AN EVALUATION OF CORN OIL, RICE BRAN AND REFINED DRY FAT AS ENERGY SOURCES FOR EXERCISED THOROUGHBREDS

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Introduction

Fat has become a popular feed ingredient in performance horse rations. There are a number of different fat sources available for use in horse feeds, and many of these such as soybean oil and rendered animal fat have been extensively studied (Lawrence, 1990; Potter et al., 1992). Others, such as rice bran and more highly refined animal fats have received less attention. Therefore, this study was conducted to compare the digestibility of several fat sources and evaluate how well they functioned as energy sources for horses during exercise.

Materials and Methods

Four mature Thoroughbred geldings were used in a 4 x 4 Latin square design experiment that evaluated 4 different concentrates. The concentrates supplied 50% of each horse's daily DE intake and 50% was supplied by forage. Diet 1 (CONTROL) received 4.0 kg sweet feed/day, diet 2 (CORN OIL) received 2.5 kg sweet feed and 500 g corn oil/d, diet 3 (DRY FAT) received 2.5 kg sweet feed and 550 g of a 92% refined dry animal fat[4] and diet 4 (RICE BRAN) received 1.0 kg sweet feed and 2.5 kg 20% fat rice bran[5] (Table 1). All horses were also fed 7.0 kg of mixed grass hay, divided into four equal feedings. All of the rations were formulated to be isocaloric and diets 2-4 supplied about 17% of the daily DE as fat. During each 3-week period, the horses were trained daily on either a high speed treadmill or mechanical walker. During the third week of each period, a 5-day complete collection digestion trial was conducted. Digestibility was determined for dry matter (DM), crude protein (CP), fat, acid detergent fiber (ADF), neutral detergent fiber (NDF) and non-structural carbohydrates (NSC). The digestibility of the individual fat sources was calculated assuming that the rest of the fat in each ration had a digestibility that was similar to the control ration. On day 3 of the digestion trial, the horses completed a competition exercise test (CET) on an inclined high speed treadmill (3^0) which consisted of a 10 min walk (1.4 m/s), 10 min trot (3.5 m/s), 2 min gallop (10.0 m/s), 20 min trot (3.5 m/s), 10 min walk (1.4 m/s) and 8 min canter (8.0 m/s). Following exercise, the horses were hand walked for an additional 30 min. Glucose, lactate and triglycerides were measured from blood plasma samples taken at specific intervals prior to, during and after the CET. Heart rate was measured during the last 15 s of each speed. On the morning of the CET the horses were fed their respective experimental rations 3 h before exercise. CONTROL horses received 1000g sweet feed,

[4]Alifet®, Alifet USA, Inc., Cincinnati, OH 45242
[5]EquiJewel™ High Fat Stabilized Rice Bran, Producers Rice Mill, Inc., Stuttgart, AR 72160

DRY FAT horses received 625 g sweet feed + 137.5 g dry fat, RICE BRAN horses received 250 g sweet feed + 625 g rice bran and CORN OIL horses received 625 g sweet + 125 g corn oil. No hay was fed prior to the CET.

Table 1. Nutrient composition of diets

	Hay	Sweet Feed	Dry Fat	Rice Bran	Corn Oil
DM %	90.5	90.2	99.0	91.8	100.0
CP %[1]	18.7	10.3	0.4	14.2	0.0
ADF %[1]	31.4	8.6	0.5	13.7	0.0
NDF %[1]	46.0	17.5	1.0	22.2	0.0
FAT %[1]	3.3	5.0	93.3	22.9	100.0
NSC %[1,2]	23.4	63.9	5.3	23.6	0.0

[1]100% dry basis
[2]non structural carbohydrates (100-CP-fat-NDF-ash)

Results and Discussion

There was a trend towards lower dry matter digestibility in the DRY FAT group compared to the CONTROL and CORN OIL treatments ($p<.10$) (Table 2). This reduction was primarily due to lower CP and NDF digestibility. Non-structural carbohydrate (NSC) was not different between treatments. Apparent fat digestibility was similar between all three supplemental fat sources and significantly higher than the CONTROL treatment ($P<.05$). The estimated fat digestibility of each fat source was very high (88%-94%) and not significantly different ($p>.05$). There was a trend for CORN OIL digestibility to be higher ($p<.10$), but this small difference may have actually been an artifact since it was impossible to insure that all of the corn oil offered was actually consumed. The sweet feed/corn oil treatment contained 20% corn oil and some of this oil coated the horses' faces and feed tubs when it was fed. There was no way to accurately measure this wastage, so the calculation of fat digestibility was based on 100% intake.

Table 2. Digestibilities of experimental diets

	Control	Dry Fat	Rice Bran	Corn Oil	SEM	Treatment Effect
DM %	67.4[a]	61.2[b]	65.8[ab]	67.2[a]	1.47	.10
CP %	67.5[b]	61.5[a]	69.7[b]	70.1[b]	.68	.05
ADF %	35.1	34.4	48.6	51.4	6.5	NS
NDF %	47.7[ab]	45.7[a]	55.8[ab]	56.2[b]	2.33	.05
NSC %	93.3	83.3	88.1	84.5	3.33	NS
Total FAT %	50.0[a]	69.2[b]	72.0[b]	75.6[b]	1.97	.05
Source Fat %	--	89.0[a]	88.0[a]	94.0[b]	.52	.10

[ab]means in the same row lacking a common superscript are different

There have been a number of studies evaluating the digestibility of fat by horses. Kentucky Equine Research has evaluated 30 different rations ranging in total fat from 2.2% to 5.5% (Pagan, 1998). The diets ranged from pure alfalfa hay to a combination of sweet feed and fescue hay to pelleted concentrates fed with timothy hay. The average apparent digestibility of the fat in these diets equaled 58.4% which is similar to the CONTROL treatment in this study. Vegetable oils are readily digested by horses. Estimated true digestibility for corn, soybean and peanut oil equals 90% and higher.

Animal fats tend to be less digestible. The true digestibility of animal fat is around 75% (Pagan, 1996). The estimated digestibility of all three fat sources in this study was near 90% which is typical for vegetable oil, but quite high for animal fat.

Table 3. Plasma glucose (mg/dl) during competition exercise test

Sample time	Control	Dry Fat	Rice Bran	Corn Oil	SEM	Treatment Effect
3 Hr Pre	101.8	93.1	98.0	96.9	3.2	NS
2 Hr Pre	103.3 [ab]	97.5 [a]	105.1 [b]	101.3 [ab]	2.5	0.1
1 Hr Pre	103.3 [b]	93.9 [ab]	101.9 [ab]	92.9 [a]	2.7	0.05
Pre	97.6	89.6	96.6	97.5	3.0	NS
10 Min Walk	94.1 [b]	87.6 [a]	92.5 [b]	91.0 [ab]	1.0	0.05
10 Min Trot	84.9	83.5	87.4	90.3	2.7	NS
2 Min Gallop	85.3 [a]	85.8 [a]	87.1 [ab]	93.5 [b]	2.6	0.1
20 Min Trot	97.0	93.3	95.1	101.4	3.4	NS
10 Min Walk	104.1	95.1	97.4	103.4	3.6	NS
8 Min Canter	99.6	97.3	98.0	100.6	3.3	NS
Post	116.8	108.1	107.6	114.0	3.8	NS
30 Min Post	125.8	107.3	104.4	129.0	14.6	NS
1 Hr Post	115.0	99.9	101.1	114.6	8.5	NS
2 Hr Post	99.0	95.4	98.3	97.8	3.6	NS

[ab]means in the same row lacking a common superscript are different

Table 4. Plasma lactate (mmol/l) during competition exercise test

Sample time	Control	Dry Fat	Rice Bran	Corn Oil	SEM	Treatment Effect
3 Hr Pre	0.63	0.63	0.53	0.65	0.07	NS
2 Hr Pre	0.68 [ab]	0.74 [b]	0.65 [ab]	0.6 [a]	0.04	0.1
1 Hr Pre	0.53	0.69	0.58	0.59	0.07	NS
Pre	0.56	0.46	0.45	0.51	0.05	NS
10 Min Walk	0.48	0.58	0.53	0.55	0.07	NS
10 Min Trot	0.68	0.70	0.59	0.71	0.05	NS
2 Min Gallop	5.11	6.66	5.73	6.65	0.60	NS
20 Min Trot	1.26 [ab]	1.15 [ab]	0.83 [a]	1.35 [b]	0.18	0.1
10 Min Walk	1.11 [b]	1.04 [ab]	0.75 [a]	1.1 [b]	0.09	0.05
8 Min Canter	4.81	5.2	4.24	6.44	0.97	NS
Post	4.50 [ab]	4.98 [ab]	3.25 [a]	6.64 [b]	0.90	0.05
30 Min Post	1.84	1.65	1.38	2.39	0.46	NS
1 Hr Post	1.4125	1.4125	1.125	1.4625	0.34	NS
2 Hr Post	0.95	1.1	1.0125	1	0.14	NS

[ab]means in the same row lacking a common superscript are different

All of the horses successfully completed the CET on every treatment. Plasma glucose was lower in the CORN OIL treatment 2 h after feeding than in the CONTROL diet ($p<.05$)(Table 3). Other than during the first 10 min walk, when DRY FAT glucose

was lower than the CONTROL and RICE BRAN treatments, plasma glucose was unaffected by treatment during exercise.

Plasma lactate is shown in Table 4. As expected, lactate increased in all treatments during the 2 min gallop and again during the 8 min canter. Surprisingly, lactate was significantly lower in the RICE BRAN compared to the CORN OIL treatments post-exercise ($p<.05$). Lactates in the CONTROL and DRY FAT treatment were similar throughout exercise.

Heart rates during the gallop were significantly lower in the CONTROL and RICE BRAN horses compared to the DRY FAT and CORN OIL treatments ($p<.05$)(Table 5). There was also a trend for heart rate to be lower in the RICE BRAN treatment than the CORN OIL treatment during the 8 min canter ($p<.10$). This is consistent with the difference found in post-exercise lactates between these two treatments.

Table 5. Heart rate (beats/min) during competition exercise test

Sample time	Control	Dry Fat	Rice Bran	Corn Oil	SEM	Treatment Effect
10 Min Walk	72.5	82.8	76.8	82.5	4.4	NS
10 Min Trot	108.3[a]	122.5[b]	110.3[ab]	116.3[ab]	3.9	.05
2 Min Gallop	181.3[a]	191[b]	179.3[a]	188[b]	2.3	.05
20 Min Trot	116.5	114	108.3	113.0	2.7	NS
10 Min Walk	75.5	76.8	73.0	73.3	2.6	NS
8 Min Canter	163.0	163.5	161.0[b]	169.3[a]	2.4	.10

[ab]means in the same row lacking a common superscript are different

Table 6. Plasma triglycerides (mg/dl) during competition exercise test

Sample time	Control	Corn Oil	Dry Fat	Rice Bran	SEM	Treatment Effect
3 Hr Pre	30	29.5	28.8	26.3	4.3	NS
2 Hr Pre	29.8	25.0	30.5	21.5	3.8	NS
1 Hr Pre	30.3	24.0	32.3	23.0	4.8	NS
Pre	32.5	27.3	32.0	25.3	5.0	NS
10 Min Walk	36.3	31.8	35.8	30.8	5.2	NS
10 Min Trot	41.8	33.8	38.0	31.5	5.5	NS
2 Min Gallop	41.3	35.0	35.5	31.3	5.4	NS
20 Min Trot	47.0 [b]	32.0 [ab]	41.8 [ab]	30.0 [a]	4.9	0.05
10 Min Walk	44.3 [b]	27.5 [a]	39.3 [ab]	28.0 [a]	5.4	0.1
8 Min Canter	50.5 [b]	31.3 [a]	41.1 [ab]	32.5 [a]	6.0	0.1
Post	52.0 [b]	34.5 [a]	49.2 [ab]	38.5 [ab]	5.7	0.1
30 Min Post	47.0 [b]	32.5 [ab]	39.5 [ab]	23.5 [a]	7.8	0.1
1 Hr Post	39.3	29.8	32.5	25.3	6.0	NS
2 Hr Post	32.5	32.3	32.0	29.8	5.6	NS

[ab]means in the same row lacking a common superscript are different

Plasma triglycerides (TG) increased in the CONTROL treatment throughout exercise (Table 6). TG did not increase in the CORN OIL and RICE BRAN treatments during exercise and were lower than the CONTROL during the later stages of exercise. Feeding high fat diets to rats increases muscle lipoprotein lipase (LPL) and decreases adipose LPL activity (Brown and Layman, 1988). This would result in an increase in blood TG clearance during exercise. Duren et al (1987) fed exercised Thoroughbreds rations that supplied 0%, 5%, 10% or 20% of total dietary digestible energy from corn oil. They reported that horses receiving the highest levels of corn oil had the lowest level of circulating TG.

Conclusions

The results of this study suggest that fat from corn oil, rice bran (EquiJewel™) and refined dry fat (Alifet®) can be used effectively in rations for exercising horses. The fat digestibility of all three was quite high and there was little problem with palatability with any of the fat sources. The vegetable oil fats appeared to affect TG mobilization and/or TG clearance and this was probably due to a change in LPL activity in the adipose and muscle. Feeding rice bran resulted in lower lactate accumulation and lower heart rates during exercise compared to corn oil. More research is needed to determine the reason for these differences.

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