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EFFECTS OF DIETARY YEAST CULTURE SUPPLEMENTATION DURING THE CONDITIONING PERIOD ON HEART RATES AND LACTIC ACID PRODUCTION BY HORSES EXERCISED ON A TREADMILL

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Two groups of previously unconditioned young adult horses participated in 6 weeks of gradually increasing exercise on an inclined plane treadmill. The diet of one group was supplemented with a commercially-available dietary yeast culture preparation. Treadmill exercise increased plasma lactic acid concentrations in direct proportion to the duration of an exercise bout. At the end of 35 minutes of exercise, plasma lactic acid concentrations averaged 30.08 mg/dl in the supplemented horses and 41.29 mg/dl in the unsupplemented horses ($p<.01$). Although plasma glucose concentrations decreased significantly and triglyceride concentrations increased significantly as exercise duration exceeded 10 minutes, these changes were not significantly affected by yeast culture supplementation. During the 35-minute exercise bouts, significantly lower heart rates were recorded in the supplemented horses during the first 5 and the final 10 minutes of the workouts ($p<.01$). Although the exercise challenges to these horses were not severe, these results suggest that dietary yeast culture supplementation of horses entering into conditioning programs may well enhance athletic training.

(Key Words: yeast culture, conditioning, exercise, lactic acid)

Introduction

Dietary supplementation of yearling horses with yeast cultures has been shown to increase the efficiency of nitrogen utilization and to increase net nitrogen retention (Glade and Biesik, 1986; Glade and Sist, 1988). Although the fate of the additional nitrogen is not known, if muscling is enhanced by dietary yeast cultures during exercise conditioning, the subsequent performance of yeast culture supplemented horses might be affected. This possibility was examined by supplementing unconditioned young adult horses with dietary yeast culture during a 6-week conditioning regimen.

Materials and Methods

The 10 horses used in this study had all been without forced exercise for at least 4 months prior to the beginning of the study. In order to remove any confounding effects of residual conditioning, the animals were subjected to an exercise bout of 5 minutes on an inclined plane treadmill. Following this experience they were paired according to a combination of body weight, age and average heart rate during the 5 minutes of exercise. One member of each pair was randomly assigned to one of two diet groups.

Both groups received a mixed diet of oats, corn, molasses, a mineral mix and mixed alfalfa/grass hays, fed in amounts reflecting body weight and the duration of forced treadmill exercise (NRC, 1978). One group ("+YC") also received a commercially-available dried yeast culture preparation (Diamond V Mills, Cedar Rapids, Iowa), added to the total daily ration at 1% by weight. Following a 3-week diet adjustment period, during which the horses were not exercised, forced treadmill exercise was begun at 5 minutes per session, at a steady walk on an inclined plane treadmill. The duration of exercise was increased an average of 1 minute per day, 5 days a week, so that after 2, 4 and 6 weeks of conditioning the treadmill bouts were of 15, 25 and 35 minutes' duration, respectively.

At 2-week intervals the horses participated in data collection during their individual exercise bouts. Indwelling jugular catheters were inserted and the electrodes of an external, non-invasive heart rate monitor (EQB, Unionville, PA) were attached and secured with a heart girth strap. Resting heart rates were recorded and pre-exercise blood samples were drawn. The horses then mounted the treadmill and exercise began immediately. Blood samples were drawn at 5 minute intervals during the exercise bouts and for up to 20 minutes following the completion of exercise. Heart rates were manually recorded at 10-second intervals throughout the exercise bouts and post-exercise recovery periods. Plasma was separated from the blood samples and later analyzed for glucose, lactic acid, triglycerides and urea by a semi-automated method (TDX Systems, Abbott Laboratories, Abbott Park, IL). Heart rates were averaged over 60-second intervals for statistical analysis and graphical display. The resulting data were analyzed by analyses of variance for nested repeated measures (SAS, 1986).

Results and Discussion

Plasma lactic acid concentrations increased during exercise in proportion to exercise duration (Table 1), as was first reported by Krzywanek (1974). However, the increases were significantly smaller in the supplemented horses after 15 (Trial 3) and 20 (Trial 4) minutes of exercise. Human and equine athletic "fitness" have been shown to be inversely proportional to blood lactate concentrations following a given exercise challenge (Krzywanek, 1974; Thorton et al., 1983; Wilson et al., 1983; Yoshida et al., 1987).

Plasma glucose concentrations were significantly decreased in all horses as exercise duration exceeded 10 minutes (Table 2), as was first reported by Rose et al. (1977). Exercise also accelerated fatty acid metabolism (Table 3). However, increases in plasma triglyceride concentrations tended to be smaller in the supplemented horses. This observation, together with the apparently decreased rate of lactic acid production by supplemented horses, suggests that yeast culture supplementation was associated with an additional increment of aerobic metabolic capacity beyond the conditioning effects of chronic forced exercise <u>per se</u>. This conclusion is supported by the reduction in heart rates exhibited by the supplemented horses during and at the end of 35 minutes of exercise (Table 4 Figure 1).

These data suggest an enhanced conditioning effect resulted from chronic yeast culture supplementation, which was evidenced by increased aerobic capacity. The positive effects of yeast culture supplementation on nitrogen metabolism and balance (Glade and Biesik, 1986; Glade and Sist, 1988) may induce increased muscle mass or metabolic efficiency, increased vascularization of muscle or increased cardiovascular capacity or efficiency. Little is known of the responses of these systems to dietary manipulation.

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Literature Cited

Glade, M.J. and L.M. Biesik. 1986. Enhanced nitrogen retention in yearling horses supplemented with yeast culture. J. Anim. Sci. 62:1635-1640.

Glade, M.J. and M.D. Sist. 1988. Dietary yeast culture supplementation enhances urea recycling in the equine large intestine. Nutr Rep Intern 37:11-19.

Krzywanek, H. 1974. Lactic acid concentrations and pH values in trotters after racing. J. S. Afr. Vet. Assoc. 45:355-360.

Rose, R.J., R.A. Purdue and W. Hensley. 1977. Plasma biochemistry alterations in horses during an endurance ride. Eq. Vet. J. 9:122-126.

SAS. 1986. Sas User's Guide. Statistical Analysis System Institute, Cary, NC.

Thornton, J., B. Essen-Gustavsson, A. Lindholm, D. McMiken and S. Persson. 1983. Effects of training and detraining on oxygen uptake, blood gas tensions, pH and lactate concentrations during and after exercise in the horse. In: Snow, D.H., S.G.B. Persson and R.J. Rose (eds.). Equine Exercise Physiology. Granta, Cambridge, pp. 470-486.

Wilson, R.G., R.B. Isler and J.R. Thornton. 1983. Heart rate, lactic acid production and speed during a standardized exercise test in standard-bred horses. In: Snow, D.H., S.G.B. Persson and R.J. Rose (eds.). Equine Exercise Physiology. Granta, Cambridge, pp. 487-496.

Yoshida, T., M. Chida, M. Ichioka and Y. Suda. 1987. Blood lactate parameters related to aerobic capacity and endurance performance. Euro. J. Appl Physiol. 56:7-11.

Table 1. Effects of supplemental yeast culture (YC) on plasma lactic acid concentrations (mg/dl) in horses exercised on a treadmill.

Exercise Time (min)	Plasma Lactic Acid (mg/dl)							
	Trial 1		Trial 2		Trial 3		Trial 4	
	-YC	+YC	-YC	+YC	-YC	+YC	-YC	+YC
0	3.90	4.85	5.36	6.04	5.51	5.72	6.25	6.09
5	11.63	10.47	11.47	8.14	9.70	9.79	10.11	7.52
10			9.61	7.15	10.30	10.56	9.69	6.86
15			13.17	10.77	15.94	11.21[a]	11.82	10.58
20					15.22	11.59[a]	19.58	14.70[a]
25					26.24	20.29[b]	26.62	20.80[b]
30							34.12	25.96[b]
35							41.29	30.08[b]
Post-Exercise:								
5	13.34	11.45	13.98	11.63	37.03	23.84[b]	57.18	40.58[b]
10			10.15	9.60	26.02	20.60[b]	45.64	30.75[b]
15					19.50	12.65[b]	31.24	20.32[b]
20					9.74	7.65	21.07	11.01[b]

pooled SEM: 1.49

[a] $p<.05$, -YC vs. +YC
[b] $p<.01$, -YC vs. +YC

Table 2. Effects of supplemental yeast culture (YC) on plasma glucose concentrations (mg/dl) in horses exercised on a treadmill.

Exercise Time (min)	Plasma Glucose (mg/dl)							
	Trial 1		Trial 2		Trial 3		Trial 4	
	-YC	+YC	-YC	+YC	-YC	+YC	-YC	+YC
0	82.81	88.47	84.14	85.45	91.37	89.89	93.09	89.15
5	80.42	86.94	85.32	77.36	88.86	81.21	84.75	79.94
10			73.81	74.64	71.40	70.59	80.73	79.83
15			82.81	80.93	66.41	62.27	72.45	70.41
20					61.60	61.03	68.58	68.62
25					73.69	66.36	69.05	62.21
30							72.80	67.96
35							77.10	65.63
Post-Exercise:								
5	79.24	86.13	80.30	86.24	77.99	79.63	86.79	82.69
10			85.44	85.81	80.82	83.60	86.62	83.50
15					81.27	84.25	87.17	81.11
20					89.94	88.26	90.98	88.26

pooled SEM: 3.29

Table 3. Effects of supplemental yeast culture (YC) on plasma triglyceride concentrations (mg/dl) in horses exercised on a treadmill.

Exercise Time (min)	Plasma Triglycerides							
	Trial 1		Trial 2		Trial 3		Trial 4	
	-YC	+YC	-YC	+YC	-YC	+YC	-YC	+YC
0	10.91	8.38	6.80	9.62	7.60	9.98	8.37	11.55
5	13.73	9.10	10.62	11.30	20.63	13.50	22.64	14.01
10			17.97	13.14	26.63	22.09	21.76	18.76
15			17.54	12.42	21.51	20.77	20.82	23.20
20					19.67	21.58	24.90	23.45
25					22.48	22.69	19.34	25.24
30							24.10	23.56
35							24.14	23.42
Post-Exercise:								
5	8.71	7.45	21.64	16.19	23.43	19.30	19.81	28.28
10			16.67	16.10	21.42	16.94	17.54	17.82
15					18.35	18.99	17.29	13.80
20					12.67	11.17	16.98	17.72

pooled SEM: 2.88

Table 4. Effects of supplemental yeast culture (YC) on the end-of-exercise heart rates (beats per minute) of horses exercised on a treadmill.

Trial	Duration of Exercise (minutes)	Heart Rates -YC	Heart Rates +YC
1	5	185	180
2	15	186	165[a]
3	25	129	116
4	35	120	99[a]

pooled SEM: 8.95

[a] $p<.05$, -YC vs. +YC

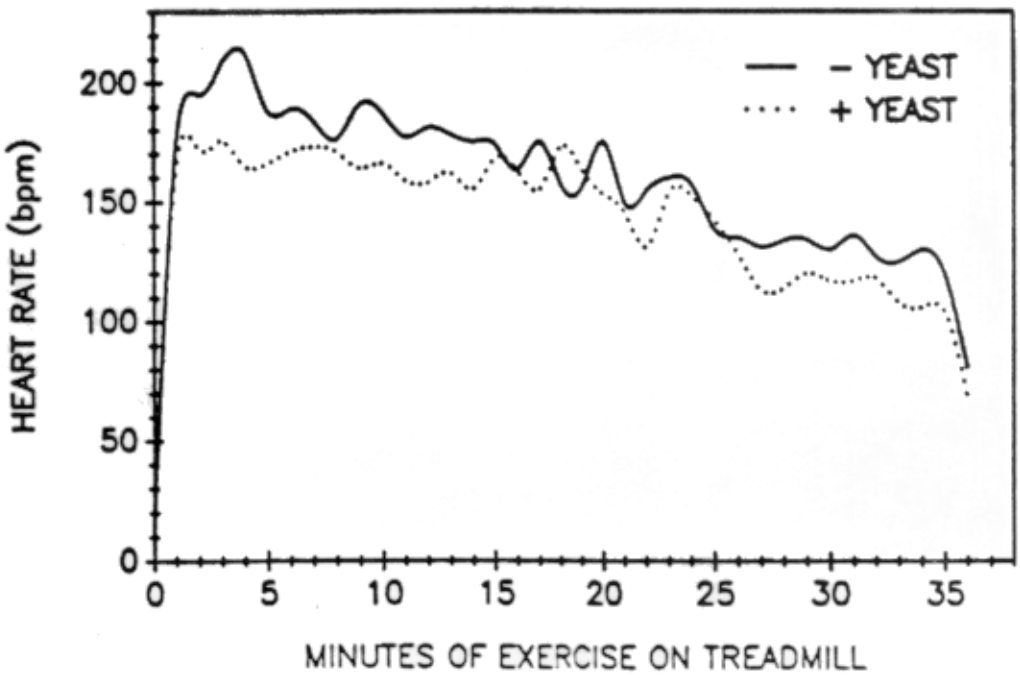

Figure 1