THE EFFECT OF DIFFERENT FAT SOURCES ON EXERCISE PERFORMANCE IN THOROUGHBRED RACEHORSES

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Introduction

Energy is the factor that should be considered first when evaluating the nutrition of the performance horse, since it is the factor most likely influenced by exercise. A number of studies have evaluated different sources of energy for performance horses. Different levels of fat and protein have been fed to horses in an attempt to alter performance. Also, combinations of high protein, high fat and high carbohydrate diets have been used to alter muscle glycogen storage in horses. The results of dietary manipulations on equine performance have not been conclusive. Therefore, the following study was conducted to further evaluate the effect of dietary energy source on energy utilization during exercise in Thoroughbred racehorses. In particular, two different sources of dietary fat were compared, both alone and as a mixture, to a more traditional high carbohydrate diet.

Materials and Methods

Nine Thoroughbred racehorses were used in this six month long Latin square design study. Each of these horses had either raced or was in race training at the beginning of the experiment and they ranged in ability from horses that had not broken their maiden to a multiple graded stakes winner of almost 1 million dollars. Eight of the horses were 4 or 5 years old, while the elite racehorse was 12 years old. The horses were fed the following diets (table 1): 1) *control-* a traditional high carbohydrate grain based pelleted diet with oats and corn providing the majority of the starch in the diet 2) *soy-* a grain based pellet with 10% added soybean oil 3) *coconut-* a grain based pellet with 10% added coconut oil and 4) *mixed-* a grain based pellet with 5% added soy oil and 5% added coconut oil.

Each horse was fed the control diet along with free choice grass hay for a four week period at the beginning of the experiment. The horses then performed a five day standardized exercise test (SET5) on an inclined (6°) high speed treadmill[1] to determine baseline fitness and ability (table 2). Using data from this test, the horses were divided into four groups and fed one of the four diets for a five week period. During the first three weeks of each period, the horses were galloped every other day on the treadmill for 1 or 2 miles. During week 4, the first standardized exercise test (SET5) took place over five days. Each day, the horses warmed up on the treadmill for 2 minutes at a walk, 4 minutes at a trot (~4.25 m/s) and then galloped at a fixed speed for 1 mile.

[1] *Beltalong, Euroa, Australia*

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Table 1. Ingredient composition of experimental diets

Ingredient	control	soy oil	coconut oil	mixed oil
soybean meal	0.00%	6.75%	6.75%	6.75%
wheat middlings	10.0%	10.0%	10.0%	10.0%
oats	36.25%	36.25%	36.25%	36.25%
corn	43.0%	25.75%	24.0%	25.0%
alfalfa meal	5.0%	5.0%	5.0%	5.0%
molasses	3.75%	3.75%	3.75%	3.75%
vit/mineral premix[1]	2.0%	2.5%	2.5%	2.5%
soy oil	0.0%	10.0%	0.0%	5.0%
coconut oil[2]	0.0%	0.0%	12.5%	6.25%

[1]*KER 1, Kentucky Equine Research, Versailles, KY*
[2]*Mil-ko-lac Dry Fat CO, Freeborn Foods, Albert Lea, MN*
This product contained about 80% coconut oil

At the end of the 1 mile gallop the horses were warmed down at a trot for 4 minutes and a walk for 1 minute. Heart rate was monitored throughout exercise and a venous blood sample was taken at the end of the 5 minute warm-down. This test was repeated over 5 consecutive days so that speeds of about 7,8,9,10, and 11 m/s were measured. Blood plasma was analyzed for glucose, ammonia and lactic acid.

horse	V_{200} (m/s)	V_{LA4} (m/s)
1	10.27	10.31
2	9.91	10.15
3	8.26	9.46
4	9.05	10.90
5	8.39	10.71
6	8.77	10.12
7	9.59	10.89
8	9.23	9.03
9	10.50	11.13

Table 2. Pre-test SET5 results

During the 5th week of each period, the horses performed a second, one day standardized exercise test (SET1). This test, conducted 4 to 6 hours after the morning meal, consisted of 2 minutes walking, 4 minutes trotting and eight minutes galloping at speeds between 8 and 9 m/s on the treadmill. These speeds produced a heart rate of between 180 and 220 beats per minute (ave. 200). Blood samples were drawn from an indwelling jugular catheter at rest, after the trotting warm-up, at four minutes into the gallop, at the end of the gallop (8 minutes) as well as after a five minute warm-down (5P) (4 minutes trotting, 1 minute walking) and 10 minutes after the gallop (10P). Blood samples were immediately centrifuged and the plasma frozen for later analysis of lactic acid,

glucose, ammonia, free fatty acids, glycerol, and triglycerides.

After the first period, the horses were switched to another diet according to a Latin square design and the trial repeated. During each period, each individual horse repeated the SET1 at exactly the same speed as every other period. Speed between horses varied according to ability, but the speed of the individual was constant. During each period, the horses were fed their respective diets at levels of intake to maintain body weight. The horses were weighed weekly and adjustments in feed intake were based on these weights. Each day, 40% of the horse's grain was fed in the morning and 60% fed in the evening. During the study, grain intake averaged 4,418, 3,873, 4,100, and 3,923 grams per day for the control, soy, coconut and mixed diets, respectively. Grass hay was offered free choice to the horses throughout the study.

Results and Discussion

V_{LA4} measured during SET5 was significantly ($P<.05$) lower (10.15 m/s) in the control diet than when either soy (10.52 m/s), coconut (10.46 m/s), or mixed (10.69 m/s) oils were fed (figures 1 & 2). V_{200} measured during SET5 (figure 3) averaged 9.58, 9.71, 9.49, and 9.51 m/s in the control, soy, coconut, and mixed diets, respectively. V_{200} was significantly higher in the soy diet than in either the coconut or mixed diets.

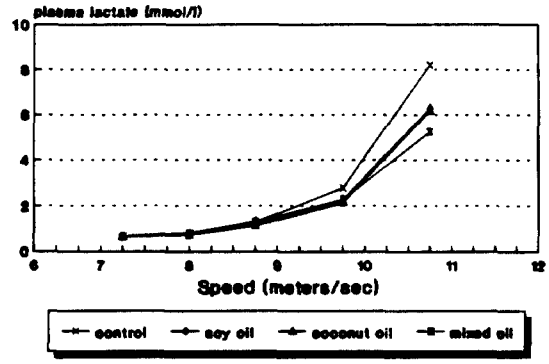


Figure 1. Lactic acid during SET5

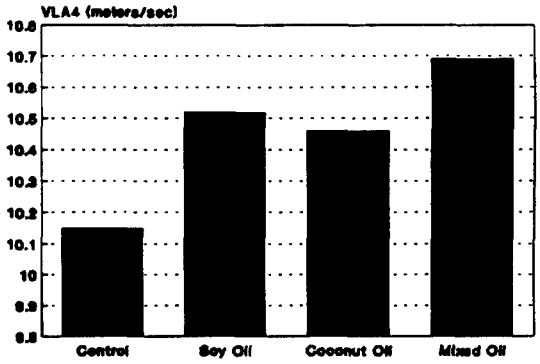


Figure 2. V_{LA4} during SET5

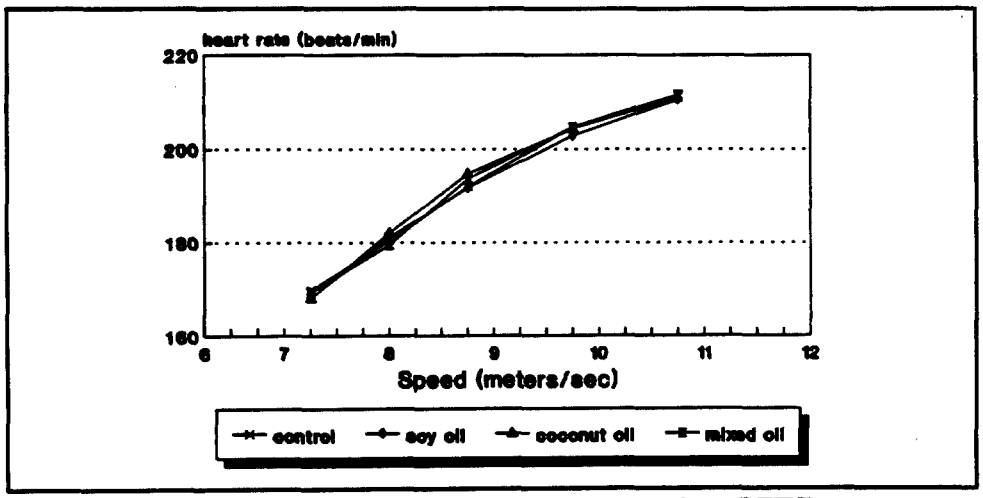


Figure 3. Heart rate response during SET5

During SET1, blood glucose was not significantly different between treatments at any speed (figure 4). Blood lactate, however, was significantly lower than the control in the coconut oil group at 4 minutes into the gallop ($P < .05$) and at 5 and 10P ($P < .10$). Lactic acid was significantly lower ($P < .10$) than the control in the mixed oil group at 10P (figure 5).

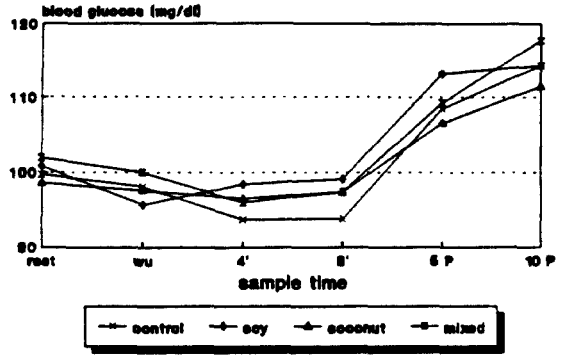


Figure 4. Blood glucose during SET1

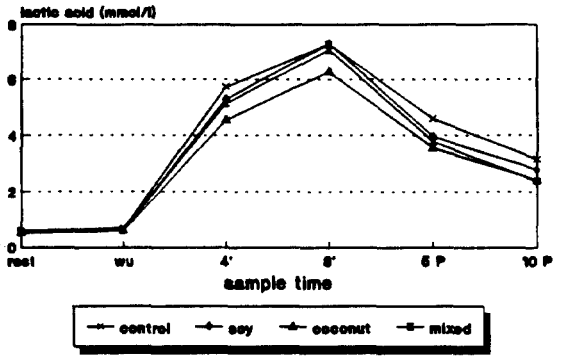


Figure 5. Blood lactate during SET1

Blood ammonia during SET1 is shown in figure 6. Blood ammonia was significantly lower ($P < .05$) in coconut oil group than the soy oil group at both 4 minutes into the gallop and after the warm-down exercise (5P). Triglycerides (figure 7) were not significantly different between treatment groups even though there was a trend towards higher triglycerides in the fat fed groups than in the control group horses.

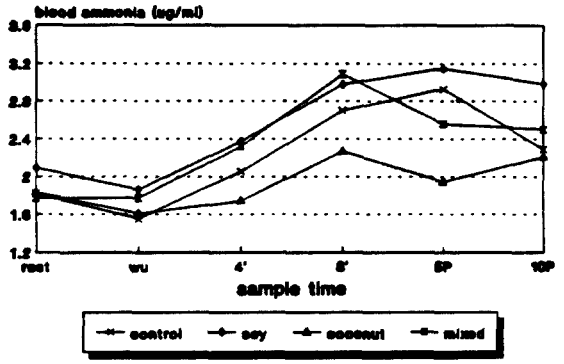


Figure 6. Blood ammonia during SET1

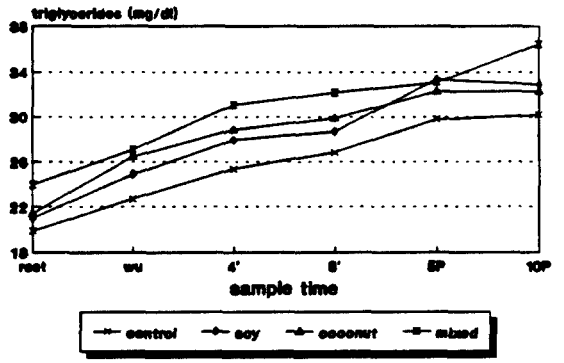
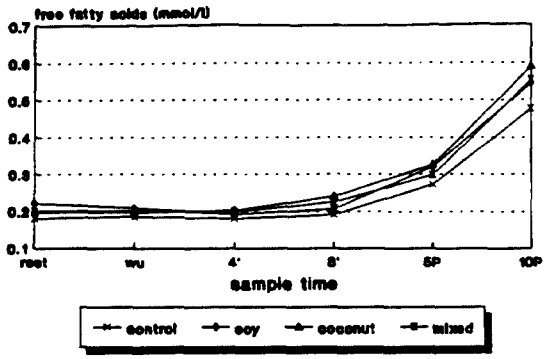


Figure 7. Triglycerides during SET1

Plasma free fatty acids (FFA) were significantly higher ($P < .05$) in the coconut group than in the control horses at 8 minutes into the gallop, at the end of the warm-down (5P) and at 10 minutes after the gallop (figure 8). Blood glycerol (figure 9) was lower in the coconut group than in the soy oil group at rest ($P < .05$) and after the warm-down ($P < .10$). Glycerol was lower in the coconut group than the control horses after the warm-up and 4 minutes into the gallop. In all treatment groups, glycerol increased dramatically after the warm-down and during recovery.



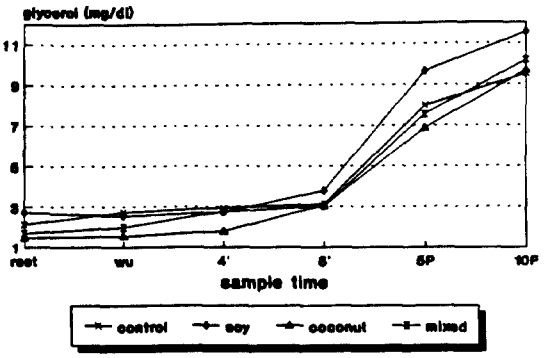


Figure 8. Free fatty acids during SET1 **Figure 9. Blood glycerol during SET1**

Feeding fat affected the horses metabolic response to a standardized exercise test. During the SET5, V_{LA4} was significantly lower in the control fed group than in all three fat fed treatments. At the top speed (10.7 m/s) run in this test, plasma lactates averaged 56% higher in the control group vs the mixed fat treatment. Because of the exponential nature of lactate accumulation with increasing speed, this difference could have a major impact on time to fatigue in racehorses. The reason for this difference in lactate production remains unclear. Did the horses use fat as a substrate for energy generation instead of anaerobic glycolysis, or did feeding fat alter the selection of other substrates by the muscle during intense exercise?

During the 8 minute gallop in SET1, blood lactate was lower and free fatty acids were higher in the coconut oil treatment than in the control group. In addition, blood ammonia was low in the coconut group throughout the exercise test. Perhaps coconut oil, with a large percentage of both saturated and medium chain length fatty acids, can be mobilized and oxidized quickly enough to produce a significant amount of energy during intense exercise. More research is needed to further identify the role that chain length and degree of saturation play in fat metabolism during intense exercise in the horse.

Of course, endocrine control of substrate selection during exercise cannot be overlooked. In the SET1, however, since the exercise was performed 4 to 6 hours after eating and since resting blood glucose levels were indicative of a post absorptive state, it seems unlikely that differences in substrate selection were caused by altered insulin status.

Finally, it is very important to remember that this study and most others that have evaluated feeding fat to horses have been of short duration. The long term effects of feeding high fat diets to performance horses has not been adequately addressed. Until this is done, caution should be used in interpreting these results.