments which were due to the treatment effects (P<0.05).

Table 3. Means of crude protein degradation and crude protein degradability coefficients of feeds by incubation at different times in the *in situ* method (% DM).

Treatment	Incubation times (h)									Degradation coefficients				
	0	2	4	6	8	12	16	36	48	a	b	c	ED	RSD
A	3.27^{c}	7.32^{c}	10.82^{c}	13.83^{c}	16.44^{c}	20.62^{c}	23.75^{c}	30.79^{c}	32.03^{c}	3.28^{c}	29.63^{b}	0.073^{b}	26.57^{c}	1.29^{b}
B	13.84^{a}	20.69^{a}	26.17^{a}	30.56^{a}	34.07^{a}	39.41^{a}	42.56^{a}	48.52^{a}	49.29^{a}	13.84^{a}	35.95^{a}	0.107^{a}	43.77^{a}	0.99^{b}
C	6.98^{b}	11.32^{b}	18.23^{b}	18.23^{b}	20.94^{b}	25.23^{b}	28.37^{b}	35.09^{b}	36.17^{b}	6.98^{b}	29.87^{b}	0.078^{b}	34.13^{b}	1.62^{a}
SEM**	0.29	0.43	0.61	0.715	1	0.662	0.636	0.315	0.0349	0.29	0.562	0.0073	1.2	0.16

a=Crude protein solution at zero time (%), b=Fermentable material (%), c=Constant degradability coefficients at time t (%/h), ED=Effective degradation (The passage of time r=0.02), RSD= Residual standard deviation. A: sun flower meal, B: sun flower meal treated with 0.5% urea, C: sun flower meal treated with microwave. a,b,c = Within a column, means without a common superscript letter differ (P< 0.05).

Means of the data presented in table 3 show that in zero-hour of incubation, treatments B (13.84%) and A (3.27%) had the highest and lowest rumen CP disappearance (P<0.05). Results of dry matter and crud protein degradation show processing with urea and microwave increase the degradability and metabolizable protein in the sun flower meal. Crud protein degradability coefficients of the treatments presented in table 3 show that coefficient (a) had the highest and lowest values for treatments B (13.84%) and A (3.28%), respectively (P<0.05). These results were predictable due to the high solubility of urea. Treatments B (35.95 %) and A (29.63%) had the highest and lowest coefficient (b) that were significantly different (P<0.05). This could be due to their high levels of crude protein which the cause is microbial growth and increment the protein degradation.

The data presented in table 1 shows the mmetabolizable protein components of the experimented feed. The results obtained for the quick degradation protein indicated that the processing of sun flower meal increased the amount of QDP. Effective ruminal degradable protein in sun flower meal processed with 0.5% urea with 156.11 g/kg DM and sun flower meal with 89.89 g/kg DM had the most and the least ERDP, respectively. Besides, the data obtained revealed that sun flower meal enriched with 0.5% urea with 300.94 g/kg DM of mmetabolizable protein had higher metabolizable protein than the other treatments.

The high amounts of the percentage of the dry matter in the meals enriched with 0.5% urea can be caused by adding 0.5% of urea to the treatments. The meals processed with 0.5% urea had more crude protein than the meals processed with microwave. This difference in crude protein of the meals processed 0.5% urea could be explained by the percentage of protein of the meals processed

with microwave. This can be due to the effects of the treatment, i.e. the processing. The data presented in table 2 shows that sun flower meal processed with microwave had initially higher value of degradability of dry matter than the other treatments. However, after 36 hours of ruminal incubation, the rate of degradability of dry matter of sun flower meal processed with 0.5% urea was higher than the other treatments. The results obtained showed that enriching sun flower meal with 0.5% urea decreased the quickly degradable part (a) of the dry matter compared to microwave. Means of the data presented in table 3 show that in zero-hour of incubation, treatments B (13.84%) and A (3.27%) had the highest and lowest rumen CP disappearance ($P<0.05$). This difference can be due to processing sun flower meal with urea that is highly soluble and decreases ruminal pH fluctuations, and therefore in increases proteolytic activity of the rumen microorganisms that it has caused higher CP degradation. Homolka et al. [12] show crude protein degradation of rapeseed meal is 14.7% at zero h ruminal incubation. The data obtained from this study showed that treatments B (49.29%) highest and A (32.03%) lowest CP disappearance in 48 h incubation. Crud protein degradability coefficients of the treatments presented in table 3 show that coefficient (a) had the highest and lowest values for treatments B (13.84%) and A (3.28%), respectively ($P<0.05$). These results were predictable due to the high solubility of urea. Homolka et al. [12] reported crude protein of part a of rapeseed meal 13.6% which is higher than the results (3.28% for treatment A) of the present study.

Also, the findings of the present study for coefficient b (29.63%) of sun flower meal were less the value reported by Gonzales et al. [13] (81.1%). These differences can be imputed to the differences in the varieties used, the sampling conditions, and the basic ration of the animals under study, the size of the holes of the nylon bags, the microbial contamination, the method of washing the bags, the different methods of processing. Also, Homolka et al. [12] reported coefficient b of rapeseed meal as 78.6% which was higher than the findings of the present study.

In the present study, the potential degradability (a + b) of protein of sun flower meal processed with 0.5% urea was 49.79% which indicated the low degradability rate of crude protein of in rumen. According to table 2, the processing of sun flower meal with urea and microwave caused a considerable increase in the values of parts a and b. This is due to the increase of crude protein and decrease of anti-nutritional materials and cell wall through processing of meal. It indicates the efficiency and the improvement of performance and nutritional value of feed due to processing.

The sun flower meal processed with 0.5% urea in times of 0 to 48 hours had higher rate of ruminal disappearance of crude protein than the other treatments. The sun flower meal had lower values of ruminal disappearance of crude protein than the treatments processed with 0.5% urea and processed with microwave. Gonzales et al. [13] reported the percentage of quick degradation protein of rapeseed and processed rapeseed as 13.6 and 31.4%, respectively. These are against with the results of the present study. These differences can be due to the differences in the varieties studied, the climatic conditions, the different processing methods, the differences in the experiment conditions, and the basic ration of the fistulated animals in the above studies.

The use of microwave is one of the methods of meal processing which has been studied recently [14]. Microwave is one of the electromagnetic waves and is considered as a physical factor protein denaturation. Microwave produces heat by the creation of rotation and friction in the bipolar molecules and ions and increase molecules collision with each other and unlike conventional heating methods in which the heat penetrates into the food surface, here heat is created in feed sections equally which is an important advantage of this processing method.

Results of dry matter and crud protein degradation show processing with urea and microwave increase the degradability and metabolizable protein in the sun flower meal. The microorganisms in the rumen of ruminants are able to degrade the protein and use the nitrogen for making microbial proteins. If it is fed along with a light source of carbohydrates, it will increase the production of microbial in the ruminants [15,16]. The results obtained showed that there were significant

statistical differences between metabolizable protein of the treatments of this experiment ($P<0.05$). In general, the amount the metabolizable protein of the feed is influenced by factors such as the rate of crude protein and the rate of degradability of protein in rumen.

CONCLUSION

It can be concluded that sun flower meal produced in the country has nutritional value and suitable amount of metabolizable protein and processing with microwave and urea can improve its nutritional value and metabolizable protein. Using microwave is an appropriate strategy for increasing efficiency of using crude protein. The results of effective degradability and digestibility of sun flower meal with the power of 800 watts for 1.30 minutes allowed the protein to pass through. Being quick and cheap, processing with microwave is a useful method for changing the degradability of protein of oilseed meals. Regarding the findings of this research, it is clear that sun flower meal, sun flower meal processed with 0.5% urea, and sun flower meal processed with microwave have high digestive potential. If there is more information about these, they can be used as alternative feed for ruminants.

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