8-1983

Effect of degradability of protein on milk production and composition of early lactation cows

Jeffry Shannon Miller

Recommended Citation

Miller, Jeffry Shannon, "Effect of degradability of protein on milk production and composition of early lactation cows. " Master's Thesis, University of Tennessee, 1983.
https://trace.tennessee.edu/utk_gradthes/7552

To the Graduate Council:

I am submitting herewith a thesis written by Jeffry Shannon Miller entitled "Effect of degradability of protein on milk production and composition of early lactation cows." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

M. J. Montgomery, Major Professor

We have read this thesis and recommend its acceptance:

K. M. Barth, B. R. Bell

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a thesis written by Jeffry Shannon Miller entitled "Effect of Degradability of Protein on Milk Production and Composition of Early Lactation Cows." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

M. J. Montgomery
M. J. Montgomery, Major Professor

We have read this thesis
and recommend its acceptance:

Karl M. Barth

Benny R. Bell

Accepted for the Council:

CW Minkel
The Graduate School

EFFECT OF DEGRADABILITY OF PROTEIN ON MILK PRODUCTION AND COMPOSITION OF EARLY LACTATION COWS

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Jeffry Shannon Miller
August 1983

Dedicated to the Memory of

Dr. Eric Wallace Swanson

and

Dr. Edd Coolidge Hogg

I am grateful to have known these two fine gentlemen

ACKNOWLEDGMENTS

The author wishes to express his indebtedness to the following people:

To the late Dr. E. W. Swanson for his advice and leadership during the course of the author's studies;

To Dr. M. J. Montgomery for serving as major professor and reviewing the manuscript;

To Dr. K. M. Barth for serving on his committee and reviewing the manuscript;

To Dr. B. R. Bell for serving on his committee and reviewing the manuscript;

To J. A. Bacon for the laboratory analysis and for his friendship and advice and anecodotes that kept the author's morale high;

To Clyde Holmes, Bill Morrison, Tim Martinek, Kevin Hill, and the entire staff of The University of Tennessee, Knoxville dairy experiment station for their help with this experiment;

To The University of Tennessee, Knoxville Computer Center for the use of the computer for statistical analysis;

To Thomas Dale Bryson for his help with the laboratory analysis;

To fellow graduate students for their friendship and advice;

To Tina Shipley, Dave Michel, Teresa Mann, Lisa Bettison, Nancy Mitchell, Pat Bosheers, Dave Watkins, and Chris Stearns for always being there when needed;

To my mother and father without whose support, both financial and spiritual, this manuscript could not have been a reality;

To my Aunt Josephine without whose love and financial support my education would have not been possible; and

To Tom and Aaron, my nephews, the thought of them keeps me going.

ABSTRACT

A feeding trial was conducted to determine the effects upon milk production and milk composition of cows fed either a high degradable protein source or a low degradable protein source. Initially 18 cows were used in a switchback design with three experimental periods. Due to illness and a desire to keep subclass numbers equal, four were dropped.

The high degradable protein source consisted of barley, ear corn, shelled corn, soybean meal, salt, and trace minerals ground and ensiled at a 70% dry matter level. The low degradable protein source consisted of brewers dried grains, distillers dried grains, shelled corn, soybean meal (heated to 135°C for eight hours), salt, and trace minerals ground and bagged dry.

Each cow received 7 lbs. alfalfa hay, and silage in a 3:2 as fed ratio with concentrate fed free choice to permit 10% refusal. Each experiment period lasted 28 days with the first seven days of each period being an adjustment period. Weekly composition AM and PM milk samples were taken and analyzed for total solids and crude protein. Milkfat data were obtained via the Dairy Herd Improvement Association. Feed samples were taken every 10 days and analyzed for crude protein, crude fiber, acid detergent fiber, ash, dry matter, and ether extract. Protein solubility was determined on the first and last feed samples obtained. Body weights were taken weekly and milk weights were recorded daily.

Milk yield and composition between the experimental groups did not differ significantly. Dry matter intake and crude protein intake did differ significantly between groups but was a created difference due to the difference in dry matter between the two diets. Body weights did not differ significantly between the two diets.

TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

CHAPTER I

INTRODUCTION

Recent economic evaluations of dairy farms have indicated that approximately 50% of the operating cost is spent in the procurement of feedstuffs. Protein is the most expensive nutrient of the diet. Therefore, the milk producer is most reluctant to spend more than needed to obtain more protein or waste what protein he has on hand.

One method of conserving protein is to insure the animals are utilizing the protein to the best of their ability. The ruminant digestive system is geared toward the utilization of high fiber forages. This is due to microbial digestion preceding amino acid uptake. Often more protein is destroyed by the bacteria than is manufactured (Satter and Roffler, 1975).

To insure better utilization of protein by the animal, the protein needs to bypass the rumen and be digested postruminally. Previous work has indicated that the proportion of degradable (rumen solubilized) to nondegradable (bypass) must be increased above the ratio that occurs in most natural feedstuffs in order for the most efficient utilization of protein to occur (Chalupa. 1975). If the ratio is shifted more toward the degradable portion, the ruminant animal will lose nitrogen. This loss is in the form of ammonia which is a normal by-product of microbial fermentation. The ammonia is then excreted as urea (Satter and Roffler, 1975). However if the ratio is shifted more towards the nondegradable portion there is evidence to suggest that normal rumen fermentation may be decreased. This would result in poorer digestion of fibrous feedstuffs.

Theoretically at peak lactation and high feed intake, the maximum degradable protein which can be utilized may be less than 60% (Satter and Roffler, 1975). Therefore, if 10% of the protein which would be degraded by microbial fermentation could be replaced by a nondegradable protein source, the amount and percentage of dietary protein could be reduced with no adverse effects upon milk production and composition, resulting in less cost to the dairyman.

The diets of this experiment were formulated in such a manner that both diets were composed of essentially the same ingredients with one ration being more susceptible to microbial degradation. In ration one, corn, barley, and soybean meal were combined and ensiled to increase protein solubility in the rumen. In ration two, distillers grains (processed corn), brewers grains (processed barley), and heated soybean meal were mixed and fed dry.

The objectives of this study were to compare milk production and composition of high producing Holstein cows in early lactation when fed a high or low degradable diet.

CHAPTER II

REVIEW OF LITERATURE

I. RUMINAL UTILIZATION OF NITROGENOUS NUTRIENTS

Utilization of dietary nitrogen differs between those animals that rely on mainly a hydrolytic digestive system than those that depend upon a fermentative type digestion (Satter and Roffler, 1975). The utilization of nitrogenous nutrients in ruminants is especially different due to the fact that the area of amino acid absorption follows the area of microbial fermentation. Satter and Roffler (1975) proposed a diagramatic scheme to represent the utilization of nitrogenous compounds in the rumen (Figure 1).

As mentioned earlier, feed ingested by the ruminant is subjected to microbial degradation. The amount of degradation that occurs is dependent upon the solubility of the feed, the level of feed intake and rate of passage, and rumen pH. End products of this degradation are volatile fatty acids, carbon dioxide, methane, ammonia, heat, and some ATP. These products are utilized by the ruminant with a small proportion being used for microbial growth (Tamminga, 1980). In addition, the amount and composition of nitrogenous metabolites depend on extent of dietary protein digestion, rate of microbial synthesis, composition of microorganisms, time spent by microorganisms in the rumen,

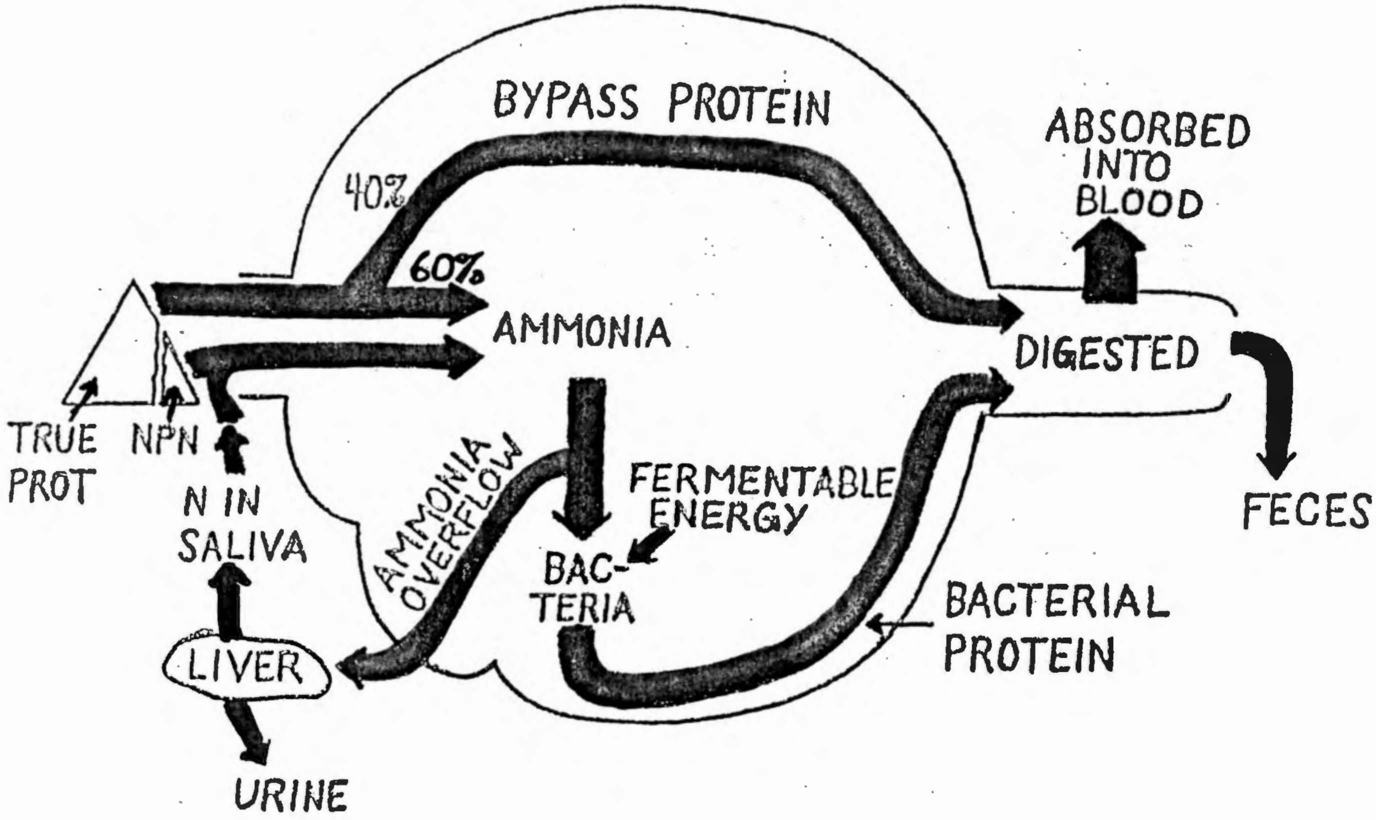

FIGURE 1. Schematic diagram of protein utilization by the ruminant.

Reprinted from Satter and Roffler, 1975.

extent of addition or removal of nitrogen in the omasum and abomasum and other considerations (Hogan, 1975).

Dietary nonprotein nitrogen, salivary nitrogen, and possibly a small amount of urea entering across the rumen wall are converted almost totally to ammonia. The amount of ammonia that can be utilized by bacteria will depend on the number of bacteria and how rapidly they are growing (Satter and Roffler, 1975). When bacteria are unable to utilize all ammonia produced, the excess ammonia is absorbed from the recticulorumen or passed to the lower GI tract where it is absorbed and eventually converted to urea by the liver (Satter and Roffler, 1975).

Extensive nitrogen recycling into the gastrointestinal tract of sheep has been reported (Cocimano, 1967). Ford and Milligan (1970) found that the amount of plasma urea nitrogen recycled when rations are fed that contain 9%-17% crude protein may be equal to 20%-30% of the dietary nitrogen.

II. INTESTINAL UTILIZATION OF NITROGENOUS NUTRIENTS

According to Hogan (1975) the metabolism of nitrogenous compounds in the intestines can be considered under three headings: (1) addition of endogenous nitrogen; (2) digestion and absorption in small intestine; and (3) digestion and absorption in the large intestine. The addition of nitrogen in secretions, either by direct movement from the blood and as sloughed epithelial cells occurs in nonruminants as well as ruminants (Snook and Meyer, 1964).

Hogan (1975) reported that most nitrogen is reabsorbed before the terminal ileum. Also, Hogan (1975) reported that the loss of endogenous nitrogen from the terminal ileum is most severe when animals are infested with helminths.

Attempts to estimate the release and absorption of amino acids have been based on the differences between the amounts of amino acids entering the duodenum and passing through the terminal ileum. Such methods underestimate the total amount of nitrogen absorbed because they ignore endogenous nitrogen (Hogan, 1975). Digesta that passes from the abomasum is comprised of about 80% amino acids. The digesta that leaves the terminal ileum is comprised of approximately 66% amino acids (Hogan, 1975). In the cecum, proteins are degraded with a rapid deamination of amino acids (Hecker, 1971).

Subjecting diets that are high in fiber or high in nonprotein nitrogen to microbial fermentation increases their nutritive value to the ruminant whereas the nutritive value of feedstuffs that are low in fiber and high in protein is decreased by mirobial fermentation. It has been demonstrated that increasing the supply of amino acids postruminally enhances growth and lactation of ruminants (Chalupa, 1975). This postruminal increase in amino acids can be accomplished by employing several methods, but perhaps the most noted method is to alter the feedstuff, either physically or chemically, to facilitate rumen by-pass.

III. CHEMICAL TREATMENT OF PROTEIN SUPPLEMENTS

Peter et al. (1971) reported that in vitro ammonia production was significantly reduced when soybean meal was treated with either acrolein, formaldehyde, glycoxal, or glutealdehyde as opposed to soybean meal that was treated with distilled water. In addition, in vitro protein solubility was significantly depressed when soybean meal was treated with either formaldehyde, glutealdehyde, or glycoxal. In a feeding trial reported in the same article formaldehyde treated and glycoxal treated soybean meal significantly improved the gains of sheep. In addition, feed treated with either aldehyde improved feed conversions. However, Faichney and Davies (1972) found no significant differences in live weight gains, feed conversion, digestibility of the diet and the levels of urea, glucose, and alpha amino nitrogen in the plasma of calves fed formaldehyde treated peanut meal or untreated soybean meal fed at two different protein levels.

Nishimuta et al. (1972) reported that lambs fed formalin treated soybean meal had lower dry matter and crude protein digestibility coefficients. The lambs that were fed formalin treated meal had lower nitrogen retention values which indicates the treated meal escaped postruminal enzymatic degradation. In a feeding trial in which lambs were fed either formaldehyde treated or untreated casein, the group receiving the treated casein grew significantly faster and had higher feed conversions (Faichney, 1971).

IV. HEAT TREATMENT OF PROTEIN SUPPLEMENTS

It has been found by several researchers, Chalupa (1975), and Clark (1975), that a negative correlation exists between protein degradation in the rumen and the amount of protein being absorbed in the small intestine. One method of decreasing the protein solubility in the rumen is by subjecting the feedstuffs to temperatures between 130°C and 180°C for extended periods of time. Sherrod and Tillman (1964) found that steers achieved superior gains and feed efficiencies when fed cottonseed meal that had been autoclaved for 60 minutes as compared to steers fed nonautoclaved meals or meals that had been autoclaved longer. In addition, Glimp et al. (1967) reported that lambs fed heat treated soybean meal in a ration containing 12% protein had higher weight gains than the lambs fed untreated meal. However, when the protein level was increased to 17% no significant weight gains were reported.

Netemeyer et al. (1982) reported that cows achieved significantly higher milk yields when fed heat treated soybean meal compared to cows that were fed conventionally processed soybean meal. Milk composition was not affected. Nishamuta et al. (1972) reported that lambs fed extensively heated soybean meals had higher nitrogen retention values than lambs fed conventionally processed meals. However, cellulose digestibility was significantly reduced.

Hudson et al. (1970) found that the concentration of dry matter reaching the abomasum increased significantly when lambs were fed heated soybean meal. Total nitrogen in abomasum contents increased when lambs received the heated meal. They reported that this increase was due to the amount of nonprotein nitrogen that reached the abomasum. Abrar and Schingoethe (1979) reported that cows receiving heat treated soybean meal produced slightly more milk during the first eight weeks of lactation when protein supply was limiting. But milk production did not differ significantly from cows receiving regularly extracted soybean meal during the latter weeks of lactation. In a later experiment, Mielke and Schingoethe (1981) reported no significant differences in milk production or milk fat percentage when cows were fed heat treated soybean meal as compared to regular extracted soybean meal.

Youssef (1966) reported that increasing the percentage of heated concentrates in the daily ration significantly increased the total volatile fatty acids and the normal proportion of propionic acid while decreasing the normal proportion of acetic acid which resulted in a narrower acetate to propionate ratio. Also, it significantly lowered ruminal pH and insignificantly decreased the ammonia content of the rumen fluid of one fistulated Friesian cow.

V. ALCOHOL BY-PRODUCTS AS A FEED FOR LIVESTOCK

The alcoholic beverage industry uses large amounts of corn and barley to produce their product. After the alcohol is produced there are large amounts of spent grains remaining. These grains are conducive to animal feeding and especially ruminants due to the high protein level and by-pass qualities of the grains. The main problem when feeding alcohol by-products to ruminants is the lack of palatability of the grain. Morrison (1961) stated that neither brewers grains nor distillers grains are very well liked by livestock and they should not be more than one-half of the ration. Also, with the popularity of ethanol production as a fuel source the amount of these by-products is expected to increase.

Brewers Grains

Brewers grains consists primarily of the extracted residues of the process of brewing (Merchen et al., 1979). These grains can be sold as wet brewers grains (WBG) or brewers dried grains (BDG). These grains are not very palatable but offer a good source of protein. The protein contained in brewers grains is a source of protein which easily escapes solubilization by the microbial population in the rumen (Satter and Whitlow, 1977). Brewers grains when fed in conjunction with nonprotein nitrogen, offer improved utilization of the proteins to the ruminant. The nonprotein nitrogen provides the microbial population with sufficient nitrogen to meet their requirements; thus, feeding of brewers grains minimizes losses as absorbed ammonia (Krause, 1973; Klopfenstein, 1974).

The feeding of WBG has gained interest in recent years due to the high energy cost of drying the grains. However the feeding of wet brewers grains is usually limited to farms in close proximity to breweries (Murdock et al., 1981). Also the feeding of the wet grains requires special handling procedures. Owen (1959) encountered high levels of lactic acid in wet brewers grains that had soured or spoiled after heaping the grains in piles on the ground. The drying of the grains alleviates these problems, as the (BDG) can be transported easier and will not spoil as readily.

Merchans et al. (1979) reported that the total and nonammonia nitrogen levels reaching the abomasum were significantly higher when steers received dried brewers grains. Also, Preston et al. (1973) reported greater average daily gains in steers fed fattening rations which used brewers dried grains as a replacement for either 25% or 30% of the corn. Preston concluded that this improvement in average daily gain may have been due to the elimination of rumen keratosis or liver abscesses in the cattle fed brewers dried grains. Klopfenstein et al. (1977) also reported improved average daily gains and feed efficiencies in calves fed (BDG) as compared to calves fed soybean meal or urea.

Distillers Grains as a Feed Source for Ruminants

The process of fermenting grains for ethanol production leaves approximately one-third of the grains as residue. The distillation method common to ethanol production is described in

Figure 2. This method of distillation produces several possible feeds: distillers solubles, distillers dried solubles, wet distillers grains and dried distillers grains.

Klopfenstein (1981) reported that distillers feeds are generally considered to be a source of naturally protected proteins. This natural protection makes distillers grains a favorable feed for ruminant animals due to the low degradability of the protein in the rumen. Waller et al. (1980) quantified the by-pass value of distillers grains, reporting a value for by-pass of 53%. This means that 47% of the protein in distillers grains is degradable in the rumen. In addition Sniffen and Hoover (1978) reported that corn distillers dried grains have 10.3% soluble protein, 23.4% bound unavailable protein, and 66.3% insoluble available protein. Poos and Klopfenstein (1979) found that distillers dried grains were approximately equal to soybean when fed separately. When fed together, the dried distillers grains appeared to be 40%-50% superior to soybean meal.

In addition to having high protein levels and natural by-pass qualities, it appears that distillers feeds stimulate other digestive functions. Little et al. (1967) reported that distillers dried solubles were a potent source of unidentified factors which stimulated cellulose digestion.

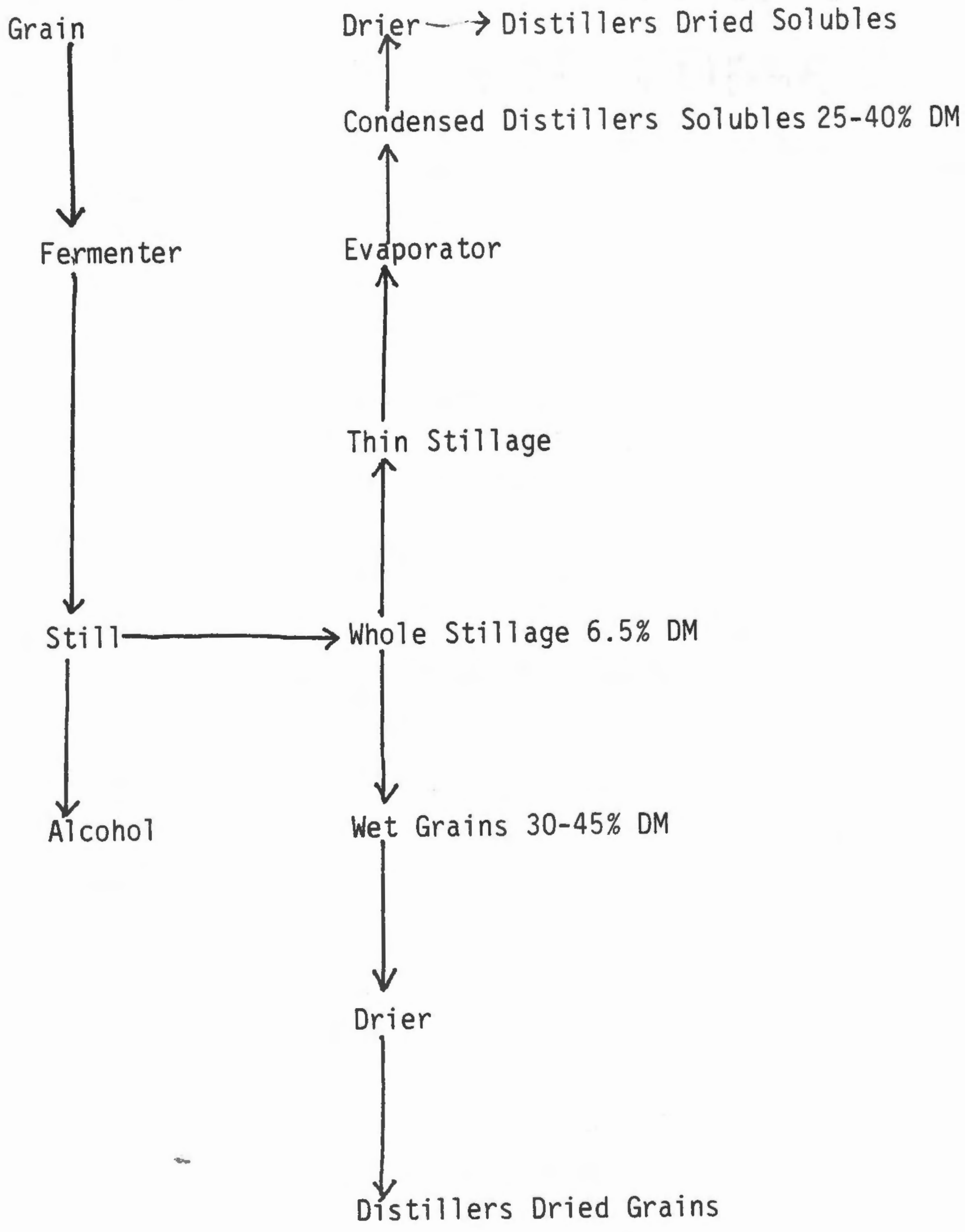

FIGURE 2. By-products of alcohol production.

Derived from Poos and Klopfenstein, 1979.

VI. HIGH MOISTURE ENSILAGE

With the increasing cost of fuel for powering on the farm grain dryers, many livestock producers are harvesting their corn at a higher level of moisture and ensiling it. This alleviates the fuel cost and has the extra advantage of liberating the land earlier for other crops. Corn grain, like all other ensiled material ferments during the ensiling process. This fermentation changes the natural characteristics of corn with regard to the nutritive value to animals.

During the fermentation process of high moisture corn, the proteins present change from an insoluble form to a soluble form. Much of the natural protein is degraded to nonprotein nitrogen (Prigge et al., 1976b). This increase in solubility is positively correlated with time of ensiling (Prigge et al., 1976a). In conjunction with this, the dry matter disappearance values of high moisture corn increase as the ensiling process is lengthened (Gaylean et al., 1974).

Lambs fed high moisture corn produced less urinary nitrogen and had a greater percentage of absorbed nitrogen than did lambs fed dried corn (Prigge et al., 1976). However no significant effects were reported when lambs were fed either high moisture corn, dry corn or acid treated high moisture corn (Polzin et al., 1972).

Voelker et al. (1982) reported no significant differences of milk yield, milk composition, dry matter intake, body weights, or rumen fatty acid production when cows received either high moisture corn or dry corn in a complete mixed ration.

CHAPTER III

MATERIALS AND METHODS

I. FEED PREPARATION

High Moisture Ration

The high moisture ration mix consisted of 35.1% barley, 15.0% corn grain, 36.4% ear corn, 11.7% soybean meal, .4% salt, .4% limestone, and 1.3% dicalcium phosphate. These ingredients were ground and mixed in a portable mixer grinder. The mix was then augered into a mix wagon equipped with electronic weigh cells. At this point, water was added to lower the dry matter to approximately 70%. The high moisture ration was thoroughly mixed and transferred into 55 gallon drums double lined with heavy plastic bags. The high moisture ration was tightly packed into the drums and the inner bag was folded and the outer bag was then tied. The drums were then sealed with rubber gaskets and lids and set aside for at least 30 days before feeding. The protein level of the high moisture ration was low, so 48% soybean meal was added at 1% of the total mix (Table 1).

Heated Dried Ration

The heated dried ration mix consisted of 67.7% corn grain, 12.55% dried brewer grains, 12.95% dried distillers grains, 4.3% heated soybean meal, .5% salt, .5% limestone, and

TABLE 1. Chemical Composition of Major Ingredients of the Rations on an as Fed Basis

Ingredient	% of mix	DM	TDN	CP	CF	CA	P
High Moisture Ration							
Ground ear corn	36.4	30.86	24.69	2.78	2.78	.015	.080
Corn grain	15.0	13.03	11.47	1.22	.26	.004	.040
Barley	35.1	30.28	24.83	2.85	2.27	.139	.097
Soybean meal 48%	11.7	10.28	8.33	5.66	.31	.037	.077
Salt	.4	.40	-	-	-	-	-
Limestone	.4	.40	-	-	-	.144	-
Dicalcium phosphate	1.3	1.29	-	-	-	.306	.243
Total	100.0%	86.54	69.32	12.51	5.62	.645	.537
Heated Dried Ration							
Corn grain	67.7	58.83	59.58	6.36	1.35	.02	.209
Brewers grains	12.55	11.16	8.28	3.31	1.81	.04	.07
Distillers grains	12.95	11.15	10.88	4.11	.67	.01	.05
Soybean meal heated	4.3	3.99	3.48	2.38	.13	.02	.03
Salt	.5	.5	-	-	-	-	-
Limestone	.5	.5	-	-	-	.180	.0001
Dicalcium phosphate	1.5	1.48	-	-	-	.356	.283
Total	100	87.61	82.22	16.16	3.96	.626	.632

1.5% dicalcium phosphate. The soybean meal was heated 50 pounds each time in a forced air oven at 135°C for eight hours. The soybean meal was then rebagged and set aside for mixing. The ingredients for heated dried ration were ground and mixed and rebagged for feeding purposes (Table 1).

II. SILAGE AND HAY

For this experiment corn silage was fed primarily from one silo with dry matter as close to 30% as possible. The hay used was from various sources. The hay was sampled and fed as received from suppliers.

III. ANIMALS AND EXPERIMENTAL DESIGN

Initially 18 Holstein cows ranging from second to sixth lactation were selected from the Knoxville dairy experimental units milking herd. these 18 animals were blocked according to milk production during previous lactation, and body weight. Due to illness and poor production three cows were dropped and replaced by three first lactation heifers. The treatments were assigned to cows randomly. The experiment was a switchback design with three 28 day experimental periods. The cows were moved into the housing facilities three days postpartum and were switched to their respective rations in the adjustment procedure shown in Table 2. Following this adjustment procedure, data were collected for the remaining 21 days. Rations

TABLE 2. Adjustment Procedure of Rations for Switching of Treatments

Day	Current ration (%)	Experimental ration (%)
1	100	0
2	80	20
3	70	30
4	60	40
5	40	60
6	30	70
7	20	80
8	0	100

were then switched in the same manner for the remaining two experimental periods. Treatments were set up in the following manner: Group 1, cows starting on high moisture ration, Period 1 = high moisture ration, Period 2 = heated dried ration, Period 3 = high moisture ration; Group 2, cows starting on heated dried ration, Period 1 = heated dried ration, Period 2 = high moisture ration, Period 3 = heated dried ration. During the course of the experiment, three more cows were dropped due to illness. In order to statistically analyze the data, cow number 213 was dropped to keep equal subclass members. The remaining 14 cows completed the experiment.

IV. HOUSING, FEEDING, AND MILKING

The cows were housed in a barn equipped with individual tie stalls. The stalls were equipped with individual water bowls and feed mangers. The cows were fed three times daily. They received three parts silage to two parts concentrate on an as fed basis twice daily and seven pounds of alfalfa hay once daily. The amount of ration fed was adjusted to insure at least a 10% refusal. No feed was fed in the milking barn. The cows were milked twice daily at 5:00 A.M. and 5:00 P.M.

V. COLLECTION OF DATA

Body weights were obtained on each cow during the first transitional period and once per week thereafter. Composite A.M. and P.M. milk samples were obtained weekly by means of an in-line proportional milk sampler. These samples were analyzed for total solids and crude protein. Data for butterfat percentages were obtained once per month when the entire herd was tested by the Dairy Herd Improvement Association. Milk weights were obtained at each milking by means of in-line volumetric weigh jars.

Representative samples of hay, silage, HMC, and HDC were taken every 10 days and analyzed for crude protein, crude fiber, acid detergent fiber, ash, ether extract, and dry matter. Amounts of feed fed and refused were weighed and recorded daily.

VI. PROTEIN SOLUBILITY STUDY

Both rations, high moisture ration and heated dried ration, were subjected to protein solubility analysis twice during the course of the experiment. The samples used were taken at the start of the experiment and at the end of the experiment. After 2 hrs. incubation in .15 molar NaCl as outlined by Crooker et al. (1978), crude protein was determined by the Kjeldahl method. These values are a relative measure between feedstuffs and do not measure degradability.

VII. ANALYTICAL METHODS

Samples of experimental rations were dried in a forced air oven at 50°C for 48 hrs. to determine dry matter. After equilibrating to room temperature, samples were ground through a 1 mm screen for laboratory analysis. Nitrogen on samples was determined by the Kjeldahl method (AOAC, 1965). Crude fiber, ether extract, and ash were determined by the methods described by AOAC (1965). Acid detergent fiber was determined by the method described by Van Soest (1963).

Total solids of the milk samples were determined by drying the milk samples for 3 hrs. in a 100°C oven. Crude protein of the milk samples was determined by the Kjeldahl method (AOAC, 1965).

VIII. STATISTICAL ANALYSIS

Statistical analysis were performed on the data as a switchback design using the method for analysis as described by Brandt (1938). Difference values were obtained by using the formula D = period 1 - (2 x period 2) + period 3. These difference values were analyzed using the statistical analysis system using the model Y = group treatment. A probability level of .05 was used to determine significant differences.

CHAPTER IV

RESULTS AND DISCUSSION

I. DRY MATTER INTAKE

Dry matter intake (DMI) was significantly different between the two treatment groups, group 1 (treatment scheme 1, 2, 1) and group 2 (treatment scheme 2, 1, 2). The mean difference values for DMI were -11.78 lbs. for group 1 and +4.94 lbs. for group 2 (Table 3). When student t-test was applied, a t-value of 4.76 was calculated which indicated that group 2 had a significantly higher DMI P<.005 (Table 4). This difference in DMI for group 2 is attributed to the higher dry matter percentage between rations 93.02 for ration 2 as compared to 68.77 for ration 1.

Crude Protein Intake

Crude protein intake (CPI) was significantly different P<.0001 in favor of group 2 (Table 4). The mean difference values for CPI were -2.24 lbs. for group 1 and +1.06 lbs. for group 2 (Table 5). the significant difference of CPI between rations was due to the increased dry matter intake by cows in group 2. Higher dry matter intake resulted in higher crude protein intake.

Dry Matter Intake Expressed as Pounds Per 100 lbs. Body Weight

Dry matter intake expressed in terms of body weight, (DMCWT) was determined to be significantly different (P<.0002). This, of

TABLE 3. Average Daily Dry Matter Intake (Pounds)

Cow No.	Period 1	Period 2	Period 3	D value[1]
Group 1[2]				
83	40.86	46.48	42.32	- 9.78
207	30.36	41.82	35.28	-18.00
206	29.54	39.45	33.20	-16.16
124	44.70	49.10	40.92	-12.58
266	30.22	38.12	26.28	-19.74
50	48.75	44.21	42.27	+ 2.60
204	39.02	40.79	33.73	- 8.83
Total	263.45	299.97	254	-82.49
Mean	37.64	42.85	36.28	-11.78
Group 2[3]				
182	30.17	31.19	34.26	+ 2.05
215	28.71	29.34	33.21	+ 3.24
119	44.94	44.03	45.11	+ 1.99
125	41.59	35.73	31.00	+ 1.13
262	21.29	18.44	19.92	+ 4.33
924	40.26	28.83	34.28	+16.88
216	26.48	24.74	27.95	+ 4.95
Total	233.44	212.30	225.73	34.57
Mean	33.35	30.33	32.25	+ 4.94
Total both groups	496.89	512.27	479.73	
Mean	35.49	36.59	34.27	

---

[1] D value is the statistical value obtained by the formula [period 1 - (2 x period 2) + period 3].

[2] Group 1 treatment scheme 1, 2, 1.

[3] Group 2 treatment scheme 2, 1, 2.

TABLE 4. t-Values, Students t-Test

Variables	t-value	Level of significance
Body weight	.67	NS
Milk yield	.42	NS
Milk fat percent	.29	NS
4% FCM	.45	NS
Crude protein milk percent	.88	NS
Total solids milk percent	.25	NS
Dry matter intake	4.76	P<.0005
Crude protein intake	7.07	P<.0001
Dry matter intake Expressed per 100 lbs. body weight	5.23	P<.0002

TABLE 5. Average Daily Crude Protein Intake (Pounds)

Cow No.	Period 1	Period 2	Period 3	D value[a]
Group 1[a]				
83	5.50	6.46	5.78	- 1.64
207	4.12	5.85	4.87	- 2,71
206	4.05	5.56	4.65	- 2.42
124	6.07	7.14	5.53	- 2.68
266	3.16	5.44	3.74	- 3.98
50	6.61	6.46	5.70	- .61
204	5.44	5.83	4.58	- 1.64
Total	34.95	42.74	34.85	-15.68
Mean	4.99	6.11	4.98	- 2.24
Group 2[a]				
182	4.38	4.34	4.92	+ .62
215	4.13	4.04	4.74	+ .79
119	6.28	6.00	6.52	+ .80
125	5.90	4.88	4.54	+ .68
262	3.08	2.51	2.98	+ 1.04
924	5.77	4.14	4.91	+ 2.40
216	3.77	3.41	4.11	+ 1.06
Total	33.31	29.32	32.72	+ 7.39
Mean	4.76	4.19	4.67	+ 1.06
Total both groups	68.26	72.06	67.57	
Mean	4.88	5.15	4.83	

---

[a] Refer to Table 3 for explanation of these values.

course, was attributible to the significant difference in dry matter intake in favor of cows in group 2. The mean difference values for DMCWT were -6.29 lbs. for group 1 and +.38 lbs. for cows on group 2 (Table 6). The t-value for DWCWT was 5.23 (Table 4).

Protein Solubility

The percent of soluble crude protein in the high moisture concentrate increased from 27.52% at the beginning of the experiment to 28.32% at the end of the experiment (Table 7). The high moisture concentrate at the start of the experiment was ensiled for a period of 30 days prior to feeding. It was during this period that most of the protein content was solubilized and it was not expected for much more solubilization to occur. The percentage of soluble crude protein for the heated dried concentrate ration decreased from 14.64% to 12.25% during the course of the experiment (Table 7). This decrease is probably due to difference in the shipments of the feeds as the supply of brewers grains depleted and a new shipment had to be obtained.

Body Weight

Body weights of cows were not significantly affected during the course of the experiment. Group 1 had a mean difference value of -19 lbs. for body weight while group 2 had a mean difference value of -3.29 lbs. for body weight (Table 8). The t-value for body weight was .67 (Table 4).

TABLE 6. Average Daily Dry Matter Intake in Pounds Per 100 lbs. Body Weight

Cow No.	Period 1	Period 2	Period 3	D value[a]
Group 1[a]				
83	2.78	3.05	2.76	- .558
207	2.65	3.39	2.81	-1.336
206	2.29	3.08	2.59	-1.261
124	3.55	3.81	3.17	- .908
266	2.87	3.41	3.33	-1.620
50	3.51	3.31	3.15	.033
204	3.00	3.08	2.52	- .640
Total	20.65	23.15	19.35	- 6.29
Mean	2.95	3.31	2.76	- .898
Group 2[a]				
182	2.18	2.19	2.42	+ .225
215	2.46	2.46	2.80	+ .337
119	3.45	3.35	3.37	+ .119
125	2.87	2.49	2.18	+ .073
262	2.42	2.09	2.20	+ .440
924	2.67	1.93	2.21	+1.017
216	1.91	1.75	2.01	+ .419
Total	17.96	16.27	17.20	2.63
Mean	2.56	2.32	2.46	.38
Total both groups	38.61	39.42	36.55	
Mean	2.76	2.82	2.61	

[a] Refer to Table 3 for explanation of these values.

TABLE 7. Solubility of the Crude Protein Content of the Experimental Ration on a Dry Matter Basis

	Crude protein (%)	Percentage of the crude protein that is soluble in .15 NaCl
High moisture ration sampled at beginning	15.30	27.52
High moisture ration sampled at end	15.61	28.32
Mean	15.46	27.92
Heated dried ration sampled at beginning	16.33	14.64
Heated dried ration sampled at end	16.32	12.25
Mean	16.33	13.45

TABLE 8. Average Daily Body Weight (Pounds)

Cow No.	Period 1	Period 2	Period 3	D value[a]
Group 1[a]				
83	1471	1524	1531	- 46
207	1146	1231	1256	- 60
206	1285	1281	1278	+ 1
124	1259	1287	1290	- 25
266	1053	1118	1128	- 55
50	1390	1334	1340	+ 62
204	1300	1323	1336	- 10
Total	8904	7990	9159	-133
Mean	1272	1141	1308	- 19
Group 2[a]				
182	1385	1426	1415	- 52
215	1167	1191	1185	- 30
119	1301	1313	1338	+ 13
125	1449	1437	1425	0
262	879	881	904	+ 21
924	1510	1490	1545	+ 75
216	1389	1415	1391	- 50
Total	9080	9153	9203	- 23
Mean	1297	1308	1315	-3.29
Total both groups	17984	17143	18362	
Mean	1285	1225	1312	

---

[a] Refer to Table 3, page 24, for explanation of these values.

II. MILK YIELD AND COMPOSITION

Milk Yield

Mean difference value for milk yield per day were .58 lbs. and -1.55 lbs. for group 1 and group 2, respectively. The mean milk yields per day of cows in group 1 were 85.20 lbs. for period 1, 79.63 lbs. for period 2, and 74.64 lbs. for period 3. Cows in group 2 had mean milk yield, per day of 89.47 lbs., 85.64 lbs., and 80.27 lbs for periods 1, 2, and 3, respectively (Table 9). The t-value for milk yield per day was .42 which was nonsignificant (Table 4, page 25). The results are similar to Mielke and Schingoethe (1981) who reported no significant differences in milk production and composition when cows receive a heated protein source. This is not consistent with the data of Clark (1975) and Chalupa (1975) who reported higher milk yields when cows receive more amino acids postruminally.

Milk Fat Percentage

Milk fat percentage (MF%) did not differ significantly between the two groups. Group 1 had a mean MF% of 3.07 for period 1, 2.94 for period 2, and 3.13 for period 3. Group 2 had a mean MF% of 3.2, 3.08, and 3.18 for periods 1, 2, and 3, respectively. The mean difference values for MF% were 2.2 for group 1 and 1.5 for group 2 (Table 10). The t-value for MF% was .29 which was nonsignificant (Table 4, page 25).

TABLE 9. Average Daily Milk Yield (Pounds)

Cow No.	Period 1	Period 2	Period 3	D value[a]
Group 1[a]				
83	78.82	65.87	61.71	8.782
207	73.92	77.34	67.45	-13.314
206	93.97	97.69	93.79	- 7.619
124	89.33	81.57	71.94	- 1.873
266	66.08	62.69	57.29	- 2.009
50	105.42	91.29	93.54	16.382
204	88.83	80.92	76.76	3.737
Total	596.37	557.38	522.48	4.086
Means	85.20	79.63	74.64	.58
Group 2[a]				
182	75.91	72.59	70.64	1.368
215	101.16	93.44	87.79	2.062
119	98.86	93.51	92.41	-15.766
125	115.43	105.30	103.66	8.486
262	69.91	65.15	64.34	3.961
924	89.47	88.27	73.99	-13.076
216	75.53	71.23	69.09	2.149
Total	626.27	599.49	561.91	-10.816
Means	89.47	85.64	80.27	- 1.55
Total both groups	1222.64	1156.88	1084.38	
Means	87.33	82.63	77.46	

---

[a] Refer to Table 3, page 24, for explanation of these values.

TABLE 10. Milk Fat Percent

Cow No.	Period 1	Period 2	Period 3	D value[a]
Group 1[a]				
83	3.7	3.0	3.2	+ .9
207	2.9	2.9	3.6	+ .7
206	3.2	2.9	3.0	+ .4
124	3.0	3.0	3.1	+ .1
266	3.0	3.3	2.9	- .7
50	2.7	2.9	2.8	- .3
204	3.0	2.6	3.3	+1.1
Total	21.49	20.58	21.91	2.2
Mean	3.07	2.94	3.13	
Group 2[a]				
182	3.2	2.8	2.7	+ .5
215	2.7	2.5	2.8	+ .5
119	4.2	3.6	3.7	+ .7
125	2.9	2.8	3.2	+ .5
262	2.5	3.2	2.7	-1.2
924	4.0	3.8	4.0	+ .4
216	2.9	2.9	3.0	+ .1
Total	22.4	21.56	22.56	1.5
Mean	3.20	3.08	3.18	

---

[a] Refer to Table 3, page 24, for explanation of these values.

Four Percent Fat Corrected Milk Yield Per Day

Milk yield per day was corrected to 4% milk fat by using the formula (.4 x milk) + 15 x (milk x (fat/100)). Cows in group 1 had a mean fat corrected milk (FCM) yield of 73.17 lbs. for period 1, 66.82 lbs. for period 2, and 64.70 lbs. for period 3. Cows in group 2 had a mean FCM yield of 76.17 lbs., 74.00 lbs., and 70.68 lbs. for periods 1, 2, and 3, respectively. The mean difference values for FCM were 4.08 lbs. for cows in group 1 and 1.72 lbs. for cows in Group 2 (Table 11). When the students t-test was applied to these values, a t-value of .45 was calculated which was nonsignificant (Table 4, page 25).

Milk Crude Protein Percent

Milk crude protein percentage (MCP%) was calculated to be nonsignificant. Mean MCP% for cows in group 1 were 3.08, 3.03, and 3.17 for periods 1, 2, and 3, respectively while cows in group 2 had values of 3.02, 2.82, and 2.94 for periods 1, 2, and 3, respectively. Mean difference values of MCP% were +1.37 and +2.49 for cows in group 1 and group 2, respectively (Table 12). When students t-test was applied, a t-value of .88 was calculated which was nonsignificant (Table 4, page 25).

Milk Total Solids Percent

Cows in group 1 had a mean milk total solids percent (MTS%) of 11.13 for period 1, 11.27 for period 2, and 11.58 for period 3. Cows in group 2 had a mean MTS% of 11.05, 11.09, and 11.00 for

TABLE 11. Average Daily Four Percent Fat Corrected Milk Yield (Pounds)

Cow No.	Period 1	Period 2	Period 3	D value[a]
Group 1[a]				
83	75.27	55.99	54.30	+17.59
207	61.73	64.58	63.40	- 4.035
206	82.69	81.57	79.72	- .727
124	75.93	69.34	62.22	- .515
266	56.17	56.11	47.84	- 9.209
50	84.86	76.23	76.70	+ 9.111
204	75.50	63.93	68.69	+16.342
Total	512.16	467.75	452.89	28.557
Mean	73.17	66.82	64.70	4.08
Group 2[a]				
182	66.80	59.52	58.98	+ 6.735
215	81.44	72.42	71.98	+ 8.583
119	101.82	97.30	88.25	- 4.536
125	96.38	86.35	91.22	+14.909
262	54.18	57.33	51.79	- 8.68
924	89.47	85.62	73.99	- 7.78
216	63.07	59.48	58.72	+ 2.829
Total	533.16	518.02	494.73	12.06
Mean	76.17	74.00	70.68	1.72
Total both groups	1065.32	985.77	947.67	
Mean	76.09	70.41	67.69	

[a] Refer to Table 3, page 24, for explanation of these values.

TABLE 12. Milk Crude Protein Percent

Cow No.	Period 1	Period 2	Period 3	D value[a]
Group 1[a]				
83	3.36	3.34	3.40	+ .28
207	3.54	3.16	3.22	+ .44
206	3.35	2.86	2.93	+ .56
124	2.92	3.28	3.48	- .16
266	2.75	2.88	3.01	0
50	2.68	2.76	2.92	+ .08
204	3.00	3.04	3.25	+ .17
Total	21.56	21.21	22.19	+1.37
Mean	3.08	3.03	3.17	+ .195
Group 2[a]				
182	3.18	2.86	3.23	+ .69
215	3.55	2.71	2.87	+ 1
119	3.22	2.74	2.85	+ .59
125	2.73	2.81	2.75	+ .14
262	2.96	2.94	3.13	+ .21
924	2.51	2.70	2.83	- .06
216	3.00	2.99	2.90	- .08
Total	21.14	19.74	20.58	2.49
Mean	3.02	2.82	2.94	.356

[a] Refer to Table 3, page 24, for explanation of these values.

periods 1, 2, and 3, respectively. Mean difference values for MTS% were 1.26 for cows in group 1 and -.9 for cows in group 2 (Table 13). Students t-test was applied and a t-value of .25 was calculated. MTS% was determined to be nonsignificant (Table 4, page 25).

The nonsignificance of the variables for milk composition is consistent with the data of Netemeyer et al. (1982) who reported that milk composition was not significantly affected when cows received heated soybean meal. Also, Mielke and Schnigoethe (1982) reported no significant change in milk fat percentage when cows receive heated soybean meal.

TABLE 13. Milk Total Solids Percent

Cow No.	Period 1	Period 2	Period 3	D value[a]
Group 1[a]				
83	11.89	12.15	12.84	.43
207	12.22	11.16	11.61	1.51
206	10.91	10.33	11.14	1.39
124	11.76	12.42	12.37	- .71
266	10.03	11.12	11.69	- .52
50	10.60	11.07	10.86	- .68
204	10.52	10.63	10.58	- .16
Total	77.91	78.89	81.06	1.26
Mean	11.13	11.27	11.58	.18
Group 2[a]				
182	10.96	11.80	11.77	- .87
215	10.75	10.33	10.97	+1.06
119	12.17	11.04	10.74	+ .83
125	10.01	10.67	10.60	- .73
262	11.30	11.05	11.20	+ .4
924	11.19	12.12	11.00	-2.05
216	10.97	10.62	10.73	+ .46
Total	77.35	77.63	77.00	- .9
Mean	11.05	11.09	11.00	- .128

[a] Refer to Table 3, page 24, for explanation of these values.

CHAPTER V

SUMMARY AND CONCLUSIONS

The objectives in this experiment were to determine the effects of a high degradable protein versus a low degradable protein upon milk production and composition. The results obtained from this experiment were all nonsignificant for each variable except dry matter intake and crude protein intake. The significant difference was created as the dry matter of HDC was higher than that of the HMC ration.

Several researchers have reported increased milk yield when a higher percentage of dietary protein bypasses the microbial digestion of the rumen and is digested in the postruminally. One measure of a protein's resistance to microbial degradation is the protein's solubility. A relative measure using .15 molar salts was used for this study and the relative solubility between the two diets suggests that the HDC should be more resistant to microbial degradation. One possibility to explain the nonsignificant values for milk yield would be that although the relative solubilities were vastly different, the degradability of the two diets were not different.

LITERATURE CITED

LITERATURE CITED

Ahrar, M. and D. J. Schingoethe. 1979. Heat treated soybean meal as a protein supplement for dairy cows. J. Dairy Sci. 62:932.

AOAC. 1975. Official Methods of Analysis, (12th ed.). Association of Official Agricultural Chemists. Washington, D.C.

Brandt, A. E. 1938. Tests of significance in reversal or switchback trials. Iowa Agric. Exp. Sta. Res. Bull. 234, p.1.

Chalupa, W. 1975. Rumen by-pass and protection of proteins and amino acids. J. Dairy Sci. 58:1198.

Clark, J. H. 1975. Lactational responses to postruminal administration of proteins and amino acids. J. Dairy Sci. 58:1178.

Cocimano, M. R. and R. A. Leny. 1967. Metabolism of urea in sheep. Br. J. Nutr. 21:353.

Crooker, B. A., C. J. Sniffen, W. H. Hoover, and L. L. Johnson. 1978. Solvents for soluable nitrogen measurements in feedstuffs. J. Dairy Sci. 61:437.

Faichney, G. L. 1971. The effect of formaldehyde-treated casein on the growth of ruminant lambs. Aust. J. Agr. Res. 22:453.

Faichney, G. J. and H. C. Davies. 1972. The effect of formaldehyde treatment of peanut meal in concentrate diets on the performance of calves. Aust. J. Res. 23:167.

Ford, A. I. and C. P. Milligan. 1970. Tracer studies of urea recycling in sheep. Can. J. Anim. Sci. 50:129.

Gaylean, M. L., E. C. Prigge, and R. R. Johnson. 1974. Dry matter disappearance and gas production of high moisture corn. J. Anim. Sci. 39:238 (Abstr.).

Glimp, H. A., M. R. Karr, C. O. Little, P. G. Woolfolk, G. E. Mitchell Jr., and L. W. Hudson. 1967. Effect of reducing soybean protein solubility by dry heat on the protein utilization of young lambs. J. Anim. Sci. 26:858.

Hecker, J. F. 1971. Metabolism of nitrogenous compounds in the large intestine of sheep. Br. J. Nutr. 25:85.

Hogan, J. P. 1975. Quantitative aspects of nitrogen utilization in ruminants. J. Dairy Sci. 58:1164.

Hudson, L. W., H. A. Glimp, C. O. Little, and P. G. Woolfolk. 1970. Ruminal and postruminal nitrogen utilization by lambs fed heated soybean meal. J. Anim. Sci. 30:609.

Klopfenstein. T. 1974. New concepts in protein nutrition for ruminants. Proc. Nebraska Feed and Nutr. Conf. P.B1.

Klopfenstein, T. 1981. Alcohol by-products for ruminants. Proc. Maryland Nutr. Conf. for feed manaf. pp.78.

Klopfenstein, T., N. Merchan, and W. Rounds. 1977. Value of brewers dried grains protein for beef cattle. Page 36 in Tech. Papers Feed Conf., U.S. Brewers Assoc. Inc., St. Louis, MO.

Krause, V. E. 1973. Dehydrated alfalfa as a protein source in ruminant rations. PhD Dissertation, University of Nebraska, Lincoln.

Little, C. O., G. D. Potter, and G. E. Mitchell. 1967. Rumen stimulatory factors in distillers feeds: current development. Proc. Distillers Feed Conf. 22:13.

Merchen, N., T. Hanson, and T. Klopfenstein. 1979. Ruminal by-pass of brewers dried grain protein. J. Anim. Sci. 49:192.

Mielke, C. D. and D. J. Schingoethe. 1981. Heat treated soybeans for dairy cows. J. Dairy Sci. 64:1579.

Morrison, F. B. 1961. Feeds and Feeding Abridged. p. 296.

Murdock, F. R., A. S. Hodgson, and R. E. Riley, Jr. 1981. Nutritive value of wet brewers grains for lactating cows. J. Dairy Sci. 64:1826.

Netemeyer, D. T., L. J. Bush, J. W. Ward, and S. A. JaFri. 1982. Effect of heating soybean meal for dairy cows. J. Dairy Sci. 65:235.

Nishamuta, J. F., D. G. Ely, and J. A. Boling. 1972. Nitrogen metabolism in lambs fed soybean meal treated with heat, formalin, and tannic acid. J. Nutr. 103:49.

Owens, E. L. 1959. Observations on the toxicity of brewers grains for dairy cows. N. Z. Vet. 7:43.

Peter, A. P., E. E. Hatfield, F. N. Owens, and U. S. Garngus. 1971. Effects of aldehyde treatments of soybean meal on invitro ammonia release, solubility and lamb performance. J. Nutr. 101:605.

Polzin, H. W., D. E. Otterby, J. M. Murphy, and D. G. Johnson. 1971. Utilization of ensiled, acid tested and dry corn on lambs. J. Anim. Sci. 35:1133.

Poos, M. J. and T. Klopfenstein. 1979. Nutritional value of by-product of alcohol production for livestock feeds.

Preston, R. L., R. D. Vance, and V. R. Cahill. 1973. Energy evaluation of brewers grains for growing and finishing catte. J. Anim. Sci. 37:174.

Prigge, E. C., R. R. Johnson, F. N. Owens, D. Williams. 1976a. Utilization of nitrogen from ground high moisture corn and dry corn by ruminants. J. Anim. Sci. 43:705.

Prigge, E. C., R. R. Johnson, F. N. Owens, and D. Williams. 1976b. Soluble nitrogen and acid production of high moisture corn. J. Anim. Sci. 42:490.

Satter, L. D. and R. E. Roffler. 1975. Nitrogen requirement and utilization in dairy cattle. Symposium. J. Dairy Sci. 58:1219.

Satter, L. D. and L. W. Whitlow. 1977. Resistance of protein in brewers dried grains to microbial degradation in the rumen. U.S. Brewers Assoc. Feed Conf. p.7.

Sherrod, L. B. and A. D. Tillman. 1962. Effects of varying the processing temperatures upon the nutritive values for sheep of solvent extracted soybean and cottonseed meals. J. Anim. Sci. 21:901.

Sniffen, C. J. and W. H. Hoover. 1978. Amino acid profile of dietary by-pass protein and its importance to ruminants. Proc. Distill. Feed Conf. 33:61.

Snook, J. T. and J. H. Meyer. 1964. Factors influencing the significance of endogenous nitrogen to the nonruminant: In the role of the gastrointestinal tract in protein metabolism. H. N. Muno, ed. Blackwell, Oxford.

Steel, J. W. and J. P. Hogan. Unpublished data.

Tamminga, S. 1980. Amino acid supply and utilization in ruminants. Precirculated Paper 3rd International Symposium on Protein Metabolism and Nutrition.

Van Soest, P. J. 1963. The chemical basis for the nutritive evaluation of forages. Proc. National Conf. on Forage Quality and Utilization. Lincoln, Nebraska U.I.

Voelker, H. H., D. J. Schnigoethe, A. K. Clark, G. D. Stewart, and F. C. Ludens. 1982. High moisture versus dry corn in complete mixed rations for lactating cows of production and type breeding groups. J. Dairy Sci. Suppl. 1, 65:149.

Waller, J., T. Klopfenstein, and M. Poos. 1980. Distillers feeds as protein sources for growing ruminants. J. Anim. Sci. 51:1154.

Youssef, S. 1966. The effect of heating the concentrate portion of the ration or the ammonia, pH and volatile fatty acid contents of the rumen fluid of the cow. Gast-Medewerker Aanhet Instituut Voor Veevoedingsonderzock "Hoorn" gedurende de zomer von 1966.

APPENDIX

TABLE 14. Means and Standard Deviations of Feed Analysis

Sample	Hay	Silage	High Moisture Conc.	Heated Dry Conc.	Soybean Meal
Analysis					
Dry Matter (%)	91.25 ± 1.69	32.83 ± 1.51	68.77 ± .43	93.02 ± 1.06	89.00 ± .60
Crude Protein (%)	17.07 ± .99	8.44 ± .32	15.32 ± .21	16.61 ± .22	49.23 ± .54
Crude Fiber (%)	34.43 ± 3.15	20.65 ± 1.16	6.64 ± .84	5.56 ± .23	2.67 ± 1.62
Acid Det. Fiber (%)	41.16 ± 3.19	20.06 ± 1.42	9.46 ± .78	9.14 ± .44	4.69 ± .98
Ash (%)	7.09 ± 2.43	4.39 ± .40	4.37 ± .69	5.35 ± .21	7.44 ± .69
Ether Extract (%)	2.79 ± 2.56	3.75 ± .612	3.44 ± .76	5.411 ± .22	2.86 ± 1.2

TABLE 15. Means and Standard Deviations for Production Data

	Period 1	Period 2	Period 3
Group 1			
Body wt. (lbs)	1272.00 ± 140.53	1299.71 ± 122.66	1308.43 ± 121.01
Milk yield (lbs)	85.19 ± 13.23	79.63 ± 12.58	74.64 ± 14.47
Milk fat (%)	3.07 ± .31	2.94 ± .21	3.13 ± .27
Four percent fat corrected milk (lbs)	73.16 ± 10.53	66.82 ± 9.64	64.69 ± 11.44
Milk crude protein (%)	3.08 ± .33	3.03 ± .20	3.17 ± .22
Milk total solids (%)	11.13 ± .82	11.27 ± .75	11.58 ± .80
Dry matter intake (lbs)	37.64 ± 7.74	42.84 ± 3.94	36.28 ± 5.93
Crude protein intake (lbs)	4.99 ± 1.24	6.11 ± .61	4.98 ± .74
Dry matter intake Per body weight (lbs)	2.95 ± .45	3.31 ± .27	2.76 ± .31
Group 2			
Body wt. (lbs)	1297.14 ± 214.60	1307.57 ± 212.59	1314.71 ± 210.99
Milk yield (lbs)	89.47 ± 16.63	85.64 ± 16.18	80.27 ± 14.50
Milk fat (%)	3.20 ± .65	3.08 ± .47	3.18 ± .48
Four percent fat corrected milk (lbs)	79.02 ± 18.06	74.00 ± 15.98	70.71 ± 15.16
Milk crude protein (%)	3.02 ± .34	2.82 ± .11	2.94 ± .17
Milk total solids (%)	11.05 ± .64	11.09 ± .65	11.00 ± .39
Dry matter intake (lbs)	33.35 ± 8.89	30.33 ± 8.10	32.25 ± 7.60
Crude protein intake (lbs)	4.76 ± 1.22	4.19 ± 1.09	4.67 ± 1.06
Dry matter intake Per body weight (lbs)	2.56 ± .50	2.32 ± .52	2.46 ± .47

VITA

Jeffry Shannon Miller was born in McDowell, Kentucky on December 2, 1958. His parents are Mr. and Mrs. Hugo E. Miller, Drift, Kentucky. After graduation from McDowell High School in June 1976 he entered Berea College and graduated May 1980 with a B.S. in Agriculture. He entered The University of Tennessee, Knoxville to pursue a degree in animal science with emphasis on dairy nutrition and management. After a years leave of absence the degree was granted August 1983. The author is a member of Delta Tau Alpha and an Associate Member of Farmhouse Fraternity.