# THE EFFECT OF XYLOSE TREATMENT ON DRY MATTER AND CRUDE PROTEIN DEGRADABILITY CHARACTERISTICS OF SOYBEAN MEAL, FULL FAT SOYBEAN AND SOYBEAN SEED IN SHEEP

Pinar Sacakli[1], Sakir Dogan Tuncer[1], Bekir Hakan Koksal[2], Zehra Selcuk[3], Bugra Genc[3]
[1]*Ankara University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Diseases 06110, Diskapi, Ankara, Turkey; Tel. +90(312) 3170315/309; +90 (312) 3181758, e-mail: psacakli@ankara.edu.tr*
[2]*Adnan Menderes University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Diseases; 09016, Isikli, Aydin, Turkey*
[3]*Ondokuz Mayis University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Diseases, 55139, Kurupelit, Samsun, Turkey*

**Summary.** The study was conducted to determine the effects of xylose treatment of soybean meal (SBM), full fat soybean (FFSB) and soybean seed (SBS) on rumen degradability of dry matter (DM) and crude protein (CP) in four ruminally cannulated two years old Merino rams. These feedstuffs were treated with water + heat, water + heat + 2% xylose or 3% xylose. Xylose treatments at both levels (2% and 3%) decreased ($p<0.001$) effective degradability values (*Pe*) of DM and CP in SBM. Although the calculated reduction coefficients for effective CP degradability values of SBM treated with 2% and 3% xylose (37% vs 41%) were similar, they were different compared to that of untreated SBM. The calculated reduction coefficients for effective CP degradability values of FFSB and SBS treated with 2% and 3% xylose were 15.6% and 25%; 25.8% and 28.3, respectively. In conclusion, xylose treatment is more effective on protection of SBM proteins from rumen degradation compared to FFSB and SBS proteins when the calculated reduction coefficients for effective CP degradability values were considered. There was no difference between the effective CP degradability of xylose treated SBM, hence 2% xylose level is sufficient for SBM while high xylose level is necessary for FFSB and SBS. This may be resulted from high ether extract and processing methods of FFSB and SBS. For this reason xylose level may be increased for its effectiveness depending on the oil content and processing methods of FFSB and SBS.

**Keywords:** full fat soybean, rumen degradability, soybean meal, soybean seed, xylose.

# KSILOZĖS ĮTAKA SOJŲ PAŠARO, SOJŲ PUPELIŲ IR SOJŲ GRŪDŲ SAUSOSIOS MEDŽIAGOS IR BALTYMŲ VIRŠKINAMUMUI AVIŲ DIDŽIAJAME PRIESKRANDYJE

Pinar Sacakli[1], Sakir Dogan Tuncer[1], Bekir Hakan Koksal[2], Zehra Selcuk[3], Bugra Genc[3]
[1]*Gyvūnų mitybos ir mitybos ligų katedra, Veterinarinės medicinos fakultetas, Ankaros universitetas 06110, Diskapi, Ankara, Turkija*
*tel. +90 (312) 317 0315/309; +90 (312) 318 1758; el. paštas: psacakli@ankara.edu.tr*
[2]*Gyvūnų mitybos ir mitybos ligų katedra, Veterinarinės medicinos fakultetas, Adnan Menderes universitetas 09016, Isikli, Aydin, Turkija*
[3]*Gyvūnų mitybos ir mitybos ligų katedra, Veterinarinės medicinos fakultetas, Ondokuz Mayis universitetas 55139, Kurupelit, Samsun, Turkija*

**Santrauka.** Atliktas tyrimas ksilozės įtakai sojų pašaro (SP), sojų pupelių (SPU) ir sojų pupelių grūdų (SPG) sausosios medžiagos ir baltymų virškinamumui avių didžiajame prieskrandyje nustatyti. Bandymas atliktas su keturiais suaugusiais (2 metų) Merinosų veislės avinais, kuriems į didžiuosius prieskrandžius chirurginiu būdu implantuotos kaniulės. SP, SPU ir SG buvo plaunami vandeniu ir kaitinami (1 variantas). Po savaitės avinai buvo šeriami pašaru, paruoštu plaunant ir kaitinant su 2 proc. ksilozės (2 variantas), o dar po savaitės – šeriami pašarais, paruoštais plaunant ir kaitinant su 3 proc. ksilozės (3 variantas). Didžiojo prieskrandžio turinio mėginiai tyrimui buvo imami iš avinų didžiuosiuose prieskrandžiuose implantuotų kaniulių.

Nustatyta, kad, SP papildžius 2 proc. ir 3 proc. ksilozės sausosios medžiagos (SM) ir pašarinių baltymų (PB), virškinamumas didžiajame prieskrandyje ženkliai pablogėjo ($p<0,001$). Nors PB baltymų virškinamumas, papildžius SP 2 proc. ir 3 proc. ksiloze (37 proc. ir 41 proc.), nesiskyrė, tačiau buvo ženkliai blogesnis palyginti su SP, nepapildytu ksiloze (1 variantas). Nustatyta, kad SPU ir SPG, papildytų 2 proc. ksiloze (2 variantas), PB virškinamumas buvo atitinkamai 15,6 proc. ir 25 proc., o papildytų 3 proc. ksiloze − 25,8 proc. ir 28,3 proc. Tyrimai parodė, kad ksiloze papildytas SP yra geriau apsaugotas nuo PB virškinimo avių didžiajame prieskrandyje palyginti su SPU ir SPG pašariniais baltymais. Ištirta, kad, norint pabloginti PB virškinamumą avių didžiajame prieskrandyje, SP užtenka 2 proc. ksilozės priedo, o SPU ir SPG būtinas 3 proc. ksilozės priedas. Todėl, prieš šeriant smulkiuosius atrajotojus SPU ir SPG, dėl juose esančios didesnės aliejų koncentracijos palyginti su SP, rekomenduojama ilgiau plauti, kaitinti ir naudoti didesnės koncentracijos ksilozę pašarui papildyti.

**Raktažodžiai:** sojų pupelės, sojų pašaras, sojų pupelių grūdai, ksilozė, proteinų virškinamumas didžiajame prieskrandyje, avys.

**Introduction.** Experiments demonstrated rumen degradability of soybean proteins was reduced by non-enzymatical browning (Thomas et al., 1979; Nakamura et al., 1994; Tuncer and Sacakli 2003). Windschitl and Stern (1988), reported that rumen degradability of soybean meal (SBM) was reduced with 1% xylose or 5% lignosulfonate ($LSO_3$) treatment. Cleale et al. (1987) showed that in vitro ammonia release from SBM was suppressed by non-enzymatic browning and varied by the source and quantity of reducing sugar. Moreover, they showed that the most reactive sugar was xylose, because it was active even at room temperature. While the effectiveness of xylose treatment was determined on SBM protein, the effects on whole soybean seed (SBS) and full fat soybean (FFSB) proteins to reduce protein degradability in the rumen is largely unknown. The previous studies are controversial, although xylose treatment successfully protected proteins of SBM from rumen degradation (Mir et al. 1984; Can and Yilmaz, 2002; Tuncer and Sacakli, 2003), Sacakli and Tuncer, (2006) have demonstrated xylose treatment was less effective on protecting of cotton seed meal (CSM) proteins compared to protecting of SBM proteins.

Nutrients compositions of feed may also effective in obtaining different results from various procedures performed to protect feed from degradation in the rumen (Mir et al. 1984; Windschitl and Stern, 1988; McAllister et al. 1993; Tuncer and Sacakli, 2003; Sacakli and Tuncer, 2006). Oil content of soybean meal used in the study was lower than that of FFSB and SBS, due to that obtained by the solvent extraction.

The aim of this study is to determine the effect of xylose treatment of SBM, FFSB and SBS on dry matter (DM) and crude protein (CP) rumen degradability characteristics.

**Material and Methods.** Four ruminally cannulated Merino rams weighing an average of 60 kg, were kept in the individual cages and fed with a ration containing of 200 g concentrate (50% barley, 25% sunflower meal, 22% wheat bran, 1% salt, 1% dicalcium phosphate and 1% vitamin + mineral premix,) and 1000 g alfalfa hay (Table 1), twice daily (at 09.00 h and at 16.00 h).

Table.1 **Chemical Composition of the Experimental Feeds**, (% DM basis)

| Feeds | Organic matter | Crude protein | Ether extract | Crude fiber | Crude ash | Nitrogen free extract |
|---|---|---|---|---|---|---|
| Alfaalfa hay | 91.10 | 13.68 | 1.70 | 27.87 | 8.90 | 47.85 |
| Concentrate mixture | 96.40 | 17.06 | 2.58 | 9.77 | 3.60 | 66.99 |
| SBM | 93.00 | 45.35 | 1.85 | 4.30 | 7.00 | 41.50 |
| FFSB | 94.35 | 36.08 | 21.52 | 6.68 | 5.65 | 30.07 |
| SBS | 94.15 | 37.85 | 22.05 | 7.80 | 5.85 | 26.45 |

Notes: SBM: Soybean meal, FFSB: Full fat soybean, SBS: Soybean seed

After grinding to pass 3mm screen size, soybean meal, full fat soybean and soybean seed were treated with water + heat (this treatment was applied to determine the effects of water and heat at 100 $C^o$ for 2 h without xylose), with water + heat + 2% xylose or, with water + heat + 3% xylose. The DM of SBM, FFSB and SBS was determined by drying at 105 $C^o$ for 24 h, and sufficient water or mixtures of water and xylose (2% and 3%) were added to elevate the moisture content of samples to 25% (McAllister et al. 1993). These meals were thoroughly mixed with each solution and heated for 2 h at 100 $C^o$ in a convection air oven.

Nylon bag technique was used to measure disappearance of DM and CP of untreated and treated SBM, FFSB and SBS in the rumen. Two nylon bags (45μm pore size; 9x 14 cm bag size) containing 5 g of test samples untreated and treated SBM, FFSB and SBS for each incubation time were incubated in the rumen of four rams during experimental period. Two bags of each type of samples were removed after 2, 4, 8, 16, 24 and 48 h of incubation in the rumen. Then bags were washed in running tap water until clear rinse water obtained. Bags were dried at 60 $C^o$ for 48 h and weighed. Digestion kinetics and effective rumen degradability of DM and CP were determined according to the equation of Orskov and McDonald (1979). Chemical composition of experimental feeds and DM (ID 7.003) and CP (Kjeldahl-N ID 7.015) content of their washed residues after rumen incubation were determined according to the methods of the AOAC (1984).

Rams are not statistically different for physiological and other traits such as health, ages, live weights etc. during experimental periods. Therefore, the ordinary least square procedure was used to determine differences among the treatment groups for the rumen degradation characteristics of dry matter and crude protein of untreated and treated SBM, FFSB and SBS (Searle et al. 1992).

Statistical analyses of data were performed by repeated two-way linear model (Snedecor and Cochran, 1980). The significance of differences between treatment means was compared by DUNCAN test (Duncan, 1955). Statements of statistical significance are based on $P<0.05$.

**Results.** Untreated SBM, FFSB and SBS were progressively degraded in the rumen and after 48 h incubation; CP disappearances of SBM, FFSB and SBS reached to 87.9%, 91.4% and 92.6%, respectively. The study indicated that the DM and CP disappearances of SBM, FFSB and SBS were reduced after all rumen incubation times, by 2% or 3% xylose treatments (Tables 2, 3 and 4). Increasing the xylose level was more effective on decreasing of CP degradability.

Table 2. **The rumen degradation characteristics** (%) **of dry matter and crude protein of untreated and treated soybean meal**

| | Incubation time, h | | | | | | Degradability characteristics,% | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 8 | 16 | 24 | 48 | a | b | c $h^{-1}$ | Pe 0.05 |
| Dry Matter | | | | | | | | | | |
| SBM | $35.5^{a}$ | $41.0^{a}$ | $50.7^{b}$ | $65.4^{b}$ | $75.6^{b}$ | $91.0^{a}$ | $29.4^{a}$ | 69.4 | $0.046^{c}$ | $62.6^{b}$ |
| SBM+WH | $37.0^{a}$ | $44.6^{a}$ | $56.9^{a}$ | $73.0^{a}$ | $82.1^{c}$ | $92.5^{a}$ | $28.2^{a}$ | 67.6 | $0.070^{b}$ | $67.1^{a}$ |
| SBM+2%X | $21.4^{b}$ | $26.5^{b}$ | $35.7^{c}$ | $50.0^{c}$ | $60.5^{a}$ | $77.6^{b}$ | $15.8^{b}$ | 72.4 | $0.040^{c}$ | $48.0^{b}$ |
| SBM+3%X | $21.3^{b}$ | $27.1^{b}$ | $37.0^{c}$ | $51.5^{c}$ | $61.0^{a}$ | $74.0^{c}$ | $14.9^{b}$ | 64.4 | $0.053^{c}$ | $47.9^{b}$ |
| | *** | *** | *** | *** | *** | *** | *** | NS | * | *** |
| Crude Protein | | | | | | | | | | |
| SBM | $21.7^{b}$ | $28.4^{b}$ | $40.1^{b}$ | $57.6^{b}$ | $69.7^{a}$ | $87.9^{a}$ | $14.3^{a}$ | $83.2^{a}$ | $0.046^{ab}$ | $54.1^{b}$ |
| SBM+WH | $25.6^{a}$ | $32.9^{a}$ | $45.3^{a}$ | $62.8^{a}$ | $73.9^{a}$ | $88.4^{a}$ | $17.3^{a}$ | $76.8^{ab}$ | $0.057^{a}$ | $57.8^{a}$ |
| SBM+2%X | 7.3c | $12.2^{c}$ | $21.1^{c}$ | $35.6^{c}$ | $46.5^{b}$ | $66.1^{b}$ | $2.0^{b}$ | $80.1^{a}$ | $0.035^{c}$ | $34.3^{c}$ |
| SBM+3%X | $7.2^{c}$ | $11.9^{c}$ | $20.2^{c}$ | $33.4^{c}$ | $43.1^{b}$ | $59.3^{c}$ | $2.2^{b}$ | $68.2^{b}$ | $0.039^{bc}$ | $31.7^{c}$ |
| | *** | *** | *** | *** | *** | *** | *** | * | ** | *** |

Notes: SBM: Soybean meal, a: the rapidly soluble fraction b: the potentially degradable fraction c: the constant rate of disappearance of *b* Pe: the effective degradation WH: water +heat treatment, X: xylose treatment.

p>0.05: means of same letters in column are non significant; *p<0.05; **p<0.01; ***p<0.001

Table 3. **The rumen degradation characteristics** (%) **of dry matter and crude protein of untreated and treated full fat soybean**

| | Incubation time, h | | | | | | Degradability characteristics, % | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 8 | 16 | 24 | 48 | a | b | c $h^{-1}$ | Pe 0.05 |
| Dry Matter | | | | | | | | | | |
| FFSB | $35.0^{a}$ | $42.9^{a}$ | $55.7^{a}$ | $72.5^{a}$ | $82.0^{a}$ | $92.3^{a}$ | 26.0 | 68.8 | 0.071 | $66.2^{a}$ |
| FFSB+ WH | $35.1^{a}$ | $41.8^{a}$ | $53.1^{a}$ | $69.0^{a}$ | $78.9^{a}$ | $91.4^{a}$ | 27.5 | 68.1 | 0.059 | $64.3^{a}$ |
| FFSB +2%X | $31.1^{b}$ | $37.6^{b}$ | $43.4^{b}$ | $63.5^{b}$ | $73.0^{b}$ | $85.6^{b}$ | 23.8 | 67.4 | 0.058 | $59.2^{b}$ |
| FFSB +3%X | $30.9^{b}$ | $36.4^{b}$ | $45.8^{b}$ | $59.7^{b}$ | $69.1^{c}$ | $82.9^{c}$ | 24.8 | 65.5 | 0.049 | $56.7^{c}$ |
| | ** | *** | *** | ** | *** | *** | NS | NS | NS | *** |
| Crude Protein | | | | | | | | | | |
| FFSB | $26.9^{a}$ | $34.5^{a}$ | $47.3^{a}$ | $65.5^{a}$ | $76.9^{a}$ | $91.4^{a}$ | $18.4^{a}$ | $77.8^{a}$ | 0.058 | $59.5^{a}$ |
| FFSB+ WH | $24.8^{b}$ | $32.1^{b}$ | $44.5^{a}$ | $65.5^{a}$ | $74.2^{b}$ | $89.9^{a}$ | $16.6^{a}$ | $79.9^{a}$ | 0.055 | $57.8^{a}$ |
| FFSB +2%X | $17.6^{c}$ | $25.5^{c}$ | $38.6^{b}$ | $56.2^{b}$ | $66.6^{c}$ | $78.7^{b}$ | $8.4^{b}$ | $73.8^{b}$ | 0.067 | $50.2^{b}$ |
| FFSB +3%X | $15.8^{d}$ | $22.4^{d}$ | $33.5^{c}$ | $49.4^{c}$ | $59.4^{d}$ | $72.4^{c}$ | $8.4^{b}$ | $68.5^{c}$ | 0.057 | $44.6^{c}$ |
| | *** | *** | *** | *** | *** | *** | *** | ** | NS | * |

Notes: FFSB: Full fat soybean, a: the rapidly soluble fraction b: the potentially degradable fraction c: the constant rate of disappearance of *b* Pe: the effective degradation WH:water +heat treatment, X: xylose treatment

p>0.05: means of same letters in column are non significant; *p<0.05; **p<0.01; ***p<0.001

Rapidly soluble fraction (*a*) of DM and CP of SBM, FFSB and SBS did not show any change with water+heat treatment, except for decreasing CP *a* value (P<0.001) of SBS. Whereas both DM and CP *a* values of SBM were decreased (P<0.001) by xylose treatments, DM *a* values of FFSB and SBS had no change. Crude protein *a* values of FFSB and SBS were reduced (P<0.001) by xylose treatments at the level of 2% and 3%.

The potential degradability value (*b*) of DM of SBM was not affected by all treatments. Crude protein *b* value of SBM treated with 3% xylose decreased (P<0.05) compared to that of untreated and 2% xylose treated SBM. Potentially degradable fraction of CP of FFSB (P<0.01) and SBS (P<0.001) was decreased by both 2% and 3% xylose treatments.

The rate of disappearance (*c*) of DM potentially degradable fraction in xylose treated SBM was not statistically different compared to untreated SBM, but the rate of disappearance of CP potentially degradable fractions was dramatically reduced (P<0.01) by 2% xylose treatment. However, when 3% xylose treatment was applied to SBM, the rate of disappearance of CP potentially degradable fractions was similar to both untreated SBM and 2% xylose treatment. On the other hand, water + heat treatment of SBM increased *c* value of DM (Table 2). Neither water+heat treatment nor xylose treatment had an effect on the rate of disappearance of DM and CP values of FFSB while xylose treatments reduced (P<0.001) DM and CP *c* value of SBS.

Table 4. **The rumen degradation characteristics** (%) **of dry matter and crude protein of untreated and treated soybean seed**

| | Incubation time, h | | | | | | Degradability characteristics, % | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 8 | 16 | 24 | 48 | a | b | c $h^{-1}$ | Pe 0.05 |
| Dry Matter | | | | | | | | | | |
| SBS | $27.1^{a}$ | $37.0^{a}$ | $52.8^{a}$ | $73.0^{a}$ | $83.7^{a}$ | $94.8^{a}$ | 15.4 | 81.5 | $0.076^{a}$ | $64.7^{a}$ |
| SBS+ WH | $24.1^{b}$ | $32.9^{b}$ | $47.3^{b}$ | $67.2^{b}$ | $79.1^{b}$ | $93.4^{a}$ | 14.2 | 83.4 | $0.063^{b}$ | $60.7^{b}$ |
| SBS+2%X | $17.1^{c}$ | $22.5^{c}$ | $32.1^{c}$ | $47.4^{c}$ | $58.5^{c}$ | $77.1^{b}$ | 11.2 | 78.7 | $0.038^{c}$ | $45.4^{c}$ |
| SBS+3%X | $17.4^{c}$ | $22.7^{c}$ | $32.2^{c}$ | $47.5^{d}$ | $58.9^{c}$ | $78.6^{b}$ | 11.7 | 81.3 | $0.036^{c}$ | $45.9^{c}$ |
| | *** | *** | *** | *** | *** | *** | | | *** | *** |
| Crude Protein | | | | | | | | | | |
| SBS | $18.1^{a}$ | $26.5^{a}$ | $40.9^{a}$ | $61.6^{a}$ | $74.9^{a}$ | $92.6^{a}$ | $8.6^{a}$ | $90.6^{a}$ | $0.055^{a}$ | $56.1^{a}$ |
| SBS+ WH | $12.8^{b}$ | $22.1^{b}$ | $37.5^{b}$ | $59.4^{b}$ | $72.9^{b}$ | $89.9^{b}$ | $2.4^{b}$ | $92.9^{a}$ | $0.059^{a}$ | $52.8^{b}$ |
| SBS+2%X | $9.3^{c}$ | $15.8^{c}$ | $27.2^{c}$ | $44.7^{c}$ | $57.1^{c}$ | $76.5^{c}$ | $2.3^{c}$ | $85.2^{b}$ | $0.042^{b}$ | $41.6^{c}$ |
| SBS+3%X | $7.8^{d}$ | $14.2^{d}$ | $25.5^{d}$ | $43.1^{d}$ | $55.5^{c}$ | $75.2^{c}$ | $0.9^{c}$ | $85.5^{b}$ | $0.042^{b}$ | $40.2^{d}$ |
| | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** |

Notes: SBS: Soybean seed, a: the rapidly soluble fraction b: the potentially degradable fraction c: the constant rate of disappearance of *b* Pe: the effective degradation WH:water +heat treatment, X: xylose treatment

p>0.05: means of same letters in column are nonsignificant; *p<0.05; **p<0.01; ***p<0.001

In the present study, water+heat treatment increased (P<0.001) effective degradability (*Pe*) of DM and CP of SBM. The same treatment did not affect DM and CP *Pe* values of FFSB, and decreased (P<0.001) DM and CP *Pe* values of SBS. At both levels xylose treatments decreased (P<0.001) effective degradability values of DM and CP in SBM. The calculated reduction coefficients for effective CP degradability values of 2% and 3% xylose treated SBM were 37% and 41% compared to untreated SBM, respectively. However, there was no statistically significant difference between xylose levels.

In this study, as observed in SBM treatment, xylose treatment of FFSB and SBS decreased effective degradability values of DM and CP of FFSB and SBS. Also, in contrast to SBM, the effective CP degradability values of FFSB and SBS were decreased significantly with 3% xylose treatment compared to treatment with 2% xylose. Effective CP degradability values were reduced by 2 and 3% xylose treatment at the rate of 15.6% and 25% for FFSB, 25.8% and 28.3 % for SBS, respectively.

**Discussion.** Rapidly soluble fraction (*a*) of CP value in SBM determined in this trial is in agreement with the other studies (Harstad and Prestlokken, 2000; Tuncer and Sacakli, 2003; Wulf and Südekum, 2005) using xylose treated SBM. Similarly, Wulf and Südekum (2005) found that rapidly soluble DM and CP of xylose treated SBS had lower (P<0.001) degradability than those of the untreated SBS. Moreover, in the present study, in all soybean samples treated either 2% or 3% xylose, rapidly soluble CP values showed equal decrease that is, there were no differences between xylose levels on this parameter.

In the report of Tuncer and Sacakli (2003), *b* value of DM in SBM was not changed by 0.5, 1 and 2% xylose treatments. However, it was also determined that *b* value of CP decreased. While the xylose level increased, the decrease in *b* value was more pronounced. In the present study, with the exception of CP, potentially degradable fractions of DM of FFSB and SBS showed no change with the water+heat or xylose treatments. Although, Wulf and Südekum (2005) determined a lower potentially degradable DM and CP for SBS to that observed in the present study, the results obtained in both studies were in agreement with that xylose treatment had an effect on potentially degradable CP and significantly reduced (P<0.001) potentially degradable CP.

Similar to our findings, the results of many studies (Beauchemin et al., 1995; Stanford et al., 1995; Tuncer and Sacakli, 2003) showed that *c* values of CP of SBM and canola meal (CM) were reduced by xylose or LSO3 treatments.

Effective degradability (*Pe*) of untreated SBM used in this study had lower CP degradability than the 66% and 71% values reported by Can and Yilmaz (2002) and Windcshitl and Stern (1988). However, Gonzalez et al. (2002) reported that effective degradability of CP of solvent extracted SBM samples ranged from 46.1 to 67.0%.

Similar to our results, effective CP degradability values of canola meal (McAllister et al. 1993) and SBM (Windschitl and Stern, 1988) were reduced by 5% LSO3 treatment. Additionally, Can and Yilmaz (2002) reported that xylose treatment of SBM reduced CP degradation, increased escape protein.

As in present study, Wulf and Südekum (2005) indicated that effective CP degradability value ($k=0.05h^{-1}$) was as low as 42% for xylose treated SBS compared to 67% for untreated SBS. Tuncer and Sacakli (2003), studied with 0.5, 1 and 2% xylose treated SBM and CM, reported a similar pattern to that observed in the present study. The experiment demonstrated, when the level of xylose used in the treatment increased, effective DM and CP degradability values of both SBM and CM were reduced. But, this reduction was less effective at

decreasing effective CP degradability of CM containing 20% ether extract than that of SBM. There are discrepancies in situ disappearance values between experiments, which partly may result from methodological differences, varietal differences in the meal incubated, basal diet or variation in the extent of microbial contamination of the incubated samples (Freer and Dove, 1984; Nocek, 1988).

In this study, it may be concluded that xylose treatments of SBM, FFSB and SBS decrease CP degradability values compared to water+heat treatment. So, the large reduction in effective degradability of CP recorded in the present study cannot be attributed to solely to the effect of heating. Furthermore, a direct relationship between effective degradation of FFSB or SBS and the xylose levels used the trial was evidenced, since 3% xylose induced more marked decreases of CP effective degradation than 2% xylose.

**Conclusion**

Present study indicated that xylose treatment of soybean and its products is effective on protection of soybean proteins (SBM, FFSB, SBS) from rumen degradation. There were no significant decreasing affects on CP degradability of SBM between different xylose levels. As the xylose level is increased, the reduction of rumen degradability is decreased numerically for SBM and statistically for both FFSB and SBS. For this reason, further research is necessary to determine more effective xylose level especially, FFSB and SBS.

**References**

1. Association of Official Analytical Chemists. Official methods of analysis. 14th edition. AOAC, Washington, DC USA, 1984.

2. Beauchemin KA, Bailey DRC, Mcallister TA and Cheng KJ. Lignosulfonate-treated canola meal for nursing beef calves. Can J Anim Sci 1995. 75. P. 559–565.

3. Can A and Yilmaz A. Usage of xylose or glucose as non-enzymatic browning agent for reducing ruminal protein degradation of soybean meal. Small Ruminant Research 2002. 46. 173–178.

4. Cleale RMIV, Britton RA, Klopfenstein TJ, Bauer ML, Harmon DL and Satterlee LD. Induced non-enzymatic browning of soybean meal. II. Ruminal escape and net portal absorbtion of soybean protein treated with xylose. Journal Animal Science 1987. 65. P. 1319–1326.

5. Duncan DB. Multiple Range and Multiple F tests. Biometrics 1955.11. P. 1–42.

6. Freer M and Dove H. Rumen degradation of protein in sunflower meal, rapeseed meal and lupin seed placed in naylon bags. Animal Feed Science and Technology., 1984. 11. P. 87–101.

7. Gonzalez J, Andres S, Rodriguez CA and Alvir MR. In situ evaluation of the protein value of soybean meal and processed full fat soybeans for ruminants. Animal Research 2002. 51. P. 455–464.

8. Harstad OM and Prestlokken E. Effective rumen degradability and intestinal indigestibility of individual amino acids in solvent-extracted soybean meal (SBM) and xylose-treated SBM (SoyPass) determined in situ. Animal Feed Science and Technology 2000. 83. P. 31–47.

9. Mir Z, Macleod GK, Buchanan-Smith JG, Grýeve DG and Grovum WL. Methods for protecting soybean and canola proteins from degradation in the rumen. Canadian Journal of Animal Science 1984. 64. P. 853–865.

10. McAllister TA, Cheng KJ, Beauchemin KA, Bailey DRC, Pickaord and MD Gilbert RP. Use of lignosulfonate to decrease the rumen degradability of canola meal protein. Canadian Journal of Animal Science 1993. 73. P. 211–215.

11. Nakamura T, Klopfenstein TJ, Gibb DJ and Britton RA. Growth efficiency and digestibility of heated protein feed to growing ruminants. Journal Animal Science 1994. P. 72. 774–782.

12. Nocek JE. In situ and other methods to estimate ruminal protein and energy digestibility. A review. Journal of Dairy Science 1988. 71. P. 2051–2069.

13. Orskov ER and McDonald I. The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. Journal of Agricultural Science 1979. 92. P. 499–503.

14. Sacakli P and Tuncer SD. The effects of xylose treatment on rumen degradability and nutrient digestibility of soybean and cottonseed meals. Asian-Australasian. Journal of Animal Science 2006. 19. P. 655–660.

15. Searle SR Casella G and McCulloch CE. Variance Components. A Wiley-Interscience Publication, John Wıley&Sons, Inc., New York. 1992.

16. Snedecor GW and Cochran WC. Statistical Methods. 7th edition. Iowa State University Press, Ames, Iowa. 1980.

17. Stanford K, Mcallister TA, Xu Z, Pickard M and Cheng KJ. Compression of lignosulfonate treated canola meal and soybean meal protein as rumen undegradable protein supplements for lambs. Canadian Journal of Animal Science 1995. 75. P. 371–377.

18. Thomas E, Trenetle A and Burroughs W. Evaluation of protective agents applied to soybean meal and fed to cattle. I. Laboratory measurements. Journal of Animal Science 1979. 49. P. 1337–1345.

19. Tuncer SD and Sacakli P. Rumen degradability characteristics of xylose treated canola and soybean meals. Animal Feed Science and Technology 2003. 107. P. 211–218.

20. Windschitl PM and Stern MD. Evaluation of

calcium lignosulfonate - treated soybean meal as a source of rumen protected protein for dairy cattle. Journal of Dairy Science. 1988. 71. P. 3310–3322.

21. Wulf M and Südekum KH. Effects of chemically treated soybeans and expeller rapeseed meal on in vivo and in situ crude fat and crude protein disappearence from the Rumen. Animal Feed Science and Technology. 2005. 118. P. 215–227.

Received 24 February 2011
Accepted 15 November 2011