

Ruminant Nutrition: By-Products and Supplements

1133 Effects of supplementing transition cow diets with different levels of dietary glycerol on performance, efficiency, and blood metabolites. J. Boyd¹*, J. Bernard¹, and J. West¹, ¹The University of Georgia, Tifton, ²US Dairy Forage Research Center, Madison, WI.

A study was conducted to determine the effects of dietary glycerol on dry matter intake (DMI), milk yield and components, blood metabolites, and efficiency in the transition cow. The study was conducted from Feb. to Oct. of 2008 using 48 cows (25 primiparous and 23 multiparous). The study ran from 3wk prepartum to 8wk postpartum with a randomized block design using a 2 × 2 factorial. Treatments were prepartum control and postpartum control (CC); prepartum control and postpartum 400g/h/d glycerol (CG); prepartum 200g/h/d glycerol and postpartum control (GC); prepartum 200g/h/d glycerol and postpartum 400g/h/d glycerol (GG). Cows were assigned to treatment by previous or predicted production values, parity, and estimated calving date. Diets were corn silage based and balanced to be isocaloric and isonitrogenous. Data was analyzed using Proc MIXED of SAS with contrasts and 2 and 3 way interactions. Postpartum DMI ($P = 0.15$) was 16.1, 17.3, 18.7, and 16.7 kg/d (± 0.81) for CC, CG, GC, and GG respectively. Milk yield ($P = 0.59$) was 32.4, 34.4, 35.0, and 34.8 (± 1.70) for CC, CG, GC, and GG respectively. Milk protein percentage ($P = 0.08$) was 3.4%, 3.9%, 3.8%, and 4.0% (± 0.18) for CC, CG, GC, and GG respectively. Efficiency defined as (ECM/DMI) [$P = 0.15$] was 2.11, 2.09, 1.98, and 2.25 (± 0.08) for CC, CG, GC, and GG respectively. No statistical effect on serum glucose (average 66.1 mg/dl) or blood urea N (average 15.2 mg/dl) was observed. Non-esterified fatty acids and B-hydroxybutyrate concentrations were not affected by treatment averaging 0.62 mEq/L and 8.0 mg/dl respectively. The inclusion of glycerol in the diet resulted in a numerical improvement in milk yield and components compared with CC. GG resulted in a numerical improvement on efficiency compared with CC, CG, and GC. Researchers observed that the use of dietary glycerol as an energy source may be useful in improving production and efficiency in the transition cow though further research is needed to determine the optimum levels.

Key Words: transition cow, glycerol, efficiency

1134 The influence of *Bacillus pumilus* 8G-134 on milk production of dairy cows in early lactation. J. D. Ferguson¹*, Z. Wu¹, D. W. Remsburg¹, and K. Mertz², ¹University of Pennsylvania, School of Veterinary Medicine, Kennett Square, ²Danisco Animal Nutrition, Waukesha, WI.

The usage of direct-fed microbials (DFM) has become common in the dairy industry, but questions regarding their value remain prevalent. The efficacy of 3 different DFM feeding regimens on lactation performance was determined. Forty Holsteins (24 multiparous) were randomly assigned to one of 4 dietary treatments for the last 2 wk prepartum and the first 22 wk postpartum. The treatments included a placebo (CO), a *Propionibacterium* DFM prepartum followed by a *Lactobacillus* DFM postpartum (PL), and a DFM comprised of *Bacillus pumilus* 8G-134 offered at 5×10^9 (BL) or 1×10^{10} (BH) CFU/d. The TMR was the same for all treatments and fed to treatment groups once a day to 5% refusal. The treatment products were top dressed daily. Daily samples of TMR and orts were collected from each group and analyzed monthly. Cows were milked twice a day, and milk from AM and PM milking was analyzed for composition once a week. Milk production was compared between treatments using the Mixed Model Procedure of SAS. Group DMI was similar among treatments. Milk yield was higher for BL and

BH than for CO and PL, and milk fat content was higher for PL, BL, and BH than for CO. The increase in milk yield with *B. pumilus* 8G-134 and the increase in milk fat for all DFM treatments indicate the benefits of these DFM.

Table 1. Lactation performance of dairy cows receiving different direct-fed microbials

Item	CO	PL	BL	BH	SEM	P
Milk, kg/d	33.8 ^a	33.3 ^a	35.5 ^b	35.1 ^b	0.6	0.04
Milk fat, %	3.57 ^a	3.82 ^b	3.81 ^b	3.88 ^b	0.08	0.05
Milk protein, %	2.89	2.91	2.88	2.90	0.03	0.92
MUN, mg/dl	10.9	11.2	11.2	11.2	0.3	0.91
SCC, log	5.9 ^a	6.4 ^a	5.0 ^b	5.0 ^b	0.3	0.01

^{a,b}Means with different superscripts in a row were different ($P < 0.05$).

Key Words: direct-fed microbials, milk production, dairy cow

1135 Utilization of wet brewers grains as a replacement for corn silage in lactating dairy cow diets. C. L. Mahnken*, B. J. Bradford, T. G. Rozell, and M. J. Brouk, Kansas State University, Manhattan.

Eight primiparous (192 DIM) and 4 multiparous (191 DIM) mid-lactation Holstein cows were used to evaluate replacing corn silage (CS) and soybean meal with a blend of wet brewers grains (WBG) and cracked corn on a short-term basis. Milk production, composition, DMI and production efficiency were evaluated. Cows were allotted to a 4 × 4 Latin Square with 3 replications blocked by parity, days in milk and energy corrected milk (ECM). Four diets were evaluated; 0 WBG (0% WBG and 24% CS of diet DM), 12 WBG (12% WBG and 12% CS), 18 WBG (18% WBG and 6% CS), and 24 WBG (24% WBG and 0% CS). Crude protein and starch levels were balanced between diets by varying the levels of cracked corn and soybean meal. Fifteen day periods were used, d11–15 were designated for collection. Orts were collected daily and TMR was fed at 5 to 10% above previous day's intake. Cows were milked 3x/day and milk weights recorded at every milking. Milk samples, body weights and BCS were taken -2 and -1d pre-trial to obtain baseline data and d14 and 15 of each period. During collection, TMR and orts were taken d1, 3 and 5. Fecal grab samples were taken d12–15 at 8 h intervals and advanced 2 h every 24 h period to account for diurnal variation. Dry matter intake was similar ($P = 0.21$) among treatments (20.3, 20.8, 20.9 and 21.2 kg/cow) for 0 WBG, 12 WBG, 18 WBG AND 24 WBG respectively, however CP intake of 24 WBG was greatest ($P = 0.03$) while 0 WBG was lowest. NDF intake was lower for 0 WBG compared with all other treatments and 24 WBG was higher than 12 WBG ($P = 0.005$). Dietary fat intake was different ($P < 0.001$) across all treatments, increasing with WBG inclusion. Inclusion of WBG had no effect ($P = 0.19$) on milk production (30.5, 31.5, 31.6 and 32.1 kg/cow), fat percent or amount, protein percent, SNF, lactose or SCC, but protein yield and MUN were lower ($P = 0.04$) with 0 WBG compared with 18 WBG and 24 WBG. Efficiency of production did not differ ($P = 0.86$) among treatments. Results suggest WBG fed in conjunction with grass hay can replace CS in lactating cow diets for a short-term period.

Key Words: by-product, production efficiency, forage replacement

1136 Methane suppressing effect of flaxseed in diets containing hay or silage. Y.-H. Chung*, M. L. He, S. M. McGinn, T. A. McAllister,

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Including flaxseed (flax) in the diet of cattle can increase n-3 fatty acid content of milk and meat. Our study investigated the potential of flax to reduce enteric methane (CH₄) emissions from cows when added to diets containing hay or silage. Effects of forage type and flax inclusion on ruminal fermentation and apparent nutrient digestibility were also studied. Twelve ruminally cannulated, non-lactating Holstein cows were used in a replicated 4 × 4 Latin Square design with 21-d periods. Experimental diets (50:50 forage to concentrate ratio; DM basis) were formulated as a 2 × 2 factorial using either alfalfa-grass (mostly grass, chopped) mixed hay or barley silage as the forage source with or without 15% (ration DM; provided 5.2% added fat) ground flax as a partial replacement of barley grain. Diets were fed once daily as a total mixed ration. Enteric CH₄ production was measured for 3 d using the sulfur hexafluoride tracer gas technique. Without flax inclusion, cows produced 31, 26 or 29% less ($P \leq 0.5$) CH₄ when fed hay compared with silage (207 vs. 300 g CH₄/head/d, 19.6 vs. 26.4 g CH₄/kg of DMI, or 30.4 vs. 42.9 g CH₄/kg of digestible DMI, respectively). The lower CH₄ emissions per unit of intake from cows fed hay, as compared with those fed silage, may be partially attributable to lower ruminal pH due to sorting of the hay diet. Including flax in the hay diet did not further suppress CH₄ emissions whereas, including flax in the silage diet reduced ($P \leq 0.5$) daily g CH₄ per head by 36% and CH₄ production per kg DMI and per kg digestible DMI by 33 and 28%, respectively. Flax inclusion lowered CH₄ emissions of cows fed the silage diet in part by depressing ($P \leq 0.5$) fermentation of ruminal fiber and total tract fiber digestibility, a response not observed with the hay diet. Our study demonstrated that including 15% ground flax in a barley silage-based diet, with an aim of enhancing n-3 fatty acid content of meat, is an effective practice to mitigate enteric CH₄.

Key Words: forage type, flaxseed, enteric methane emissions

1137 Effects of live yeast culture supplementation (*Saccharomyces cerevisiae*) and nutritional management on ruminal pH and fermentation in early lactation dairy cows. R. M. Al Ibrahim*, V. P. Gath, C. McCarney, P. Duffy, and F. J. Mulligan, *University College Dublin, Dublin 4, Ireland.*

The aim of this study was to investigate the potential effect of yeast culture (YC) on rumen physiology of dairy cows nutritionally managed to have an abrupt introduction to pasture after calving or a more gradual introduction to pasture. Eight Holstein dairy cows in early lactation fitted with ruminal cannulas were randomly allocated to a 2 × 2 factorial experimental arrangement. Treatments were supplementation with YC (2.5 g/cow/d × 10⁹ CFU of *S. cerevisiae*¹⁰²⁶/g; supplemented, Y or control, C; n = 4) and nutritional management (abrupt introduction to pasture, AP; or TMR for the first 21 DIM and then gradual introduction to pasture, GP; n = 4). Cows on pasture (perennial ryegrass) were supplemented with pasture lactating compound (±YC) at rate of 3.5 kg DM/cow/d twice daily. Rumen fluid samples were harvested on d 8, 9, 10 and 22, 23, 24 PP to assess volatile fatty acids (VFA), ammonia-N, lactic acid and protozoal count. Internal pH meters were installed in the rumen of cows to continuously monitor rumen pH during the sampling days. Data were analyzed using the Mixed procedure in SAS v 9.1, 2004. A higher total VFA concentration during the both first and second measuring periods was detected in Y group in comparison with C group. Protozoal count was higher ($P = 0.009$) in GP than AP groups during the first measuring period while no effect was detected in the second measuring period. Rumen pH and lactic acid in the first measuring period were not affected by YC supplementation while nutritional

management had an effect with higher pH ($P = 0.001$) and lower ($P = 0.007$) lactic acid in GP than AP groups. Whereas, during the second measuring period Y and GP groups had higher pH and lower lactic acid in comparison with C and AP groups. Results suggested that dietary supplementation with YC during early lactation increased the rumen pH and total VFA and decreased lactic acid while the abrupt introduction to pasture after calving reduced the rumen PH and increased lactic acid with no effect on rumen VFA.

Key Words: dairy cows, nutrition changes, yeast culture, rumen fermentation

1138 Effect of supplemental corn dry distiller grains plus solubles on digestibility of steers grazing native range during summer growing season. M. F. Martínez-Pérez¹, D. Calderón-Mendoza², N. J. Dupass¹, A. Islas¹, J. Armendariz¹, A. M. Encinias¹, F. Loya-Olguin², and S. A. Soto-Navarro*¹, ¹New Mexico State University, Las Cruces, ²Universidad Autónoma de Baja California, Mexicali, BC, Mexico.

Sixteen English-crossbred steers (360 ± 28.9 kg) fitted with ruminal cannulas grazing native range during the summer growing season were used in a completely randomized design to evaluate effects of corn distiller grains plus solubles (DDGS) supplementation level (0, 0.2, 0.4, and 0.6% BW) on forage intake, digestibility, and rumen fermentation characteristics. The experiment was conducted during the first and second weeks of October 2008. Steers grazed a single native range pasture with supplements offered individually once daily at 0700. Forage OM, NDF, CP, and EE intake decreased ($P \leq 0.05$) linearly with increasing DDGS supplementation level. Total CP and EE intake increased ($P < 0.01$) with increasing DDGS supplementation level. Digestibility of OM, CP, and NDF increased (linear; $P < 0.01$) with increasing DDGS supplementation level while digestion of EE increased (linear and cubic effect; $P \leq 0.04$) with increasing DDGS supplementation level (40.81, 54.31, 50.99, and 70.07 ± 3.89% for 0, 0.2, 0.4, and 0.6% of BW, respectively). Forage masticate in situ soluble linearly increased ($P < 0.01$) and slowly degradable CP fraction linearly decreased ($P > 0.01$) with increasing DDGS supplementation level. Forage in situ masticate DM and NDF disappearance rate increased (quadratically; $P \leq 0.05$) and DDGS in situ DM disappearance rate increased (linearly; $P > 0.03$) with increasing supplementation levels. Forage and DDGS UIP (% of CP), ruminal pH, and VFA concentration were not affected ($P \geq 0.25$) by DDGS supplementation level. These results indicate that DDGS supplementation improved total CP and EE intake and digestibility of OM, NDF, CP, and EE of steers grazing native range during the forage growing season. Therefore, DDGS represent a viable supplement for cattle grazing native range during the forage growing season when forage has medium or high quality.

Key Words: DDGS supplementation, grazing native range, steers

1139 Effect of replacing grain and silage with wheat distiller grain on intake, digestibility and urine purine derivatives in finishing beef cattle. Y. L. Li*^{1,2}, W. Z. Yang¹, T. A. McAllister¹, and K. A. Beauchemin¹, ¹Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB, Canada, ²Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, China.

Our objective was to evaluate the effects of wheat dried distillers grains' with solubles (DDGS) when used to partially replace barley grain and forage or to entirely replace forage in the finishing diet of beef cattle. Effects on intake, digestibility, and purine derivatives (PD) in urine (as an indication of microbial protein synthesis) were evaluated. Eight ruminally fistulated Angus heifers were assigned to a replicated 4 × 4

Latin square design with 4 treatments: control, low (25%), med (30%), and high (35%) DDGS (DM basis). The diets consisted of barley silage, barley concentrate, and wheat DDGS in ratios of 15:85:0, 10:65:25, 5:65:30 and 0:65:35 (DM basis), respectively. The dietary contents (% DM) of CP were higher for DDGS diets (mean \pm SD, 21.3 \pm 1.6) than for the control (11.5) diet, but all diets had similar NDF contents (mean \pm SD, 23.2 \pm 1.1). DMI (kg/d) was lower ($P < 0.01$) for the high DDGS diet (7.9) than for other 3 diets (9.1). Increasing DDGS content of diets linearly reduced ($P < 0.01$) starch intake. Total digestibility (% intake) of DM quadratically ($P < 0.01$) changed with the highest digestibility for high DDGS (79) and the lowest for low DDGS (76). There were linear ($P < 0.01$) increases in the total digestibilities of CP, NDF and starch with increasing DDGS and decreasing silage in the diet. Total excretion of PD (mmol/d) quadratically ($P = 0.02$) increased with the highest excretion for low (282) and med DDGS (295) diets and the lowest for control (231). It was concluded that partially replacing barley grain and silage with wheat DDGS improved total digestibilities of CP and NDF, as well as microbial protein synthesis. Entirely removing silage from a finishing diet may improve feed efficiency due to lower DMI and higher digestibility, but further work is needed to determine whether the risk of acidosis is also increased.

Key Words: wheat DDGS, intake, digestibility

1140 Feeding wheat distillers grains compared with corn distillers grains in diets for lactating dairy cows: Effect on milk production and rumen fermentation. M. M. Abdelqader* and M. Oba, *University of Alberta, Edmonton, AB, Canada.*

In western Canada, dried distillers grains with soluble (DDGS) is produced from mixtures of corn and wheat at variable ratios, and used as a source of dietary crude protein. The objective of this study was to determine the effect of feeding corn DDGS (CDG), wheat DDGS (WDG), and a 50:50 mixture of both (CWDG) on dry matter intake, milk production, milk composition, and feed efficiency of dairy cows in mid-lactation. Sixteen multiparous and 16 primiparous lactating Holstein cows were used in a replicated 4 \times 4 Latin square with 3-wk periods. Dietary treatments were a control diet containing canola meal as the primary protein source (CON) and diets containing CDG, WDG, or CWDG. The treatment protein sources supplied 35% of dietary crude protein, and all diets were formulated for similar protein (17.9%) and fat (4.5%) contents. Dry matter intake tended to be higher when cows were fed WDG diet compared with CDG (25.4 vs. 22.9 kg/d; $P = 0.08$), but milk yield was not affected by treatment and averaged at 36.3 kg/d. As such, feeding CDG tended to increase feed efficiency compared with WDG (milk yield/dry matter intake; 1.64 vs. 1.45; $P = 0.08$). However, no differences in DMI and milk yield were observed between CON and diet containing DDGS. Furthermore, concentrations of milk fat, protein, lactose, and milk urea nitrogen were not affected by treatment, and averaged at 3.59%, 3.11%, 4.54%, and 10.7 mg/dL, respectively. Rumen pH was not affected by dietary treatment and averaged at 6.19. However; cows fed CDG had lower ($P = 0.03$) NH₃-N concentration in the rumen compared with those fed the WDG and CWDG diet (9.4 vs. 12.9 and 12.5 mg/dL, respectively). In conclusion, regardless type of grain source, DDGS can be used as an alternative protein source in diets for lactating dairy cows, but type of grain from which DDGS is produced may affect feed efficiency.

Key Words: corn DDGS, wheat DDGS, feed efficiency

1141 *Megasphaera elsdenii* effects on adaptation to concentrate diets. L. K. Thompson*¹, P. H. Henning², and J. S. Drouillard¹, ¹*Kansas State University, Manhattan*, ²*MS-Biotech, Centurion, South Africa.*

Crossbred (n = 80; 408 \pm 66 kg initial BW) steers were used in a randomized complete block experiment to evaluate effects of oral dosing of *Megasphaera elsdenii* strain NCIMB 41125 (ME). Cattle fed forage diets for 3 wk after arrival were allotted to factorialized treatments consisting of step-up regimen (17 or 8 d) and oral drenching with a placebo or 10¹¹ cfu ME. Diets consisted of alfalfa hay and steam-flaked corn, with 36 mg/kg monensin. The 17-d regimen used 5 diets (45, 35, 25, 15, and 6% roughage) with diet changes on d 5, 9, 13, and 17. The 8-d regimen used 3 diets (45, 25, and 6% roughage) with diet changes on d 4 and 8. On d 1, steers were weighed, orally dosed with ME or Placebo, placed in individual pens, and fed ad libitum for 63 d. Feed offered and refused were measured daily to determine daily DMI. On d 64, cattle were consolidated into pens of 10 animals each (2 pens/treatment) and fed until harvest on d 95. ME cattle maintained more consistent intakes ($P = 0.07$) during the initial 3 d of concentrate feeding compared with Placebo cattle. ME cattle tended to have greater ADG in the first 63 d ($P = 0.11$), particularly with the accelerated step-up (interaction, $P = 0.11$). HCW increased ($P = 0.10$) with ME, but were not affected by step-up regimen or the interaction between ME and step-up regimen. Liver abscess rates tended ($P = 0.14$) to be greater for cattle on the accelerated step-up. A single oral dose of *Megasphaera elsdenii* strain NCIMB 41125 can be used effectively to transition cattle from forage to high-grain diets in 8 d.

Table 1. Effects of *Megasphaera elsdenii* on intake and carcass characteristics

Item	17d/-ME	17d/+ME	8d/-ME	8d/+ME	SEM
DMI d 1-3, kg/d	2.87	3.46	2.83	4.13	0.791
DMI d 1-3 CV, %†	117	102	119	84	14
DMI d 1-63, kg/d	8.23	8.74	8.40	8.41	0.223
Liver abscess, %	4.7	5.5	20.1	9.7	6.6
HCW, kg†	334	338	324	335	4.4

†Main effect of ME, $P \leq 0.10$.

Key Words: *Megasphaera elsdenii*, intake, feedlot

1142 Effects of adding a mycotoxin-sequestering agent on milk aflatoxin M1 concentration and the performance and immune response of dairy cattle fed an aflatoxin B1-contaminated diet. O. C. M. Queiroz*, A. T. Adesogan, C. R. Staples, J. Hun, M. Garcia, L. F. Greco, and L. J. Oliveira, *Department of Animal Sciences, University of Florida, Gainesville.*

The objective was to examine effects of adding 2 doses of a montmorillonite-based mycotoxin adsorbent on milk aflatoxin M1 (AFM1) concentrations and the performance and innate immune response of dairy cows fed an aflatoxin B1 (AFB1)-contaminated diet. Eight lactating cows were used in an experiment with a duplicated 4 \times 4 Latin square design with 12-d periods. Treatments included the following: 1) Control diet (C); 2) Toxin diet (T) containing C and 75 μ g/kg of AFB1; 3) Low-clay (LC) diet containing T and 0.2% Calibrin A (Amlan International, Chicago, IL); and 4) High-clay diet (HC) containing T and 1% Calibrin A. Milk production and DMI were recorded daily, and milk was sampled twice daily on d 5, 9, 10, 11, and 12 in each period. Blood samples were collected on d 5 and 9 of each period. The model included treatment, square and period effects and significance was declared at $P < 0.05$. Dietary treatments did not affect DMI, milk yield, or feed efficiency.

Feeding T instead of C tended to reduce 3.5% FCM yield (19.0 vs. 20.8 kg/d; $P = 0.08$, SE = 0.79) and reduced milk fat yield (0.67 vs. 0.74 kg/d; SE = 0.03) and milk protein concentration (3.28 vs 3.36%; SE = 0.03). Concentrations of AFM1 in milk of cows fed the T and LC diets were similar (0.63 and 0.65 $\mu\text{g}/\text{kg}$) and greater than those of cows fed the HC diet (0.48 $\mu\text{g}/\text{kg}$; SE = 0.04), but cows fed C had trace levels (0.03 $\mu\text{g}/\text{kg}$; SE = 0.04). Haptoglobin concentration was greater (22.0 vs. 14.4; SE = 1.9) and $\beta 2$ -integrin expression (220 vs. 130; $P = 0.1$; SE = 32) tended to be greater in cows fed diet T instead of C, but values for cows fed LC, HC and C did not differ. Feeding HC or LC instead of T prevented the increased innate immune response and decreased FCM yield caused by T, but milk AFM1 concentration was only reduced by feeding HC instead of T.

Key Words: mycotoxin adsorbent, aflatoxin, immunity

1143 The effect of rumen-protected methionine and choline on productive performance of Holstein dairy cows. M. Ardalan*, M. Dehghan-Banadaky, and K. Rezayazdi, *Department of Animal Science, University College of Agriculture and Natural Resources, University of Tehran, Karaj, Iran.*

Forty Holstein dairy cows in their first and second lactation were used in a lactation study from 4-week prepartum through 10-week postpartum to investigate the effect of feeding ruminally protected sources of methionine and choline on productive performance of Holstein dairy cows. Cows (10 cows per treatment = 6 cows in 1st lactation and 4 cows

in 2nd lactation) were housed in individual tie stalls. Animals were randomly assigned to receive one of the following treatments in a 2×2 factorial design 4-week before their expected calving dates, using block randomization based on parity: 18 g/d of rumen-protected methionine product (RPM), 60 g/d of rumen-protected choline product (RPC), 18 g/d of RPM + 60 g/d of RPC, or neither supplement (control). The repeated measurements of milk yield and composition were analyzed as a linear mixed model (Proc Mixed) with the best fitted covariance structure of SAS. The statistical model included the fixed effects of treatment, parity, time (week of lactation), treatment \times time, and the random effect of cow within treatment and parity. The error covariance structure used for the repeated measures was the first-order heterogeneous autoregressive structure. The supplementation of RPC significantly affected milk yield, FCM, and ECM across lactation weeks ($P < 0.05$). The actual milk yield, FCM, and ECM were greater for RPC-fed cows than other treatment groups ($P < 0.05$). The RPM and RPC have significant effects on the lactose percentage of milk across lactation weeks, but the treatments did not significantly affect fat and protein percentages of milk. Also, RPC significantly affected fat, protein, and lactose yields of milk across lactation weeks ($P < 0.05$). There was a significant interaction effect of RPM \times RPC for lactose percentage of milk ($P < 0.05$). In general, the RPM \times RPC \times time had not any significant effect on milk yield and composition. The results of this study indicated the positive effect of RPC supplementation on the productive performance of dairy cows.

Key Words: rumen-protected methionine, rumen-protected choline, productive performance