FOCUS ON RESEARCH

EQUINE RESEARCH REVIEW

Diamond V Original Product has been shown to affect the growth, nutrient digestibility, nitrogen retention and exercise parameters of foals, growing horses, equine performance athletes and mature to geriatric horses. Ongoing research has been conducted by feeding Diamond V Original Product to horses at various university and research institutes.

YOUNG GROWING HORSES

A summary of three trials measuring body weight and wither height of horses supplemented with Diamond V Original Product is in Table 1. Bennett et al. (1991) reported numerical improvements in growth and wither height when yearling quarter horses were supplemented with Original Product (2 oz/d Original XP™ (XP)). Yearlings supplemented with Original Product were approximately 9 pounds heavier at the end of the 182-day trial, representing a 3% greater weight gain over animals fed a control diet. Wither height gains were 7% higher in the supplemented animals and hip height gains were 23% greater. Feed efficiency was numerically improved 7-10% by feeding Original Product in the last five months of the study. Mason (1988) reported that growth rate of wild, recently weaned foals was increased ($P < 0.01$) by Diamond V Original Product (2.5% Original YC™ (YC)). In the 120-day study, average daily gain (ADG) and wither height were increased ($P < 0.01$) significantly by 60% and 55%, respectively. Although not statistically significant, feed efficiency was improved by about 39% in animals supplemented with Original Product. In the third trial, weanling foals were fed a diet that contained 0 or 2.5% YC (Brown, 1985). Foals supplemented with Original Product showed gains of approximately 30 pounds more body weight and ¼ inch higher withers height in the 77-day test period.

TABLE 1
Effects of Diamond V Original Product on body weight and wither height in horses.

	Body Weight, lbs					Wither Height, in		
Trial/Treatment	**Initial**	**Final**	**Gain**	**Days**	**ADG**	**Initial**	**Final**	**Gain**
Bennett et al, 1991[1]								
Control	502.87	793.43	290.56	182	1.60	50.55	55.00	4.45
Diamond V Original Product	502.87	802.47	299.60	182	1.65	50.35	55.12	4.77
Mason, 1988[1]								
Control	449.13	521.00	71.87[a]	120	0.59[a]	50.59	52.84	2.25[a]
Diamond V Original Product	447.88	561.99	114.11[b]	120	0.95[b]	49.70	53.20	3.50[b]
Brown, 1985[1]								
Control	645.00	772.14	127.14	77	1.65	53.36	56.61	3.25
Diamond V Original Product	664.17	821.88	157.71	77	2.05	54.08	57.56	3.48

[1]Treatments: Bennet et al, 1991 – 0 or 2 oz Diamond V Original XP per day; Mason, 1988 and Brown, 1985 – 2.5 % Diamond V Original YC; Diamond V Mills, Cedar Rapids, IA

[ab]Means within a column within a study with unlike superscripts differ ($P < 0.01$)

Diamond V®

NUTRIENT DIGESTIBILITY

Table 2 illustrates two studies showing the effects of adding Original Product to horse rations. Thoroughbred yearlings supplemented with Original Product (4 oz Original YC) had greater ($P < 0.05$) hemicellulose digestibility (Glade and Biesik, 1986). In the same study, an average of a 10 g increase ($P < 0.01$) in net nitrogen retention was reported. Improvements of dry matter, NDF and ADF apparent digestibility also were noted. Richard Godbee (1983) at Clemson University also observed a numerical increase in apparent digestibility of dry matter, NDF, ADF and hemicellulose with yeast culture supplementation in three-year old Quarter Horse geldings. Crude protein digestibility was 4.1% greater in horses supplemented with Original Product (4 oz Original YC). This could explain the increase in nitrogen retention when horses received the diets containing Original Product.

TABLE 2
Effect of Diamond V Original Product on nutrient digestibility and nitrogen retention in horses.

	Apparent Digestibility, % of Intake				Nitrogen Retention	
Trial/Treatment	**DM**	**NDF**	**ADF**	**Hemicellulose**	**g/d**	**% of Intake**
Glade and Biesik, 1986[1]						
Control	71.8	56.5	51.4[a]	58.0	7[c]	12.6[c]
Diamond V Original Product	78.4	71.0	78.5[b]	68.5	14[d]	22.6[d]
Godbee, 1983[1]						
Control	51.3	36.0	22.0	48.5	4.9	4.5
Diamond V Original Product	52.3	37.6	23.1	50.3	10.8	9.8

[1]Treatments: Both studies supplemented 0 or 4 oz Diamond V Original YC per day
[ab]Means within a column within a study with unlike superscripts differ ($P < 0.05$)
[cd]Means within a column within a study with unlike superscripts differ ($P < 0.01$)

A trial conducted with mature 14 to 18 year old geldings examined the effects of Original Product on nutrient digestibility (Switzer, 2003; Table 3). Horses received diets containing 0, 0.5 or 1% Original XP. Horses fed Original Product had a 3.8% higher ($P < 0.05$) mean crude protein digestibility as compared to the controls. Magnesium digestibility was 7.8% greater ($P < 0.05$) in horses supplemented with 0.5% Original Product when compared to control animals. Fiber fractions (ADF and NDF) of the diet were numerically greater in horses supplemented with Original Product.

Forage quality is a major component of quality horse nutrition. Improving the feed value of lower quality forages is advantageous for any horse producer. In a trial conducted with mature geldings, high and low quality forages diets with and without Original Product supplementation were evaluated (Morgan, 2006; Table 3). When low quality forage diets were fed, crude protein ($P < 0.03$) and hemicellulose ($P < 0.01$) digestibility increased with the inclusion of Original Product (2 oz Original XP). It was also noted that NDF and dry matter digestibility tended ($P < 0.10$) to increase when Original Product was added to the low quality forage ration.

TABLE 3
Effect of Diamond V Original Product on nutrient digestibility in horses.

	Apparent Digestibility, % of Intake				
Trial/Treatment	**DM**	**NDF**	**ADF**	**Hemicellulose**	**CP**
Switzer, 2003					
Control	60.3	47.7	39.0	—	73.9[a]
0.5% Diamond V Original Product	60.8	48.9	43.0	—	77.7[b]
1.0% Diamond V Original Product	61.0	50.2	44.0	—	74.6[a]
Morgan et al, 2006[1]					
High Quality Forage (HQ)	46.2[c]	37.8[f]	29.6	48.6[f]	57.6[f]
HQ + Diamond V Original Product	44.6[c]	36.6[f]	29.6	46.0[f]	56.3[f]
Low Quality Forage (LQ)	37.7[d]	25.1[g]	18.5	35.8[g]	47.5[g]
LQ + Diamond V Original Product	40.9[e]	30.4[h]	19.4	41.1[h]	52.3[h]

[1]Treatments: Both studies supplemented 0 or 4 oz Diamond V Original YC™ per day
[ab]Means within a column within a study with unlike superscripts differ ($P < 0.05$)
[cde]Means within a column within a study with unlike superscripts differ ($P < 0.10$)
[fgh]Means within a column within a study with unlike superscripts differ ($P < 0.05$)

PERFORMANCE HORSES AND EXERCISE PHYSIOLOGY

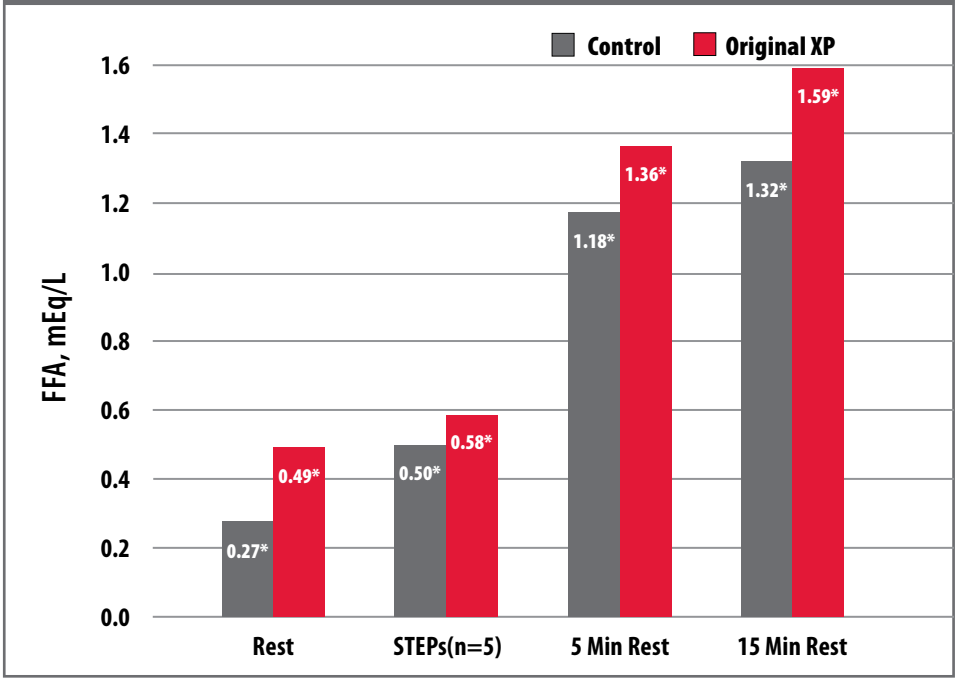
Dietary energy is what empowers a horse to perform with both speed and endurance. Methods of increasing digestible energy from equine diets have been shown to improve with inclusions of Diamond V Original Product. Monitoring plasma metabolite concentrations and heart rates provides additional indicators of the horse's energy metabolism and their ability to perform.

1. Blood plasma triglyceride (TG) or free fatty acids (FFA)
Lipid metabolism (turnover) is correlated to concentrations of FFA in the blood. Plasma FFA concentrations increase during and immediately following exercise. Glade and Campbell-Taylor, 1990 reported that Diamond V Original Product (1% Original XP) supplemented horses had a slower rise in plasma FFA rates during an exercise period indicating a more efficient uptake of FFA by the working muscles (data not shown). Another study reported that FFA levels in animals following exercise remained elevated ($P < 0.05$) suggesting that dietary supplements of Original Product may enhance the oxidation of free fatty acids especially during the recovery period (Miller-Graber, 1994). This indicates a possible conversion of energy usage from muscle glycogen to fat utilization.

A significant ($P < 0.05$) diet by conditioning effect for plasma TG was reported in a study conducted by Klosterman et al (1993). Before conditioning, Original Product (1% by weight) increased TG during exercise and recovery, while after conditioning, Original Product decreased TG.

Wickler (2002) confirmed in a standardized exercise test that Original Product supplementation in horses increased blood FFA concentrations significantly ($P < 0.05$) at every STEP and during REST periods before and after exercise (Figure 1). This indicates increased fat utilization and a sparing of blood glucose in the exercised horse.

FIGURE 1
Effect of Diamond V Original XP on free fatty acid (FFA) concentration

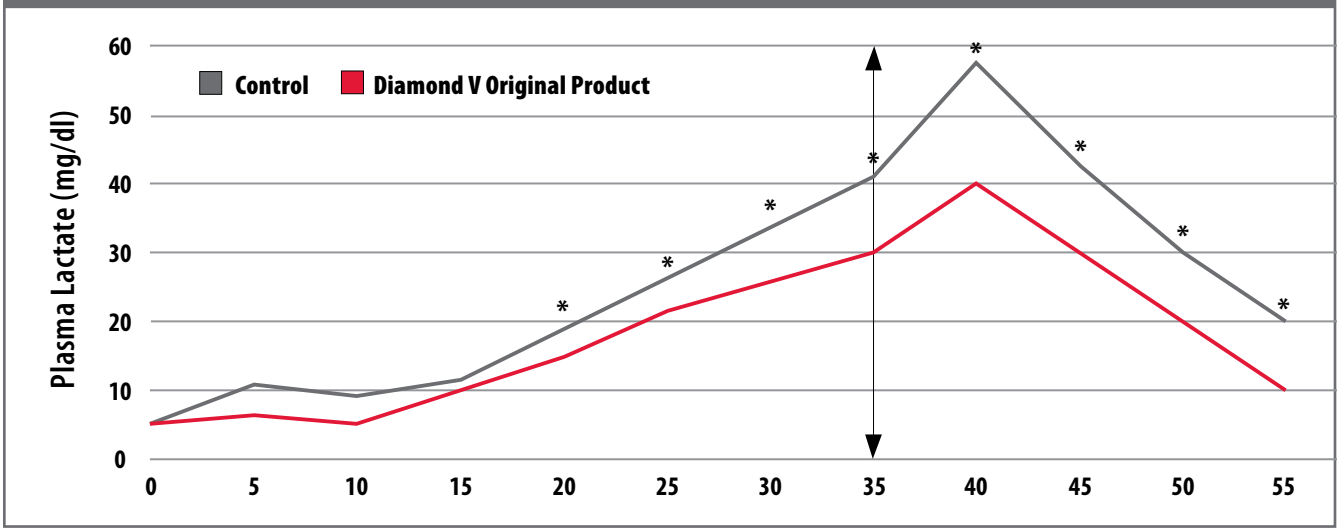


Wickler et al, 2002.
* $P < 0.05$

2. Blood plasma lactate

Blood plasma lactate levels are proportional to the rate of intramuscular production of lactic acid from exercise intensity and duration in horses. In essence, lactate is produced throughout exercise and blood lactate is an assessment of muscle metabolism and related to fatigue. In an exercise trial, Glade & Campbell-Taylor (1990) showed that horses supplemented with Diamond V Original Product (1% by weight) exhibited significantly smaller and slower increases in plasma lactate concentration (Figure 2). This effect was greater and became statistically significant ($P < 0.01$) as the length of exercise increased from 20 minutes or longer. Wickler (2002) reported a numerical reduction in blood lactate levels during the exercise portion of a standardized exercise test in horses. Any treatment that decreases lactic acid production in the muscle would potentially increase athletic capacity of the animal.

FIGURE 2
Effect of Diamond V Original Product on plasma lactate levels in horses exercising for 35 minutes, followed by 20 minutes resting period



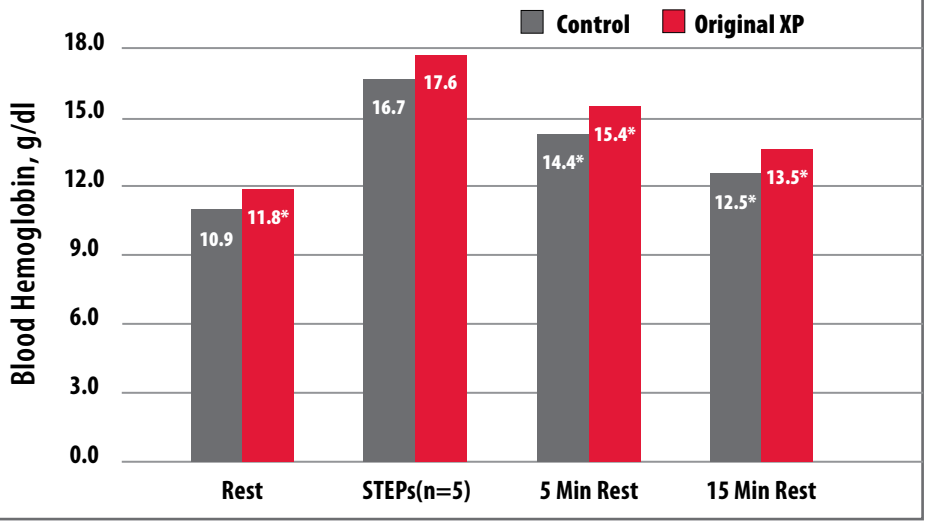
Glade and Campbell-Taylor, 1990.
* $P < 0.01$

3. Blood hemoglobin (Hb) and packed cell volume (PCV)

Increasing blood hemoglobin or PCV has the advantage of increasing the blood's oxygen carrying capacity. Athletic performance in horses (Standardbreds and Arabians) has been correlated with total blood volume. An increase in blood oxygen carrying capacity by increasing the number of red cells (PCV) has been shown to increase athletic ability. Both PCV and Hb have been used as measures of oxygen carrying capacity of horses. It is know that both PCV and Hb levels rise during exercise as a metabolic response to increased need for oxygen to the muscles. In an iron supplementation trial (Loch, 1984), Diamond V Original Product plus additional iron fed to horses showed an increase ($P < 0.05$) in PCV in the final week over control and the iron supplemented animals only. Overall Diamond V Original Product plus iron supplemented horses showed a trend for the highest PCV and Hb both before and after exercise of all groups.

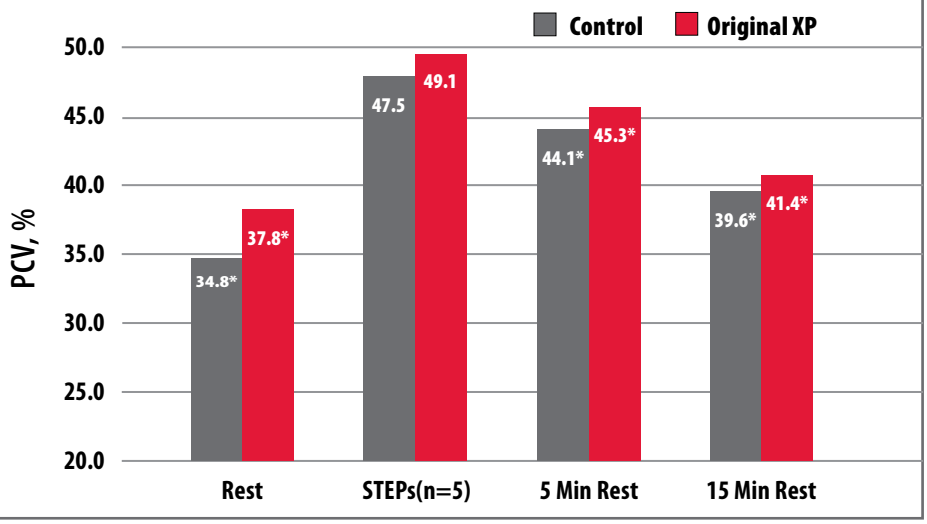
Biel et al. (1990) reported trends of higher Hb concentrations during exercise and increased PCV during recovery in horses supplemented with Original Product. The research suggests that red blood cell turnover time is about 90 days, therefore trials designed to show PCV and Hb benefits should extended through 90 days. Wickler, 2002, showed that Original Product increased blood hemoglobin and PCV significantly ($P < 0.05$) over control animals before, during and after exercise tests in Arabian horses (Figure 3 and 4).

FIGURE 3
Effect of Diamond V Original XP on blood hemoglobin



Wickler et al, 2002.
* $P < 0.05$

FIGURE 4
Effect of Diamond V Original XP on packed cell volume



Wickler et al, 2002.
* $P < 0.05$

4. Heart Rate

Lower heart rates in horses indicate relatively reduced cardiac output and therefore increased efficiency in energy metabolism and oxygen utilization. This leads to a greater capacity for performing a given amount of work by the animal. Glade and Campbell-Taylor (1990) conducted a 35-minute exercise trial and showed significantly ($P < 0.01$) lower heart rates in horses supplemented with Original Product during the first 5 and final 10 minutes of the workouts. In another study, Miller-Graber et al. (1994) reported that the velocity required to maintain 160 beats per minutes at the 5th minute of exercise averaged 15.26 and 16.21 feet per second in the control and Original Product supplemented horses, respectively. This means that the horses fed Original Product maintained the same heart rate while running faster compared to unsupplemented horses. Lowered heart rates in responses to work loads are a good indication of the relative improved fitness of horses.

SUMMARY

Diamond V Original Product can affect the growth of weanling foals. Average daily gain, withers height and hip height were greater when foals were supplemented with Original Product in these studies. Improvements in feed efficiency were also noted in growing foals when fed Original Product. In both growing and mature horse nutrition programs, positive effects of Original Product can be seen on nutrient digestibility and retention. As there is increased utilization and retention of nutrients, improvements in feed efficiency will be seen. Lower quality forage feeding values can be affected by Diamond V Original Product. Furthermore, Original Product can affect the athletic performance of horses. Research has shown that feeding Original Product affects plasma fatty acid levels, plasma lactic acid concentrations, hemoglobin and packed cell volumes of the blood and the overall heart rate of horses during and after exercise.

IMPLICATIONS

Diamond V Original Product's effects can be seen when fed to horses in all stages of growth and physical activity. Nutrient digestibility and nitrogen retention have been affected by the inclusion of Original Product in horse feeds. Athletic performance as measured by plasma triglyceride, lactic acid, hemoglobin and packed cell volume and heart rates can be altered when including Original Product in the various diets. Feeding Diamond V Original Product at the recommended level (Table 4) can help insure that horses perform to their genetic and athletic potential.

TABLE 4
Recommended Feeding Rates for Diamond V Original Product in Horses (oz/head/d)

Class	XP	XPC
Foal Starter	0.5	0.125
Mares/Stallions	2.0	0.5
Show/Performance	2.0	0.5
Senior	2.0	0.5
Draft Horses	4.0	1.0

REFERENCES

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

Morgan, L.M., J.A. Coverdale, M.A. Froestchel, and I. Yoon 2006. Effects of yeast culture supplementation on digestibility of varying quality forage in mature horses. J. Anim. Sci. 84 (Suppl. 1: W95.

Switzer, S.T., L.A. Baker, J.L. Pipkin, R.C. Bachman, and J.C. Haliburn. 2003. Effect of yeast culture supplementation on nutrient digestibility in aged horses. EQ008-s (Research Summary).

Godbee, R. 1983. Effect of yeast culture on apparent digestibility and nitrogen balance in horses. EQ200 (Research Summary.

Brown. 1985. Effect of Diamond V Yeast Culture on weanling Standardbred foals. EQ100 (Research Summary).

Mason, T.R. 1988. Effect of yeast culture on growth of young wild horses. EQ101 (Research Summary).

Bennett, K.G., W.E. Loch, J.C. Lattimer, and E.M. Green. 1991. Effects of Saccharomyces cerevisiae yeast culture supplementation on weight gains, skeletal growth, and bone density of the third metacarpal in yearling quarter horses. J. Anim. Sci. 69 (Suppl. 1): 324.

Glade, M.J. and M. Campbell-Taylor. 1990. Effects of dietary yeast culture supplementation during the conditioning period on equine exercise physiology. Equine Vet. Sci. 10 (6): 434-443.

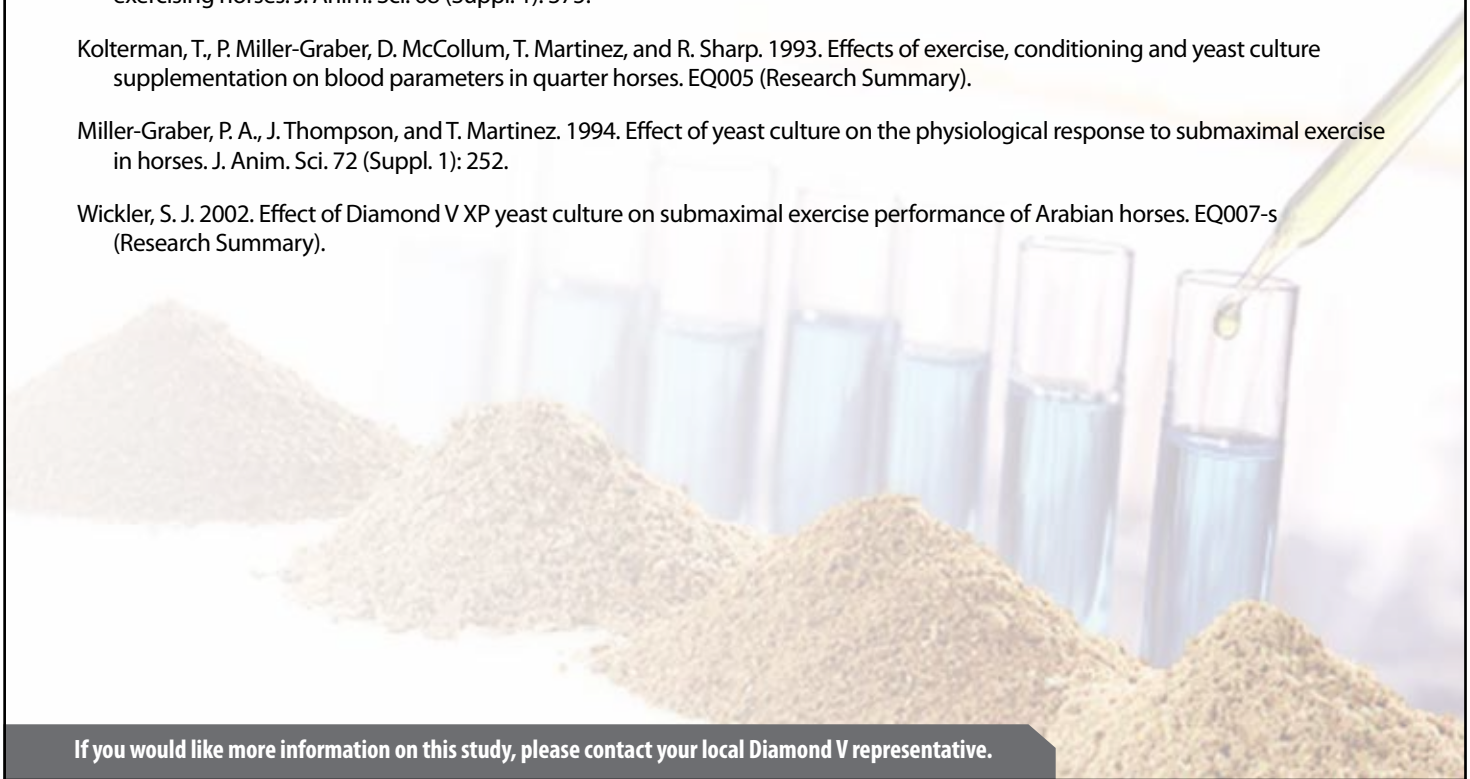
Loch, W.E. 1984. Effects of supplemental iron, live Saccharomyces cerevisiae yeast and exercise on hemoglobin and packed cell volume of the blood of horses. Equine Vet. Sci. 4 (3): 125-127.

Biel, M., L. Lawrence, J. Novakofski, K. Kline, D. Mclaren, L. Moser, and D. Powell. 1990. Effect of yeast culture supplementation on exercising horses. J. Anim. Sci. 68 (Suppl. 1): 375.

Kolterman, T., P. Miller-Graber, D. McCollum, T. Martinez, and R. Sharp. 1993. Effects of exercise, conditioning and yeast culture supplementation on blood parameters in quarter horses. EQ005 (Research Summary).

Miller-Graber, P. A., J. Thompson, and T. Martinez. 1994. Effect of yeast culture on the physiological response to submaximal exercise in horses. J. Anim. Sci. 72 (Suppl. 1): 252.

Wickler, S. J. 2002. Effect of Diamond V XP yeast culture on submaximal exercise performance of Arabian horses. EQ007-s (Research Summary).



If you would like more information on this study, please contact your local Diamond V representative.

2525 60th Avenue SW | Cedar Rapids, IA 52404 | USA
TF: 800.373.7234 | Phone: +1.319.366.0745 | **diamondv.com**

Diamond V®
The Trusted Experts In Nutrition & Health®

MADE IN USA