

EFFECT OF SUPPLEMENTAL IRON, LIVE SACCHAROMYCES CEREVISIAE YEAST AND EXERCISE ON HEMOGLOBIN AND PACKED CELL VOLUME OF THE BLOOD OF HORSES

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SUMMARY

Nine mature Quarter Horses were used in a 6-week-long experiment designed to examine the effect of supplemental iron in the form of ferrous sulfate and of iron plus a live yeast culture on percent hemoglobin (Hb) and percent packed cell volume (PCV) before and after exercise. The results show that the addition of 545 mg of iron sulfate had no significant effect on percent Hb or packed cell volume before or after exercise. The addition of 545 mg of iron sulfate plus 113.5 gms of live yeast culture to the ration caused a slight over-all increase in Hb, however, the difference was significant ($P < .05$) only in the 6th week of the experiment.

There were significant ($P < .05$) weekly fluctuations in Hb and PCV and it is theorized that environmental temperature played a role in these differences. As has been previously reported, exercise caused an increase in both PCV and Hb.

INTRODUCTION

Horsemen have recognized that horses with greater than average capacity to transport oxygen in the circulatory system are usually more successful as race horses than other individuals of the same breed⁴. In addition, the necessity of an adequate supply of iron to help the body fight infection was demonstrated by Weiss⁵. A number of commercial iron and vitamin products have been fed in an attempt to increase the oxygen carrying capacity of the blood. There is great variation in the biological availability of iron from different sources. Ferrous sulfate has been used as a standard and other sources compared to it.

The requirement of horses for iron is estimated to be less than 40 mg per kilogram of diet for mature horses

and 50 mg per kilogram for rapidly growing foals³. This would indicate that mature horses on normal diets and not heavily parasitized should not require supplemental iron; however, the feeding of iron supplements continues to be a common practice among horsemen.

This experiment was conducted to determine the effect of adding supplemental iron, or iron plus live *saccharomyces cerevisiae* yeast, to the ration of mature horses on the oxygen carrying capacity of the blood.

MATERIALS AND METHODS

Nine Quarter Horses, aged 3 through 6, from the University of Missouri-Columbia Quarter Horse herd were allotted into 3 groups by age and sex (2 mares and 1 gelding per group) and randomly assigned to one of 3 treatments in a repeated measurement design. All 3 groups were fed brome hay at the rate of 1 kg per 100 kg body weight per day. In addition, group I was fed a concentrate mixture (Table 1), calculated to contain 50 mg of iron per kg, at the rate of 1 kg per 100 kg body weight per day. Group II was supplemented with 545 mg of iron sulfate^b per day in addition to the concentrate mix and brome hay. Group III received 545 mg of iron sulfate plus 113.5 gms of live *saccharomyces cerevisiae* yeast culture^a per day.

Two blood samples were taken via jugular venipuncture between 1:30 and 3:00 pm at the beginning of the experiment and weekly for 6 consecutive weeks beginning February 17, 1983. The first sample was taken while the horses were at rest and a second blood sample was taken immediately following 10 minutes of exercise on a long line at a fast trot (approximately 13 km per hour). The blood samples were drawn into heparinized Vacutainer tubes and placed in crushed ice for transporting to the laboratory. The horses were exercised in a similar fashion on days when samples were not taken.

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Acknowledgments: Supported in part by a gift from Diamond V Mills, Inc., Cedar Rapids, Iowa.

^aDiamond V. Mills, Inc., Cedar Rapids, Iowa.

^bContains 30% Fe.

TABLE 1

Concentrate Mixture	
	%
Corn	25.00
Cane molasses	7.50
Oats	55.25
44% Soybean meal	5.00
Wheat bran	5.00
Calcium carbonate	.75
Dicalcium phosphate	.75
Trace mineralized salt*	.50
Vitamin A and D premix	.25
*trace mineralized salt	
	%
Salt (NaCl)	93-94
Zn	0.350
Mn	0.280
Fe	0.175
Cu	0.035
I	0.007
Co	0.007

As soon as the samples were taken and transported to the laboratory they were examined for percent packed cell volume (PCV) and hemoglobin (Hb).

The data were analyzed by analyses of variance using the method of Gill and Hafs^w for analysis of repeated measurements.

RESULTS

Packed cell volume

Results of PCV determinations are shown in Tables 2 and 3. Ten minutes of exercise caused PCV to increase ($P < .01$) from a mean of 34.7% at rest to 43.2% in samples taken immediately after exercise. In the blood samples taken prior to exercise, there were no differences ($P > .05$) in PCV between any of the treatment groups. There was a weekly fluctuation in pre-exercise PCV ($P < .05$), with the lowest over-all mean on week 2 and the highest mean on week 4. In samples taken after exercise, PCV appeared to be highest in group 3, but the difference was not significant ($P > .05$), except in week 6, the last week of the trial.

TABLE 2

Percent Packed Cell Volume From Horses at Rest Least Squares Means

		Week							
		-	1	2	3	4	5	6	-
Group	1		33.7 ^a	33.1 ^a	32.6 ^a	35.7 ^a	33.7 ^a	35.1 ^a	34.0 ^a
	2		36.4 ^a	33.3 ^a	33.6 ^a	35.3 ^a	34.8 ^a	35.3 ^a	34.8 ^a
	3		34.3 ^a	34.2 ^a	34.0 ^a	37.1 ^a	35.8 ^a	37.1 ^a	35.4 ^a
	-		34.8 ^{ab}	33.5 ^a	33.4 ^a	36.0 ^{bc}	34.8 ^{ac}	35.8 ^{bc}	34.7

a b c Means with different superscripts are different ($P < .05$).

Table 3

Percent packed Cell Volume From Horses After 10 Minutes of Exercise Least Squares Means

		Week							
		-	1	2	3	4	5	6	-
Group	1		43.6 ^{ac}	39.0 ^a	42.3 ^a	45.3 ^a	43.6 ^a	40.4 ^a	42.4 ^a
	2		40.7 ^a	38.6 ^a	42.1 ^a	45.4 ^a	44.2 ^a	43.9 ^a	42.5 ^a
	3		45.1 ^{bc}	40.8 ^a	44.3 ^a	44.7 ^a	44.6 ^a	48.5 ^a	44.7 ^a
	-		43.1 ^a	39.4 ^b	42.9 ^{ac}	45.1 ^{ac}	44.1 ^{ac}	44.3 ^{ac}	43.2

a b c Means with different superscripts are different ($P < .05$).

Hemoglobin

Exercise affected hemoglobin levels similar to PCV, increasing it from a mean of 10.9 gms/dl before exercise to 13.4 gms/dl after exercise. In both pre and post exercise samples, treatment 3 was higher in Hb than treatment 1 in the 6th week of the trial (Tables 4 and 5). In the post exercise samples, group 3 was higher in Hb than either group 1 or 2. On a weekly basis, when horses from all 3 groups were pooled, hemoglobin was higher in weeks 3 through 6 ($P < .05$) than in weeks 1 and 2 in the post exercise samples.

DISCUSSION AND CONCLUSIONS

PCV and Hb levels before and after exercise were similar to those reported by Brody et al.¹. Ten minutes of

Table 4

Hemoglobin (gm/dl) From Horses at Rest Least Squares Means

		Week							
		-	1	2	3	4	5	6	-
Group	1		10.5 ^a	10.7 ^a	10.2 ^a	11.1 ^a	11.0 ^a	10.2 ^a	10.6 ^a
	2		11.1 ^a	10.8 ^a	10.8 ^a	11.2 ^a	10.9 ^a	10.8 ^{ab}	10.9 ^a
	3		10.4 ^a	11.4 ^a	10.4 ^a	11.5 ^a	11.7 ^a	11.2 ^b	11.0 ^a
	-		10.7 ^{ac}	11.0 ^{ab}	10.5 ^{ac}	11.3 ^{bc}	11.0 ^{abc}	10.7 ^{ac}	10.9

a b c Means with different superscripts are different ($P < .05$).

Table 5

Hemoglobin (gm/dl) From Horses After 10 Minutes of Exercise Least Squares Means

		Week							
		-	1	2	3	4	5	6	-
Group	1		12.6 ^a	12.8 ^a	13.7 ^a	14.3 ^a	13.4 ^a	12.8 ^a	13.3 ^a
	2		12.5 ^a	11.8 ^a	13.5 ^a	13.8 ^a	14.4 ^a	13.4 ^a	13.2 ^a
	3		13.3 ^a	12.8 ^a	13.8 ^a	13.6 ^a	13.8 ^{ac}	14.5 ^b	13.6 ^a
	-		12.8 ^a	12.5 ^a	13.7 ^b	13.9 ^b	13.9 ^b	13.6 ^b	13.4

a b c Means with different superscripts are different ($P < .05$).

Table 6

Difference in Hemoglobin (gm/dl) Between Samples taken Before and Those Taken After Exercise

		Week						
		1	2	3	4	5	6	-
Group	-	1	2	3	4	5	6	-
	1	2.0 ^{ab}	2.1 ^a	3.4 ^a	3.2 ^a	2.4 ^a	2.6 ^a	2.6 ^a
	2	1.4 ^b	1.0 ^a	2.7 ^a	2.6 ^a	3.6 ^a	2.6 ^a	2.3 ^a
	3	2.9 ^{ac}	1.4 ^a	3.4 ^a	2.1 ^a	2.7 ^a	3.3 ^a	2.6 ^a
-	2.1 ^{ad}	1.5 ^a	3.2 ^{bc}	2.6 ^{cd}	2.9 ^{bc}	2.8 ^{cd}	2.5	

a b c Means with different superscripts are different (P<.05).

exercise caused a significant increase in both parameters in all treatment groups. The addition of 545 mg of iron sulfate to the daily ration caused only a slight (non-significant) increase in hemoglobin level in the blood samples taken prior to exercising the horses. Added iron (group 2) had no effect on Hb after 10 minutes of exercise and no effect on PCV in any of the 6 weeks of the trial.

The addition of iron plus live yeast culture (group 3) caused an increase (P<.05) in PCV in week six of the trial. When the weekly blood samples were pooled, group 3 was highest in both Hb and PCV both before and after exercise, but the differences were not significant (P>.05).

Supplementation with iron plus live yeast culture (group 3) caused PCV to increase more (P<.05) during

Table 7

Difference in Percent Packed Cell Volume Between Samples Taken Before and Those Taken After Exercise

		1	2	3	4	5	6	-
Group	-	1	2	3	4	5	6	-
	1	10.0 ^a	5.9 ^a	9.7 ^a	9.6 ^a	9.9 ^a	5.3 ^a	8.4 ^a
	2	4.4 ^b	5.3 ^a	8.4 ^a	10.0 ^a	9.4 ^a	8.6 ^{abc}	7.7 ^a
	3	10.8 ^a	6.6 ^a	10.3 ^a	7.7 ^a	8.7 ^a	11.4 ^{bc}	9.2 ^a
-	8.4 ^{abc}	5.9 ^b	9.5 ^{ac}	9.1 ^{ac}	9.4 ^{ac}	8.4 ^{ab}	8.4	

a b c Means with different superscripts are different (P<.05).

exercise than in groups 1 and 2. There was no treatment effect on the difference between pre and post exercise Hb levels (Tables 6 and 7).

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