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Effect of rumen undegradable fat at two levels of undegradable intake protein in early lactation through mid-lactation of dairy cows

Markus Hugh Campbell

To the Graduate Council:

I am submitting herewith a thesis written by Markus Hugh Campbell entitled "Effect of rumen undegradable fat at two levels of undegradable intake protein in early lactation through mid-lactation of dairy 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.

J.K. Miller, Major Professor

We have read this thesis and recommend its acceptance:

J.C. Waller, J.K. Bernard

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 Markus Hugh Campbell entitled "Effects of Rumen Undegradable Fat at two Levels of Undegradable Intake Protein in Early Lactation Through Mid-Lactation of Dairy 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.

James K. Miller

J. K. Miller, Major Professor

We have read this thesis
and recommend its acceptance:

John K. Bernard

John C Waller

Accepted for the Council:

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EFFECT OF RUMEN UNDEGRADABLE FAT AT TWO LEVELS OF UNDEGRADABLE INTAKE PROTEIN IN EARLY LACTATION THROUGH MID-LACTATION OF DAIRY COWS

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Markus Hugh Campbell

August 1993

DEDICATION

This thesis is dedicated to my son and daughter, Thomas Drew and Sarah Ann Campbell.

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Sincere appreciation is extended to Dr. J. K. Miller, Major Professor, for his guidance and patience. Gratitude is offered to Dr. J. C. Waller and Dr. J. K. Bernard for their comments and assistance. Appreciation is expressed to CBP Resources, Inc. for providing the Carolac and Caromeal. Special thanks to the workers of University of Tennessee Cherokee Dairy Unit, without their help the research would not have been possible. Thanks to Dr. F. M. Hopkins and M. Daughtridge-Coppock for assistance with ultrasound measurements. Appreciation is extended to Dr. A. M. Saxton and Dr. J. D. Quigley for statistical assistance. Thanks to Clyde Holmes for encouragement and patience. Thanks to my parents, George T. and Iva Jean for their encouragement. Last, but not least, special thanks to my wife, Susan, for her support and patience throughout this course of graduate study.

ABSTRACT

Sixty multiparous Holstein cows were fed four concentrates formulated to contain 0 or .45 kg supplemental fat (SF) and 16% CP of which 36 or 42% was undegradable intake protein (UIP). A commercial blend of hydrolyzed feather meal and conventional cooker-dried blood meal along with dried distillers grain were used to increase the UIP percentage. Prilled, partially saturated beef tallow was the supplemental fat source. The control diet (36% UIP and 0 SF) was fed during the covariate period from calving through wk 4. At wk 5 postpartum, cows were switched to one of four experimental concentrates which they received for the following 17 wk: control, Fat (36% UIP and .45 kg SF), UP (42% UIP and 0 SF), and Fat + UP (42% UIP and .45 kg SF). The main effects were increased UIP and SF.

Milk yield, concentrate intake, body weight and body condition score were not different due to treatment. Fat treatment tended to increase yield of four percent FCM (42.9 vs 40.8 kg/d) and milk protein (1.32 vs 1.23 kg/d). UP treatment had no significant effects. The interaction of Fat + UP decreased milk fat percent (2.79 vs 3.10%) and increased milk protein percent (3.12 vs 3.02%), which supports increased UIP content in the diet when SF is fed.

Ultrasound measurements taken at the withers, between the twelfth and thirteen rib, and midpoint of the hooks and pins were compared with body condition scores (scale 1 = thin, 5 = fat). A low correlation between ultrasound measurements and body condition score indicates that body condition in dairy cattle should not be predicted by ultrasound measurements.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The ruminant animal can ultilize feedstuffs that are of little or no value to non-ruminants because of microbes in the rumen. Rumen microbes can digest structural carbohydrates into volatile fatty acids which provide energy for the host. They also convert nonprotein nitrogen and low quality protein into high quality microbial protein. Microbes, when washed from the rumen into the lower digestive tract, become available as absorbable protein with an amino acid profile similar to that found in milk. Microbial protein is thus an excellent source of protein for the lactating dairy cow. However, there is an upper limit to the amount of microbial protein that can be produced, which restricts milk production of cows fed only forage. In addition, rumen microbes may indiscriminately deaminate dietary protein faster than the ammonia can be incorporated into microbial protein. Since excess ammonia is converted to urea and excreted, microbial protein may fall short of the cow's total absorbable protein requirements.

When milk production is expected to be higher than can be supported by energy or microbial protein from forage alone, concentrates are added to the diet. The concentrates both increase energy content of the diet and allow for maximum microbial production. The ratio of concentrate to forage is important to microbial health which is very sensitive to changes in pH. Experience has shown concentrate should not exceed 60% of total dietary dry matter to avoid decreasing rumen pH to levels unfavorable for microbial growth.

Dairy cows in early lactation are unable to increase energy intake to meet energy requirements for high milk production so negative energy balance occurs. Since concentrate is limited at 60% of dry matter intake, more energy dense feeds are needed. Supplemental fat such as animal fat, vegetable fat, or oil seeds can be used to increase energy content of the diet since fat contains 2.25 times as much energy as carbohydrates. However, addition of fat to diets above five percent of total dry matter intake has detrimental effects on fiber digestion and results in milk fat depression. To avoid milk fat depression, fat added above five percent of total dry matter intake should be protected from rumen degradation.

The additional absorbable protein requirement of a high producing cow can not always be met simply by increasing dietary protein. This may result in deamination of protein in the rumen faster than the microbes can use the ammonia so the excess is lost as urea and microbial protein does not meet absorbable protein requirements. In addition, body condition is lost during the period of negative energy balance in early lactation. Weight lost in early lactation is much higher in fat than protein so additional protein is needed to utilize the mobilized fat for milk production. For these reasons, additional protein absorbable from the lower digestive tract should be beneficial.

Fat sources, which were unprotected in the rumen, have been added to diets to increase energy density and milk production. Rumen protected fat sources have been added to diets to increase milk fat percent in addition to milk yield. However, a lower milk protein percent has been observed with most protected fat sources. Apparently supplemental fat increases lactose synthesis, without increasing milk protein synthesis giving an illusion of milk protein percent depression. Prilled, partially saturated tallow has been used without a depression in milk protein percent. The objective of this experiment was to valuate the effect of prilled, partially saturated tallow of dairy cows in early lactation and determine if increased level of undegradable intake protein would further increase milk protein percent.

CHAPTER II

REVIEW OF LITERATURE

Dairy cows peak in lactation before peak in dry matter intake is reached. During the lag time for dry matter intake to become adequate for milk production, cows are in negative energy balance. Supplemental fats added to diets to increase energy intake (Casper et al., 1990; Palmquist, 1991) have increased milk yield in some (Casper et al., 1990; Jenkins and Jenny, 1989; Lubis et al., 1990; Palmquist and Jenkins, 1980; Satter, 1986; Sklan, 1991; Wonsil and Herbein, 1991) but not all comparisons (Dunkley et al., 1977; Grummer, 1988; Jerred et al., 1990; MacLeod et al., 1977; Palmquist, 1988). No milk yield response was observed when supplemental fat was fed in early lactation (Skaar et al., 1989). The lack of response in early lactation may be due to reduced dry matter intake when supplemental fat is fed. Furthermore, fat can have detrimental effects on rumen fiber digestion (Guillaume et al., 1991; Jenkins and Jenny, 1989; Lubis et al., 1990) and thus, decrease milk fat percentage. The cow is dependent on the rumen microbes to produce volatile fatty acids for energy and microbial protein which can be absorbed in the lower digestive tract

(Church, 1988). To protect the rumen microbes from harmful effects and still provide energy for absorption in the small intestine, rumen protected fat sources have been developed (Lubis et sl., 1990; Schauff, 1989). Total fat provided can reach 7 to 8% of total dry matter intake (Palmquist and Conrad, 1978). Unprotected fats can provide 4 to 5% of fat in diets fed to lactating dairy cows, but the remaining 3 to 4% of the maximum 8% should be provided by rumen protected sources. For example, partial hydrogenation of tallow increases melting point and decreases hydrolysis in the rumen (Jenkins and Jenny, 1989; Palmquist and Jenkins, 1980). Partially hydrogenated fats are more digestible than completely hydrogenated fat in the small intestine (Wu et al., 1991). Although, there is generally a depression of milk protein percentage with most added supplemental fats (Burgess et al., 1987; Canale et al., 1990; Casper et al., 1990; Dunkley et al., 1977; Grummer, 1988; MacLeod et al., 1977, Palmquist and Jenkins, 1980; Satter, 1986), not all supplemental fats, for example prilled fat (Grummer, 1988), reduce milk protein percent (Jerred et al., 1990).

Some researchers suggest 72 g additional rumen undegradable intake protein should be fed with each megacalorie of net energy lactation from fat above 3% (Ferguson et al., 1988). Protein in the diet is divided into rumen degradable and undegradable portions (Chalupa, 1984). The rumen microbes require a nitrogen concentration of 5 mg/100 ml of rumen fluid for maximum microbial protein production (Satter and Slyter, 1974). This level of nitrogen should be provided to obtain the benefical energy production from fiber digestion by rumen microbes. A diet containing 11 to 14% crude protein (dry matter basis) will provide the required nitrogen for maximum microbial production (Satter and Roffler 1975). Weight loss in early lactation is five times greater in fat than protein, therefore an increased dietary protein level is required for utilization of mobilized fat (McGuffey et al., 1990). Supplemental fat did not decrease body weight loss but, cows on supplemental fat had greater body weight gain after wk 8 of lactation than controls (Skaar et al., 1989). Since protected fat is mostly unavailable in the rumen, less energy is available for synthesis of microbial protein (Canale et al., 1990; Dunkley et al., 1977). If protein is low, lipoprotein synthesis may also be reduced and very low density lipoproteins are a major pathway for lipid transport to the mammary gland (Canale et al., 1990; Glascock and Welch, 1974). An inadequate supply of fat and protein to the mammary gland can reduce synthesis of both milk fat and milk protein. Additional undegradable intake protein is required to increase total protein flow to the small intestine (Satter, 1986) and possibly increase amount of milk protein produced, as has been shown with ruminally protected amino acids (Canale et al., 1990; Clark, 1975; Donkin et al., 1989; Rogers et al., 1987). Milk yield responded to increased undegradable intake protein in some (Broderick, 1986; Cadorniga and Satter, 1988; McGuffey et al., 1990; Taylor et al., 1991) but not all (Donkin et al., 1989; Guillaume et al., 1991; Robinson et al., 1991; Taylor et al., 1991) investigations. Neither have protected amino acids always increased milk protein percent (Guillaume et al., 1991; Papas et al., 1984; Rogers et al., 1987). In another study cows fed protected methionine consumed more feed and gained more weight than controls (Papas et al., 1984).

Results have varied when supplemental fat and ruminally protected sources of amino acids were combined by different investigators. The combination of added fat and ruminally protected amino acids increased milk fat and milk yield more than the sum of either fed separately in one study (Canale et al., 1990). Effects of supplemental fat in the form of calcium salts and increased level of undegradable intake protein were additive in another report (Ferguson et al 1988). The present experiment was designed to evaluate responses of dairy cows in early lactation to supplemental fat from prilled partially saturated tallow and increased undegradable intake protein and possible interactions on milk yield, four percent fat corrected milk, and yields and percentages of milk fat and protein. Since prilled fat sources have not shown a depression in milk protein percent, possibly the combination of prilled fat and increased undegradable intake protein may increase milk protein percent. An increase in milk protein percent becomes more important as the pricing deferential shifts more toward milk protein percent and away from milk fat percent. Additional parameters included concentrate intake, body weight and body condition.

Cows with the proper amount of body condition at calving will produce more milk than cows that are under condition (Wildman et al., 1982). Proper body condition is important for optimal health and enhanced reproductive performance. Cows in proper body condition had fewer days to first service and conception than thin cows and less reported incidence of mastitis (Jones and Garnsworthy, 1988). However, body condition is a subjective observation which allows interpretation error by the individual that is scoring. Ultrasound measurements were shown to be correlated to fat depth over the 10th and 13th rib (r^2 =

.589) in lactating dairy cows (Jones and Gransworthy, 1988). Ultrasound measurements or body condition scores were as accurate as carcass measurements in predicting body composition in beef cows (Bullock et al., 1991). Body condition scoring is largely evaluated from the fat covering of the rump and tailhead area. The area above the 12th and 13th rib is also evaluated. Ultrasound measurements have not been compared to this area between the hooks and pins. Body condition scores (subjectively on a scale 1 = thin, 5 = fat) and ultrasound measurements (objective) at the areas of body condition scoring and at withers were compared as means of evaluating and predicting body condition in dairy cows.

CHAPTER III

MATERIALS AND METHODS

Sixty multiparous Holstein cows were used in a 2 X 2 factorial experiment starting October 1991. Postpartum cows were fed alfalfa hay and corn silage mixed with small grain silage for ad libitum intake during a 4 wk covariate period. Cows were started at 5.44 kg of control concentrate at d 1 postpartum and were increased .45 kg per day until a maximum of 18.1 kg was reached. Cows were blocked according to body condition score (< 3.5, = > 3.5) and lactation number (2 and > 2) in wk 4. Cows were randomly assigned to treatment for wk 5 through wk 22. Treatments were arranged in a 2 X 2 factorial with concentrate fed with or without addition of prilled partially saturated tallow (SF) (Carolac, CBP Inc. Raliegh N. C.) and two levels of concentrate undegradable intake protein as factors. Hydrolyzed feather meal and conventional cooker-dried blood meal (Caromeal, CBP Inc. Raliegh N. C.), as well as distillers dried grain with solubles were used to increase undegradable intake protein of concentrate. Ingredients were adjusted to increase undegradable intake protein content and maintain isonitrogenous concentrates.

Isonitrogenous concentrates were formulated to contain 36% UIP and 0% SF (control), 36% UIP and 4% SF (Fat), 42% UIP and 0% SF (UP), 42% UIP and 4% SF (Fat plus UP). Cows were challenged fed concentrate at 18 kg/d from wk 5 through wk 13. After wk 13 cows receive 1 kg concentrate for each 2.1 kg of milk yield. Diets containing supplemental fat were fed at a rate of 11.3 kg/d to provide .45 kg/d of supplemental fat to each cow. The control concentrate filled the remaining balance for the fat treatment and the UP concentrate was used for the remaining balance for the fat plus UP treatment. The four concentrates were stored in sperate bins and provided to individual cows continuously via electronic feeder (Ration Master II, Alfa-Laval Agri, Inc., Kansas City, Mo.). Cows receiving the control and fat treatments were housed on the west side of the lot and cows receiving the UP and Fat plus UP treatments were housed on the east side of lot. Hay 1 was fed on the west side of the lot and hay 2 was fed on the east side of the lot. Silage and hay were offered for ad libitum intake at 0700, 1300 and 1630 hr.

Samples were taken weekly of all concentrates and forages and were combined in 4 wk composites. Samples were dried at 100 C to determine dry matter and ground through a 1 mm screen. Samples were then analyzed for crude protein, ether extract, gross energy (Association of official analytical chemist, 1980), acid detergent fiber and neutral detergent fiber (Goering and Van Soest, 1970). Calcium was determined by atomic absorption spectroscopy (Emmel et al., 1977). Phosphorus was determined by ultraviolet visual fast scan spectrophometer (Hawk et al., 1948). Undegradable protein was estimated using published values (NRC, 1989).

Individual feed concentrate was electronically measured daily for a weekly total. Milk production was measured twice daily at 0130 and 1330 hr (Palor Master, Alfa-Laval Agri. Inc., Kansas City, Mo.) and totaled for each week. Milk samples were taken at two consecutive A.M. and P.M. milkings and analyzed for milk fat and protein percent weekly by infrared analysis (Bentley 2000, Bentley Instruments Inc., Chaska, MI). Body weights were measured at 0800 hr every 4 wk (average of 2 consecutive days during treatment and 3 consecutive days averaged at the beginning and end of the treatment period).

Data were analyzed using the general linear mixed model procedure of GLMM with the model

$$Y_{ijk} = \mu + B\ (cov) + T_i + C(T)_{ij} + W_k + (W*T)_{ik} + e_{ijk}$$

where

Y is the dependent variable (milk yield, four percent fat corrected milk, milk component, body weight, body condition score, and concentrate intake;

μ is the overall mean of the population;

B is the linear regression coefficient for the dependent variable during wk 2 through 4 of lactation for cow j;

T_i is the average effect of treatment i;

$C(T)_{ij}$ is the average effect of cow j nested with treatment i;

W_k is the average effect of wk k;

e_{ijk} is the unexplained residual element assumed to be independent and identically distributed.

Since the correlation between each wk was different, a repeated measures analysis was considered but determined not necessary.

Body condition scores (scale 1 = thin, 5 = fat) were measured subjectively monthly. Ultrasound measurements of fat were measured at point of withers, between twelfth and thirteen rib, and between hooks and pins every 4 wk with five mega hertz transducer (Pie Medical Scanner 450 UG, Pie Medical Equipment B. V., Philipsweg, Netherlands) and compared to the subjective body condition scores.

Data were analyzed using regression procedure of SAS with the model:

$BCS_{ijk} = W_i + R_j + H_k$

where:

BCS_{ijk} is the dependent variable (body condition score);

W_i is the ultrasound measurements taken at withers;

R_j is the ultrasound measurement taken between twelfth and thirteenth rib;

H_k is the ultrasound measurement taken at midpoint of hooks and pins.

CHAPTER IV

RESULTS AND DISCUSSION

Forage chemical analysis is presented in table 1. Crude protein values for the alfalfa hay were lower than estimated and may have resulted in a deficiency of protein provided to rumen microbes resulting in less benefit from increased undegradable intake protein.

TABLE 1. Chemical composition of forage.

Item	Hay #1	Hay #2	SE[1]	Silage	SE[2]
			%		
DM	88.06	89.48	3.48	31.71	2.10
			% DM		
CP	16.67	17.18	1.38	7.87	1.15
EE	1.78	1.29	.28	2.80	.42
ADF	38.15	42.44	2.68	30.83	4.80
NDF	53.76	56.30	2.51	49.31	10.14
Ca	10.89	10.43	1.22	4.44	3.65
P	3.35	3.02	.16	2.97	.48

[1]Standard deviation of sample analysis of hay 1 and hay 2.
[2]Standard deviation of sample analysis of silage.

The ingredient composition and chemical analysis of the experimental concentrates are listed in table 2.

TABLE 2. Ingredients and chemical composition of the experimental concentrates.

Ingredient	Treatment				
	Control	Fat	UP	Fat+UP	SE
Wheat middlings	39.20	37.63	33.70	32.35	
Corn	39.12	37.56	39.65	38.06	
Soybean meal 48% CP	12.70	12.19	6.90	6.62	
Distillers dried grains	0.00	0.00	9.20	8.83	
Limestone	1.65	1.58	1.55	1.49	
Molasses	4.00	3.84	4.00	3.84	
Salt	0.90	0.86	0.90	0.86	
Animal fat	0.88	0.84	0.30	0.29	
Dynamate	0.50	0.48	0.50	0.48	
Dical. Phos.	1.05	1.01	1.30	1.25	
Feather and blood meal[1]	0.00	0.00	2.00	1.92	
Supplemental fat[2]	0.00	4.00	0.00	4.00	
DM (%)	87.97	88.77	88.46	88.87	.84
CP (% of DM)	17.73	17.48	17.72	17.02	.68
UIP (% of CP)[3]	36.00	36.00	42.00	42.00	
EE (% of DM)	4.52	7.84	5.11	8.18	1.84
ADF (% of DM)	6.29	6.61	7.10	7.00	.97
NDF (% of DM)	22.96	23.04	23.98	24.24	1.70
GE (Kcal/g of DM)	4.39	4.50	4.42	4.54	.10
Ca (mg/g of DM)	13.72	14.58	15.09	14.16	2.21
P (mg/g of DM)	8.42	8.21	8.77	8.49	.49

[1] Caromeal, CBP Inc. Raliegh N.C.

[2] Carolac, CBP Inc. Raliegh N.C.

[3] Calculated by estimates in NRC 1989

The addition of supplemental fat increased the ether extract 3.07%, which is slightly less than the calculated 3.96%. Gross energy increased by .11 Kcal/g which indicates a large increase in energy considering that the range for lactating dairy cows for net energy lactation is only .29 Kcal/g of dry matter intake.

Milk yield, milk components, concentrate intake, body weight and body condition scores are listed in table 3. Although not significant (P = .26), supplemental fat tended to increase milk yield more than three percent (Figure 1). An increase in milk yield was observed with other research where supplemental fat was added to the diet (Broderick, 1986; Canale et al., 1990; Casper et al., 1990; Ferguson et al., 1988; Kim et al., 1993; Satter, 1986). An increased in milk yield resulted when sodium alginated tallow was added to the diet (Hoffman et al., 1991). However, there are studies where protected tallow did not significantly change milk yield (Drackley and Elliott, 1993; Dunkley et al., 1977). Cows fed fat treatment tended to maintain a slightly higher level of milk production throughout the trial which is evidence of a higher plane of energy intake. Fat treatment tended to increase four percent fat corrected milk yield by 2.6 kg/d (P = .09). This increase in fat corrected milk yield is agreeable with results where tallow

TABLE 3. Effects of supplemental fat, increased UIP and interaction on milk yield, four percent fat corrected milk yield, milk fat percent and yield, milk protein percent and yield, concentrate intake, body weight and body condition score.

	Treatment[1]					Effects (P)[2]		
Item[3]	Cont	Fat	UP	F+UP	SE	F	F+UP	TxWk
MY	40.8	42.9	40.3	42.2	1.2			
4%FCM	34.7	37.3	33.6	33.7	1.1	.09		.05
MF%	3.10	3.14	2.95	2.79	.11		.04	.02
MP%	3.02	3.08	3.02	3.12	.03		.04	
FY	1.23	1.33	1.16	1.13	.05	.12		.02
PY	1.23	1.32	1.21	1.29	.03	.08		
CI	15.0	15.7	14.7	15.4	.4			
BW	636.9	632.3	634.1	626.0	12.6			
BCS	2.5	2.5	2.6	2.4	.08			

[1]Treatments: Cont (36% UIP, 0 SF); Fat (36% UIP, 4% SF); UP (42% UIP, 0 SF) F + UP (42% UIP, 4% SF).

[2]Effects: F = Fat, F + UP = Fat + UP interaction, T x Wk = Treatment by Week interaction, UP not listed (no significant effects). P values > .12 are not listed.

[3]MY = milk yield, 4%FCM = four percent fat corrected milk, MF% = milk fat percent, MP% = milk protein percent, FY = milk fat yield, PY = milk protein yield, CI = concentrate intake, BW = body weight, BCS = body condition score.

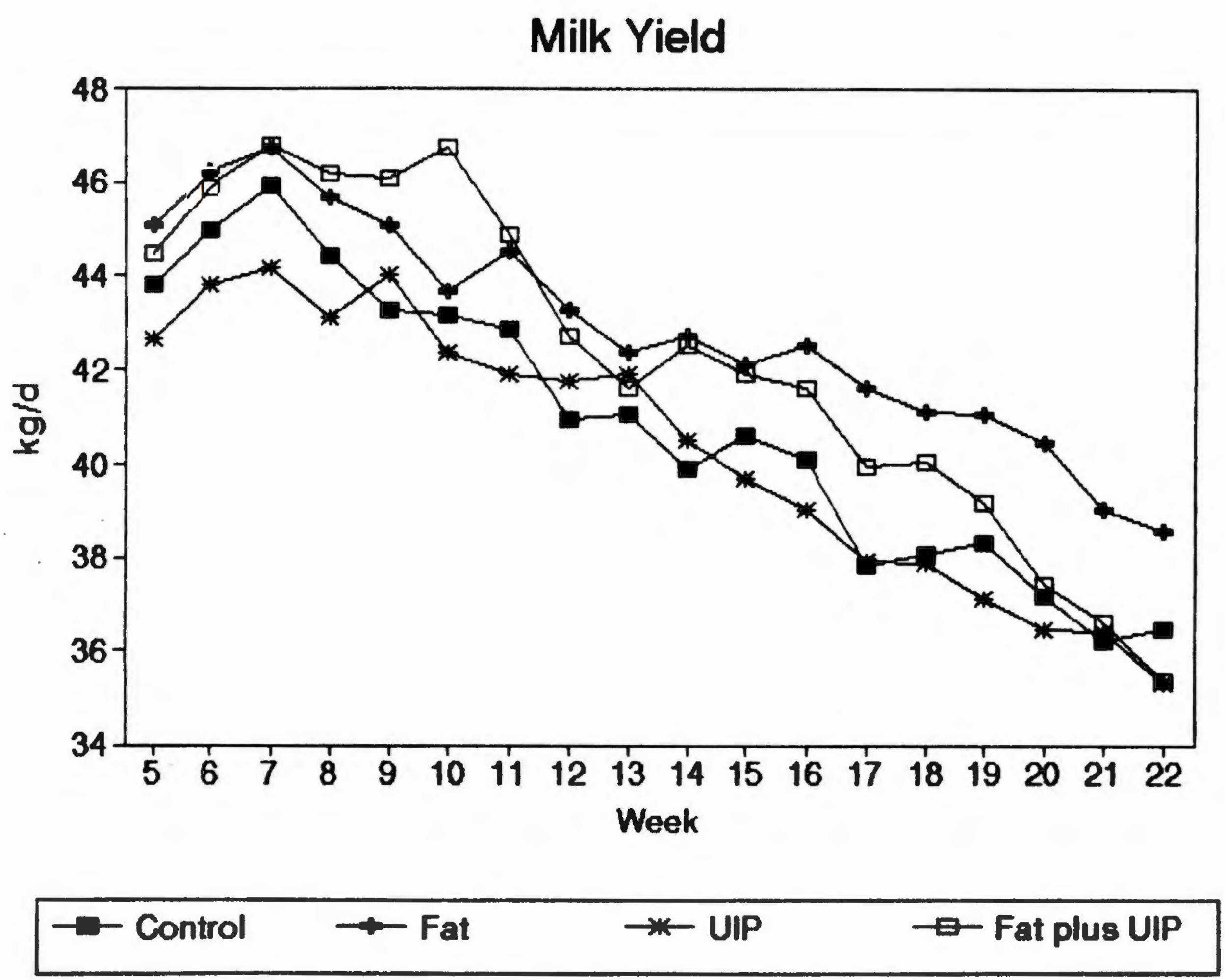

Figure 1. Effects of treatments on milk yield.

was used as the supplemental fat source (Canale et al., 1990; MacLeod et al., 1977). A continuous response to supplementation of fat was not apparent until wk 5 of treatment which is consistent with other study results (Hoffman et al., 1991; Jerred et al., 1990; Palmquist, 1988; Skaar et al., 1989). There was also a significant interaction between fat treatment and wk for four percent fat corrected milk yield (P = .05), which indicates that the additional energy from supplemental fat allowed the cows to maintain a higher lactation curve which can be observed for milk yield in figure 1, as well as four percent fat corrected milk yield in figure 2.

Fat treatment tended to increase milk fat yield (P = .12) which indicates an increase in energy utilized for production. An increase in milk fat percent is common with fat supplementation (Canale et al., 1990; Dunkley et al., 1977; Jerred et al., 1990; MacLeod et al., 1977) provided fiber digestion is not disturbed. There was a significant interaction between fat and wk for milk fat yield (P = .02). As expected the milk fat yield curve closely follows the four percent fat corrected milk yield curve. The combination of fat plus UP significantly decreased milk fat percent (P = .04) and had a significant interaction between fat plus UP and wk (P = .02). This unexplained decrease in

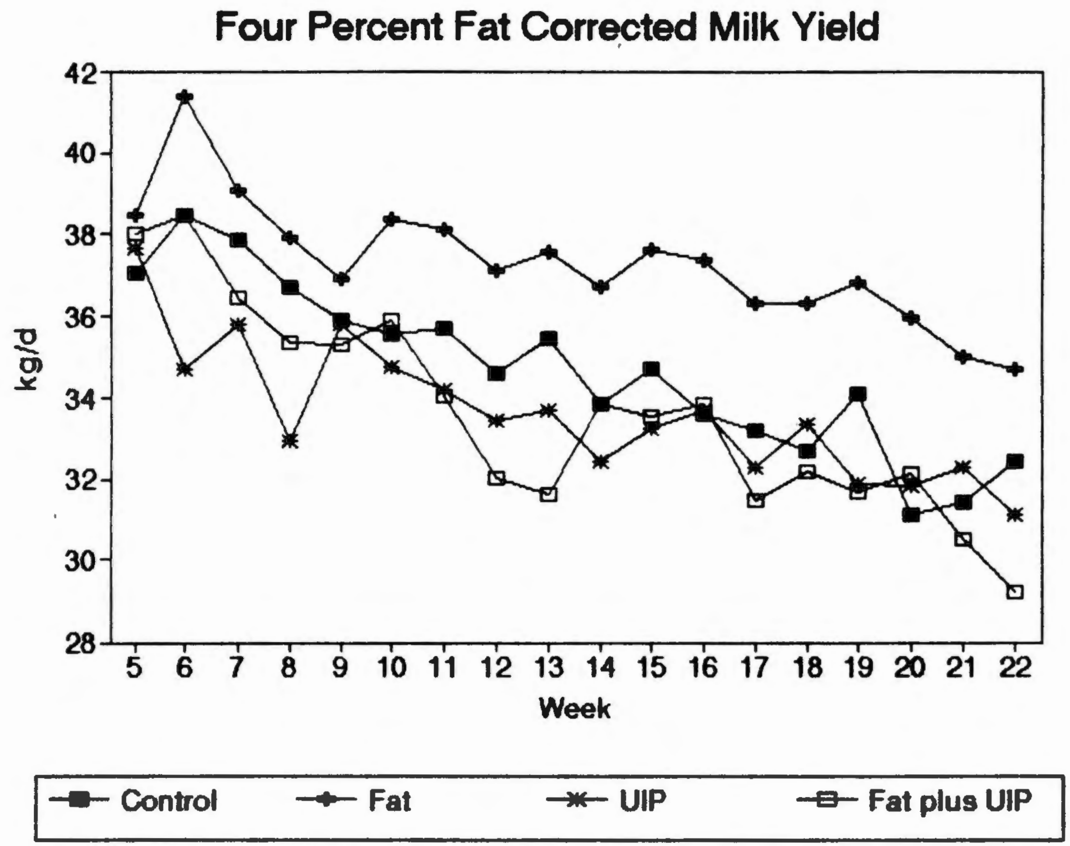

Figure 2. Effects of treatments on four percent fat corrected milk yield.

milk fat percent is inconsistent with other research where supplemental fat and increased undegradable intake protein increased milk fat percent (Canale et al., 1990) or had no effect on milk fat percent (Ferguson et al., 1988; Hoffman et al., 1991). Milk fat components and treatment by wk interactions are presented graphically in figure 3.

Although not significant (P = .24), fat treatment tended to increase milk protein percent numerically as well as milk yield resulting in a moderate increase in milk protein yield (P = .08). Fat treatment did not significantly alter milk protein percent which is consistent with other study findings where due to lack of increase milk yield, milk protein did not appear to be depressed by fat supplementation (Grummer, 1988; Jerred et al., 1990; Schauff and Clark, 1989). However it is uncommon to have an increase in milk protein percent when supplemental fat is fed. Combination of fat plus UP significantly increased milk protein percent by .10 percent (P = .04) and tended to increase milk protein yield (P = .19). This increase in milk protein may be due to the additional amino acids escaping the rumen and increased absorption in the small intestine as has been observed when rumen protected amino acids were fed (Canale 1990, Donkin 1989, Rogers 1987). Milk protein components are presented in figure 4.

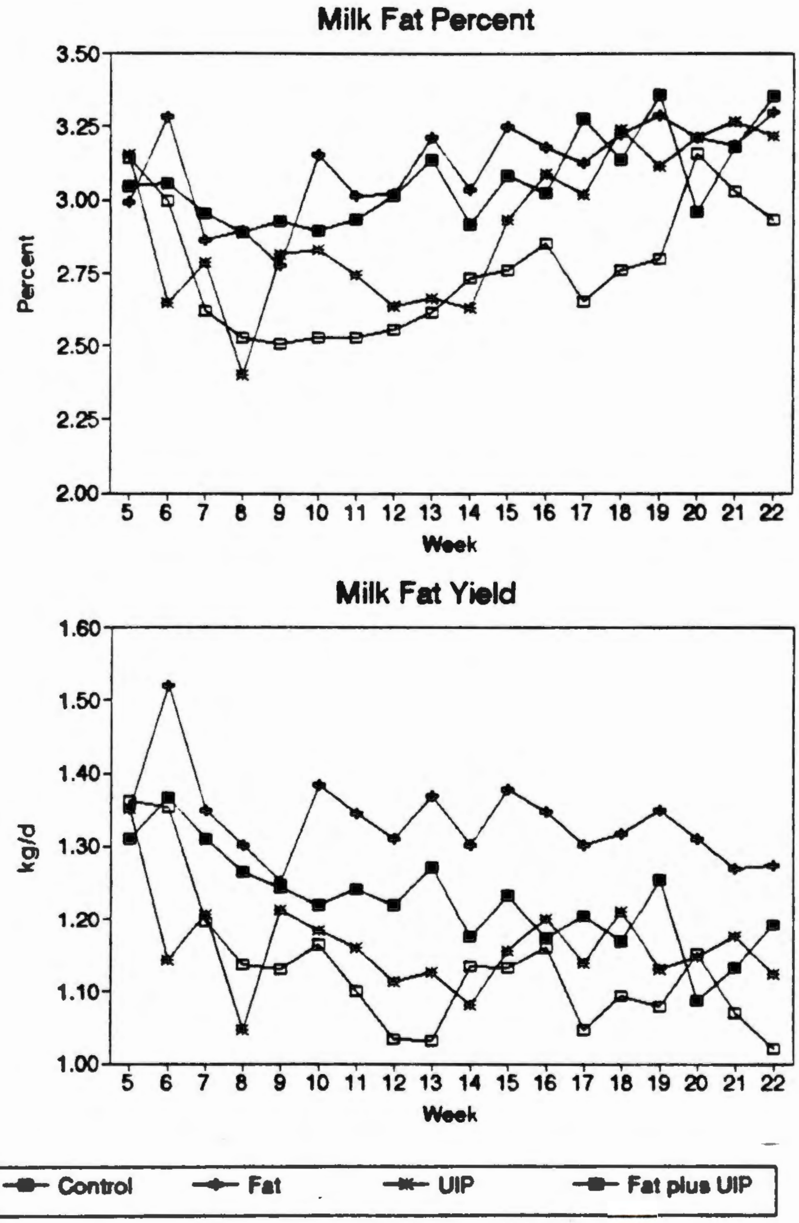

Figure 3. Effects of treatments on milk fat percent and yield.

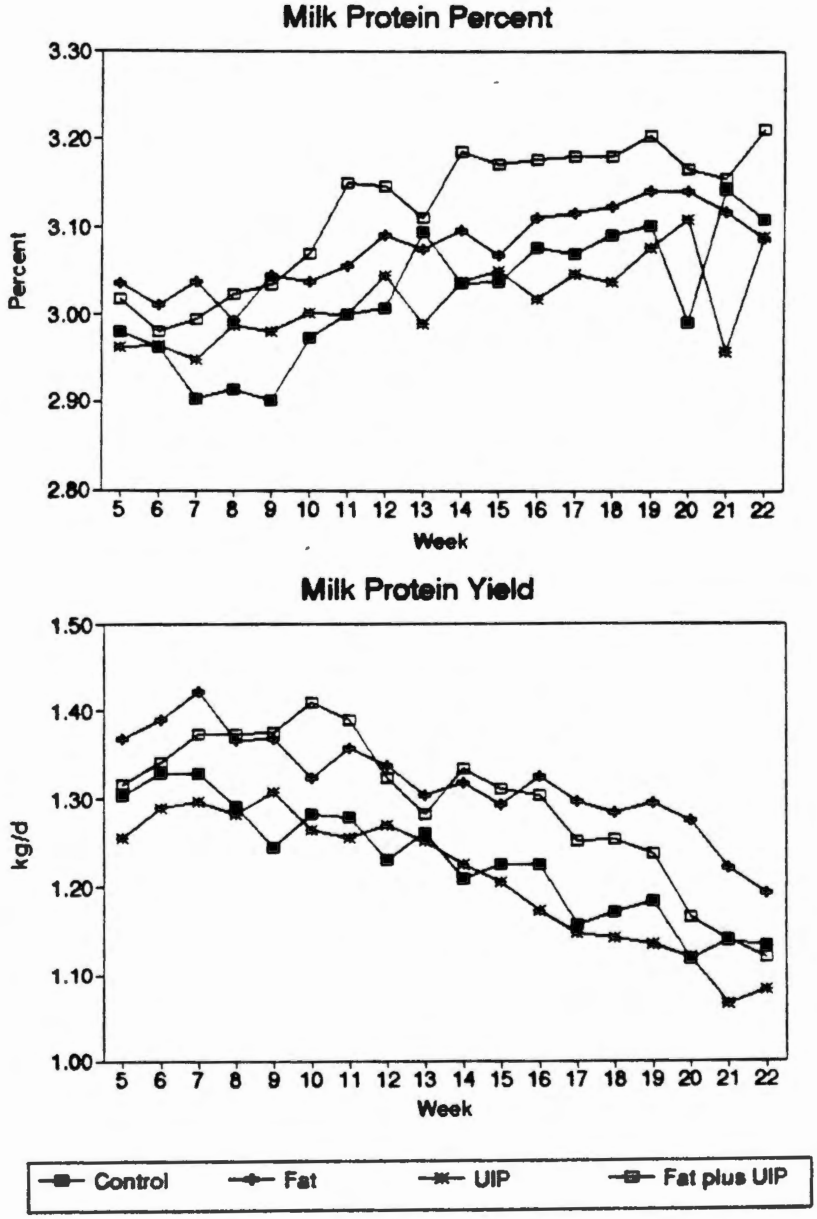

Figure 4. Effects of treatments on milk protein percent and yield.

Although not significant (P = .2), concentrate intake was slighty higher for fat treatment than UP treatment (15.7 vs 14.7 kg/d), which may account for some of the production differences. A decrease in concentrate intake is supported by the observations of another study (Sklan and Tinsky, 1993), where increased undegradable intake protein content resulted in decreased intake. The high level of concentrate consumed in this trial may have resulted in more protein escaping the rumen providing less benefit from the increase of undegradable intake protein. Concentrate intake is presented graphically in figure 5.

Cows fed the fat plus UP treatment tended to gain less weight and had a slightly lower body condition score (figure 6). This maybe an indication of increased utilization of body reserves related to increased milk protein percent.

The combination of fat plus UP treatment increased milk protein percent while decreasing milk fat percent. If the pricing differential continues to shift more toward milk protein content and away from milk fat content this would be a more beneficial use of resources.

UP treatment alone had no significant effects. Again, this may have been due to the high level of concentrate consumed in this trial. Estimates of undegradable intake protein from NRC (1989), were used to balance concentrates.

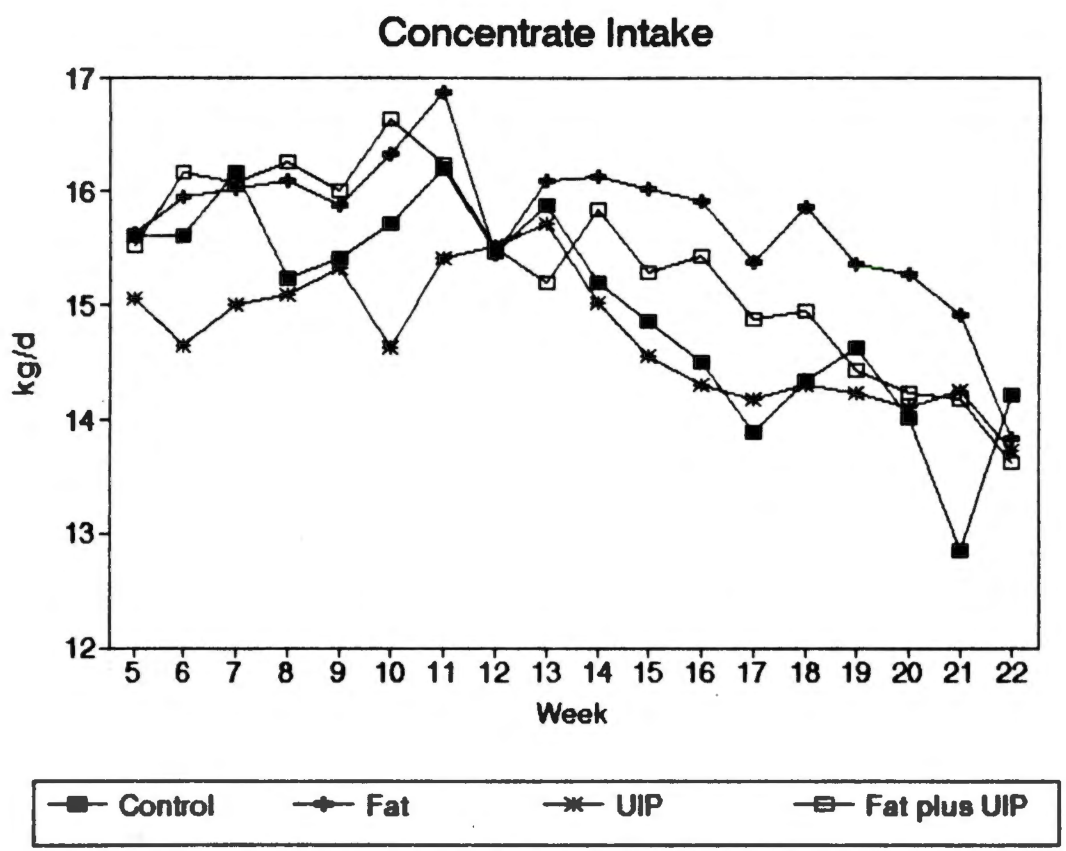

Figure 5. Concentrate intake variation among treatments.

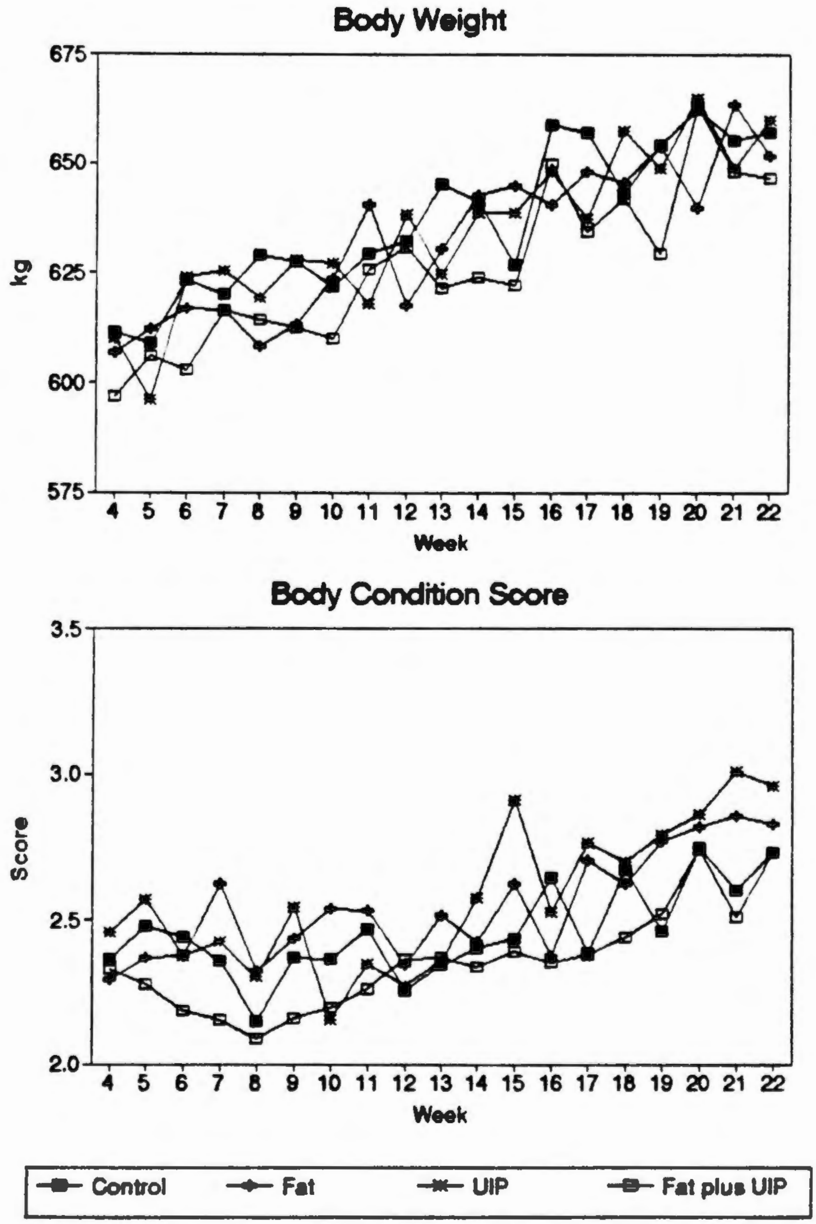

Figure 6. Effects of treatments on body weights and body condition score.

Some of the estimates are based on very few numbers which, results in much variation. Additionally total dry matter intake was not known in this experiment, making undegradable intake protein a best guess.

Ultrasound measurements were not highly correlated with body condition scores ($r^2 < .14$) in this experiment. Correlations are presented in Table 4. This is inconsistent with other findings observed in dairy cattle (Jones 1988), and beef cattle (Bullock 1991). Beef cattle have a wider range of fat thickness than dairy cattle which allows for more accurate ultrasound measurement between two different condition scores. The low correlation may have been due to the inexperience of the technician using the ultrasound. Some difference in results are due to postional alteration as well as variation of pressure of transducer against the animal (Stouffer, 1961; Williams, 1965). The ultrasound used in this study had an precision of .1 mm. If precision of the ultrasound could have been increased to .01 or .001 mm, then the correlation between body condition score and ultrasound measurements might have been represented.

TABLE 4. Correlation between body condition score and ultrasound measurements.

Measurement area	r^2	P
Withers	.13	.0001
Between 12th and 13th rib	.03	.0041
Between hooks and pins	.02	.0116

CHAPTER V

CONCLUSIONS

This experiment was designed to determine the effects of supplemental fat and increased undegradable intake protein and their interactions on production, body weight and body condition. Milk yield was not significantly affected by treatment which is consistent with other studies (Drackley and Elliot, 1993; Dunkley et al., 1977; Grummer, 1988; Jerred et al., 1990; MacLeod et al., 1977; Palmquist, 1988). Yield of four percent fat corrected milk and milk protein yield were moderately increased by fat treatment. Milk protein percent was not decreased by fat treatment which is compatible with other study results (Grummer, 1988; Jerred et al., 1990) where milk yield was not increased by fat supplementation. The interaction of fat plus UP significantly decreased milk fat percent and significantly increased milk protein percent. This would support increasing undegradable intake protein content of the diet when supplemental fat is fed to increase milk protein percent, if there was incentive for protein production.

Body weight and body condition score were not significantly affected by treatment. However, the interaction of fat plus UP slightly decreased body condition score, which may have some relationship with increased milk protein percent.

Ultrasound measurements made in .1 mm intervals were not effective for predicting or measuring body condition of dairy cows in this experiment. Unlike results observed in beef cattle (Bullock et al., 1991) and dairy cattle (Jones and Garnsworthy 1988), body condition scores were not highly correlated with ultrasound measurements in dairy cows. This inconsistency between dairy and beef cows is likely due to the great difference in back fat thickness.

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