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Effects of Supplemental Levels of Fermentation Product on Lactation Performance in Dairy Cows under Heat Stress

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ABSTRACT: The objectives of this study were to evaluate the effects of different supplemental levels of fermentation product (SCFP; Original XP; Diamond V) on lactation performance in Holstein dairy cows under heat stress. Eighty-one multiparous Holstein dairy cows were divided into 27 blocks of 3 cows each based on milk yield (23.6±0.20 kg/d), parity (2.88±0.91) and day in milk (204±46 d). The cows were randomly assigned within blocks to one of three treatments: 0 (control), 120, or 240 g/d of SCFP mixed with 240, 120, or 0 g of corn meal, respectively. The experiment was carried out during the summer season of 2014, starting from 14 July 2014 and lasting for 9 weeks with the first week as adaption period. During the experimental period, average daily temperature-humidity index (measured at 08:00, 14:00, and 20:00) was above 68, indicating that cows were exposed to heat stress throughout the study. Rectal temperatures tended to decrease linearly (p = 0.07) for cows supplemented with SCFP compared to the control cows at 14:30, but were not different at 06:30 (p>0.10). Dry matter intake was not affected by SCFP supplementation (p>0.10). Milk yield increased linearly (p<0.05) with increasing levels of SCFP. Feed efficiency (milk yield/ dry matter intake) was highest (p<0.05) for cows fed 240 g/d SCFP. Cows supplemented with SCFP gained (p<0.01) body weight, while cows in the control lost body weight. Net energy balance also increased linearly (p<0.01) with increasing levels of SCFP. Concentrations of milk urea nitrogen (p<0.01) decreased linearly with increasing levels of SCFP, while no difference (p>0.10) was observed among the treatments in conversion of dietary crude protein to milk protein yield. In summary, supplementation of SCFP alleviated the negative effect of heat stress in lactating Holstein dairy cows and allowed cows to maintain higher milk production, feed efficiency and net energy balance. Effects of SCFP were dose-dependent and greater effects were observed from higher doses. (Heat Stress, , Lactation Performance, Dairy Cow)

INTRODUCTION

Heat stress is detrimental to dairy cows. The comfortable ambient temperatures for dairy cows are between 5°C and 25°C, and a temperature-humidity index (THI) above 68 typically affects dairy production parameters negatively (Burgos-Zimbelman and Collier, 2011). During warm summer months, milk production decreases by 10% to 35%, which represents a significant cost to the global dairy industry (St-Pierre et al., 2003). The deficit in energy and nutrient availability in heat stressed cows is thought to limit milk production during a thermal load (Shwartz et al., 2009). Methods of increasing digestion efficiency and providing additional energy include supplemental dietary modifiers.

Cows under heat stress are at a higher risk for suboptimal rumen function (Baumgard et al., 2006). Increased respiration rate (causing increased secretion of bicarbonate by the kidneys), reduced feed intake (causing reduced rumination and saliva production) and altered feeding behavior (sorting, slug feeding, etc.) are among the contributing factors (Berman et al., 1985; Collier et al., 2006). Optimizing rumen function of heat stressed cows could mitigate the negative effect of heat stress on lactation performance of dairy cows.

Feed additives such as

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fermentation product (SCFP; Original XP; Diamond V, Cedar Rapids, IA, USA) are widely used as ruminant fermentation modifiers to optimize rumen health and improve lactation performance in dairy cows. Arambel and Kent (1990) suggested that yeast products might be more effective under heat stress than in normal conditions. Schingoethe et al. (2004) reported a significant improvement in feed efficiency when mid-lactation dairy cows were supplemented with SCFP during summer months. Optimum feeding rate of SCFP may differ under heat stress condition. However, optimum level of supplementary SCFP under heat stress has not been determined.

Therefore, we hypothesized that SCFP would improve lactation performance of dairy cows exposed to heat stress and a higher feeding rate of SCFP could be more effective under such conditions. To address this hypothesis, the daily (08:00, 14:00, 20:00). Recorders were set at the east and west of the study pen, and placed at a height of 1.9 m from the floor. Temperature and relative humidity were recorded within±0.2°C and ±2%, respectively. The THI was

Effect of SCFP supplementation on dry matter intake and lactation performance in dairy cows during heat stress

Parameters	SCFP supplementation (g/d)			SEM	p-value		
	0	120	240		T	L	Q
DMI (kg/d)	17.2	16.9	16.9	0.23	0.60	0.33	0.77
Yield (kg/d)							
Milk	20.8[b]	21.3[ab]	21.5[a]	0.19	0.04	0.02	0.50
3.5% FCM[1]	24.3	24.9	24.6	0.25	0.23	0.32	0.16
ECM[2]	24.9	25.4	25.2	0.24	0.33	0.41	0.21
Milk protein	0.718	0.722	0.718	0.0077	0.94	0.98	0.72
Milk fat	0.939	0.973	0.955	0.0112	0.10	0.32	0.07
Milk composition (%)							
Fat	4.55	4.65	4.54	0.085	0.34	0.93	0.14
Protein	3.44	3.44	3.41	0.029	0.63	0.41	0.61
Lactose	4.77	4.74	4.80	0.019	0.18	0.43	0.09
Total solids	13.8	13.8	13.7	0.09	0.82	0.79	0.57
SCC ($\times 10^4$) /mL	19.8	22.4	21.3	2.51	0.75	0.66	0.54
MUN (mg/dL)	15.5[a]	15.3[a]	14.6[b]	0.21	0.02	<0.01	0.25
BW gain (g/d)	–13.0[c]	17.8[a]	11.1[b]	0.61	<0.01	<0.01	<0.01
BCS	2.82[b]	3.05[a]	2.84[b]	0.071	0.04	0.83	0.01
Feed efficiency[3]	1.28[b]	1.29[b]	1.32[a]	0.012	0.04	0.07	0.72
Nitrogen conversion[4]	0.269	0.272	0.275	0.0035	0.55	0.28	0.97
Net energy balance[5]	2.81[c]	3.12[b]	4.13[a]	0.047	<0.01	<0.01	<0.01

SCFP, fermentation product (Diamond V Original XP, Cedar Rapids, IA, USA); SEM, standard error of the mean; T, treatment effect; L, linear effect; Q, quadratic effect; DMI, dry matter intake; FCM, fat-corrected milk; ECM, energy corrected milk; SCC, somatic cell count; MUN, milk urea nitrogen; BW, body weight; BCS, body condition score; NE_L, net energy for lactation.

[1] 3.5% FCM = (milk kg×0.432)+(fat kg×16.216) (Dairy Records Management Systems, 2006).

[2] ECM = 0.3246×milk yield (kg)+13.86×milk fat (kg)+7.04×milk protein (kg) (Orth, 1992).

[3] Feed efficiency = milk yield/DMI.

[4] Nitrogen conversion = milk protein yield/dietary crude protein intake.

[5] Net energy balance = $(DMI \times NE_L \text{ diet}) - [(0.08 \times BW^{0.75}) + \{(0.0929 \times fat + 0.0563 \times protein + 0.0395 \times lactose) \times milk\ yield\}]$ (NRC, 2001).

[a-c] Means within a row with different superscripts differ (p<0.05, n = 27).

fat percentage (p>0.10) nor milk protein percentage (p>0.10) was affected by SCFP-supplementation. The positive effect on milk production resulted in 3.6% greater (p = 0.10) milk fat yield in cows fed 120 g/d SCFP than that of the control cows and supported the results reported in the meta-analysis. No differences (p>0.10) among the groups were observed in contents of milk lactose, total solids, and SCC, similar with the results reported by Schingoethe et al. (2004), where the SCFP products were fed to mid-lactation dairy cows during hot season. Concentrations of MUN decreased linearly (p<0.01) with increasing levels of SCFP, but no difference was observed among the treatments in conversion of dietary N to milk N. Lower concentration of MUN with 240 g/d SCFP supplementation in dairy cows might indicate higher amino acid utilization for productive uses.

Cows supplemented with SCFP gained (p<0.01) BW, but control cows lost BW during the study (Table 4). Body condition score of cows fed 120 g/d SCFP were higher (p<0.05) than that of the control cows and cows fed 240 g/d SCFP. Net energy balance, calculated based on DMI, milk yield and composition, and estimated BW (NRC, 2001), increased linearly (p<0.01) with increasing levels of SCFP. Improved BW gain, BCS and milk yield without affecting DMI supports the improved net energy balance with SCFP supplementation. Such results in the present study suggest that SCFP supplementation dosage dependently improves dietary energy utilization or absorption in heat-stressed dairy cows.

CONCLUSION

Supplementation of SCFP alleviated the negative effect of heat stress in lactating Holstein dairy cows and allowed cows to maintain higher milk production, feed efficiency and net energy balance. Effects of SCFP were dose-dependent and greater effects were observed from higher doses.

CONFLICT OF INTEREST

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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