Timing of Meals May Affect Performance

BY AMY JANE FITZGERALD

Looking for that edge that might make your horse run faster, jump higher, or perform longer? Recent research done by the scientists at Kentucky Equine Research (KER) might provide an answer.

In a study titled "Time of Feeding Critical For Performance," Dr. Joe D. Pagan and the staff at KER designed two trials: one to determine whether feeding grain with or without hay prior to a competition exercise test (CET) would affect substrate utilization (how a horse uses fuel); and a second to determine whether feeding forage but no grain prior to a CET would affect substrate utilization and performance. The first trial examined feeding hay, grain, or both at four different times prior to exercise, and the second trial investigated feeding only forages at four different times. The results may provide the edge that will put your horse over the top.

Competition exercise tests are designed to simulate the demands placed on horses during strenuous activity. The two studies KER designed utilized the high-speed treadmill to exercise the horses and to enable researchers to draw blood from the horses while they were working at various speeds. Using information obtained from studying the plasma, the researchers hoped to find how different feeds and time of feeding would effect the horses and their performance. Plasma variables are the key indicators as to how the body performs and copes with the physiological stresses presented during exercise. Blood samples were taken during the last 30 seconds of each speed. These samples could only be obtained through the accessibility of the animal on the treadmill. Researchers can stand literally right beside the horse as it is exercising and are able to draw blood without interrupting the horse's rate of speed. A CET was designed to simulate the conditions of a three-day event, as time of feeding is particularly important to the event horse. The treadmill was raised to an incline of 3° and the horses were asked to exercise as shown in Table 1.

Performing the trials using the treadmill provided a stable environment that remained constant for each horse during each period. This ensured the accuracy of the data recorded so that it could be accurately examined and valid information could be obtained.

GAIT	TIME	SPEED	PHASE
Walk	10 min	1.4 m/s	A
Trot	10 min	3.7 m/s	A
Gallop	2 min	10.7 m/s	B
Trot	20 min	3.7 m/s	C
Walk	10 min	1.4 m/s	C
Canter	8 min	9.0 m/s	D
Hand Walk	30 min	––	Warm down

Table 1.

The results from the studies indicated that feeding hay with grain would increase gut fill and thus increase body weight, which is detrimental to racing. However, raising the level of gut fill is associated with additional volume of water and electrolyte reservoir in the hindgut, which is advantageous to endurance riding. So, for a racehorse it would be wise to feed early enough in the day to enable the horse's system to eliminate most of the feed, but an endurance horse would do better when its feed was delivered closer to the time of competition.

If a horse is fed grain two hours before competition, the horse will metabolize sugars rather than free fatty acids (FFA). The sugar fuel store depletes much more quickly than the fat fuel store, so for prolonged competition such as an endurance event or the endurance phase of a three-day event, it is recommended to encourage FFA metabolism. The horse's sugar levels will have returned to baseline before the start of the competition, and the fat stores will become more accessible as a fuel source.

As equine performance continues to become increasingly more competitive, it is crucial that horses have access to fuel at the instant of demand. This maintains excellent performance, ensures the integrity of the horse's physical being, and also promotes the safety of both horse and rider.

equine research. This means that comparisons of further exercise tests for the same horse or measurements from other horses of similar fitness level or age can be made.

There have been many groundbreaking findings from researchers that have used high-speed treadmills. Of major importance was the contribution of equine exercise physiology studies to the success of the equestrian disciplines at the Olympic Games in 1996. Three years later researchers described how laboratory treadmill studies had assessed the limitations to performance of heat and humidity and how fluid and electrolyte losses were documented. Energy expenditure and heat production were also estimated, and these data allowed significant advances in the knowledge of thermoregulation.

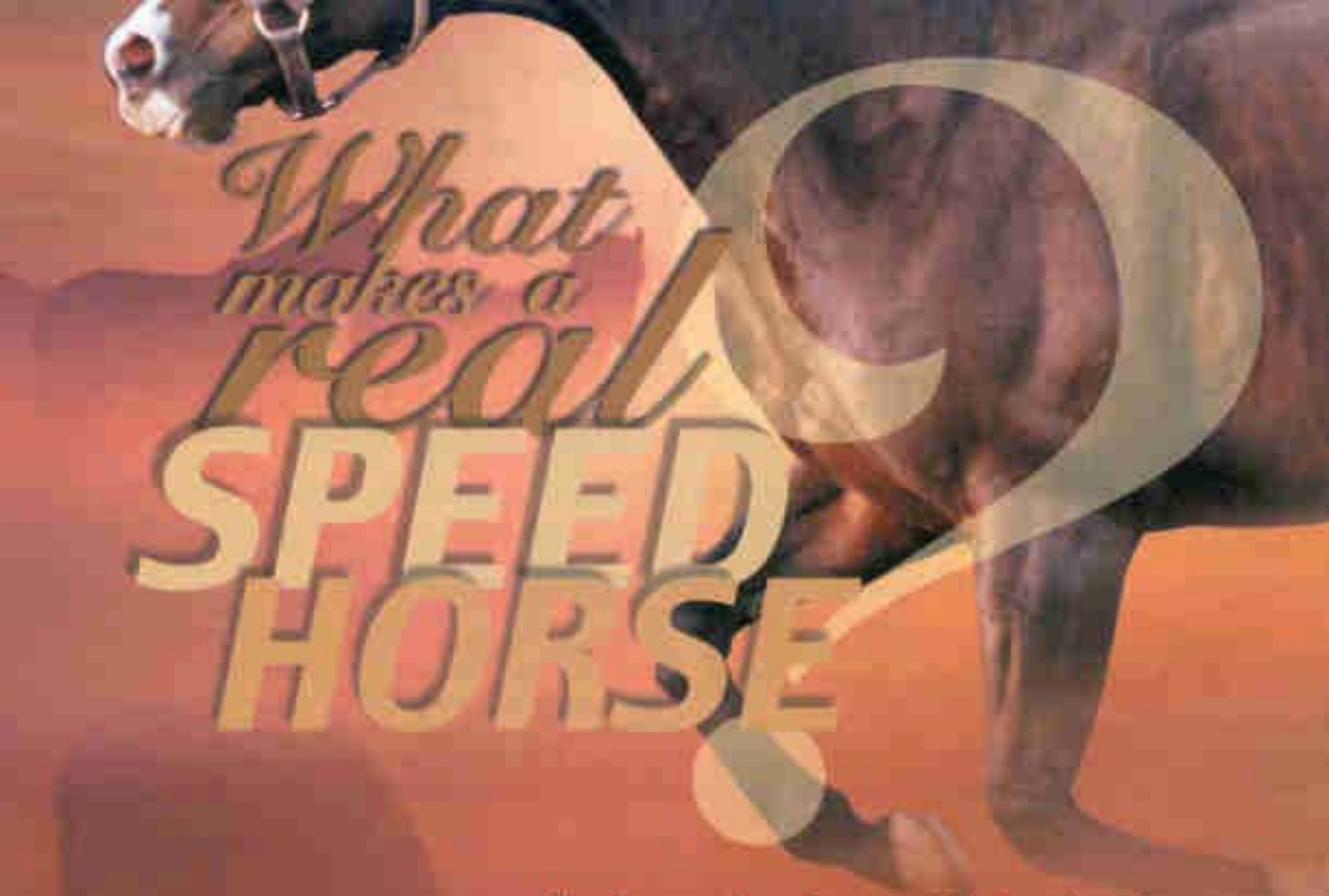
Kentucky Equine Research began conducting equine nutrition and sports medicine research in 1988, and the quantity of published research rivals that of leading universities.

While most horses adapt well to treadmill exercise, the horse must be acclimatized to its use. Each horse must be treated as an individual during acclimatization. Some horses will readily adjust to exercising on the treadmill while others may take more time to become comfortable with the equipment. Introducing the horse to the treadmill must be done slowly. For example, the horse is initially led to the treadmill and given the opportunity to become accustomed to the sights, sounds, and smells of the area. Then the machinery is turned on one component at a time until all are operating together. The machinery includes the fans used to cool the horses and the treadmill itself. The treadmill is first set at a slow speed and raised to an incline so that the horse can become familiar with the various noises. Once the horse has become more settled in its environment, it is led on and off the treadmill, and then the treadmill is switched on. It is necessary for several people to be with the horse during its first few times on the machine, so the horse may be gently encouraged from behind should it not move forward or try to back off the treadmill. The speed can then be increased over several days. Anticipation of exercise and apprehension can significantly increase heart rate levels, so the horse should perform several complete test runs prior to the start of the trial's exercise test.

Kentucky Equine Research (KER) began conducting equine nutrition and sports medicine research in 1988, and the quantity of published research rivals that of leading universities. KER regularly presents research findings at both national and international conferences including the International Conference on Equine Exercise Physiology (ICEEP) held every four years. At the most recent conference in Utsunomiya, Japan, research coauthored by KER scientists constituted nearly 40% of papers in the nutrition of the performance horse section. The research farm has always been equipped with a treadmill, although the first one was a much-simplified version of the current high-speed treadmill (Equigym, formerly known as Stratton Equine Enterprise, Lexington, KY) found at the modern research facility. The treadmill has been incorporated into numerous trials at the KER farm. (See page 4 for information on KER's new research facility.)

The speeds at which a horse can be exercised on the treadmill are typically measured in meters per second (m/s). A meter is equal to 1.0936 yards. The speeds usually are: walk, 1.7 m/s; trot, 3.7 m/s; canter, 9.2 m/s; and gallop, 10.7 m/s. During a research trial, however, these speeds vary depending on the type of trial being conducted and also on the breed of horse (an endurance horse such as an Arabian would probably not be able to travel faster than 10 m/s, whereas a Thoroughbred would start to fatigue after 12 m/s). A horse may be asked to perform either an incremental exercise test or a high-speed exercise test. Incremental exercise tests are more commonly used and allow data to be collected during submaximal and maximal exercise. The speed of the treadmill is increased every 60-120 seconds until a predetermined heart rate has been obtained or until the horse cannot keep up with the speed of the treadmill. An example of an incremental exercise test involving four submaximal steps follows: a warm-up period of 3 minutes at 4 m/s followed by 90 seconds at 6 m/s and then 1-minute steps at 8, 10, 11, 12, and 13 m/s. High-speed exercise tests involve rapid acceleration by the horse to a near-maximal speed (gallop) or intensity in a short period of time (5 seconds) until a point is reached where the horse can no longer maintain the intensity. For both types of exercise tests, it is important that the horse be fully acclimatized to the treadmill and be properly conditioned.

Many measurements are taken while the horse is exercising on the treadmill. One of these is oxygen uptake (VO_2), a measurement of the body's total aerobic metabolic rate (cardiovascular and respiratory systems). Indirect calorimetry is used to measure oxygen concentrations and carbon dioxide production by collection of expired air samples during exercise. The horse wears a mask over the face attached by tubing to the calorimeter. This enables the calculation of total energy expenditure and the relative amounts of carbohydrate and fat utilized by the horse. VO_2 is measured as milliliters of oxygen per kilogram body



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All modern race horses have superb limbs and muscles. But that's not the true source of their speed and power. It's a horse's heart and lungs and their ability to supply oxygen to the muscles that makes Thoroughbreds capable of reaching high speeds. Research has documented that a horse's heart beat can jump from 36 beats per minute at rest to 240 at a full gallop–an increase of nearly seven times to an amazing 4 beats per second!

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weight per minute. VO_{2max} is the highest rate of oxygen consumption by an individual. It is a good indicator of athletic potential, but the percentage of VO_{2max} that can be sustained during prolonged exercise must also be considered. VO_{2max} occurs when oxygen uptake is monitored in a continuous manner and does not increase despite a stepwise increase in the workload of the horse (maximal exercise to exhaustion). Submaximal exercise occurs when aerobic energy supply can meet all of the energy demands of the horse; this is mainly the case in endurance rides where 30 to 60 percent of VO_{2max} is demonstrated. Conversely, supramaximal exercise occurs when the workload of the horse is greater than that provided for by the maximal rate of oxygen uptake (VO_{2max}). Energy demand exceeds aerobic energy supply; therefore, anaerobic energy production is required. This typically occurs in Thoroughbred and Quarter Horse racing, which demonstrate 125 percent of VO_{2max}.

The ratio of carbon dioxide production to oxygen consumption is called the respiratory exchange ratio. Measuring this provides an indication of the proportions of the metabolic fuels that are used at a specific exercise intensity and hence allows calculation of dietary requirements. The R value (or respiratory quotient) is the amount of carbon dioxide produced divided by the amount of oxygen utilized. By measuring the R value it can be demonstrated how fat acts as a fuel for low-intensity exercise. The R value for fat oxidation is 0.71, while the R value for carbohydrate oxidation is 1.0. Values between the two indicate a mixture of carbohydrate and fat metabolism. R values greater than 1.0 indicate anaerobic metabolism producing lactate.

To measure heart rate while the horse is on the treadmill, a monitor attached to the horse sends information directly to a computer, which provides a readout of the horse's heart rate. Resting heart rate in the horse is approximately 30-40 beats per minute (bpm). Maximum heart rate is usually between 240-250 bpm. Heart rate may be used as a predictor of a horse's athletic performance. The velocity that a horse achieves at a heart rate of 200 bpm (V_{200}) provides an approximation of the maximal aerobic power that the horse can achieve. This can be calculated from heart rates measured while the horse is exercising at different speeds on the treadmill. The V_{200} is simple to measure and provides an indication of the horse's adaptation both during and after training. An increase in speed while maintaining V_{200} indicates a favorable training adaptation by the horse.

Valuable data are collected, analyzed, and used by KER researchers in the formulation of feeds to enhance the horse's performance.

Blood samples are taken routinely throughout exercise tests and after the tests have been completed. These samples provide information about the function of a number of body systems. Researchers can measure glycemic response to different feeds, monitor improvements in training, determine causes of reduced performance, and predict athletic ability. For instance, racehorses show large increases in lactate production during maximal exercise, while endurance horses have small increases in lactate production. The rate of increase of lactate in the blood may be used as an indirect indicator of cardiovascular and metabolic capacity.

From these and other measurements taken from the horse during a research trial, valuable data are collected, analyzed, and used by KER researchers in the formulation of feeds to enhance the horse's performance. Equine sports medicine continues to grow, and KER is one of the innovative companies that is aiming to be at the forefront of exercise physiology research.


Photo by Robin Stanbach

KER intern Amy Jane Fitzgerald draws blood for evaluation.

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