Effects of Fat Content and Source on Consumption Time in Two-Year-Old Quarter Horses

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ABSTRACT

Twelve two-year-old quarter horses were used in this study to determine if the amount and source of fat supplement influenced consumption of grain. The experiment took place at Sam Houston State University's Equine Center in Huntsville, Texas. Horses were allotted into one of three treatment groups. All horses received 1.5% BW in hay and 1% BW in grain twice per day throughout the study. Treatment group one received no additional top-dressed fat to the diet and was considered the no added oil (NO) treatment group. Treatment group two received 0.099 kg of additional top-dressed soybean oil (SO) to the diet. Treatment group three received 0.099 kg of additional top-dressed fish oil (FO) to the diet. Elapsed time for horses to consume the treatment rations was recorded at each feeding from d1 to d21. Results of this study indicate that over the entire 21-day treatment period, horses in the SO and FO treatment groups took longer ($P < 0.001$) to consume their rations than horses in the NO treatment group. Further, SO and FO were consumed at a similar rate ($P > 0.05$) over the entire study. Similar trends were observed when comparing mean daily and weekly consumption times between treatments.

KEY WORDS: fish oil, soybean oil, quarter horse

INTRODUCTION

In recent years, fat supplementation has become common in the typical equine diet which is different from the early 1970s, where little fat was added. It has been determined that horses can digest fats very efficiently which is surprising since their natural diet is low in fat (Pilliner and Davies 2004).

Fats provide a source of essential fatty acids to the horse's diet. Essential fatty acids include linoleic acid (an omega-6 fatty acid) and alpha-linolenic acid (an omega-3 fatty acid). Adding fat in the diet may assist with a more efficient utilization of fat-soluble vitamins A, D, E, and K (Warren 2004).

Since the horse's total daily intake is limited, additional fat in the diet can result in a substantial increase in calories without the requirement of more feed. Due to the fact

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that fat contains more energy than carbohydrates and is available to horses, fat is an ideal supplement for increased gains in thin horses as well as maintaining body condition of older horses (Warren 2004).

Meeting the energy demands of working and growing horses may require large amounts of grain to be fed that is high in starch. Horses have limited capacity for starch digestion. The more starch that escapes duodenal digestion, the more that may be fermented in the hindgut which could potentially lead to a decrease in gut pH, disruption of normal microbial populations, and an increased risk for digestive disturbances. Replacing some of the grain with fat, which contains no starch, aids in minimizing the risk of digestive upsets. Adaptation to dietary fat may spare muscle glycogen by increasing the use of fatty acids as fuel and reducing the amount of liver and muscle glycogen used for energy needs (Warren 2004).

According to Warren (2004), fat supplementation also reduced the horse's thermal load. The lower heat load associated with feeding fat lessens the need for evaporative heat loss therefore reducing the water and electrolyte loss. Fat may favorably alter the horse's behavior. Warren (2004) found that feeding horses a high fat diet caused insulin production to be suppressed reducing the "sugar high." Furthermore, increasing dietary fat and decreasing dietary starch resulted in beneficial effects in horses with polysaccharide storage myopathy and recurrent exertional rhabdomyolysis (Valberg and McKenzie 2005). Likewise, Rich (2004) stated that feeding fat gave gloss to the hair coat and improved skin health.

Animal and vegetable-based fats are the major sources of fat available for equine consumption (Valberg and McKenzie 2005). Vegetable oils tend to be higher in unsaturated fatty acids than animal fats (Warren 2004). Vegetable oils are also highly digestible at 90% to 100% and are very energy dense. The most palatable and commonly used sources of these vegetable oils tend to be corn and soybean oil (Valberg and McKenzie 2005). These sources of fat are attractive to feed companies because they are readily available and are generally the most economical sources of fat.

While vegetable fats tend to be very digestible, animal fats vary in digestibility between 75% and 90% (Valberg and McKenzie 2005). Traditional animal sources of fat include beef tallow, lard, and fish oil (Warren 2004). Tallow and lard are no longer used in horse feeds due to the rise of bovine spongiform encephalopathy. In the past, problems with fish oil included low palatability due to impurities causing foul taste and smell. However, recent manufacturing methods have been somewhat successful in removing many of these impurities increasing palatability (Rich 2004).

While soy and corn oil are commonly used in the equine feeding industry, these products are highest in linoleic acids when compared to other fat sources. Fish oil and linseed oil, on the other hand, tend to be very high in linolenic acid (Rich 2004). Fish oil is also an excellent source of eicosapentaenoic acid and docosahexaenoic acid. Other benefits of fish oil supplementation include lower heart rates throughout exercise tests, lower packed cell volumes, and lower free fatty acids (O'Connor et al., 2004).

The primary omega-6 fatty acid is linoleic acid whereas the primary omega-3 fatty acid is alpha-linolenic acid (Rich 2004). Once in the body, these essential fatty acids are further metabolized to produce other fatty acids. Arachidonic acid is the predominant product of linoleic acid metabolism whereas eicosapentaenoic acid is the major product of linolenic metabolism. Arachidonic acid and eicosapentaenoic acid are both metabolized into eicosanoids which are potent regulators of vital body functions. Grain products typically contain linoleic acid, whereas forage contains predominantly linolenic acid (Warren 2004).

Omega-6 fatty acids tend to increase blood clotting and increase inflammatory response. On the other hand, omega-3 fatty acids tend to decrease blood clotting and decrease inflammatory response. There is growing interest in omega-3 fatty acids as they are thought to possibly be useful in treating heaves, recurrent uveitis, and hives (Warren 2004). Omega-3 fatty acids may be useful in preventing or treating upper airway diseases, degenerative joint diseases, and laminitis (Warren 2004).

Natural feed ingredients generally contain less than 3% fat. However, the equine digestive tract can handle greater amounts of dietary fat when introduced gradually (Rich 2004). The ideal amount of fat supplementation has not been determined and likely differs based on the horse's intended use, amount of grain replacement desired, and the horse's energy expenditure. A horse can tolerate up to 20% of its diet as fat but 10% is generally a reasonable limit (Warren 2004).

The objective of this study is to determine the effects of fat source and amount on consumption time when feeding two-year-old quarter horses. There are many benefits of adding fat to the equine diet. The results of this study will provide insight into the differences in palatability, and therefore utility, of fats from vegetable versus animal sources.

MATERIAL AND METHODS

Twelve two-year-old quarter horses were used to determine consumption time when fed different sources and amounts of fat in their diets. All treatment groups were blocked by sex and location in the barn. Prior to arriving to the barn, the horses were maintained in a natural pasture setting together as a uniform group. Genetics among horses were similar and all were born within three months of each other. Upon arrival to the research facility, all horses were weighed, dewormed with a common commercial anthelmintic, and randomly placed in 3.048 m x 4.267 m box stalls where they were housed for the remainder of the experiment. Stalls were bedded with pine wood shavings with access to clean, fresh water and salt at all times. Throughout the experiment, horses were exercised daily which typically consisted of 30 minutes to an hour of riding or lunging.

Upon initiation of the study, horses were divided into three treatment groups. Each treatment group received approximately 1% BW of a commercially produced, textured, sweet feed referred to as grain and 1.5% BW of Coastal bermudagrass hay (*Cynodon dactylon)* per day. All horses were fed grain and hay twice daily. Treatment group 1 was considered the control group and therefore no additional oil was added to the grain ration. This group is identified as the no oil (NO) treatment group. Treatment group 2 received an additional 0.099 kg of soybean oil every feeding as a top-dress to the grain ration. This group was identified as the soybean oil (SO) treatment group. Treatment group 3 received an additional 0.099 kg of fish oil every feeding as a top-dress to the grain ration. This group was identified as the fish oil (FO) treatment group. Rations for treatments 2 and 3 were balanced to provide approximately 8.5% total fat in the diet from the grain/oil top-dress source. The soybean oil used in the experiment as a top-dress had no additional flavor enhancer. The fish oil was flavor-enhanced by the manufacturer to aid in consumption. Nutrient analysis of grain, hay, SO, and FO are listed in Table 1 as analyzed by Dairy One Forage Testing Laboratory (Ithaca, New York).

Table 1. Nutrient Analysis of Grain, Hay, FO and SO.[a]

Item	Grain	Hay	SO	FO
DM, %	90.7	95	0.1	0.1
CP, %	15.1	9.9	-	-
CF, %	5.8	1.9	100	99
ADF, %	8.6	39.2	-	-
NDF, %	0.18	72.8	-	-
Ca, %	0.01	0	-	-
P, %	0.01	0	-	-
DE, Mcal/Kg	3.48	1.83	15.16	12.15

[a] Dry Matter Basis.

Table 2 illustrates the amount of fat provided by each treatment group. Treatment 1 contained 3.45% total fat in the diet compared to treatments 2 and 3 which contained approximately 4.54% total fat in the diet. Treatment 1 received approximately 5.78% of fat from the grain, whereas treatments 2 and 3 received approximately 8.52% from the grain and oil. Typical high fat grain rations that are provided to horses contain a minimum 7% crude fat. Diets were formulated and adjusted so that the top-dress treatments were above this value and the control treatment was below this value. Warren (2004) stated that horses can receive up to 20% total fat in the diet, therefore total fat content in diets were believed to not affect consumption.

Table 2. Amount of Fat Consumed per Day by Treatment.[a]

	NO	SO	FO
Grain, kg	0.21	0.21	0.21
Hay, kg	0.103	0.103	0.103
SO, kg	0	0.099	0
FO, kg	0	0	0.099
Total Fat Consumed, kg	0.313	0.412	0.412
Fat Consumed from Grain + Oil, %	5.78	8.52	8.52
Fat Consumed in Total Diet, %	3.45	4.54	4.54

[a] Dry Matter Basis.

Table 3 illustrates the Daily Digestible Energy Nutrient Requirements for horses at 24 months of age (National Research Council 2007). This table is based on horses that will have a mature body weight of 500 kg. The table indicates the different digestible energy (DE) requirements for horses 24 months of age under maintenance, light, moderate, heavy, and very heavy exercise.

Table 4 reports the daily consumption of DE each horse received in each treatment group. Total amount of DE consumed daily for each treatment group was: NO = 22.6 Mcal, SO = 24.10 Mcal, and FO = 23.82 Mcal. Referring back to values in Table 3, all treatment groups received a level of digestible energy that met the requirements for a 24-month-old horse receiving light to moderate exercise.

Table 3. NRC Daily Digestible Energy Requirements for Horses 24 Months of Age.[a]

Type	DE, Mcal
Maintenance	18.7
Light Exercise	21.8
Moderate Exercise	24.8
Heavy Exercise	27.9
Very Heavy Exercise	32.5

[a] Mature Body Weight of 500kg.

Table 4. Daily Consumption of Digestible Energy on a Dry Matter Basis.

Source (Mcal/d)	NO	SO	FO
Grain	12.64	12.64	12.64
Hay	9.96	9.96	9.96
Fish Oil	-	-	1.20
Soybean Oil	-	1.50	-
Total	22.6	24.10	23.80

The horses were fed at 07:00 and 18:30 hours every day throughout the trial. After feeding, horses were monitored to determine length of time necessary to consume each treatment diet. Times were recorded up to 300 minutes. After 300 minutes elapsed, horses were no longer observed and received a 300 for consumption time. The statistical analysis was conducted using SPSS (2009) one-way ANOVA to determine differences in consumption rates.

RESULTS

All horses remained healthy and vigorous throughout the study and showed no signs of colic. Initial and ending weights are reported in Table 5. All weights were similar ($P > 0.05$) among treatment groups at the beginning and end of the trial.

Table 5. Mean Initial and Ending Weights of Horses by Treatment, kg.

Weight	NO	SO	FO	P-value
Initial	398.70	373.80	389.60	0.145
Ending	391.00	375.60	387.40	0.334

In Table 6, mean consumption time over the entire trial by treatment group is reported. The NO group consumed the entire diet in a shorter period of time ($P < 0.001$) than the SO and FO treatment groups. The FO and SO treatments were similar ($P > 0.05$) in consumption time throughout the entire study.

Mean consumption times of NO, SO, and FO from weeks 1, 2, and 3 are reported in Table 7. Consumption time for NO was similar ($P > 0.05$) for weeks 1 and 2, but consumption time increased and was significantly different ($P < 0.001$) in week 3.

Consumption time for SO and FO increased significantly from week 1 to 2 ($P < 0.001$) and from week 2 to 3 ($P < 0.001$).

Table 6. Overall Mean Consumption Time for NO, SO, and FO Diets, Minutes.

Days	NO	SO	FO	P-value
21	36.70[a]	152.90[b]	161.4[b]	< 0.001

[a, b] means in the same row without a common superscript are significantly different.

Table 7. Weekly Mean Consumption Times within Treatment for NO, SO, and FO Diets, Minutes.

Week	NO	SO	FO
1	21.43[a]	29.00[a]	38.02[a]
2	19.88[a]	129.61[b]	150.61[b]
3	68.82[b]	300.00[c]	295.61[c]
P-value	< 0.001	< 0.001	< 0.001

[a,b,c] means in the same column without a common superscript are significantly different.

Weekly mean consumption times for all treatments are reported in Table 8. Mean consumption times were compared across treatments. In week 1, consumption time for NO was significantly shorter ($P = 0.015$) than that of FO. Consumption time for SO was similar to the other two treatments. In week 2, NO was consumed significantly faster ($P < 0.001$) than SO and FO, but no difference existed in consumption time of SO and FO. In week 3, NO was again consumed significantly faster ($P < 0.002$) than SO and FO, and SO and FO were consumed at a similar rate.

Table 8. Weekly Mean Consumption Times between Treatments for NO, SO, and FO Diets, Minutes.

Week	NO	SO	FO	P-value
1	21.43[a]	29.00[a,b]	38.02[b]	0.015
2	19.88[a]	129.61[b]	150.61[b]	< 0.001
3	68.82[a]	300.00[b]	295.61[b]	< 0.002

[a,b] means in the same row without a common superscript are significantly different.

Daily mean consumption time for NO, SO, and FO diets are reported in Table 9. Consumption time for the NO diet was similar ($P = 0.239$) for d 1 to d 21. From d 1 to 9, SO consumption time was similar ($P > 0.05$). Consumption time at d 10 significantly increased ($P < 0.001$) through d 14 for SO. From d 14 to 21, consumption time for SO was 300 minutes. For FO, consumption time was similar ($P > 0.05$) for d 1 to 8. Consumption time at d 9 significantly increased ($P < 0.001$) through d 14 for FO. At d 14, consumption time for FO was 284 minutes or greater. Consumption time for FO from d 14 to 21 was similar ($P > 0.05$).

The daily mean consumption time for NO, SO, and FO is reported in Table 10. Consumption time for NO, SO, and FO are similar from d 1 to 7. However, NO was consumed faster ($P = 0.006$) than FO on d 8. Also, consumption time on d 8 for SO was intermediate and similar (P > 0.05) to both NO and FO. On d 9 and 10, all diets were consumed at a similar rate (P > 0.05). On d 11, NO was consumed faster than FO (P = 0.009), but SO was consumed at a similar rate to both NO and FO (P > 0.05). On d 12, NO was consumed faster (P = 0.016) than SO and FO. From d 13 to 21, NO was again consumed faster (P < 0.001) than SO and FO.

Table 9. Daily Mean Consumption Times within Treatment for NO, SO, and FO Diets, Minutes.

Day	NO	SO	FO
1	34.75	$46.25^{a,b}$	66.63^{b}
2	19.38	$38.75^{a,b}$	$61.25^{a,b}$
3	18.00	27.88^{a}	22.50^{a}
4	18.63	22.50^{a}	$39.13^{a,b}$
5	20.50	21.75^{a}	$27.63^{a,b}$
6	19.63	23.13^{a}	24.25^{a}
7	19.13	22.75^{a}	24.25^{a}
8	18.75	22.88^{a}	$27.75^{a,b}$
9	20.75	$37.75^{a,b}$	65.00^{b}
10	20.88	$71.63^{b,c}$	$42.88^{a,b}$
11	17.25	103.75^{c}	$198.38^{c,d}$
12	17.75	160.13^{d}	186.25^{c}
13	19.75	211.13^{e}	239.50^{d}
14	24.00	300.00^{f}	294.50^{e}
15	55.38	300.00^{f}	300.00^{e}
16	71.75	300.00^{f}	300.00^{e}
17	73.88	300.00^{f}	$284.50^{d,e}$
18	56.00	300.00^{f}	300.00^{e}
19	79.25	300.00^{f}	300.00^{e}
20	74.38	300.00^{f}	294.38^{e}
21	71.13	300.00^{f}	290.38^{e}
P-value	0.239	< 0.001	< 0.001

^{a,b,c,d,e,f} means in the same column without a common superscript are significantly different.

Table 10. Daily Mean Consumption Times between Treatments for NO, SO, and FO Diets, Minutes.

Day	NO	SO	FO	P-value
1	34.75	46.25	66.63	0.332
2	19.38	38.75	61.25	0.371
3	18	27.88	22.5	0.173
4	18.63	22.5	39.13	0.246
5	20.5	21.75	27.63	0.181
6	19.63	23.13	24.25	0.178
7	19.13	22.75	24.25	0.104
8	18.75^{a}	22.88^{a,b}	27.75^{b}	0.006
9	20.75	37.75	65	0.073
10	20.88	71.63	42.88	0.207
11	17.25^{a}	103.75^{a,b}	198.38^{b}	0.009
12	17.75^{a}	160.13^{b}	186.25^{b}	0.016
13	19.75^{a}	211.13^{b}	239.50^{b}	< 0.001
14	24.00^{a}	300.00^{b}	294.50^{b}	< 0.001
15	55.38^{a}	300.00^{b}	300.00^{b}	< 0.001
16	71.75^{a}	300.00^{b}	300.00^{b}	< 0.001
17	73.88^{a}	300.00^{b}	284.50^{b}	< 0.001
18	56.00^{a}	300.00^{b}	300.00^{b}	< 0.001
19	79.25^{a}	300.00^{b}	300.00^{b}	< 0.001
20	74.38^{a}	300.00^{b}	294.38^{b}	< 0.001
21	71.13^{a}	300.00^{b}	290.38^{b}	< 0.001

^{a,b} means in the same row without a common superscript are significantly different.

DISCUSSION

Warren (2004) stated that horses can consume up to 20% fat in the diet with 10% being ideal. In this study, the percentage of fat in the total diet was between 3.45% and 5.45%. Therefore, rate of consumption should not have been affected due to the amount of fat in the diet.

All horses remained healthy with no signs of illness or colic throughout the duration of the study. The initial and ending weights of horses were similar ($P > 0.05$). However, mean weights from the beginning to the end of trial showed trends of minor weight loss. This may have been due to the daily exercise that the horses were receiving. Upon initiation of the study, digestible energy amounts from all feed sources were analyzed to determine the amount of digestible energy each treatment provided so that consumption of excessive energy would not affect ration consumption. According to the National Research Council (2007), the digestible energy the horses were consuming was within the digestible energy requirements for a 24-month-old horse in light to moderate training.

Results of this study indicate that two-year-old quarter horses consuming a typical grain ration without an oil top-dress will consume the grain ration in approximately 30 minutes. When soy or fish oil is top-dressed on the grain ration, consumption time will increase to approximately 2.5 hours. Rich (2004) stated that vegetable sources of fat tend to be more palatable to horses than animal sources. She further stated that most vegetable sources including soy oil were quite palatable. This study disagrees with Rich (2004) due to the significant increase in time that the soy oil top-dressed ration was consumed when compared to the control ration. This study further disagrees with the statement from Rich (2004) that vegetable sources were more palatable than animal sources since the study indicates that the soy oil top-dressed ration was consumed similarly to the fish oil top-dressed ration over the entirety of the trial. However, it is important to note that consumption of soy oil and fish oil may have been affected by the flavor enhancer added by the manufacturer to the fish oil. Soy oil was not flavor-enhanced.

When considering weekly consumption of diets, the NO diet was consumed in approximately 20 minutes for the first two weeks. However, in week 3, the diet was consumed in approximately 68 minutes which was significantly longer than the first two weeks. An explanation for this is unknown. Assumptions can be made that the feed may have been from a different batch that was manufactured from the feed company causing palatability issues. When considering SO and FO, both treatment group consumption times increased drastically from week 1 to week 2, and week 3. Assumptions can be made that the increased oil included in the grain rations caused a decrease in consumption, again disagreeing with Rich (2004).

When comparing the treatment groups within each week, SO was consumed in approximately 30 minutes and was similar in consumption time to both NO and FO which were consumed in 21 and 38 minutes, respectively. It is interesting to note that all diets in the first week were consumed in less than 40 minutes. When comparing diets in weeks 2 and 3, results are different. SO and FO in weeks 2 and 3 were consumed at a similar rate. In week 2, they were consumed in approximately 2 to 2.5 hours whereas NO was consumed in approximately 20 minutes. In week 3, SO and FO were consumed in 5 hours indicating that the horses at this point were refusing to consume the entire grain source and oil top-dress provided to them. In week 3, NO consumption time was approximately 68 minutes which was a much longer consumption time when compared to the first two weeks of NO, but was still significantly lower than SO and FO in week 3. Conclusions from the increased consumption time can include a change in feed ration makeup and/or lack of palatability of oil top-dressed rations.

Daily consumption times of NO from d 1 to d 21 were not different. However, referring back to the weekly analysis, there were significant differences between weeks 1 and 2 when compared to week 3. When observing mean values over the 21-d period, mean consumption times tended to be low from d 1 to d 14. From d 16 to d 21, mean values appear higher. Therefore, it can be concluded that day means may have not had enough observations to show significant differences. When evaluating SO and FO consumption rate from d 1 to d 21, consumption times increased significantly. When comparing NO, SO, and FO within day of treatment, no differences existed between treatments from d 1 to d 7. From d 12 to d 21, NO consumption time was much lower than that of SO and FO. Consumption times for SO and FO eventually reached five hours or more.

According to a study completed by Hayes and Kouba (2007), horses receiving flavored fish oil diets tended to have a lower consumption time between d 4 and d 7 whereas 91.6% of horses had been consuming all grain on d 3. Similar to the results in the Hayes and Kouba (2007) study, a lower consumption time was documented by d 13 in this study. Feeding FO with an added flavor, as in the previous mentioned study by Hayes and Kouba (2007), could be a potential method to increase the consumption time and palatability of fish oil in the diet. Rich (2004) stated that FO had a lower palatability due to impurities causing a foul taste and smell when compared to NO and SO. This could have affected the horses consumption time. However, horses in this study on the SO treatment had a significant increase in consumption time as well. The SO and FO groups were also similar in that they both had an increase in consumption time over the duration of the experiment. A possible method in reducing the odor of the fish oil could be to clean feeders daily in order to reduce the odor of fish oil from the previous day(s) or by feeding a grain source that will help to minimize the taste such as a textured sweet feed. Conclusions from this study are that adding oil to a typical grain ration increases consumption time, but soy oil and fish oil added to a grain ration are consumed similarly. Further research needs to be conducted with longer feeding periods, different grain sources, texture of the fat (oil vs. dry), flavoring, and percent of fat in diet to determine which factors have the most influence on consumption of fat supplements.

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