Journal of Animal and Veterinary Advances 7 (10): 1227-1236, 2008
ISSN: 1680-5593

Effects of Various Chemical Treatments on Nutritive Value of the Rosehip (*Rosa canina* L.) Seed for the Ruminant Animals

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Abstract: This experiment was conducted to determine nutrient composition of rosehip seed and determine the effects of various chemical treatments on its nutritive value for ruminants. Three, 2 years old Awassi rams were incubated with rosehip seed subjected to no treatment, ammonization (4%), urea addition (4%) and NaOH treatment (1.5%). After 72 h incubation, ruminal disappearance and degradation kinetics of nutrients in response to different chemical treatment and treatment duration were analyzed using nonlinear model. Concentrations of DM, CP, NDF, ADF, ADL and crude ash were 95.05, 8.84, 60.00, 51.80, 29.91 and 3.49%, respectively, in untreated rosehip seed. Treatments significantly altered nutrient composition, especially protein content. Effective degradability of DM, CP, NDF and ADF were 29.1, 79.6, 9.3 and 4.8% for untreated rosehip seed; 25.7, 69.6, 1.0 and 6.2% for rosehip seed treated with 4% ammonia; 24.3, 83.4, 4.5 and 3.9% for rosehip seed treated with 4% urea and 1.28, 17.9, -1.3 and -8.6% for rosehip seed treated with 1.5% NaOH, respectively.

Key words: Rosehip seed, nutrient composition, nutritive value, ruminal degradability, *Ruminant* sp.

INTRODUCTION

Rosehip (*Rosa canina* L.) is an annual waxy shrub plant (Ercisli and Guleryuz, 2006). It has abundant fruit (Ercisli and Guleryuz, 2006; Uggla *et al*., 2003) that is commonly utilized for fruit juice, herbal tea, marmalade and jam production as well as drug production and food fortification (Tarakci and Kucukoner, 2004; Villaran *et al*., 1997). Fruit comprises of pericarb (70%) and seed (30%) (Çinar and Dayisoylu, 2004). Moreover, its roots, stems and leaves are utilized in paint production. Rosehip fruit is rich in Organic Matter (OM) (Demir and Ozcan, 2001), fat (linoleic acid, linolenic, palmitic and stearic acids) (Machmudah *et al*., 2007; Nowak, 2005), macro and micro minerals (Ozcan *et al*., 2008) and vitamins (especially vitamin C and folic acid) (Salminen *et al*., 2005; Stralsjo *et al*., 2003).

Rosehip posses antioxidant activity, as shown by radical scavenging capability (Daels-Rakotoarison *et al*., 2002; Su *et al*., 2007) and chelating activity of phenolic matters (Yoo *et al*., 2008), such as flavones, anthocyanin (1-611 mg/100 g) and ellagitannins (1-330 mg/100 g) (Koponen *et al*., 2007; Salminen *et al*., 2005). Gao *et al*. (2000) reported that antioxidants was 23.23 mg g^{-1} total carotenoids and 76.26 mg g^{-1} total phenolics and that phenolic component contributed to antioxidant activities more than ascorbate (85 vs. 14%). Rosehip seed contains 8.2 g glyceride oil/kg, 0.4 g sterol/kg, 71 mg gamma-tocopherol/kg, phospholipds (phosphatldylcholine, 2.8 g kg^{-1}; phosphatidylinositol, 1.3 g kg^{-1} and phos-phatidylethanolamine, 1.4 g kg^{-1}) (Zlatanov, 1999), suggesting pharmacological properties. These functional fats could be related to rosehip oil's hypolipidemic effect in hamster (Gonzalez *et al*., 1997) through increasing biliary cholesterol excretion (Lutz *et al*., 1991). Rosehip also contains some other functional nutrients that include quercetin, luteolin, apigenin and kaempferol (Karakaya and El, 1999), which have antimutagenic activity (Karakaya and Kavas, 1999). Indeed, it is beneficial in the treatment of osteoarthritis and lower back pain (Chrubasik *et al*., 2007) and colonic injury (Hakansson *et al*., 2006) due to inhibiting cyclooxygenase-1 and-2 (Jager *et al*., 2007) and malondia-ldehyde (Hakansson *et al*., 2006). Its antiinflammatory properties are exerted via inhibiting chemotaxis of leukocytes (Larsen *et al*., 2003). Antioxidant capacity is

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also related to higher protective effect on gap-junction intercellular communication and DNA and enhanced activity of the antioxidative enzymes such as superoxide dismutase and catalase (Yi *et al*., 2007; Yoo *et al*., 2008).

Rosehip seed constitutes 20-44% of wet weight (Yildiz and Nergiz, 1996). Some studies tested rosehip seed utilization in ovine and avian species (Sen and Günes, 1996). Dry matter (DM), OM, crude protein (CP), ether extract (EE), ash, crude fiber (CF), nitrogen-free extract (NFE) and metabolizable energy (ME) contents of rosehip seed are reported to be 94, 92, 8.7, 8.6, 1.9, 31.6, 43.5% and 1800 kcal kg^{-1} (Nichita *et al*., 1981). About 69% of CP is digestible. These suggest that it is equivalent in protein, but rich in fat and fiber, comparing with commonly used grains. This experiment was conducted to determine nutrient composition of rosehip seed and alterations in its nutritive value for ruminants in response to various chemical treatments.

MATERIALS AND METHODS

Animal and diet: Three 2 years old mature Awassi rams were obtained from the Atatürk Üniversity Research Farm and ruminally fistulated one month more prior to *in sacco* study. The experiment was conducted during winter in 2007. Rams were fed twice daily to receive 125% of nutrient requirements for maintenance (NRC, 1985). The ration contained grass hay (0.9-1.2 kg day^{-1}) (90.7%, DM; 5.0%, CP; 38.6%, ADF; 55.9%, NDF; 2.6% EE and 10.0%, crude ash) and concentrate mixture (0.3-0.4 kg day^{-1}) (89.6%, DM; 10.6%, CP; 4.6%, CF; 2.6%, EE and 4.9%, crude ash). Rams had free access to water all times.

Treatment and *in sacco* incubation: Before chemical treatments, rosehip seed was ground to pass a 2 mm screen. Ground rosehip seed (1 kg) was mixed with 4% ammonia (vol/vol) and 4% urea (wt/vol) for 10, 20 and 30 days in 3 different polyethylene bags at room temperature. Rosehip seed (1 kg) was also treated with 1.5% NaOH (10 L) for 20 h and then rinsed with tap water for 18 h.

After drying at 65°C for 48 h, 5-6 g samples were put in nylon bags (Dacron material, 7×14 cm, with an average pore size of 45 μm) for 8, 16, 24, 48 and 72 h incubation in the rumen after morning feeding (AFRC, 1992). Duplicates of each of samples were put in each of rams. At the end of each incubation period, the bags were removed from the rumen and washed thoroughly under running tap water until the rinsing water was colorless. They were washed again in a washing machine with cold water (3×5 min) until all ruminal colors disappeared. Samples were then oven dried to constant weight at 55°C for 48 h. The washing losses were determined by washing bags with samples prior to incubation.

Sample collection and analytical procedure: The basal diet and rosehip samples before and after incubation were analyzed for DM, CP, EE and ash contents using wet chemistry (AOAC, 1990) as well as for NDF, ADF, Acid Detergent Lignin Concentrations (ADL) (Goering and Van Soest, 1970) using Fibre Analyser (Ankom^{220} Fiber Analyzer, Ankom Co., USA).

Degradability kinetics calculation: The *in sacco* degradation kinetics was fitted to the following exponential equation (Ørskov and McDonald, 1979):

$$\text{Degradability (\%)} = (a+b)\,(1-e^{-ct})$$

where,

- a : Soluble fraction (%).
- b : Insoluble but degradable fraction (%).
- c : Fractional rumen degradation rate per hour of b.
- t : Incubation time (h).
- (a+b) : Maximal degradability.

Effective Degradability (ED) was calculated using Neway software (Version 5.0, Rowlett Research Institute, Aberdeen, UK), assuming that ruminal outflow rate (k) is 2% for low producing ruminants, 5% for sheep and beef and 8% for high producing cows per hour (ED, % = a + (bc)/(c+k)).

Statistics: Effects of chemical treatments were analyzed separately in a complete randomized design. Data were subjected to one-way ANOVA as repeated measures with time being subplot (SAS, 1999). The general linear model to test the effects of chemical treatments and treatment durations was as follows:

$$Y_{ijk} = \mu + T_i + t_j + (T*t)_{ij} + e_{ijk}$$

where,

- Y_{ijk} : Response variable.
- μ : Population mean.
- T_i : Ith treatment.
- t_j : Jth time relative to incubation.
- e : Residual error.

In addition to orthogonal contrast (untreated vs. treated rosehip seeds), the polynomial contrast option

was also computed to evaluate the nature of responses to increasing treatment duration with ammonia and urea (linear and quadratic effects of treatment duration). The effects were considered to be significant at $p<0.05$.

RESULTS

Nutrient composition: Rosehip seed contained 95.05, 8.84, 60.00, 51.80, 29.91 and 3.49% DM, CP, NDF, ADF, ADL and crude ash, respectively (Table 1). It appeared that chemical treatment did not change DM content. However, ammonia, urea and NaOH treatments were associated with a 68% increase, a 99% increase and a 86% decrease in CP, respectively. Alterations in NDF, ADF, ADL and ash contents in response to ammonia and urea treatments were negligible, whereas those in response to NaOH treatment were remarkable (about a 1.5-fold increase for all).

Effect of urea treatment and treatment duration: Ammonization of the rosehip seed affected DM, CP, NDF, ADF and ADL degradabilities ($p<0.0001$ for all variables; control vs. ammonia). Prolonging ammonia treatment duration linearly decreased DM, CP and NDF degradabilities and linearly increased ADF and ADL degradabilities ($p<0.0001$ for all variables). Average degradability was 41.17, 39.21, 36.28 and 37.83% for DM; 86.41, 85.23, 83.01 and 84.61 for CP; 16.11, 13.06, 11.28 and 10.38% for NDF; 16.80, 18.45, 17.32 and 25.49% for ADF and -30.04, -22.75, -12.04 and 0.69% for ADL when ammonia treatment lasted for 0, 10, 20 and 30 days, respectively. As incubation time progressed, DM degradability increased from 33.29-43.76%; CP degradability increased from 79.85-89.99%; NDF degradability increased from 10.70-14.18%; ADF degradability increased from 18.00-21.02% and ADL degradability decreased from -10.27 to -31.12% ($p<0.0001$ for all variables; time effect). Moreover, DM ($p<0.0001$; Fig. 1a), CP ($p<0.0001$; Fig. 1b), NDF ($p<0.0001$; Fig. 1c), ADF ($p<0.001$; Fig. 1d) and ADL ($p<0.001$; figure not shown) degradabilities during *in sacco* incubation varied by ammonia treatment duration (ammonia treatment duration by incubation time interaction effect).

Soluble fraction (a), insoluble but degradable fraction (b) and maximal degradable fraction (a+b) for DM were not affected by ammonization and ammonia treatment duration (Table 2). Fractional rate (fraction c) ($p<0.03$) and rumen outflow rate (k) ($p<0.0001$) were lower for ammoniated rosehip seed than for untreated rosehip seed. However, ED for DM (29.30%) was unaffected by ammonization. Ammonization decreased fraction 'a' ($p<0.0001$), k ($p<0.0001$) and ED ($p<0.0001$); increased fraction 'b' ($p<0.0001$) and unaltered fraction 'a+b' and 'c' for CP and NDF. Significances linearly continued as ammonia treatment duration prolonged. Responses of degradation kinetic parameters for ADF in response to ammonia treatment were opposite to those for NDF.

Table 1: Nutrient composition of the rosehip seed subjected to various chemical treatments

	Nutrient (%)[1]					
Treatments	DM	CP	NDF	ADF	ADL	Ash
Control	95.05	8.84	60.00	51.80	29.91	3.49
4% ammonia for 10 day	94.55	14.86	58.50	52.80	27.97	3.48
4% ammonia for 20 day	93.57	14.87	58.40	52.90	31.10	3.98
4% ammonia for 30 day	93.54	14.78	56.60	57.30	36.62	3.92
4% urea for 10 day	94.56	17.74	62.90	54.30	28.20	3.45
4% urea for 20 day	93.57	17.87	64.20	56.60	30.20	2.97
4% urea for 30 day	93.57	17.28	63.20	56.60	30.87	3.47
NaOH	94.58	1.25	90.30	73.10	46.66	4.95

[1]DM = Dry Matter; CP = Crude Protein; NDF = Neutral Detergent Fiber; ADF = Acid Detergent Fiber; ADL = Acid Detergent Lignin

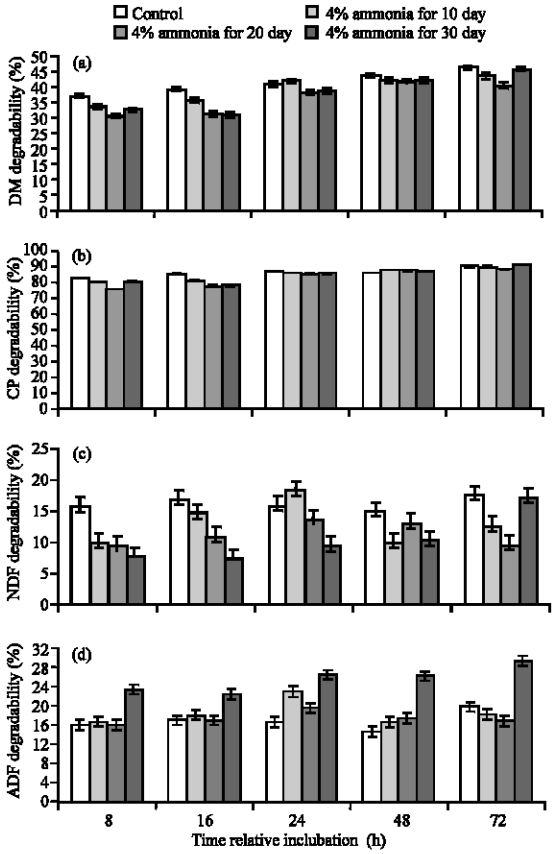

Fig. 1: Effects of treating the rosehip seed with 4% ammonia for 10, 20 and 30 days on degradability of DM (Panel A), CP (Panel B), NDF (Panel C) and ADF (Panel D)

Effect of urea: Treating the rosehip seed with urea affected DM ($p<0.0001$), CP ($p<0.0001$) and ADL ($p<0.0001$) degradabilities, but not NDF ($p<0.09$), ADF

Table 2: Effect of treating the rosehip seed with ammonia (4%) and treatment duration on degradability kinetics parameters

	Duration of ammonia treatment (d)					Significance, P<F[1]		
Variable[2]	Control	10	20	30	SEM	C vs. A	L-D	Q-D
DM								
a	29.020	29.520	24.25	23.37	2.560	0.2800	0.0700	0.7900
b	14.500	13.020	14.50	19.35	2.140	0.6500	0.1100	0.1500
a+b	43.510	42.530	38.75	42.76	1.060	0.0900	0.2100	0.0300
c	0.105	0.052	0.053	0.048	0.020	0.0300	0.0700	0.2400
k, 2%	39.980	38.350	35.25	36.57	0.300	0.0001	0.0001	0.0001
k, 5%	38.000	35.730	32.18	32.53	0.420	0.0001	0.0001	0.0060
k, 8%	36.780	34.400	30.52	30.42	0.600	0.0001	0.0001	0.0700
ED, % at 5%	29.070	29.540	24.27	23.40	2.540	0.2700	0.0600	0.8000
CP								
a	79.630	74.130	63.45	71.20	0.490	0.0001	0.0001	0.0001
b	10.600	16.900	25.05	20.88	0.430	0.0001	0.0001	0.0001
a+b	90.230	91.030	88.50	92.08	0.620	0.6700	0.2900	0.0400
c	0.042	0.039	0.057	0.037	0.004	0.6400	0.8900	0.0500
k, 2%	86.330	85.270	82.52	84.70	0.120	0.0001	0.0001	0.0001
k, 5%	84.130	81.520	77.33	80.05	0.130	0.0001	0.0001	0.0001
k, 8%	83.030	79.670	74.40	77.80	0.170	0.0001	0.0001	0.0001
ED, % at 5%	79.640	74.140	63.47	71.21	0.490	0.0001	0.0001	0.0001
NDF								
a	9.320	-0.420	1.22	1.92	0.600	0.0001	0.0001	0.0001
b	4.970	13.580	10.85	14.92	1.030	0.0001	0.0001	0.0400
a+b	14.280	13.170	12.07	16.83	1.030	0.8300	0.1700	0.0100
c	0.029	0.047	0.017	0.008	0.008	0.6000	0.0200	0.1100
k, 2%	12.130	7.980	5.93	5.97	0.300	0.0001	0.0001	0.0001
k, 5%	11.100	5.300	3.85	3.73	0.390	0.0001	0.0001	0.0001
k, 8%	10.580	3.980	3.05	2.97	0.430	0.0001	0.0001	0.0001
ED, % at 5%	9.330	-0.310	1.26	1.95	0.590	0.0001	0.0001	0.0001
ADF								
a	4.700	7.750	4.03	6.77	1.780	0.4800	0.7600	0.9300
b	10.200	9.220	11.18	17.53	1.690	0.2200	0.0050	0.0400
a+b	14.900	16.970	15.21	24.30	0.960	0.0020	0.0001	0.0020
c	0.091	0.047	0.060	0.066	0.015	0.0700	0.3700	0.1100
k, 2%	13.000	13.450	11.83	19.98	0.420	0.0004	0.0001	0.0001
k, 5%	11.300	11.570	9.63	16.58	0.530	0.0500	0.0001	0.0001
k, 8%	10.250	10.630	8.48	14.65	0.650	0.2000	0.0010	0.0003
ED, % at 5%	4.800	7.780	4.11	6.85	1.750	0.4800	0.7500	0.9400

[1]C vs. A: contrasting control vs. ammonia treatment; L-D: Linear effect of Duration of treating the rosehip with ammonia; Q-D: Quadratic effect of Duration of treating the rosehip with ammonia; [2]a = soluble fraction; b = insoluble but degradable fraction; c = fractional rumen degradation rate per hour of b; ED = Effective Degradability, % = a + (bc)/(c+k), where, k = rumen outflow rate at 2, 5 and 8% per h)

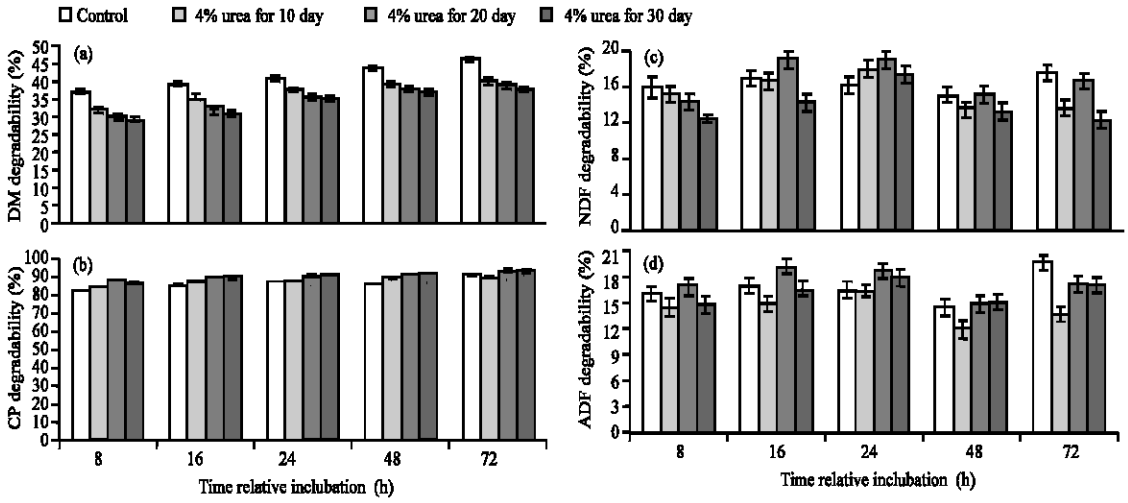

Fig. 2: Effects of treating the rosehip seed with 4% urea for 10, 20 and 30 days on degradability of DM (Panel A), CP (Panel B), NDF (Panel C) and ADF (Panel D)

Table 3: Effect of treating the rosehip seed with urea (4%) and treatment duration on degradability kinetics parameters

	Duration of urea treatment (d)					Significance, P<F[1]		
Variable[2]	Control	10	20	30	SEM	C vs. U	L-D	Q-D
DM								
a	29.020	24.710	25.630	22.530	3.120	0.2000	0.2000	0.8400
b	14.500	12.200	11.980	14.420	2.890	0.6300	0.9700	0.4200
a+b	43.520	36.920	37.610	36.950	1.380	0.0007	0.0060	0.0400
c	0.105	0.099	0.062	0.065	0.024	0.3000	0.1600	0.8600
k, 2%	39.980	34.900	33.600	32.530	0.360	0.0001	0.0001	0.0001
k, 5%	38.000	32.950	31.420	30.130	0.450	0.0001	0.0001	0.0004
k, 8%	36.780	31.650	30.170	28.800	0.660	0.0001	0.0001	0.0010
ED, % at 5%	29.070	24.760	25.650	22.580	3.100	0.2000	0.1900	0.8400
CP								
a	79.630	80.300	86.180	83.800	0.370	0.0001	0.0001	0.0006
b	10.600	9.470	8.720	9.170	0.480	0.0100	0.0300	0.1100
a+b	90.230	89.770	84.900	92.970	0.590	0.0030	0.0001	0.2300
c	0.029	0.037	0.028	0.048	0.011	0.5300	0.1500	0.1100
k, 2%	12.130	10.970	11.620	7.600	0.340	0.0001	0.0001	0.0001
k, 5%	11.100	8.920	9.380	5.930	0.430	0.0001	0.0001	0.0001
k, 8%	10.580	7.980	8.400	5.120	0.500	0.0001	0.0001	0.0001
ED, % at 5%	79.640	80.310	86.180	83.800	0.370	0.0001	0.0001	0.0006
NDF								
a	9.320	5.170	5.800	2.520	0.860	0.0001	0.0001	0.6200
b	4.970	11.070	10.950	8.270	1.100	0.0007	0.0600	0.0007
a+b	14.280	16.230	16.750	10.780	1.040	0.8000	0.0400	0.0010
c	0.029	0.047	0.017	0.008	0.008	0.6000	0.3800	0.6300
k, 2%	12.130	7.980	5.930	5.970	0.300	0.0001	0.0001	0.0005
k, 5%	11.100	5.300	3.850	3.730	0.390	0.0001	0.0001	0.1500
k, 8%	10.580	3.980	3.050	2.970	0.430	0.0001	0.0001	0.5000
ED, % at 5%	9.330	5.210	5.830	2.580	0.850	0.0001	0.0001	0.6100
ADF								
a	4.700	3.400	2.380	5.550	1.390	0.5700	0.8100	0.1200
b	10.200	8.770	11.550	9.120	1.330	0.8000	0.9300	0.7100
a+b	14.900	12.170	13.930	14.670	0.990	0.2600	0.8100	0.1000
c	0.091	0.050	0.099	0.043	0.020	0.1400	0.1800	0.6100
k, 2%	13.000	9.580	11.800	10.330	0.350	0.0001	0.0010	0.0100
k, 5%	11.300	7.750	9.850	8.800	0.450	0.0001	0.0100	0.0100
k, 8%	10.250	6.800	8.620	8.070	0.560	0.0010	0.0800	0.0200
ED, % at 5%	4.790	3.460	2.510	5.590	1.370	0.5600	0.8200	0.1200

[1]C vs. U: contrasting control vs. urea treatment; L-D: linear effect of duration of treating the rosehip with urea; Q-D: quadratic effect of duration of treating the rosehip with urea; [2]a = soluble fraction; b = insoluble but degradable fraction; c = fractional rumen degradation rate per hour of b; ED = effective degradability, % = a + (bc)/(c+k), where k = rumen outflow rate at 2, 5 and 8% per h)

(p<0.12) degradabilities (control vs. urea). Increasing urea treatment duration linearly decreased DM (p<0.0001) and NDF (p<0.004) degradabilities, linearly increased CP (p<0.0001) and ADL (p<0.0001) degradabilities and cubically decreased ADF degradability (p<0.0001). Average degradability was 41.17, 36.52, 34.85 and 33.84% for DM; 86.41, 87.38, 90.02 and 90.20 for CP; 16.11, 15.26, 16.78 and 13.72% for NDF; 16.80, 14.29, 17.46 and 16.36% for ADF and -30.04,-36.49,-25.03 and 16.10% for ADL when urea treatment lasted for 0, 10, 20 and 30 days, respectively. As the *in sacco* incubation continued, DM degradability increased from 31.83-40.49%; CP degradability increased from 85.55-91.35%; NDF degradability increased from 14.34-14.92%; ADF degradability increased from 15.62-17.00% and ADL degradability decreased from-19.28 to -64.67% (p<0.0001 for all variables; incubation time effect). Moreover, DM (p<0.51; Fig. 2a), CP (p<0.0001; Fig. 2b), NDF (p<0.07; Fig. 2c), ADF (p<0.20; Fig. 2d) and ADL (p<0.0001; Figure not shown) degradabilities during *in sacco* incubation varied by urea treatment duration (urea treatment duration by incubation time interaction effect).

Except for maximal degradable fraction (p<0.0007) and outflow rate (p<0.0001), urea treatment and its duration did not affect degradation kinetics for DM (Table 3). Expectedly, urea treatment and prolonging its duration increased fraction 'a' (p<0.0001) and decreased fraction 'b' (p<0.01) for CP. Despite no change in fraction 'c', k decreased (p<0.0001) and ED increased (p<0.0001) with treatments. Urea treatment and its duration decreased fraction 'a' (p<0.0001), whereas they increased fraction 'b' (p<0.0007) for NDF. Moreover, they significantly reduced k (p<0.0001) and ED (p<0.0001). There were urea treatment effects on degradation kinetics for ADF, except for k (p<0.0001).

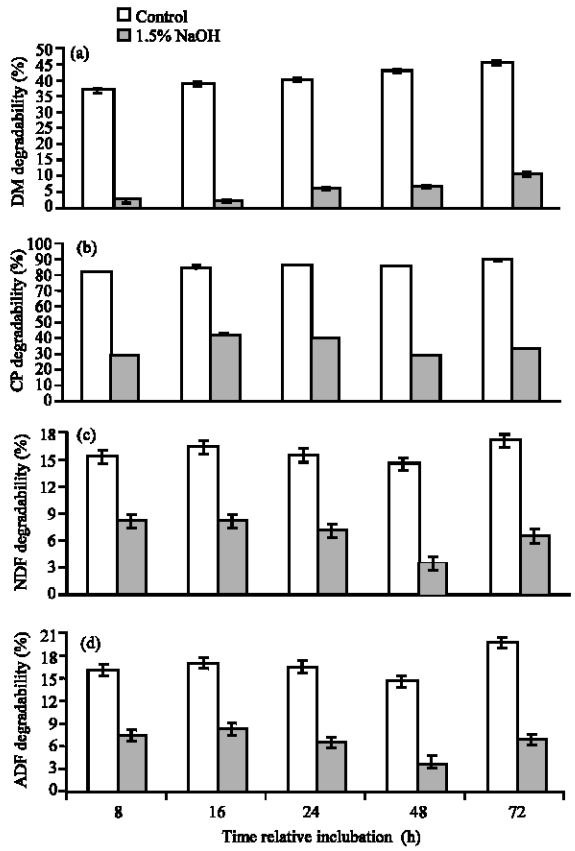

Fig. 3: Effects of treating the rosehip seed with 1.5% NaOH on degradability of DM (Panel A), CP (Panel B), NDF (Panel C) and ADF (Panel D)

Effect of sodium hydroxide treatment: Treating the rosehip seed with NaOH reduced DM (5.59 vs. 41.17%, p<0.0001), CP (35.12 vs. 86.41%, p<0.0001), NDF (6.82 vs. 16.11, p<0.0001) and ADF (6.55 vs. 16.80, p<0.0001) degradabilities and increased ADL digestibility (-22.36 vs. -30.04%, p<0.0001). DM degradability increased from 19.70-28.27% (p<0.0001); CP degradability increased from 56.18-61.97% (p<0.0001); NDF degradability increased from 11.99-12.04% (p<0.005); ADF degradability increased from 11.73-13.36% (p<0.0001) and ADL degradability decreased from -12.47 to -45.00% (p<0.0001) as *in sacco* incubation advanced (time effect). Moreover, DM (p<0.07; Fig. 3a), CP (p<0.0001; Fig. 3b), NDF (p<0.0001; Fig. 3c), ADF (p<0.04; Fig. 3d) and ADL (p<0.0001; Figure not shown) degradabilities during *in sacco* incubation varied by treating with NaOH (NaOH treatment by incubation time interaction effect). NaOH treatment dramatically reduced fraction 'a' and 'b', k and ED for all nutrients measured (Table 4).

Table 4: Effect of treating the rosehip seed with 1.5% NaOH on degradability kinetics parameters

	Treatment			
Variable[1]	Control	NaOH	SEM	p<value
DM				
a	29.020	1.230	3.190	0.0001
b	14.500	2.830	2.810	0.0200
c	0.105	0.045	0.027	0.1400
a+b	43.520	4.060	0.970	0.0001
k, 2%	39.980	3.080	0.240	0.0001
k, 5%	38.000	2.500	0.390	0.0001
k, 8%	36.780	2.200	0.590	0.0001
ED, % at 5%	29.070	1.280	3.160	0.0001
CP				
a	79.630	17.900	0.430	0.0001
b	10.600	22.550	0.510	0.0001
c	0.042	0.048	0.005	0.4700
a+b	90.230	40.450	0.790	0.0001
k, 2%	86.330	33.730	0.130	0.0001
k, 5%	84.130	28.880	0.090	0.0001
k, 8%	83.030	26.320	0.110	0.0001
ED, % at 5%	79.640	17.940	0.430	0.0001
NDF				
a	9.320	-1.650	0.460	0.0001
b	4.970	4.770	0.500	0.7800
a+b	14.280	3.120	0.110	0.0001
c	0.029	0.059	0.006	0.0070
k, 2%	12.130	1.930	0.070	0.0001
k, 5%	11.100	0.970	0.080	0.0001
k, 8%	10.580	0.380	0.140	0.0001
ED, % at 5%	9.330	-1.330	0.420	0.0001
ADF				
a	4.700	-7.580	3.330	0.0300
b	10.200	10.580	3.120	0.9300
a+b	14.900	3.000	0.280	0.0001
c	0.091	0.085	0.027	0.8900
k, 2%	13.000	1.120	0.280	0.0001
k, 5%	11.300	-0.330	0.580	0.0001
k, 8%	10.250	-1.320	0.840	0.0001
ED, % at 5%	4.800	-8.590	3.560	0.0200

[1]a = soluble fraction; b = insoluble but degradable fraction; c = fractional rumen degradation rate per hour of b; ED = effective degradability, % = a + (bc)/(c+k)), where k = rumen outflow rate at 2, 5 and 8% per h)

DISCUSSION

Rosehip fruit is extensively utilized for food production. Its residue and seed may be used for animal nutrition. However, data on its nutritive value for animal nutrition are largely lacking. Alternative feedstuffs have been focus of numerous studies to compensate deficits, especially in arid and semiarid zones where conventional animal production is predominant. Rosehip seed therefore can be an important part of ruminant diets when feedstuff shortage is faced.

The *in vivo* nylon bag technique appears to offer a quick and easy method of estimating rumen utilization of feedstuffs (Kepton, 1980). The technique measures the disappearance of feed constituents from bags containing the test diet after incubation in the rumen for varying periods. The rate of breakdown of carbohydrates is a

important determinant of voluntary intake in ruminants and the degradation of protein in the rumen influences the protein supply for the host animals and the N available for the rumen micro organism (Mehrez and Ørskov, 1977). The *in situ* technique proposed by Ørskov and McDonald (1977) is one of these procedures that help in the assignment of OM and CP degradability in rumen. The results obtained from the *in situ* technique are closely associated with findings of the standard digestive studies (Hopson *et al*., 1983). The nylon bag technique allows the description of degradability kinetics and quantity of nutrient effectively degraded in the rumen can be calculated from degradability kinetic coefficients and the outflow rate from the rumen.

Deville *et al*. (1980) evaluated nutrient composition of some alternative feedstuffs and reported that rice bran, coconut layer, pea residue and cassava leucaena leaves contained 1.3, 4.8, 3.0, 3.0 and 4.3% CP on a DM basis. Umucalilar *et al*. (2007) tested nutritive value of mistletoe for ruminants, which adapts to drought condition due to having low amount of chlorophyll-protein complexes and capacity of photosynthesis. CP and NDF contents of the mistletoe species were about 6.0 and 30.0% (Umucalilar *et al*., 2007), which are much lower than commonly used forage sources in intensive animal production facilities (NRC, 2001). Fiber level is one of the most important concerns for forage choice because it influences feed intake (Romney and Gill, 2000) through its gut filling effect. The mistletoe species contained ME ranging from 7.8-8.4 MJ kg^{-1} with *in vitro* digestibilities of DM and OM ranging from 84-87% and from 52-56%, respectively. Madibela *et al*. (2000) reported that *in vitro* DM digestibility was 53% in *Viscum* species. In comparison with commonly used conventional forages, the mistletoe species were poor in protein and fair in fiber with considerable degradability. In this experiment, data showed that rosehip seed contained low CP and high NDF (Table 1), suggesting that it may be replaced with cereal grains and fiber source. However, effectiveness of NDF remains to be tested in *in vivo* studies measuring eating behavior.

Degradation kinetics parameters (a+b and c) can represent feed quality and are predictors of intake (Ørskov *et al*., 1988). Parameter c is about 0.92-1.38% and 3.22-5.06% for roughages and energy rich foodstuffs (Mcdonald *et al*., 1988). In this experiment, parameter c was higher than that for roughages. Since, readily fermentable portion is greater than undegradable but fermentable portion, greater value for parameter a for DM degradability from parameter b in the present study may reflect inability of rosehip seed to escape the reticulorumen without being subjected to microbial attack (Table 2-4). Von Keyserlingk *et al*. (1996) reported that average rapidly soluble CP fractions in alfalfa and in grass hay were 58.99 and 43.97%, respectively. AFRC (1993) reported 'a' and 'b' values for CP degradability for dry grass hay were 32 and 63%, respectively. Rapidly solublized and potentially fermentable CP fractions of alfalfa were variable and reported to be 26.7 and 46.7% (Terramoccia *et al*., 2000) and 29.4 and 61.6% (Janicki and Stallings, 1988). Turgut and Yanar (2004) evaluated ruminal DM and CP degradation kinetics for eight forages and reported that the rapidly soluble DM and CP fractions and the potentially degradable DM and CP fractions were 17.4, 30.3, 49.7 and 26.5% for barley straw; 24.7, 38.4, 43.4 and 25.5% for wheat straw; 26.5, 63.6, 48.1 and 21.2% for oat grass; 29.0, 29.7, 46.8 and 49.6% for brome grass; 27.0, 35.3, 40.4 and 52.7% for alfalfa; 38.5, 42.7, 43.4 and 45.9% for sainfoin; 29.2, 39.7, 49.2 and 55.0% for common vetch and 28.0, 31.0, 55.4 and 50.0% for dry grass hay, respectively. For corn and sunflower mixture silages effective DM, CP and NDF degradabilities were 50.13, 71.96 and 34.93%, respectively (Banys *et al*., 1999). These values for rosehip are lower than good quality forages, but are similar to those for other alternative forage sources (Keir *et al*., 1997).

Grains are subjected to a more rapid degradation in Rumen than forages. Turgut *et al*. (2004) compared *in sacco* degradability of energy rich feedstuffs (wheat and barley) and reported that average values were 42.94, 56.24 and 99.18% for parameters a, b and a+b for CP degradability, respectively. Moreover, average of parameter 'c' and ED were 0.10 per hour and 79.01% at k = 0.05% h. In a study conducted by Murphy and Kennelly (1987), barley grain was incubated in a rumen for 2, 4, 8 and 24 h. Rumen degradabilities of CP of barley were 65.7, 74.0, 81.5, 87.8 and 95.2%, respectively. Beckers *et al*. (1995), also indicated that CP degradabilities of wheat bran at 2, 4, 8, 16, 24 and 48 h in the rumen were 43.1, 62.1, 80.6, 92.4, 92.9 and 94.3 %, respectively.

Rosehip seed feeding trials in ruminants is limited. Unsal and Yanlic evaluated inclusion of rosehip (0, 5 and 15%) in sheep diets and reported alterations in meat fatty acid content (e.g., lauric, myristic, palmitic, palmitoleic, margaric and linoleic acids and fat propoerties (e.g., melting point, refractive index and fractionation). Macit *et al*. (2003) conducted an *in sacco* study on fistulated rams to attain nutritive value of rosehip seed. Rosehip contained 93.5, 91.6, 8.7, 44.1, 8.0, 1.9, 30.9, 644 and 64.8% DM, OM, CP, CF, EE, crude ash, NFE, ADF and NDF, respectively. Degradability of DM was 32.3, 36.3, 36.2, 36.6 and 36.6; of CP was 72.7, 72.7, 78.1, 78.2 and

78.2% and of NDF was 4.8, 7.5, 7.5, 7.5 and 7.5% at 8, 16, 24, 48 and 72 h relative to *in sacco* incubation. Moreover, total degradability (a+b) and rate constant for the degradation (c) of DM, CP, CF, ADF and NDF were 36.56, 78.19, 86.77, 14.04 and 7.52% and 0.152, 0.268, 0.105, 0.159 and 0.336%, respectively. Effective degradabilities of DM, CP, CF, ADF and NDF were 34.9, 75.0, 81.0, 13.1 and 7.0% h at k = 0.02; 33.0, 70.9, 75.1, 12.0 and 6.2% h at k = 0.05 and 31.6, 67.5, 71.2, 11.2 and 5.6% h at k = 0.08, respectively.

Chemical and physical structures of starch granules and surrounding protein matrix affect starch degradation and consequently, alter rumen conditions (pH, VFA production, fiber degradation and mass stratification, retention time and passage rate of digesta and postruminal nutrient digestion). Physical processing (cracking, rolling, grinding, steaming, etc.) to disrupt seed coat in cereal grains is aimed to improve ruminal availability of energy (Owens *et al*., 1997) and nitrogenous precursors for microbial synthesis (Mathison, 1996) and attenuate the site of starch digestion (Theurer, 1986). Chemical treatments however is intended to enrich nutrients and protect nutrients from being degraded in rumen (Ørskov and Greenhalgh, 1977). Steam flaking increases (Mathison, 1996; Huntington, 1997), whereas alkali treatment decreases (Demeterova and Vajda, 1998; Tománková and Homolka, 2004) the efficacy of degradation. Tománková and Homolka (2004) reported that treating wheat and barley with NaOH (3 g/100 g) depressed their degradability (73.6 and 63.6%) at 6 h post-incubation by 46.3 and 23.2%, respectively. De Campenere *et al.* (2006) also compared degradability of rolled and NaOH treated wheat and their impacts on dairy cow performance. Rolling decreased potentially degradable fraction of DM (74.4, 95.2 and 88.2%), OM (74.4, 95.2 and 90.3%), starch (70.6, 98.1 and 97.8%) and CP (86.9, 97.1 and 95.0%) compared with untreated and NaOH wheat. However, undegraded feed protein fraction (97.1%) and in vitro OM digestibility (92.1%) did not differ by processing. *In vivo* digestibility of DM (70%), OM (72.3%), CP (64.5%), CF (58.9%), NFE (79.3%) and EE (64.6%) were not different, however, of starch was different for rolled and NaOH treated wheat (98.7 vs. 95.2%).

CONCLUSION

This experiment was conducted to investigate nutrient contents and nutritive values of rosehip seed under various chemical treatments ruminant nutrition. In comparison with commonly used conventional forages, rosehip was poor in protein and rich fiber with considerable degradability. Its protein content was comparable with graminosae grains. Moreover, protein content and its degradability can be increased by treating with urea and ammonia and decreased by treating with NaOH.

CONCLUSION

Utilization of the rosehip seed could be feasible to use as a part of forages or grain supplements after treating with urea or ammonia in ruminant feeding. Further *in vivo* studies dealing with partial replacement of rosehip seed with grains or roughages and eating behavior and Rumen fermentation pattern are necessary.

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