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Effect of Protein Sources of Isonitrogenous Whole Crop Barley Silage Based Diets on Performance and Blood Metabolites of Early Lactating Holstein Cows

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Abstract: The effect of the source of crude protein in isonitrogenuse diets on early lactating cow responses was investigated. Three isonitrogenuse diets (crude protein: 16.7%) with similar rumen degradable protein, but with different source of protein (Fish Meal (FM) + Canola Meal (CM) as 42.8 + 82.4 g kg^{-1} DM (FM/CM) or Soybean Meal (SM) + Cotton Seed Meal (CSM) as 48.8 + 91 g kg^{-1} DM (SM/CSM1) or 84 + 42.8 g kg^{-1} DM (SM/CSM2)) were provided. The diets were fed to 24 early lactating Holstein cows (8 animals per each treatment), 10±3 days in milk and 37.34 kg day^{-1} milk yield, for 7 weeks, using a completely randomized design with repeat measures of data in time. Daily Dry Matter Intake (DMI), milk yield and milk composition were recorded. Blood glucose and Blood Urea Nitrogen (BUN) were measured in weeks 3 and 6 of the experiment and some blood metabolites and enzymes including insulin, Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyrovic Transeaminase (SGPT) were measured at the last week of the experiment. There was no significant effect on DMI (FM/CM = 20.32, SM/CSM1 = 21.04 and SM/CSM2 = 20.82, SEM = 0.59 kg day^{-1}) ($p>0.05$). However, the effect of time was significant (linear and quadratic) ($p<0.0001$). Milk yield was similar among treatments. Milk composition (percentage and yield) was similar for all treatments, although time effect on milk protein and fat percentage was significant (linear and quadratic) ($p<0.05$). Plasma concentration of insulin was similar in cows fed the experimental diets (FM/CM = 9.16, SM/CSM1 = 7.90 and SM/CSM2 = 12.41, SEM = 1.34 micro U mL^{-1}). Blood urea nitrogen concentration was not differed among treatments ($p>0.05$). Serum glutamic oxaloacetic transaminase was significantly affected by the dietary protein sources (FM/CM = 74.62, SM/CSM1 = 91.12 and SM/CSM2 = 83.50 mg dL^{-1}, SEM = 6.36) ($p<0.05$), in 4 h after the morning feeding. It was concluded that protein sources with similar rumen degradability might not causing significant impact on performance and some blood metabolites in early lactating Holstein cows.

Key words: Cow, milk, protein, silage, DMI, blood metabolites

INTRODUCTION

High producing dairy cows in early lactation require 18-19% Crude Protein (CP) in the diet to support milk production (NRC, 2001). Because profits are related to reproductive performance as well as milk production, existence of a negative relationship between excessive dietary protein (>19%) and fertility could be an important consideration (Carroll *et al*., 1994). Excessive Rumen Degradable Protein (RDP) (>63% of total CP) has been reported to decrease fertility (Canfield *et al*., 1990). Fish Meal (FM) is used in dairy cow ration as a source of Rumen Un-degradable Protein (RUP) (Heravi *et al*., 2008). Of the various protein supplements that are high in RUP, FM processes a good balance of lysine and methionine (Santos *et al*., 1998). Supplementation of FM at fewer than 4% of the dietary Dry Matter (DM) might stimulate increased milk production without decreasing milk fat content (Broderick, 1992). However, when Soybean Meal (SBM) was replaced by high RUP supplements, microbial protein synthesis and flow to the duodenum decreased and the flow of non ammonia non microbial nitrogen in the duodenum increased (Clark *et al*., 1992). However, Danesh *et al*. (2008) demonstrated that the ruminal and post-ruminal protein disappearances of oil seed meals were impacted by the sources. Recent studies (Broderick, 2003; Olmos *et al*., 2006) have shown that

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with diets based on alfalfa silage and corn silage and supplemented with solvent-extracted soybean meal, maximal milk and protein production was achieved with about 16.5% CP. Relative to the composition of milk protein, Canola Meal (CM) has an excellent balance of amino acids (Piepenbrink and Schingoethe, 1998). Replacement of CM for SBM had no negative effect on milk yield (Mazhari *et al*., 2009). A supplemental supply of amino acids from sources that escape ruminal degradation and that complement the amino acid profile of microbial protein should increase performance or decrease the amount of protein required (Owens and Bergen, 1983). We hypothesized that with using the FM as protein source of diet, adding the CM as highly degradable CP could complement the effects of FM for milk production and positive effect on some measurement of blood metabolites.

Therefore, the aim of this study was to determine the effect of diets with FM (as high RUP sources) plus canola meal (as a high RDP source) or containing Cottonseed Meal (CSM, as a high RUP source) and Soybean Meal (SB, as a high RDP source) on performance and some blood metabolites of early lactating Holstein cows fed isonitrogenous whole crop barley silage based diets.

MATERIALS AND METHODS

Diets and animals: Three isonitrogenuse whole crop barley silage based diets (CP: 16.7%) with similar amount of CP degradability, but with different sources of protein (FM + CM as 4 2.8 + 82.4 g kg^{-1} DM (FM/CM) or SM + CSM as 48.8 + 91 g kg^{-1} DM (SM/CSM1) or 84 + 42.8 g kg^{-1} DM (SM/CSM2)) were provided. Dietary ingredients and chemical composition are shown in Table 1. The diets were fed to 24 early lactating Holstein cows as a total mixed ration (*ad libitum* intake) twice a day (08:00 and 17:30 h). Sixteen multiparous and eight primiparous Holstein cows averaging 10±3 days in milk and 37.37 kg day^{-1} of milk were used in this experiment. Cows were assigned to a completely randomized design employing 3 dietary treatments (8 cows per treatment) for 7 weeks. Animals were kept in tea stalls with individual feed bins in animal house and had free access to water. Banks were cleaned out each morning and orts were collected and weighted. Cows were milked three times per day at 5:00; 12:00 and 20:00 h. Dry Matter Intake (DMI) and milk production were recorded daily. Milk samples were taken at each milking during each week and mixed daily for each cow in proportion to the amount of milk produced at the 5:00; 12:00 and 20:00 h milking. Blood samples were collected in heparinized tubes from the jugular vein of each cow at 0.0, 2 and 4 h after the morning feeding in weeks 3 and 6. Samples were immediately centrifuged (3500 rpm, 10 min) and the plasma were analyzed for glucose, Blood Urea Nitrogen (BUN), insulin, Serum Glutamic Oxaloacetic Transaminas (SGOT) and Serum Glutamic Pyrovic Transaminas (SGPT).

Analytical procedure: Dietary ingredient DM was determined by drying the samples at 105°C for 24 h and Organic Matter (OM) by ashing at 550°C for 6 h. Fat content of each feed was determined using standard procedure (Tecator Soxtex 1043 Extraction). The CP content was determined by micro-Kjeldahl analysis (AOAC, 1990). Calcium concentration was determined by Flame Photometry (Model 410 Flame Photometer. Wag teg) and phosphorous content of the feeds was determined by Complexometric-Titrometric method. For measurement of Milk Urea Nitrogen (MUN), 100 μL percloric acid 25% was added to 900 μL of each milk sample, then, centrifuged (13200 rpm, 30 min, 4°C), Thereafter, 50 μL KCO3 25% was added to 450 μL of upper part of the solution. Then, the mixture was kept in room temperature for 5 h. After that, samples were centrifuged again (13000 rpm, 30 min) and upper clear solution was collected. Amount of MUN was measured using enzymatic photometric method. Amino acid concentration of the feed ingredients was determined using a Waters ACCQ. Tag Amino Acid Analysis System (Waters Corporation, Milford and MAO1757). Diet amino acid profiles are shown in Table 2. Milk samples were

Table 1: Ingredients (g kg^{-1}) and chemical compositions of the experimental diets

	Treatments*		
Items	FM/CM	SM/CSM1	SM/CSM2
Alfalfa hay	236.40	236.40	236.4
Barely silage	154.40	154.40	154.4
Corn grain	152.10	152.10	152.1
Wheat bran	82.90	82.90	82.9
Barely grain	152.10	152.10	152.1
Canola meal	86.40	0.00	0.0
Soybean meal	0.00	93.30	44.9
Cottonseed meal	0.00	44.90	88.3
Fish meal	44.90	0.00	0.0
Cotton seeds	62.20	62.20	62.2
Fat perils	13.80	13.80	13.8
Dicalcium phosphate (g kg^{-1})	1.70	1.70	1.7
Limestone (g kg^{-1})	0.60	0.60	0.6
Sodium bicarbonate (g kg^{-1})	4.80	4.80	4.8
Mineral and vitamin premix** (g kg^{-1})	6.80	6.80	6.8
CP (g kg^{-1})	16.70	16.70	16.7
ME (Mj kg^{-1})	10.20	10.20	10.2
NDF (g kg^{-1})	30.71	32.28	31.4
ADF (g kg^{-1})	17.00	17.00	17.0
Calcium (g kg^{-1})	1.50	1.30	1.4
Phosphorus (g kg^{-1})	1.40	1.30	1.3

*FM/CM: Fish Meal and Canola Meal as 42.8 and 82.4 g kg^{-1} DM, respectively; SM/CSM1: Soybean Meal and Cottonseed Meal as 48.8 and 91 g kg^{-1}, DM, respectively; SM/CSM2: Soybean Meal and Cottonseed Meal as 84 and 42.8 g kg^{-1} DM; ** Premix contained (DM basis): 190000 mg kg^{-1} Ca, 90000 mg kg^{-1} P, 50000 mg kg^{-1} Na, 9000 mg kg^{-1} Mg, 3000 mg kg^{-1} Fe, 3000 mg kg^{-1} Zn, 2000 mg kg^{-1} Mn, 100 mg kg^{-1} Co, 300 mg kg^{-1} Cu, 100 mg kg^{-1} I, 1 mg kg^{-1} Se, 500000 IU kg^{-1} vitamin A, 100000 IU kg^{-1} vitamin D3, 100 mg kg^{-1} vitamin E, 3000 mg kg^{-1} antioxidant (B.H.T)

Table 2: Amino acid concentration (percent of total amino acids) of the experimental diets

	Treatments*		
Amino acids	FM/CM	SM/CSM1	SM/CSM2
Alanine	5.10	4.58	5.00
Arginine	3.31	3.80	3.56
Cysteine	6.27	3.23	3.91
Glutamic acid and glutamine	1.06	1.70	1.70
Glycine	1.00	0.80	1.10
Isoleucine	3.10	4.77	4.30
Leusin	2.86	2.86	3.00
Methionine	6.78	5.71	6.12
Phenylalanine	2.24	2.21	2.25
Serine	5.25	5.60	5.75
Threonine	5.00	5.29	5.00
Tyrosine	3.55	3.77	3.70
Valine	1.07	0.71	0.95

*FM/CM: Fish Meal and Canola Meal as 42.8 and 82.4 g kg^{-1} DM, respectively; SM/CSM1: Soybean Meal and Cottonseed Meal as 48.8 and 91 g kg^{-1}, DM, respectively; SM/CSM2: Soybean Meal and Cottonseed Meal as 84 and 42.8 g kg^{-1} DM

used to determine fat, protein, lactose and Solid Not Fat (SNF) using Milko-tester (Foss Electeric, Conveyor 4000). Blood urea nitrogen and glucose were determined using enzymatic procedure (AOAC, 1990). Activity of SGOT and SGPT enzymes were measured (using IFCC method) by spectrophotometer. Serum insulin concentration was determined by radioimmunoassay (using TR-IFMA (time-resolved immuno fluorometric assay)).

Statistical analysis: Statistical analysis was performed as a repeated measurement Analysis of Variance (ANOVA) using MIXED procedure of SAS. The model was:

$$Y_{ijk} = \mu + T_i + A_{ij} + D_k + (T \times D)_{ik} + \varepsilon_{ijk}$$

Where,

Y_{ijk} = Dependent variable
μ = The overall mean
T_i = Treatment effect
A_{ij} = Cow in treatment
D_k = Time effect
$(T \times D)_{ik}$ = Treatment×time
ε_{ijk} = Error

RESULTS AND DISCUSSION

Intake and lactation performance: Dry matter intake, milk production and milk composition are shown in Table 3. Dry matter intake was unaffected by the treatments (FM/CM = 20.32, SM/CSM1 = 21.04 and SM/CSM2 = 20.82, SEM = 0.59, kg day^{-1}), while time effect on DMI was linearly and quadratic significant ($p<0.0001$). Milk yield and composition was similar among treatments, but cows fed FM/CM had the highest feed efficiency than the others (1.86 vs. 1.76 and 1.78, SEM = 0.06, for FM/CM, SM/CSM1 and SM/CSM2, respectively). Santos *et al.* (1998) analyzed knowledge on the implication of protein supplements and protein nutrition of lactating dairy cows in a 12 years study review. In these comparisons, intake of DM was not significantly different between cows fed SBM and Menhaden FM. However, in several comparisons, DMI of FM diets was numerically lower than that of SBM diets. Salmon FM decreased the DMI when fed at >5% of the diet DM. They reported that this negative effect of Salmon FM is probably because of its high content of unsaturated fat. Milk yield was significantly increased by FM in 8 of the 32 comparisons.

Using FM/CM diet caused to increases a non significant in milk production (37.69 vs. 36.99 and 37.08, SEM = 1.65, kg day^{-1} for FM/CM, SM/CSM1 and SM/CSM2, respectively). Several studies were conducted to compare FM to other protein sources in isonitrogenous diets. The results indicated that milk yield was not improved ($p>0.05$) when FM replaced groundnut meal (Orskov *et al.*, 1981), urea (Oldham *et al.*, 1985; Gamsworthy, 1989) or corn gluten meal (Blauwiekel *et al.*, 1989). Feeding diets supplemented with either SBM or FM to cows in early lactation resulted in similar ($p>0.05$) milk yield (Chmiel, 1987; Sloan *et al.*, 1988; Zerbhi *et al.*, 1988; McCarthy *et al.*, 1989). By replacing SBM with FM, increase in protein delivery to the small intestine was expected to increase milk yield (Blauwiekel *et al.*, 1989). In the experiment, all diets were designed to be similar in amount of protein and RDP and differences in milk production could not be related to the different in the amount of protein that received to small intestine. In the present study, the Amino Acid (AA) profile of the diets was not similar and FM/CM diets had better methionine/total AA ratio than SM/CSM1 and SM/CSM2 diets. Schwab *et al.* (1992a, b) pointed out the importance of both the amount and balance of Essential Amino Acid (EAA) in duodenal digesta and proposed that protein sources should be compared for percentage of Lysine (Lys) and Methionine (Met) in relation to the amount of total EAA. Assuming Lys and Met are the first tow limiting AA for yields of milk and milk protein in most dairy diets (King *et al.*, 1990; Schwab *et al.*, 1992a, b). Results of previous studies showed that FM is a fairly good source of Lys, Met, but reported that the effectiveness of RUP for supplying the limiting AA for milk production appears to depend on the ability of the underlying diet to maximize microbial protein production. Among RDP protein sources, CM has excellent balance of AA (Piepenbrink and Schingoethe, 1998) therefore, blend of FM and CM supply good profiles of EAA for mil production than the other protein sources. In the present study, no differences were detected in percentage or yield of lactose, Solid Not Fat (SNF) and milk protein.

Table 3: Feed intake, milk production and milk composition of early lactating Holstein cows fed diets containing different sources of protein

	Treatments*			Treatment effect		Time effect (p-value)	
Items	FM/CM	SM/CSM1	SM/CSM2	SEM	p-value	Linearly	Quadratic
Dry matter intake (kg day^{-1})	20.32	21.04	20.82	0.59	0.17	0.01	0.010
Milk yield (kg day^{-1})	37.69	36.99	37.08	1.65	0.94	0.01	0.010
Feed efficiency	1.860	1.760	1.780	0.06	0.65	0.95	0.760
Milk fat (g kg^{-1})	25.80	28.02	28.77	1.17	0.18	0.01	0.010
Milk protein (g kg^{-1})	29.58	29.52	29.70	5.20	0.88	0.01	0.010
Milk lactose (g kg^{-1})	42.75	42.86	42.40	7.30	0.73	0.58	0.830
Milk solid not fat (g kg^{-1})	79.37	79.90	78.40	13.7	0.83	0.67	0.390
Milk urea nitrogen (mg dL^{-1})	10.98	11.12	11.01	0.26	0.94	0.05	0.136

Table 4: Various blood metabolites of early lactating Holstein cows fed diets containing different sources of protein

	Time of sampling	Treatments*			Treatment effect		Time effect (p-value)	
Items	(week)	FM/CM	SM/CSM1	SM/CSM2	SEM	p-value	Linearly	Quadratic
Blood glucose (mg dL^{-1})	3	59.20	59.3	62.8	2.58	0.53	0.01	0.08
	6	61.70	63.5	66.2	1.82	0.23	0.58	0.39
Blood urea nitrogen (mg dL^{-1})	3	16.50	17.7	16.3	0.82	0.43	0.03	0.51
	6	14.60	17.6	16.4	1.08	0.17	0.01	0.38
Insulin (micro U mL−1)	6	9.16	12.4	7.9	1.34	0.10	0.01	0.09
Serum glutamic oxaloacetic transaminase (mg dL^{-1})	6	74.60	91.1	83.5	6.36	0.23	0.13	0.56
Serum glutamic pyrovic transeaminase (mg dL^{-1})	6	25.80	25.7	31.3	2.78	0.31	0.36	0.60

*FM/CM: Fish Meal and Canola Meal as 42.8 and 82.4 g kg^{-1} DM, respectively; SM/CSM1: Soybean Meal and Cottonseed Meal as 48.8 and 91 g kg^{-1}, DM, respectively; SM/CSM2: Soybean Meal and Cottonseed Meal as 84 and 42.8 g kg^{-1} DM; SEM: Standard Error of Mean

Although, milk fat yield was not significantly different, milk fat percentage was numerically lower in FM/CM treatment than the other cows (FM/CM = 25.6, SM/CSM1 = 27.5 and SM/CSM2 = 28.7, SEM = 1.1, g kg^{-1}). The detrimental effect of fish meal on milk fat secretion has been attributed to impairments in ruminal fermentation and/or post absorptive metabolism of lipids elicited by polyunsaturated fatty acids in fish oil (Ipharraguerre and Clark, 2005). Milk Urea Nitrogen in cows fed FM/CM and SM/CSM2 tended to be decrease (FM/CM = 10.98 and SM/CSM2 = 11.01 and SM/CSM1 = 11.12, SEM: 0.26, mg dL^{-1}) although, no significant differences was observed. A strong correlation exists among dietary CP, BUN and MUN (Baker *et al*., 1995; Rosler *et al*., 1993).

Blood metabolites: Data of various blood metabolites are shown in Table 4. Altering protein sources had no effect on blood glucose concentration. The results for both blood glucose and BUN concentrations were investigated separately for week 3 and 6. No difference was exist among treatments at week 3 of the experimental period, but time sampling (0.0, 2 and 4 h after the morning feeding) was linearly (p = 0.001) significant. In addition, no difference was evident at week 6, although cows fed FM/CM had numerically lower blood glucose concentration than the other cows (FM/CM = 61.07 vs. SM/CSM1 = 63.58 and SM/CSM2 = 66.20, SEM = 1.82, mg dL^{-1}). In all treatments, lowest blood glucose concentration was observed in 2 h after the morning feeding, then increased after 2 h. This decline might be related to consumption of glucose by gastrointestinal tracts. Plasma insulin concentration at the last week of the experimental period was not significantly impacted by the treatments (FM/CM = 9.16, SM/CSM2 = 7.9 and SM/CSM1 = 12.41, SEM = 1.34, micro U mL^{-1}). Several researchers demonstrated that an increase in the supply of AA to animal might be resulted in greater release of insulin (Kuhara *et al*., 1992; Lemosquet *et al*., 1997). It has been accepted that insulin is affected by the plasma concentration of glucose. In the present study, in spite of differences in blood insulin concentration, blood glucose concentration did not differ among the treatments. Blood urea nitrogen was determined at week 3 and 6 of the experimental period and results showed that it was not significantly differed among the treatments. However, at week 6, it was lower for cows fed FM/CM than the other cows (FM/CM = 14.66 vs. SM/CSM1 = 17.66 and SM/CSM2 = 16.41, SEM = 1.08, mg dL^{-1}). Lower concentration of BUN, may be reflected to the lower DMI by this group of animals. The concentration of BUN reflects the status of dietary CP such as the percentage of CP, digestibility of CP and the energy level of ration (Rosler *et al*., 1993). In most reports, the concentration of BUN is higher tat of MUN, which are in agreement with the results of the present study.

A number of blood constituents are useful as monitors for clinical or sub-clinical signs of metabolic disorder in high yielding cows. The elevation of SGPT and SGOT might be an indicator of accumulation of free fatty acids transported from blood to hepatocytes

(Studer *et al*., 1993). High concentration of SGOT might also, imply damages in organs other than the liver, because SGOT exist in muscle, kidney, intestine and brain (Xu *et al*., 1996). West (1990) suggested that arise in SGOT immediately after calving might reflect muscle damage. The two enzymes in this study did not differ across treatment rations. Although, SGOT concentration was numerically lower in cows fed FM/CM than the other cows (FM/CM = 74.6 vs. SM/CSM1 = 91.1 and SM/CSM2 = 83.5, SEM = 6.36, mg dL^{-1}).

CONCLUSION

It might be suggested that diets with similar amount of rumen degradable protein, but with different sources of protein (fish meal, canola meal, soybean meal and cottonseed meal) causing similar responses in early lactating Holstein cows. Results of the present study showed that milk production and DMI were not significantly influenced by the source of protein, when diets provided similar amount of RDP. In addition, various blood metabolite concentrations, as determined in the present study, indicated similar patterns in cows fed different protein sources. Therefore, it was concluded that diets with similar amount of RDP might not cause a difference in blood metabolite responses of early lactating Holstein cows fed isonitrogenous whole crop barley silage based rations.

REFERENCES

AOAC (Association of Official Analytical Chemists), 1990. Offical Methods of Analysis. Vol 1. 15th Edn. Arlington, VA. www.Metabase.net/doc/earth/1495/html.

Baker, L.D., J.D. Ferguson and W. Chalupa, 1995. Responses in urea and true protein of milk to different protein feeding schemes for dairy cows. J. Dairy Sci., 78: 2424-2434. http://jds.fass.org.

Blauwiekel, R., W.H. Hoover, T.K. Miller and S.D. Slider, 1989. Effect of fish meal or corn gluten protein supplements on milk production and composition in early postpartum cows. J. Anim. Sci., 67 (Suppl. 1): 508. http://jds.fass.org.

Broderick, G.L., 1992. Relative value of fish meal versus soybean meal for lactating dairy cows fed alfalfa silage as sole forage. J. Dairy Sci., 75: 174. http:// jds.fass.org.

Broderick, G.A., 2003. Effect of varying dietary protein and energy levels on the production of lactating dairy cows. J. Dairy Sci., 86: 1370-1381. http://jds.fass.org.

Canfield, R.W., C.J. Sniffen and W.R. Butler, 1990. Effect of excess degradable protein on postpartum reproduction and energy balance in dairy cattle. J. Dairy Sci., 73: 2342. http://jds.fass.org.

Carroll, D.J., F.R. Hossain and M.R. Keller, 1994. Effect of supplemental fish meal on the lactation and reproductive performance of dairy cows. J. Dairy Sci., 77: 3058-3072. http://jds.fass.org.

Chmiel, S.L., 1987. Effects of protein level and quality from soybean meal, fish meal and corn gluten meal on dry matter intake, milk yield and nitrogen utilization in high producing dairy cows. MS. Thesis. Rutgers Univ., New B~nswick, NJ. http://www.eden.rutgers.edu.

Clark, J.H., T.H. Klusmeyer and M.A. Cameron, 1992. Microbial protein synthesis and flows of nitrogen fractions to the duodenum of dairy cows. J. Dairy Sci., 75: 2304-2323. http://jds.fass.org.

Danesh, M.M., H. Jahani-Azizabadi and A.R.M. Heravi, 2008. Comparison of techniques to determine the ruminal and post-ruminal protein disappearance of various oilseed meals. Res. J. Biol. Sci., 3 (9): 1028-1033 http://www.medwelljournals.com/fulltext/rjbs/2008/1028-1033.pdf.

Gamsworthy, P.C., 1989. The interaction between dietary fiber level and protein degradability in dairy cows. Anim. Prod., 48: 271. http://www.ajas.info.

Heravi, M.A., M.M. Danesh, A. Soleimani and T. Vafa, 2008. Effect of supplemental fish meal in reproduction and immunology responses in early lactating Holstein dairy cows. J. Anim. Vet. Adv., 7 (4): 520-525. http://www.Medwelljournals.com.

Ipharraguerre, I.R. and J.H. Clark, 2005. Impacts of source and amount of crude protein on the intestinal supply of nitrogen fractions and performance of dairy cows. J. Dairy Sci., 88: (E. Suppl.): E22-E37. http://jds.fass.org.

King, K.J., J.T. Huber, M. Sadik, W.G. Bergen, A.L. Grant and V.L. King, 1990. Influence of dietary protein sources on the amino acid profiles available for digestion and metabolism in lactating cows. J. Dairy Sci., 73: 3208-3216. http://jds.fass.org.

Kuhara, T., K. Katoh, S. Oda, A. Ohneda and Y. Sasaki, 1992. Responses of metabolic hormones to prolonged intradueodenal infusion of AAs in sheep. Anim. Sci. Technol. Jpn., 63: 1123-1133. http://www.sciencedirect.com.

Lemosquet, S., N. Rideau and H. Rulquin, 1997. Insulin response to AA and glucose intravenous infusions in dairy cows synergistic effect. Horm. Metab. Res., 29: 556-560. http://www.thieme-connect.com/ejournals/toc/hmr.

Mazhari, M., M. Danesh Mesgaran and A. Heravi Moussavi, 2009. Effect of diet containing a variety of Iranian rapeseeds meal (SLMsp.) on high producing lactating Holstein cow responses. J. Anim. Vet. Adv., 8 (2): 265-269. http://www.Medwelljournals.com.

McCarthy, R.D. Jr., T.H. Klusneyer, J.L. Vicini, J.H. Clark and D.R. Nelson, 1989. Effects of source of protein and carbohydrate on ruminal fermentation and passage of nutrients to the small intestine of lactating cows. J. Dairy Sci., 72: 2002. http://jds.fass.org.

National Research Council (NRC), 2001. Nutrient Requirement of Dairy Cattle. 7th Edn. Natl. Acad. Sci., Washington, DC. http://www.nrccnrc.gc.ca/aboutUs/corporatereports/annual_report2002/index_e.html-29k.

Oldham, J.D., D.J. Napper, T. Smith and R.J. Fulford, 1985. Performance of dairy cows offered isonitrogenom diets containing urea or fishmeal in early and midlactation. Br. J. Nutr., 53: 337. www.nutritionsociety.org.uk/bjn/toc.htm.

Olmos, J.J. Colmenero and G.A. Broderick, 2006. Effect of dietary crud protein concentration on milk production and nitrogen utilization in lactating dairy cows. J. Dairy Sci., 89: 1704-1712. http://jds.fass.org.

Owens, F.N. and W.G. Bergen, 1983. Nitrogen metabolism of ruminant animals: Historical perspective, current understanding and future implications. J. Anim. Sci., 57 (Suppl. 2): 498. http://jds.fass.org.

Piepenbrink, M.S. and D.J. Schingoethe, 1998. Ruminal degradation, amino acid composition and estimated intestinal digestibilities of four protein supplements. J. Dairy Sci., 81: 454-461. http://jds.fass.org.

Orskov, E.R., G.W. Reid and I. McDonald, 1981. The effects of protein degradability and food intake on milk yield and composition in cows in early lactation. Br. J. Nutr., 45: 547. www.nutritionsociety.org.uk/bjn/toc.htm.

Rosler, D.K., J.D. Ferguson, C.J. Sniffen and J. Herrema, 1993. Dietary protein degradability effects on plasma and milk urea nitrogen and milk protein nitrogen in Holstein cows. J. Dairy Sci., 76: 525-534. http://jds.fass.org.

Santos, F.A. P., J.E. P. Santos, C.B. Theurer and J.T. Huber, 1998. Effect of rumen-undegradable protein on dairy cow performance: A 12 years study review. J. Dairy Sci., 81: 3182-3213. http://jds.fass.org.

Schwab, C.G., C.K. Bozak, N.L. Whitehouse and M.M.A. Mesbah, 1992a. Amino acid limitation and flow to duodenum at four stages of lactation. 1. Sequence of lysine and methionine limitation. J. Dairy Sci., 75: 3486-3502. http://jds.fass.org.

Schwab, C.G., C.K. Bozak, N.L. Whitehouse and V.M. Olson, 1992b. Amino acid limitation and flow to the duodenum at four stages of lactation. 2. Extent of lysine limitation. J. Dairy Sci., 75: 3503-3518. http://jds.fass.org.

Sloan, B.K., P. Rowlinson and D.G. Armstrong, 1988. The influence of a formulated excess of rumen degradable protein or degradable protein on milk production in dairy cows in early lactation. http://www.ajas.info.

Studer, V.A., R.R. Grummer, S.J. Bertics and C.K. Reynolds, 1993. Effect of prepartum propylene glycol administration on periparturient fatty liver in dairy cows. J. Dairy Sci., 76: 2931-2939. http://jds.fass.org.

West, H.J., 1990. Liver Function in Dairy Cows in Late Pregnancy and Early Lactation. In: Williams, E. (Ed.). The Bovine Practitioner. Stillwater, 25: 127-130. http://shop.elsevier.com.au/Veterinary/Food-Animals/Bovine-Theriogenology,-An-Issue-of... Practice.

Xu, S., J.H. Harrison, W. Chalupa, C. Sniffen, W. Julien, H. Sato, T. Fujeda, K. Watanabe, T. Ueda and H. Suzuki, 1996. The effect of ruminal bypass lysine and methionine on milk yield and composition of lactating cows. J. Dairy Sci., 81: 1062-1077. http:// jds.fass.org.

Zerbhi. E., C.E. Polan and I.H. Herbein, 1988. Effect of dietary soybean meal and fish meal on protein digesta flow in Holstein cows during early and midlactation. J. Dairy Sci., 71: 1248. http://jds.fass.org.