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Utilizing North Dakota Grown Hull-less Oat to Successfully Grow and Develop Yearling Horses

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Introduction

The purpose of this project is to demonstrate the acceptability of North Dakota grown hull-less oat as a feed for growing and developing yearling horses in North Dakota. Current estimates place hull-less oat production at 1% to 5% of present oat production in North Dakota. Based on the last North Dakota Agricultural Statistics five years of oat production estimates and a 2.5% level of hull-less oat, approximately 24 million pounds of hull-less oat could be available for consumption. The North Dakota horse industry is estimated at between 25,000 and 97,000 horses. A conservative estimate of 10,000 young horses consuming 8 pounds of hull-less oat for 180 days would create a market for more than 14 million pounds or almost 60% of current estimated stocks. Through trial one of this project, 24 yearling stud colts were provided 60%, 40%, 20% or 0% of their estimated daily digestive energy needs from hull-less oat. The objective was to document tolerance and performance at various levels of hull-less oats, consequently the diets were not isocaloric or isonitrogenous. Additionally, a second trial compared the performance of 20 yearling fillies that were fed diets incorporating either hull-less or conventional oats with these diets being isocaloric but not isonitrogenous.

Literature Review

Throughout the world, cereal crops have played a monumental role in human as well as animal nutrition. Considerable interest has arisen in the genetic improvement of oat grain for humans and livestock, particularly in the development of a hull-less oat, usually called naked oat (Avena sativa L) by agronomists (Hintz et al., 1991). Traditional oat varieties have a thick fibrous hull which lowers the energy value of the grain for feeding to livestock (Valentine, 1995). Plus, the low bulk density of traditional oat grain makes it expensive to store and transport relative to its nutritive value. Naked or hull-less oat on the other hand loses its hull during harvesting. Removal of the fibrous hull has a dramatic effect on improving the metabolizable energy content and increases the proportion of other nutrients relative to other cereals (Valentine, 1995). In general, the hulled (common) oat is better suited for feeding to ruminant animals while the hull-less oat would better serve the nutrition and digestive needs of nonruminants such as swine and horses.

The nutritional improvement of hull-less oat relates to a relatively high, energy rich oil content along with a high protein content with a good balance of the amino-acids lysine, methionine and cystine. With the availability of two seed varieties, Kynon and Rhiannon, the crop has been commercialized for use in specialized markets including feed for dogs and race horses (Valentine, 1990). In addition, hull-less oat grain has specific advantages for the miller. These include an improved milling yield with reduced energy costs for processing, reduced storage space requirements, and the elimination of certain pieces of equipment (Weaver, 1985). In a study by Friend et al., 1988, hull-less oat was classified as a nutrient dense feed stuff with a potential to replace part of the corn and soybean meal commonly used in swine diets. Hull-less oat has been used successfully when included in starter diets for young pigs (Christinson and Bell, 1980) and has been fed as a replacement for corn and soybean meal in diets for broiler chicks (Cave and Burrows, 1985). However, at this time only limited information exists regarding the nutritive value of hull-less oat in a diet targeted for young growing horses.

There are about 5.25 million horses in the United States today. Since many of these horses are fed commercially prepared feeds, horse feed by itself represents a huge potential market to the American feed manufacturer (Pagan and Jackson, 1991). In developing new feed formulations, one must consider palatability, relative amounts of protein, fat, energy and minerals and the total amount of feed that can be safely consumed and effectively utilized by the animal. Potter (1982) noted that inadequate levels of protein and minerals relative to the energy concentration in a diet could result in skeletal underdevelopment for young horses. Ott and Asquith (1983) found that weanling horses fed a diet lower in protein, calcium and phosphorus than NRC recommendations had significantly less height at the withers. Later studies on yearling horses by Ott and Asquith (1985) showed that wither height was not significantly greater when horses consumed higher levels of energy in a diet containing suitable nutrient/caloric ratios for protein, calcium and phosphorus. Assessment of growth in young horses can be measured by body weight, body length, wither and hip heights, as well as heart girth, forearm, gaskin and cannon bone circumferences taken every 28 days (Wall et al., 1997).

In previous studies of diets for young growing horses, quantitative protein requirement as well as the quality of that protein has been an important aspect of the research. According to Valentine (1990), the real significance of hull-less oat may be in its use in general animal feeds in place of some protein supplements. In terms of digestible energy, hull-less oat has a digestible energy content of 19-23% greater than conventional oat (Hintz et al., 1991). Granted there is variability in the energy content of traditional oat grain. Cuttleford (1990) reported that the Kynon variety of hull-less oat had a digestible energy value of 3.77 Mcal/kg for horses. The National Research Council (1989) suggested that corn grain has a DE value of 3.84 Mcal/kg. Therefore, some varieties of hull-less oat have a DE value similar to that of corn. When feeding hull-less oat, the same precautions should be taken as when feeding corn (Hintz et al., 1991). Furthermore, when switching from conventional oat to hull-less oat, it should be remembered that a given volume of hull-less oat could contain almost twice as much DE as the same volume of conventional oat (Hintz et al., 1991). For example, if hull-less oat weighs 23 Kg/bu, a quart would weigh 0.74 kg and thus would provide 0.74 kg X 3.7 Mcal/kg or 2.7 Mcal per quart of grain. Similarly, if the conventional oat weighs 16 Kg/bu, a quart would weigh 0.5 kg and provide 0.5 kg X 3.0 Mcal/kg or 1.5 Mcal per quart (Hintz, et al., 1991). From these calculations, it is easy to determine the relative energy value of hull-less oat compared to traditional varieties of oat.

Methods and Materials

Trial 1: Naked Oats fed to Yearling Colts at 0%, 20%, 40%, 60% of Digestible Energy Requirements.

Twenty-four registered yearling stud colts of ranch type ranging in weight from 556 lbs. to 818 lbs. were purchased from area producers and delivered to the research center at least 30 days prior to start date. (Appendix I) Seventeen of the twenty-four were Quarter Horses, six were Paints, and one Appaloosa. The foals were blocked by weight and randomly assigned to four treatment groups in which 0%, 20%, 40%, or 60% of their digestible energy needs were supplied by 0, 3, 6, or 9 pounds (as fed) of hull-less oats respectively. The remainder of their diet consisted of 18, 15, 12 or 9 pounds of a mixed grass hay respectively. Additionally, each foal received one pound per day of a commercial protein (28%), vitamin, and mineral supplement plus free choice white salt. The rations used for the studs are shown on Table 3.

The hull-less oats was of Paul variety and had been cleaned, clipped and bagged by Woody's Feed and Grain in Dickinson, ND by a multi step processes used for their commercially available horse oats. This process yielded 84.8% final product with a bushel weight of 52 pounds. The mixed hay was inspected prior to swathing and estimated to be 70% smooth brome, 20% Kentucky bluegrass, and 10% alfalfa. Weather delayed swathing until June 19 at which time the grasses were headed. A nutrient analysis for the hay and oats was obtained through Iowa Testing Laboratories using wet chemistry methods and is shown on Table 1. The protein, mineral and vitamin supplement was a commercial product from Woody's Feed & Grain called Complete C with the analysis as shown on Table 2.

All foals had been on free choice oats hay, one pound conventional oats, and approximately 5.5 pounds of second cutting alfalfa from their arrival at the Dickinson Research Center until 6-21-99 at which time they were switched to the mixed grass hay used for the study. The study started on 6-29-99 with the foals being individually penned and fed. The hull-less oats and supplement were incorporated into the ration up to prescribed levels over a two-week period. The feeding levels were such that the foals cleaned up the feed available prior to the next feeding

The foals were weighed on 6-23-99, blocked by weight and randomly assigned to the treatment groups. The foals were weighed again at the start of the trial on 6-29-99 and the average of these two weights was used as the initial weight. Weight, wither height, hip height, body length, forearm circumference, gaskin circumference, cannon bone circumference, and girth were measured at the start, day 28, day 56 and day 84 which was the end of the trial. Body length was measured from the point of the shoulder to the point of the buttocks while the cannon was measured approximately one half way between the knee and the fetlock. The gaskin and forearm were measured at the maximum point. The body length, gaskin, forearm, cannon bone circumference, and girth were independently measured by two researchers and the average of the measurements used.

All foals were wormed with moxidectin before start date and vaccinated for encephalomyelitis, rhinopneumonitis (herpes virus Type 1 & 4), influenza (type A_1 & A_2), and tetanus at the start of the study. The foals were housed in individual outside pens of adequate size to permit daily exercise. One of the horses, number 813, was a cribber which affected performance and thus was removed from the study analysis.

Trial 2 Naked Oats verses Conventional Oats Fed to Yearling Fillies

Twenty registered yearling fillies of ranch type ranging in weight from 644 lbs. to 854 lbs. were purchased from area producers and delivered to the research center at least 30 days prior to start date. (Appendix II) Sixteen of the twenty were Quarter Horses, three were Paints, and one Appaloosa. The foals were blocked by weight and randomly assigned to four groups, two of which received a ration

containing 4.5 pounds of hull-less oats (as fed) and two groups received a ration with 5 pounds (as fed) of conventional oats. The remainder of their diet consisted of 10 pounds of a mixed grass hay, one pound per day of a commercial protein (28%), vitamin, and mineral supplement and free choice white salt. The rations used for the fillies are shown on Table 4.

The conventional oats was commercially available horse oats from Woody's Feed and Grain that had been cleaned, clipped, and bagged like the hull-less oats described for the colts. The resulting conventional oats weighed 48 lb/bu and the analysis is shown on Table 1. The mixed hay, hull-less oats, and commercial supplement were the same feeds used for the colts and are described under trial one. Likewise, the pretrial feeding, trial dates, data collected, and collection methods were the same as described for the stud colts.

However, the feeding regime for the fillies was quite different in that this trial compared conventional oats to hull-less oats when fed an isocaloric diet. Although the foals were penned in groups of five, they were individually stalled to receive their oats and supplement which was consumed before returning to the pens. The hay was pen fed for the five head and likewise consumed prior to the next feeding.

The fillies received the same worming and vaccination program as the stud colts. The pens were outside pens with adequate space for exercise. Filly number 9266 from one of the hull-less fed groups died 55 days into the study from what was diagnosed as severe colic, thus her data was removed from the study analysis. The filly died shortly after consuming her daily oats and the diagnostic report indicated the cause of death may have been colic since no other diagnostic possibilities were found.

Results and Discussion

The data collected was analyzed using Statistical Analysis System (SAS) in which the weight, average daily gain and initial body measurements with the exception of initial weight, were all tested using initial weight as a covariate. Intermediate and final body measurements were tested using the value of that measurement at the initiation of the experiment as a covariate.

Trial 1: Naked Oats fed to Yearling Colts at 0%, 20%, 40%, 60% of Digestible Energy Requirements.

Feeding increasing amounts of hull-less oats up to 60% of digestible energy requirements did increase several of the growth measures in these yearling stud colts as summarized in Table 5. The foals fed 0, 20, 40, & 60% of their digestible energy needs from hull-less oats gained .36, .97,1.47 and 1.52 lbs/day respectively resulting in final weights of 742, 793, 834, and 839 lbs. ($p<.05$) All other measurements; body length, cannon, forearm, girth, and gaskin circumference along with hip and wither height likewise exhibit a significant ($p<.05$) linear difference in the final measurements. However five traits indicated a significant quadratic effect suggesting a diminished benefit from the added grain at the 60% level as indicated by the superscript 2 in Table 5.

Overall, the foals receiving the higher levels of hull-less oats did reveal acceptable performance in the traits measured with up to 60% of their digestible energy supplied from hull-less oats. Since the purpose of this trial was to determine this performance with 0%, 20%, 40%, or 60% of digestibility energy from hull-less oats, the diets were not isocaloric or isonitrogenous.

Trial 2 Naked Oats verses Conventional Oats Fed to Yearling Fillies

This trial compared the performance of fillies fed an isocaloric diet containing either hull-less oats or conventional oats in which the fillies fed hull-less oats revealed significantly ($p<.05$) greater daily gain, final body weight, and final body length. The fillies fed hull-less oats gained .60 lb/day over the 84-day period compared to .31 lb/day for the fillies fed conventional oats as shown on Table 6. Subsequently the final weights were heavier for the fillies fed hull-less oats, 775 lbs compared to 751 lbs for the group fed conventional oats. There were no other significant differences in final measurements for cannon bone, forearm, girth, or gaskin circumference and no significant differences in hip or wither height One of the fillies in the hull-less oats group died of apparent colic.

In summary, the fillies fed hull-less fed oats did gain more and exhibited a longer body than those fed an isocaloric, not isonitrogenous diet containing conventional oats. There were no significant differences in the other measurements taken at the end of the trial.

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Report Tables & Appendixes

Table 1.

FEED COMPOSITION (100% dry matter)				
	Crude Protein (%)	**Digestible Energy*** (Mcal/lb)	**TDN** (%)	**ADF** (%)
Mixed Hay	8.82	1.16	61.0	37.1
Conventional Oats	12.00	1.48	77.3	15.1
Hull-less Oats	18.47	1.64	85.8	3.1

Complete C	26.60	2.17	70.5	3.3

*DE=ME/.86

Table 2.

Analysis of "Complete C" Supplement (as Fed)	
Crude Protein, min.	25.00%
Crude Fat, min.	6.00%
Crude Fiber, max.	2.5%
Calcium, min.	5.00%
Calcium, max.	6.00%
Phosphorous, min.	4.50%
Copper, min.	500 ppm
Selenium, min.	4.00 ppm
Zinc, min.	1500 ppm
Potassium, min.	1.20%
Salt, min.	1.80%
Salt, max.	2.20%
Magnesium, min.	3.50%

Choline	930 mg/lb
Vitamin K, min. (menadione activity)	12 mg/lb
Vitamin B12, min.	1,400 mcg/lb
Vitamin A, min.	33,000 IU/lb
Vitamin D3, min	6,900 IU/lb
Vitamin E, min.	1,020 IU/lb

Table 3.

STUD RATIONS*								
	% of DE from Hull-less Oats							
	0%		**20%**		**40%**		**60%**	
	as fed (lb)	100% dry matter (lb)	as fed (lb)	100% dry matter (lb)	as fed (lb)	100% dry matter	as fed (lb)	100% dry matter (lb)
Mixed Hay	18.0	15.9	15.0	13.2	12.0	10.6	9.0	7.9
Hull-less Oats	0.0	0.0	3.0	2.7	6.0	5.3	9.0	8.0
Complete C	1.0	0.95	1.0	.95	1.0	.95	1.0	.95
Total (lbs.)**	**19.0**	**16.85**	**19.0**	**16.85**	**19.0**	**16.85**	**19.0**	**16.85**
Fed:***								
Crude Protein(lb)	1.65		1.94		2.20		2.49	
DE (Mcal)	20.55		22.06		23.41		24.91	

*after a two-week acclimation period

** White salt fed free choice
***Trial Design = isocaloric, not isonitrogenous

Table 4.

FILLY RATIONS*				
	Conventional Oats		Hull-less Oats	
	As Fed (lb)	**DM** (lb)	**As Fed** (lb)	**DM** (lb)
Mixed Hay	10.0	8.8	10.0	8.8
Oats	5.0	4.6	4.5	4.2
Complete C	1.0	0.95	1.0	0.95
Total lbs.**	**16.0**	**14.35**	**15.5**	**13.95**
Fed:***				
Crude Protein(lb)	1.58		1.80	
DE (Mcal)	19.09		19.09	

*after a two-week acclimation period
** White salt fed free choice
***Trial Design = isocaloric, not isonitrogenous

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