

# HIGH WHEAT CONCENTRATE MIXTURES CONTAINING DIFFERENT SOURCES OF PROTEIN FOR LACTATING DAIRY COWS

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## Story in Brief

The response of 24 Holstein cows, in their second or greater lactation, to high wheat rations containing different sources of protein were evaluated. Treatments were: a) control (60% corn with cottonseed meal), b) wheat (60%, with cottonseed meal), c) wheat (60%, with whole cottonseed), and d) wheat (60%, with corn gluten meal and blood meal). The concentrate mixtures and alfalfa hay were fed separately in a 50:50 ratio in individual stanchions twice daily. Dry matter intakes and milk yields for cows fed the respective rations were 52.2, 48.3, 48.0, 50.2 and 67.0, 60.2, 62.9, 62.5 lb/day. Percentages of milk fat and protein were 3.55, 3.42, 3.49, 3.50 and 3.12, 3.17, 3.18, 3.22. Concentration of ruminal  $\text{NH}_3\text{-N}$  was similar for all treatment groups, whereas blood urea-N was lower for cows fed the control corn ration. Molar percentage of acetic acid was higher and isovaleric lower in ruminal fluid of cows fed the corn ration than in cows fed other rations, whereas molar percentages of other VFA were similar for all groups. Ruminal pH was lowest for cows fed the wheat mixture with 60% wheat and cottonseed meal, and highest for cows fed the corn control ration.

(Key Words: Wheat, Protein, Milk Yield, Dairy Cows.)

## Introduction

There has been increasing interest in utilizing wheat for livestock feeding due to declining wheat prices brought about by surplus wheat production. Utilization of different amounts of hard red winter wheat in dairy cattle rations has been studied. Faldet et al. (1986) found a linear decrease in milk yield (66.9, 65.5, 65.1 and 63.7 lb) as the percentage of wheat was increased in the concentrate mixture from 0 to 40, 60 and 80%. Calculated ruminal undegradable protein (RUP) decreased as wheat was introduced into the ration. Nalsen et al. (1987) substituted wheat for corn on a weight and a protein basis. Calculated as-fed protein composition of the three concentrate mixtures were 12.2, 15.1 and 12.2%. Calculated ruminal undegradable protein was 6.2, 3.8 and 2.6% respectively. Milk yield of cows fed the three rations was 76.0, 74.1 and 72.6 lb. Thus, milk yield was intermediate when wheat was substituted for corn on a weight basis, rather than balancing the concentrate mixture for equal protein.

Supplying ruminal undegradable protein to the small intestine appears to be a critical factor in maintaining high milk yields when wheat comprises the major source of energy in the ration. The objective of this experiment was to compare the performance of lactating cows fed wheat-based concentrate mixtures with different protein sources using alfalfa hay as the only forage in the ration.

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## Materials and Methods

Twenty-four Holstein cows were used in a feeding trial. All cows were in their second or greater lactation and started on the feeding trial 6 to 8 weeks postpartum. A switchback design with three 4-week periods was used. The first two weeks of each period were allowed for adjustment to rations and prevent carryover effects, whereas the last two weeks of each period were used to compare treatments. Treatments consisted of four concentrate mixtures (Table 1). The control ration was a 60% corn-based concentrate mixture and the remaining three mixtures contained 60% wheat. Wheat-based concentrate mixtures were calculated to be nearly isonitrogenous. Sources of protein supplied in the mixtures varied in order to obtain different amounts of energy and ruminal undegradable protein, lysine and methionine. Alfalfa hay was the only source of forage, and was fed separately from the concentrate mixture in individual stanchions twice daily. The rations were adjusted as needed to maintain a 50% concentrate and 50% alfalfa hay consumption on a dry matter basis. Daily concentrate and hay weighbacks were composited weekly and analyzed for dry matter and crude protein. Weekly samples of concentrate and alfalfa hay were also taken for analysis.

Milk weights were recorded twice daily. On four consecutive milkings of each week, milk samples were obtained to determine fat and protein content.

Table 1. Concentrate mixtures fed with alfalfa hay<sup>1</sup>.

Composition	Corn Control	Wheat (CSM)	Wheat (WCS)	Wheat (High RUP)
Ingredients, (% as-fed)				
Corn	60	--	--	9
Wheat	--	60	60	60
Sorghum (Milo)	5.5	5.5	5.5	--
Cottonseed meal	10	10	--	--
Blood meal	--	--	--	1.5
Corn gluten meal	--	--	--	5
Whole cottonseeds	--	--	20	--
Soybean hulls	15	15	5	12
Cottonseed hulls	--	--	--	3
Fixed portion <sup>2</sup>	9.5	9.5	9.5	9.5
Calculated analysis (as-fed)				
Net energy, Mcal/100 lb	74.3	74.3	78.9	74.1
Crude fiber, %	7.9	8.4	6.9	7.7
Total protein, %	12	14.3	13.7	14.2
Rumen undeg. protein, %	5.54	3.60	3.32	4.99
Rumen undeg. lysine, %	.19	.13	.12	.16
Rumen undeg. methionine, %	.09	.05	.06	.08

<sup>1</sup>Concentrate:forage, 50:50 (dry basis).

<sup>2</sup>Fixed portion of concentrate mixture: Molasses 5, dicalcium phosphate 2.0, sodium bicarbonate 1.25, salt .75, magnesium oxide .5%.

At the end of each period, ruminal fluid samples were taken by stomach tube 3 to 4 hours after the morning concentrate feeding to determine ruminal pH, ammonia-N and volatile fatty acid concentrations. A sample of blood from the median caudal vein was also taken at this time to determine plasma urea-N concentrations.

### Results and Discussion

Total dry matter consumption was higher for cows fed the corn-based concentrate mixture (52.2 lb) than for cows fed the wheat-based mixtures (48.8 lb), as was consumption of both hay and concentrate (Table 2). Faldet et al. (1986) and Nalsen et al. (1987) also noticed a decrease in concentrate and hay intake when wheat was introduced into the ration. Decreased feed intake of cows fed the wheat-based rations may be due to altered ruminal fermentation by wheat starch. Alternatively, palatability and/or acceptability of wheat rations may be a problem. With 60% wheat in the concentrate mixture, wheat intake averaged 17 lb/day on an as fed-basis. Protein intake exceeded NRC requirements for all treatments.

Average daily milk production was significantly higher when cows were fed the corn control ration (67 lb) than for those fed the wheat-based rations. The highest milk production on the wheat-based rations was found with the 60% wheat mixture with whole cottonseed. Cows fed the ration with whole cottonseed produced more milk than cows fed the 60% wheat mixture with cottonseed meal. Cows fed the high RUP concentrate mixture (corn gluten meal and blood meal) tended to yield more milk than those fed the wheat ration in which cottonseed meal supplied the required protein, i.e., 62.5 vs. 60.2 lb ( $P < .07$ ). Because milk fat production was similar across treatments, fat corrected milk (FCM) production paralleled actual milk production. Milk protein tended

Table 2. Feed intake and milk yield by cows.

Item	Corn Control	Wheat (CSM)	Wheat (WCS)	Wheat (High RUP)
Dry matter intake, lb/day				
Concentrate mixture	26.8 <sup>a</sup>	24.8 <sup>b</sup>	24.7 <sup>b</sup>	25.6 <sup>b</sup>
Alfalfa hay	25.4 <sup>a</sup>	23.5 <sup>cb</sup>	23.3 <sup>c</sup>	24.5 <sup>ab</sup>
Total	52.2 <sup>a</sup>	48.3 <sup>cb</sup>	48.0 <sup>c</sup>	50.2 <sup>b</sup>
Protein intake				
Amount, lb/day	8.9 <sup>a</sup>	9.1 <sup>a</sup>	8.7 <sup>ab</sup>	9.7 <sup>c</sup>
% of NRC requirement	134 <sup>a</sup>	153 <sup>b</sup>	140 <sup>a</sup>	156 <sup>b</sup>
Milk yield				
Milk, lb/day	67.0 <sup>a</sup>	60.2 <sup>c</sup>	62.9 <sup>b</sup>	62.5 <sup>bc</sup>
Fat test, %	3.55	3.42	3.48	3.50
FCM, lb/day	62.3 <sup>a</sup>	54.6 <sup>c</sup>	57.8 <sup>b</sup>	57.3 <sup>b</sup>
Protein, %	3.12 <sup>b</sup>	3.17 <sup>ab</sup>	3.18 <sup>ab</sup>	3.22 <sup>a</sup>

abc Means with different superscripts differ ( $P < .05$ ).

to be higher when cows were fed the ration with high ruminal undegradable protein. This may be the result of supplying a larger amount of limiting amino acids at the site of milk protein synthesis.

Molar percentage of acetic acid was higher for cows on the corn control ration (Table 3), suggesting conditions more favorable for milk fat production. Isovaleric acid concentration and total volatile fatty acid concentration were higher when cows were fed the wheat-based rations than when fed the corn control ration. Ruminal pH was significantly lower for cows on the wheat-based rations than for those on the corn control ration. Similarly, Faldet et al. (1986) noted a linear decrease in ruminal pH as wheat was increased in the concentrate mixture. This suggests a more rapid breakdown of the wheat starch than of corn starch in the rumen, and may have resulted in the lower acetic acid concentrations found with the wheat-based concentrate mixtures. Lower ruminal pH and altered molar proportions of volatile fatty acid concentrations have been suggested as possible regulators of feed intake. The lowest ruminal pH was found with cows fed the wheat-based mixture where cottonseed meal supplied the required crude protein. Mineral buffers (Table 1) were added to all of the rations, and helped maintain ruminal pH to where problems with digestive disorders should not occur.

Ruminal ammonia-N concentrations tended to increase with the wheat-based rations, suggesting increased ruminal protein digestion with wheat. Blood urea-N concentrations were lower for cows on the corn-based ration, but did not differ among wheat-based rations.

Inclusion of a high ruminal undegradable protein tended to increase milk production when wheat was included in the diet of lactating cows.

Table 3. Responses of cows to experimental rations.

Item	Corn Control	Wheat (CSM)	Wheat (WCS)	Wheat (High RUP)
Ruminal fluid pH	6.27 <sup>a</sup>	5.86 <sup>b</sup>	6.13 <sup>a</sup>	6.17 <sup>a</sup>
Total VFA conc., mm/l	215.9 <sup>a</sup>	288.2 <sup>b</sup>	252.6 <sup>b</sup>	248.2 <sup>b</sup>
Volatile fatty acid, molar %				
Acetic	64.8 <sup>a</sup>	61.0 <sup>b</sup>	60.6 <sup>b</sup>	61.5 <sup>b</sup>
Propionic	21.5	23.2	24.5	23.1
Butyric	11.3	12.3	11.6	12.2
Isobutyric	.40	.34	.19	.34
Valeric	1.23	.98	.93	1.11
Isovaleric	.92 <sup>a</sup>	2.15 <sup>b</sup>	2.13 <sup>b</sup>	1.78 <sup>b</sup>
Acetic to propionic ratio	3.0	2.6	2.5	2.7
Blood urea-N, mg/dl	11.6 <sup>a</sup>	16.1 <sup>b</sup>	15.2 <sup>b</sup>	15.2 <sup>b</sup>
Ruminal ammonia-N, mg/dl	4.9	6.7	6.3	6.2

<sup>ab</sup>Means with different superscripts differ ( $P < .05$ ).

Calculated rumen undegradable protein was still lower than the corn-based ration which may have limited the milk production response. Although the calculated ruminal undegradable protein of the wheat ration with whole cottonseed was lower than the other three rations (Table 1), milk yield was similar to that of cows fed the high ruminal undegradable protein ration. Net energy for lactation was highest for the wheat mixture with whole cottonseed which may have increased milk production.

#### Literature Cited

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