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UTILIZATION OF COTTONSEED HULLS FOR HORSES

THE UNIVERSITY OF ARIZONA M.S. 1983

UTILIZATION OF COTTONSEED HULLS

FOR HORSES

by

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A Thesis Submitted to the Faculty of the

DEPARTMENT OF ANIMAL SCIENCES

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

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ACKNOWLEDGMENTS

I would like to thank my major professor Dr. William A. Schurg for his assistance and advice during the preparation of this thesis.

Appreciation is extended to Drs. W.H. Brown and J.D. Schuh and to the Department of Animal Science. Sincere thanks are extended to Dr. R.S.K. DeNise for her help on this thesis. Thanks are also extended to my fellow graduate students for their help at the horse center and in the laboratory.

Finally I would like to thank my parents and family for their support and love that helped me through this project.

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ABSTRACT

Two separate studies were conducted for the investigation of cottonseed hull usage for horses. The first study consisted of a growth and an acceptability trial with young growing horses. The second study compared digestion and water intake of young horses fed a cottonseed hull based diet. Low levels of cottonseed hulls (10% of the diet) do not appear to reduce the growth performance of young horses. Digestibility coefficients of the cottonseed hull diet were significantly lower ($P<.05$) for dry matter, neutral detergent fiber and ash. Cottonseed hulls increase ($P<.05$) the digestibility of phosphorous in the diet. Horses fed the cottonseed hull based diet had a higher water intake as compared to the controls. Water intake appears to be related to the crude fiber level in the diet.

CHAPTER 1

INTRODUCTION

The livestock industry in the United States, in particular the horse industry, has been expanding rapidly in the past few years. This expanding population combined with new demand for crop production and land for nonagricultural uses is taking its toll on the amount of forage produced. The world demand is for land to produce more food per acre and the crops to be primarily for human consumption.

The competition between animals, including man, for cereal grains and forages has created the need for alternative methods of feeding. Alternative feedstuffs of low quality (roughages and crop by-products) have been shown to be effective when fed to ruminant animals. The use of low quality roughages for horses has generated only limited research.

Cottonseed hulls (CSH) are abundant in areas where cotton is grown. Hulls are priced at less than half the cost of alfalfa hay, making them economically attractive to replace some expensive conventional roughages. Furthermore, CSH have been used extensively in growing and fattening cattle rations and in the rations of producing dairy cows. To date however, no research has been reported using CSH in the diet of the horse.

The objective of this study is to explore the use of CSH as a low quality or alternative roughage source in the diet of the horse and to establish CSH use in the diet of young growing animals.

CHAPTER 2

LITERATURE REVIEW

Cottonseed hulls (CSH) are a major by-product of the cottonseed industry and are widely available throughout the United States. Economic factors make the feeding of CSH to livestock very attractive when compared to the high cost of conventional roughages. Consideration of the nutritional aspects of feeding CSH to livestock as an alternative roughage source must be investigated to maximize economical CSH usage in livestock rations.

Cottonseed Hull Usage in Livestock

Emery and Kilgore (1891) were the first to study the feeding value of CSH for cattle. They compared the nutritional value of CSH to that of wheat straw, and reported that CSH had a much higher digestibility of ether extract and a lower digestibility of crude fiber. The digestibility of CSH were as follows: dry matter, 35.9%; ash, 27.1%; crude protein, 24.6%; ether extracts, 80.6%; nitrogen free extract, 40.3%; and crude fiber, 27.1%. Also, they reported that feeding CSH alone did not constitute a maintenance ration, but when cottonseed meal was added, the animal would gain weight. They reported that feeding narrow ratios of CSH to cottonseed meal increased the digestibility of all components except the ether extract. In 1894, they concluded that a 3:1 ratio of CSH to cottonseed meal fed to steers would obtain the maximum digestibility of the CSH. Harrington (1891) reported that very little of the crude protein was digested from the CSH but did indicate that the ether extract fraction was highly digestible. His study indicated the digestion coefficient for CSH were as follows: dry matter, 41.9%; ether extract, 78.0%; crude fiber, 41.4%; nitrogen free extract, 30.4%; and crude protein, 5.7%. Schneider (1947) reported that the range of digestibility for CSH were similar, but that the protein portion of the hulls had an average protein digestibility of 0.06%.

Neale (1932) reported that rations with high concentrations of CSH and supplemented with cottonseed meal and molasses could be used effectively in fattening lamb rations. Substituting CSH and cottonseed meal for alfalfa hay in rations for fattening lambs was reported by Forbes and Garrigus (1949). The digestibility of the CSH ration was 91.0% of the dry matter, 82.0% of the protein, 117.0% of the fat, 92.0% of the nitrogen free extract, and 93.0% of the energy that the lambs received from the alfalfa ration. They reported that the CSH ration was more dense and it did not receive as much action by rumination and therefore less bacterial fermentation and that there might be some effect by the CSH on the rumen microflora or digestive enzymes. Garrigus (1951) reported that 100kg of supplemented CSH (50.6% corn, 29.9% CSH, 3.0% black strap molasses, 15.5% cottonseed meal and 4.0% dehydrated alfalfa meal) could replace 80kg of good quality alfalfa hay in fattening lamb rations.

Cottonseed hulls supplemented with cottonseed meal did not compare to pasture clippings when fed to Holstein heifers. (Morris and Horton, 1959) Addition of an alcohol urea preparation improved the quality of CSH, but did not make up all the difference experienced when feeding CSH in replacement of pasture clippings.

McCoy et al. (1965) compared three rations for lactating dairy cows containing (1) ground alfalfa-orchard grass hay: (2) ground corn cobs: and (3) CSH. He reported the digestion coefficients for protein 74.0%, 73.0%, and 77.5% for rations 1, 2 and 3. For fiber; 48.0%, 35.0% and 25.0% for rations 1, 2, and 3 respectively. Villavincencio and Rusoff (1967) reported weight gains with feeder diets containing alfalfa (longstem), alfalfa (chopped), CSH, and corn cobs (ground). The CSH feed had lower values for digestible energy, dry matter digestion, and total digestible nutrients. They reported that there was slightly higher intake with CSH feed as compared to the other three.

Hale et al. (1969) reported the total digestible nutrients of CSH was 44% on a dry matter basis using beef steers. They indicated that the difference in the TDN digestibility from earlier studies was due to different cotton varieties, methods of production and delinting machinery. The present day hulls contain less lint, which is pure cellulose and should be 100% digestible by rumen organisms. They also reported that CSH appears to reduce the digestibility of alfalfa hay. Parrott (1970) compared three rations containing; ground alfalfa, alfalfa meal and CSH. He reported the calculated gross energy digestibility was 72.6%, 65.8%, and 26.8% for the 100% ground alfalfa, alfalfa meal, and CSH respectively. Cellulose digestion was significantly lower for the CSH ration than that for the ground alfalfa or the alfalfa meal rations. The high lignin content and the lower crude fiber digestibility of CSH were reasons for the low cellulose digestion. Parrott (1970) also reported a significant increase in the dry matter intake with CSH rations, compared with the ground alfalfa and the alfalfa meal. He added that as percent concentrate increased, dry matter digestibility increased.

Hunt et al. (1971) compared feeding lactating dairy cows 25, 35 and 45% CSH. He reported that the dry matter intake, digestible energy, and the digestible energy requirement were higher for the 35% CSH. There was no difference between the 25, 35 and 45% CSH feed when comparing digestion coefficients for dry matter, protein, fat, and energy. However, he did report severe problems with off feed and diarrhea with mucous encased feces with all levels of hulls fed. Sargent et al. (1975) compared a 30% CSH feed to a 50% corn silage complete feed with Holstein cows. The digestion coefficients were as follows: dry matter 59.2, 64.2; protein 65.0, 67.5; ether extract 79.6, 75.9; acid detergent fiber 16.6, 37.4; neutral detergent fiber 29.3, 40.9; cellulose 24.1, 40.6; hemicellulose 46.9, 44.2; and lignin .31, .78. He reported the digestibility of the corn silage was greater than the CSH even though the daily milk production was higher for the CSH feed.

Brown et al. (1975, 1977) reported no difference in milk percents fat, protein, solids not-fat, or fatty acids in milk when CSH replaced 10, 30 or 50% of the alfalfa cubes. There was a depressed digestibility of protein, fiber, and combustible energy. He indicated that CSH produced a negative protein digestibility of 5.9% and 9.26% in two difference trials. Brown et al. (1977) indicated that there was no significant difference between pelleted and non-pelleted CSH diets.

Hassan (1981) reported enhancement of the nutritive value of CSH by addition of cottonseed meal, soybean meal, and urea in dairy rations. He reported that the digestibility of dry matter, protein, and acid detergent fiber were higher with the addition of protein supplements, but that it was not significant. Digestibility of combustible energy was significantly reduced with the addition of a supplement.

Comparative Anatomy: The Equine and Ruminant

The horse has the ability to utilize high fiber diets. It has an anatomical arrangement that allows for the retention of high fiber feedstuff in the digestive tract to come into contact with an active microbial population. The ruminant is a polygastric with the microbial population anterior to the small intestine as opposed to the horse a monogastric with the microbial population anterior to the small intestine in an enlarged cecum and colon.

Classic differences between ruminants and nonruminants has been illustrated by Colin 1886 (Robinson and Slade, 1974). Robinson and Slade (1974) listed comparisons between the non-ruminant and ruminant: (1) there is no rumination; (2) there is no eructation; (3) the stomach is small and the rate of passage from the stomach to the large intestine is rapid; (4) enzymatic digestion of foodstuffs prior to fermentation; (5) microbes are not exposed to digestive enzymes in the small intestine. The rate of passage for the equine is intermediate between that of ruminants and non-ruminants such as the pig and chicken. Although the rapid movement of digesta through the stomach and small intestine allows little time for digestion, high grain diets are digested primarily in the small intestine.

Hintz (1969) compared the digestion coefficients of cattle, sheep, rabbits and horses and found no significant difference for feed with 15% crude fiber or less. This agreed with the findings of Olsson and Ruudvere (1955). Hintz (1969) reported that for feeds with more than 15% crude fiber, the average digestion coeffcients for organic matter and crude fiber in horses were 85% and 75% of sheep and cattle respectively. Hintz (1969) and Slade and Hintz (1969) reported that the fiber digestion was higher for horses than rabbits.

Protein digestibility increases in rations with decreasing amount of crude fiber (Hintz, 1969 and Vander Noot and Gilbreath, 1970). Retinour et al. (1969) reported that 80% of the protein digestion was post-cecal, but in later work by Reitnour et al. (1970), he determined that the major site of protein digestion was pre-cecal. In diets with high quality protein, the digestibility of protein in the horse is equal to that of ruminants. However, when diets of low quality protein are supplemented with non-protein nitrogen, the horse is not as efficient as the ruminant (Vander Noot, et al. 1967, Hintz, 1969, and Vander Noot and Gilbreath, 1970).

Increasing the amount of grain in the ration from 0-80% will cause a decrease in the digestion of the fiber constituents of the diet (Thompson et al., 1981). Pearce (1975) and Robinson and Slade (174) reported that high grain diets resulted in changing the horses pattern of digestion to that of a monograstric. The stomach and small intestine become more important in the digestion of high carbohydrate diets.

A small population of microbes exists in the equine stomach, but due to the short retention time (30 minutes), fermentation is probably insignificant (Alexander and Davies, 1963). Smith (1965) and Kern et al. (1974) reported that the bacterial population in the lower intestines of the equine is similar to ruminants. Hungate (1966) and Kern et al. (1974) compared rumen protozoa to those in the cecum and found them to be different. The primary site of fermentation is the large intestine and cecum with cellulose being fermented primarily in the large intestine (Robinson and Slade, 1974).

Hintz et al. (1971a) and Hintz, (1969) indicate that protein, carbohydrate, mineral and vitamin digestion and absorption occurs primarily in the small intestine. Neutral detergent fiber digestion and water absorption take place in the cecum and colon regardless of the hay to grain ratio in the diet.

Low Quality Roughage For Horses

With the expanding horse industry in the United States alternative feedstuffs are becoming more important for the equine. Rising cost and availability of feed are rapidly becoming important considerations to the horseowner.

The feeding value of low quality roughage in the equine has been investigated by Hintz et al. (1971a); Leonard et al. (1973); and Schurg et al. (1978). Low quality roughage is generally lower in TDN, digestible protein, lacking in minerals and vitamins, and higher in lignin and fiber.

Schurg et al. (1977) indicated the horse can be maintained on whole corn plant pellets with proper supplementation. Horses experienced excessive coprophagy and apetite depravity when fed whole corn plant pellets not supplemented with protein. Corn silage supplemented with additional nitrogen, minerals and vitamins can be fed successfully to the equine (Jordan, 1979).

Schurg et al. (1978) reported that mechanical or chemically treated rye grass straw can be fed to horses with no apparent effect on intake, maintenance of weight or digestibility. While pelleting rye grass straw decreased acid detergent fiber, neutral detergent fiber and dry matter digestibility daily consumption was higher for pelleted and other densified forms of rye grass straw over long stem straw. Israilides et al. (1981) indicated that fermentation of acid treated rye grass straw will increase the crude protein and make the fibrous fraction more digestible.

Slagsvald et al. (1979) reported that oat straw treated with anhydrous ammonia was acceptable in a horse ration. The digestibility for the untreated straw was: dry matter, 50%; cellulose, 39%; and hemicellulose, 40%; for the treated straw the digestibilities were 60, 52, and 60% respectively.

Chemical treatment of straw with alkali has been used extensively to improve straw quality. Alkali treatment of straw disrupts the cell walls by dissolving the lignin and silica, hydrolyzing uronic and acetic acids, and by swelling the cellulose fraction (Jackson, 1977). In low quality roughage rations, lignin and pectin appear to pass undigested. Increased amoungs of lignin and pectin reduce the digestibility of all components of the ration (Robinson and Slade, 1974). Schurg (1981) reported that treating wheat straw with sodium hydroxide improved energy and dry matter digestibility over untreated straw.

Ott et al. (1979) reported that 15% citrus pulp could be added to the horses diet with no aprent acceptability problems. He found that crude protein digestion was lowered with the addition of citrus pulp. The lowering of protein digestibility with the addition of low quality roughage has been show by Vander Noot and Gilbreath (1970).

Godbee et al. (1979) indicated that mares on minimal forage could be supplemented with a non-protein nitrogen source in protein blocks containing 2.13% urea. Ralston (1973) indicated that straws containing 3.5 to 5.0% crude protein could be supplemented with soybean meal, cottonseed meal or a non-protein nitrogen source, therefore improving the product for horses use.

CHAPTER 3

MATERIALS AND METHODS

Two studies were conducted to investigate cottonseed hull (CSH) usage in the horse. The first study consisted of a growth and acceptability trial using CSH in the young growing animal. The second study compared the digestion of a CSH diet and water intake in yearling and two year old horses.

Experiment 1: Growth and Acceptability

Eight (four yearlings) and (four two year olds) fillies were divided by weight and randomly alloted to one of the two experimental diets for a growth and acceptability trial. The control diet was chopped alfalfa hay (ALF) and steam processed flaked milo (SPFM) grain base diet and the experimental diet incorporated cottonseed hulls (CSH) replacing alfalfa hay. Chemical composition of diets used in all trials is shown in Table 1. The horses were individually kept in (4mx6m) outside pens with free choice water and trace mineral salt blocks. The horses were weighed initially and at weekly intervals during the 35 day trial. The horses were fed at 2.5% and 2.0% of their body weight for the yearling and two year old horses respectively. All animals were fed two times per day, at 0800 and 1800 h. Daily observations of acceptability, appearance, digestive disturbances and behavior were

Table 1. Chemical Composition of Diets Fed to the Horse Based on Control and Cottonseed Hulls (CSH).

Composition	Dietary Treaments[a] Control	CSH
Dry Matter, %	88.3	87.9
Gross Energy, Mcal/kg	4.5	4.6
Crude Protein, %	16.3	16.1
Calcium, %	0.9	1.0
Phosphorous, %	0.4	0.4
Acid Detergent Fiber, %	22.6	27.1
Lignin, %	4.8	6.2
Neutral Detergent Fiber, %	35.3	37.8
Ash, %	6.9	6.6

[a] Control (60% chopped alfalfa and 40% steam process flaked milo); Cottonseed Hull (50% chopped alfalfa, 10% CSH and 40% steam processed flaked milo).

noted. Differences in acceptability and growth rate were tested by two way analysis of variance (Steele and Torrie, 1960).

Experiment 2: CSH Digestibility Trial

Following the growth and acceptability trial, individual horses were moved into the metabolic unit. All horses were weighed at the time they were put into the digestion unit. The digestion trial consisted of a seven day preliminary phase followed by total fecal collection taken during the last five days of the trial. Water was offered ad libitum three times daily at 0800, 1200 and 1800 h. Horses were fed four times daily to reduce spillage and boredom at 0800, 1200, 1600 and 2000 h. Representative feed samples were taken at each feeding and composited. Samples of .5kg of feces from the total daily excretion were taken and dried in a forced air oven at 50 degrees C for 48 hours and ground in a Wiley mill through a 1mm screen. Samples were dried at 100 degrees C in a vacuum oven for 24 hours. From the daily fecal output, a 10% aliquot was taken and composited for further analysis. Both the composite and daily samples were analyzed.

Chemical analysis for dry matter and ash were carried out using A.O.A.C. (1980) procedures. Gross energy was obtained using isoperibolic bomb calorimetery. Acid detergent fiber and netural detergent fiber were determined according to Goering and Van Soest (1970) and Robertson and Van Soest (1977). Nitrogen, calcium and Phosphorous were determined using Technicon AutoAnalyzer. Statistical analysis to determine treatment differences was by two way analysis of variance (Steel and Torrie, 1960).

CHAPTER 4

RESULTS AND DISCUSSION

Experiment 1: Growth and Acceptability of Cottonseed Hull (CSH) Diet.

Prior to the start of the trial, the horses were minimally managed, with their diet consisting of 100% cubed alfalfa hay. The horses were fed the control diet for one week before the introduction of the experimental diet. There was no apparent acceptability problem with either the control or the cottonseed hull (CSH) diets. The bulkiness of the hulls had no effect on intake of the horses. There was minimal rejection of the CSH diet by one yearling, but was not significant. The horses showed no signs of digestive problems. Yearling horses on the CSH diet showed a considerable amount of coprophagy as compared to their counterparts on the control diet. There was no evidence of coprophagy in the two year old horses. Throughout the 35 day trial, all horses exhibited tail chewing, which was probably due to boredom and not either diet. The appearance of all horses improved during the growth trial.

Average daily gain (ADG) during the 35 day trial for all the horses on diets is listed in Table 2. There were no significant differences ($P>.05$) in ADG for the control (60% alfalfa and 40% steam processed flaked milo) or the experimental (50% alfalfa, 10% CSH and 40% steam processed flaked milo) diets for the yearlings or two year old

Table 2. Average Daily Gain of Horses Fed Control or Cottonseed Hull (CSH) Based Diets.

Diet	Gain kg/day[a]
Control (60% alfalfa + 40% milo)	0.85
CSH (50% alfalfa + 10% CSH + 40% milo)	0.71
SEM	0.08
Age[b]	**Gain kg/day[a]**
Yearling Mean Gain	0.93
Two Year Old Mean Gain	0.64
SEM	0.08

[a] LSD (.05) = .33

[b] Age effect values are composites of all yearling and two year old horses on diets.

horses. The yearlings had a greater ADG, although not significant (P>.05), when compared to the two year old horses.

Mean daily intakes on a metabolic weight basis ($kg^{.75}$) are listed in Table 3. There were no significant difference (P>.05) in g/kg intake for horses in any group. The yearling mean intake tended to be higher for both diets, but was not significantly different from the intakes of the two year olds.

No information exists on the usage of low quality roughage in young growing horse. Results of these studies would indicate that young horses supplemented with a low level (10%) of cottonseed hulls in their diet have more than adequate growth response.

Experiment 2: Cottonseed Hull (CSH) Digestibility

Apparent digestibility coefficients for the control (60% alfalfa and 40% milo) diets are listed in Table 4. Mean dry matter and NDF digestibilties were significantly higher (P<.05) for control than for the experimental diet. Digestibilities tended to be higher for ADF and lignin, but were not significantly different (P>.05). The difference in the ADF and NDF values agree with the finds of Hintz et al., (1971a). Neutral detergent fiber digestibility has been shown to be higher for grain diets as compared to forage diets. The lower NDF digestibility of the CSH diet is probably due to the poor digestibility of cottonseed hulls. Hintz et al., (1971b) reported that addition of grain to a total forage diet would not decrease digestibility of the fiber components. This conflicts with evidence that increasing the amount of grain in a complete forage diet, from 0-80% tends to decrease the digestion of the

Table 3. Mean Daily Feed Intake on a Metabolic Weight Basis for Horses Fed the Control or Cottonseed Hull (CSH) Based Diets.

Diet	Intake g/kg$^{.75}$[a]
Control (60% alfalfa + 40% milo)	67.4
CSH (50% alfalfa + 10% CSH + 40% milo)	74.2
SEM	4.17

Age[b]	
Yearling Mean Intake	76.7
Two Year Old Mean Intake	64.9
SEM	4.17

[a] LSD (.05) = 16.39.

[b] Age effect values are composites of all yearling and two year old horses on diets.

Table 4. Apparent Digestibility Coefficients of Control and Cottonseed Hull (CSH) Diets for Horses.

Item	Control ALF+SPFM	10% CSH ALF+CSH+SPFM	SEM
Dry Matter	76.1[a]	72.3[b]	0.43
Protein	75.5	76.2	1.44
Combustible Energy	74.2	71.8	0.77
Acid Detergent Fiber	52.2	47.6	1.43
Lignin	25.6	20.7	1.91
Neutral Detergent Fiber	60.7[a]	51.5[b]	0.85
Calcium	56.8	61.7	1.92
Phosphorous	16.9[a]	33.6[b]	3.05
Ash	60.4[a]	50.6[b]	1.19

[a,b] Means in same row with different letter superscripts are different ($P<.05$).

fiber fraction of the diet (Thompson et al., 1981). The ADF and NDF values for the control diet are similar to other work at the Arizona station (Kigin, 1982).

Apparent crude protein digestion was not significantly ($P>.05$) different for either diet. The protein digestibility was slightly higher for the CSH diet. This maybe due to small amounts of meal still available in the hull fraction of the diet. The protein in the hull fraction used in these studies was higher than that listed in the NRC for cottonseed hulls. For ingredient breakdown of both diets, see Appendix Table 1.

Ash apparent digestibility was higher ($P<.05$) for the control than for the CSH diet. The calcium and phosphorous digestibilties were higher for the CSH diet, although only the apparent digestibility of phosphorous was significant ($P<.05$). The Ca:P ratios were 2.25 and 2.5 for the control and CSH diets, respectively. These are within the range of ratios set by the NRC, 1978. The NRC, 1978 recommends calcium and phosphorous percentages in the diet of .50, .35 and .40, .30 for Ca and P for yearlings and two year olds, respectively. Both diets exceeded these by almost 100%. The cottonseed hulls in the CSH diet increased phosphorous digestibility significantly ($P<.05$) over the control diet. It is unlikely that the increased P would inhibit the absorption of Ca for the CSH diet (Schryver et al. 1974). The major site of Ca absorption is the small intestine and the site for P is the colon (Schryver et al., 1972).

Apparent digestibility coefficients for composite samples are presented in Table 5. All coefficients are similar, however, the digestibility for protein, ADF, lignin and phosphorous appear to be less than the mean digestibility coefficients.

<u>Experiment 2: Water Intake for Control or Cottonseed Hull (CSH) Based Diets.</u>

Average daily water intake is listed in Table 6. These values were obtained for the last five days of the collection period. There was greater water intake for those horses on the CSH diet, however, this was not significantly different (P>.05) from the control. Two year old horses consumed more water than yearlings. On a metabolic weight ($kg^{.75}$) basis, the yearlings water intake was higher than the two year olds. Although it was not significantly different (P>.05) the CSH diet resulted in a higher water intake among all horses when evaluated on a metabolic weight ($kg^{.75}$) basis. This data is presented in Table 7.

The addition of CSH to the diet increased the neutral detergent fiber fraction, and therefore increased the retention time in the large intestine and colon. An increase of water intake was needed to facilitate the digestion of the increased fiber in the diet. The colon has been recognized as the main site of water absorption (Hintz et al. 1971a; Robinson and Slade, 1974). Argenzio et al. (1974) reported that the cecum absorbs a large portion of water. These agree with the findings in this study. The horses on the CSH diet had a higher water intake and a lower percentage of water in the fecal output. This is probably due to the higher neutral detergent fiber of the CSH diet, which would agree with the work of Fonnesbeck (1968). Water intake is

Table 5. Apparent Digestibility coefficients of Composite Samples for the Control and Cottonseed Hull (CSH) Diets.

Item	Control ALF+SPFM	10% CSH ALF+CSH+SPFM	SEM
Dry Matter	76.1[a]	72.2[b]	0.63
Protein	76.5	77.9	1.65
Combustible Energy	74.1	71.6	1.04
Acid Detergent Fiber	50.8	47.3	1.60
Lignin	22.8	20.5	2.19
Neutral Detergent Fiber	60.3[a]	50.9[b]	0.91
Calcium	57.7	62.3	2.39
Phosphorous	15.5[a]	35.1[b]	4.45
Ash	60.3[a]	51.3[b]	1.49

a, b Means in the same row with different letter superscripts are different ($P<.05$).

Table 6. Mean Water Intake for Horses Fed Either the Control or Cottonseed Hull (CSH) Based Diets.

Diet	Intake l/day[a]
Control (60% alfalfa + 40% milo)	16.6
CSH (50% alfalfa + 10% CSH + 40% milo)	18.4
SEM	1.4
Age[b]	**Intake l/day[a]**
Yearling Mean Intake	16.3
Two Year Old Mean Intake	18.6
SEM	1.44

[a] LSD (.05) = 5.66

[b] Age effect values are the composite of all yearling and two year old horses on all diets.

Table 7. Mean Water Intake on a Metabolic Weight Basis for Horses Fed Either the Control or Cottonseed Hull (CSH) Diets.

Diet	Intake $l/kg^{.75}$ [a]
Control (60% alfalfa + 40% milo)	0.20
CSH (50% alfalfa + 10% CSH + 40% milo)	0.21
SEM	0.01

Age [b]	Intake $l/kg^{.75}$ [a]
Yearling Mean Intake	0.22
Two-Year Old Mean Intake	0.20
SEM	0.01

[a] LSD (.05) = .054.

[b] Age effect values are the composite of all yearling and two year old horses on all of the diets.

highly correlated to the dry matter intake, and composition of the dry matter. Fonnesbeck (1968) indicated that horses on all roughage diets, consumed more water than horses on hay-grain diets. Differences in dry matter, NDF and dry matter digestibility is highly correlated with water intake.

CHAPTER 5

SUMMARY

Eight horses, four yearlings and four two year olds, were used in two trials to determine the use of cottonseed hulls (CSH) as an alternative feedstuff for the horse. One trial evaluated growth and acceptability of a diet containing CSH, and the other trail determined the digestibility of the CSH diet.

The results of the growth and acceptability study indicate that replacement of alfalfa hay with CSH had no significant effect on the growth of the young horse. The horses accepted CSH with little or no difficulty despite the additional bulkiness of CSH.

The digestibility of CSH is much lower than that of alfalfa hay, and the addition of CSH to the diet reduced the digestibilities of dry matter, ADF, NDF, and ash. The increased fiber fraction of CSH had a negative effect in these digestibilties. There was a slight increase in crude protein digestibility in the diet with CSH.

The addition of CSH to the diet improved the digestibility of calcium and phosphorous. The addition of CSH to feeds with low P may improve the digestibility of the P fraction by increasing the amount of P in the diet.

The increased dry matter and neutral detergent fiber of CSH increased the water intake of the horses on trial. The need for good water ad libitum is necessary when feeding a low quality alternative roughage source.

Incorporating cottonseed hulls into diets, has great potential use in Arizona and other locations that grow cotton. It may be a viable way to use some of the low quality roughage produced as part of this industry. Rising cost of hay may necessitate horseowners to consider alternative forms of roughage, that are cheaper and easily incorporated into the diet.

APPENDIX

CHEMICAL COMPOSITION OF INGREDIENTS FOR CONTROL AND COTTONSEED HULL (CSH) BASED DIETS

Appendix. Chemical Composition of Ingredients for Control and Cottonseed Hull (CSH) Based Diets.

Composition	ALF[a]	SPFM[a]	CSH[a]
Dry Matter, %	92.1	91.2	93.9
Gross Energy, Mcal/kg	4.4	4.4	4.4
Crude Protein, %	19.9	11.7	6.1
Acid Detergent Fiber, %	32.5	4.6	62.8
Lignin, %	6.2	1.6	18.2
Neutral Detergent F., %	39.9	8.0	83.9
Calcium, %	1.3	0.1	0.2
Phosphorous, %	0.3	0.4	0.1
Ash, %	9.2	3.3	1.5

[a] Chopped alfalfa hay (ALF), Steam processed flaked milo (SPFM), Cottonseed hulls (CSH).

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