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PRODUCING WHEY SILAGE FOR GROWING AND FINISHING CATTLE

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INTRODUCTION

Roughage is the principal component of most cattle diets and as such can greatly influence the cost of production. The utilization of less traditional roughage sources can help decrease these costs, leading to a higher profit margin. Current research has shown that when cheese whey and residue feeds (i.e., small grain straw or low-quality hay and wheat middlings) are ensiled, a palatable and nutritious feedstuff can be produced.

This is significant for cattle producers as residue feeds such as straw are normally easily obtainable for relatively low cost. This is an opportunity producers could take advantage of to decrease feeding costs when whey and straw are both available. Cheese and yogurt plants produce, as a by-product, liquid whey. Whey is categorized as "sweet" (cheese) or "acid" (cottage cheese), depending on the manufacturing procedure employed. Whey can be decanted, or dried to various levels ranging from 8% to 45% dry matter (DM).

OBJECTIVE

Six studies were performed involving Whey Silage. The objectives of these studies were to determine if silage could be produced from "sweet" liquid cheese whey, small grain straw and wheat middlings, and to determine its effect on production and digestibility when utilized in growing and finishing diets for cattle.

MATERIALS AND METHODS

The cheese whey used in the six studies came from two different cheese plants. The batches of whey used for each study varied in dry matter and nutrient content (Table 1).

Table 1: Percentage of Nutrients in Batches of Liquid Whey

Study	Dry Matter	Crude Protein	Ca	P	K	Na
1	31.8	15.4	.75	.94	3.43	.92
2	42.8	14.0	.51	.79	2.43	.74
3 and 5	22.1	2.9	.36	.83	1.13	.45
4 and 6	43.7	3.0	.64	.87	2.63	.73

Whey silage was produced for the six individual studies using the feedstuffs and proportions shown in Table 2 (Figures 1-4).

Figure 1: Mixing of individual feedstuffs with whey.

Figure 2: Adding various feedstuffs.

Figure 3: Adding liquid cheese whey to mixer.

Figure 4: Final product or whey silage.

The ingredients were combined in a feed mixer for studies 1, 2 and 4 and packed in an open bunk silo. For Studies 3, 5 and 6 the individual feedstuffs were combined in a feed mixer and placed in a silage bag. The feedstuffs combined sufficiently well and there was little runoff of excess liquid whey after allowing approximately 10 minutes of mixing time. The whey silage was "cured" for a period of 3-4 weeks before nutrients analysis of silage was performed (Table 2). Representative samples of each feedstuff were collected prior to periodically during each of the studies for nutrient analysis.

Table 2: Proportions of Feedstuffs Used to Produce Whey Silages and Nutrient Composition

of Final Products

Study	Ingredients (DM Percent)			Nutrient Content of SilageProduced[1]					
	Whey	Straw	Wheat Middlings	DM	NEm	NEg	CP	Ca	P
1	51.5	38.3	10.2	46.4	.83	.55	12.8	.64	.67
2	59.3	31.7	9.0	53.0	.75	.47	11.0	.42	.55
3 and 5	35.4	42.0	22.6	42.5	.76	.47	6.8	.26	.59
4 and 6	51.5	38.3	10.2	44.8	.85	.56	14.3	.64	.67

[1]DM=Dry matter (%); Nem=Net energy for maintenance (Mcal/lb); Neg=Net energy for gain (Mcal/lb); Cp=Crude protein (%); Ca=Calcium (%); P=Phosphorus (%).

The cost of each common feed used in the study is recorded in Table 3. It has been adjusted to a cost per ton of dry matter value. The cost of the whey silages was calculated using the cost of the feedstuffs in Table 3 and the percentages of the ingredients used to produce whey silage in Table 2. There was no markup in any of the feeds used or costs associated with producing the silage (labor, equipment, shrink etc.)

Table 3: Costs of Feedstuffs

Feed	Percent Dry Matter	Cost ($ Per Ton Dry Matter)
Alfalfa Hay	90	100.00
Corn Silage	35	100.00
Barley Grain	90	116.67
Soybean Meal	90	262.10
Supplement	90	222.20
Whey[1]	See below	See below
Straw	90	27.70
Wheat Middlings	90	61.10
Whey Silage (study 1)	46.4	49.03
Whey Silage (study 2)	53.0	48.76
Whey Silage (study 3 and 5)	42.5	48.58
Whey Silage (study 4 and 6)	44.8	49.03

[1]Whey prices varied depending on DM content (prices on DM basis): 43% - $58/T; 32% DM - $63/T; 22% DM - $68/T

In each of the six studies the calves were randomly assigned to a control (C) or treated (T) group. The control animals were fed rations comprised of common feed ingredients (Corn Silage, Alfalfa Hay, Barley Grain, Wheat Middlings, Soybean meal and Mineral supplements.) The treated animals received rations comprised of Whey Silage in combination with common feed ingredients. The composition of each of the rations is outlined in Table 4. The cost of each ration on a dollar per ton of dry matter basis was also calculated using the feedstuff costs from Table 3.

Table 4: Feedstuffs and Rations Used in Each of Six Whey Silage Feeding Studies on A DM Percentage Basis

Study	1		2		3		4		5		6	
Group	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**
Alfalfa Hay	16.7		16.4		31.0	25.3	19.0		13.5	12.5		
Corn Silage	40.4		42.3		38.7		32.4		13.5		8.1	
Whey Silage		98.0		98.0		55.0		80.0		28.5		12.2
Barley Grain					26.4	12.2	39.9	31.3	69.7	64.8	85.6	84.1
Wheat Mids	42.4		40.3									
Soybean Meal						3.6	5.6			1.0	1.5	
Supp	1.8	2.0	2.0	2.0	3.9	3.9	2.6	3.2	3.3	3.1	4.8	3.8
Cost of Ration $/tonDM	86.40	52.49	72.31	52.22	114.85	84.87	118.35	82.85	115.65	106.77	122.56	112.54

The animals in study 1 were growing Holstein heifers. Growing beef steers were used in studies 2, 3 and 4. In studies 5 and 6 finishing beef steers were fed. Calves for all the studies were randomly assigned to control or treatment groups. Animals were fed in small pens containing 5 or 8 animals receiving the same ration (Table 5). All calves were weighed every 28 days and feed and health records were maintained daily.

Table 5: Number of Pens, Animals Per Pen and Starting Weights for Cattle on Whey Silage Studies

Study	Treatment Group	Number of pens	Number of animals / pen	Average Starting Wt. (lbs)
1	Control	3	8	557
	Treatment	3	8	580
2	Control	3	8	486
	Treatment	3	8	480
3	Control	4	5	659
	Treatment	4	5	635
4	Control	4	5	661
	Treatment	4	5	668
5	Control	3	5	897
	Treatment	3	5	885
6	Control	4	5	824
	Treatment	4	5	885

Digestibilities of the control and treated rations were obtained for studies 3 and 4. Four beef cows fitted with rumen cannulas were used in a replicated design. Cows used for the digestibility studies were individually housed in open front pens with concrete floors. All feedstuffs were fed once daily at 08:00 h for a 21 day adaptation period followed by a 6 day collection period. Rations were fed in amounts that were totally consumed daily. During the collection periods, fecal grab samples were obtained at 08:00 h from each cow. Samples of the total mixed ration (TMR), feces and individual feedstuff samples were also obtained daily throughout the collection period. Feed and fecal samples were dried and analyzed for crude protein, ash and fiber which were then used to determine digestibility. Additionally, rumen fluid was obtained from each cow using a rumen cannula and it was analyzed for pH.

For studies 5 and 6 the decision to harvest was based on ultrasound scan to determine degree of finish and quality grade.

RESULTS AND DISCUSSION

Table 6 is a summary of the production variables measured, including cost of gain. Analysis of the data demonstrated that within each study average daily gain was equal for control and treated cattle. Dry matter intake was significantly decreased for treated heifers and steers in studies 1 and 3 and increased in study 4. Furthermore, feed efficiency (FE=DMI/ADG) was significantly improved in studies 1 and 2 and decreased in study 4. The cost per pound of gain was significantly lower for groups fed Whey Silage than in the control groups in studies 1 and 2. Furthermore, in studies 3 to 6 the cost of gain was somewhat lower for the treated groups. Whey Silage comprised only 12 and 18 percent of the ration for treated animals in studies 5 and 6. Therefore, the cost per pound of gain was not affected as much by the use of this low cost feedstuff within each of these studies.

Table 6: Summary of Cattle Performance Data for Six Whey Silage Studies

Study	Type of Cattle[2]	Feeding Period	Ave. Daily Gain (lb/day)		Dry Matter Intake (lb/day)		Feed Efficiency[1]		Cost/lb of Gain	
			C	T	C	T	C	T	C	T
1	GHH	56d	2.4	2.3	17.6	14.4	7.38	6.52	.32	.16
2	GBS	56d	2.5	2.4	15.9	12.2	6.34	5.19	.23	.13
3	GBS	84d	2.5	2.2	19.6	18.5	8.71	8.73	.45	.35
4	GBS	56d	2.6	2.7	15.6	19.1	6.0	7.0	.35	.29
5	FBS	140d	3.0	3.1	24.9	26.0	8.2	8.4	.48	.45
6	FBS	84d	2.4	2.6	19.9	21.4	8.3	8.2	.51	.46

[1]DMA (dry matter intake)/ADG (average daily gain)=FE (feed efficiency)
[2]GHH = Growing Holstein Heifers, GBS= Growing Beef Steers, FBS= Finishing Beef Steers

Table 7 is a summary of the digestibility studies that were conducted. Results indicated that diets containing Whey Silage were equal in digestibility to control diets. Ensiling low-quality roughage such as straw with cheese whey has an effect on the physical structure of the straw making it more digestible. This is significant for cattle producers as straw is normally easily obtained for relatively low cost. This is an opportunity producers could take advantage of to decrease feeding costs when whey and straw are both available.

Table 7: The Effect of Whey Silage on Digestibility and Rumen pH in Growing Rations for Beef Cattle

Variable	Study 3		Study 4	
	C	T	C	T
DMD (%)	59.9	66.9	65.0	57.0
NDFD (%)	32.6	34.1	38.5	43.4
pH	5.9	6.0	6.5	6.3

Personal communication with the operators of various cheese plants suggests that whey availability is dependant on volumes of milk produced within given areas. This is not necessarily a concern; however, since Whey Silage can be produced at any time of the year. A producer can take advantage of this situation and produce silage when whey becomes available. A stockpile of straw and wheat middlings would ensure supplies were in place to accomplish this. All of the feedstuffs necessary to produce Whey Silage are by-products and are priced accordingly. The reduction in cost from feeding inexpensive Whey Silage could result in a significant increase in profit since feed is the largest input cost for cattle producers.

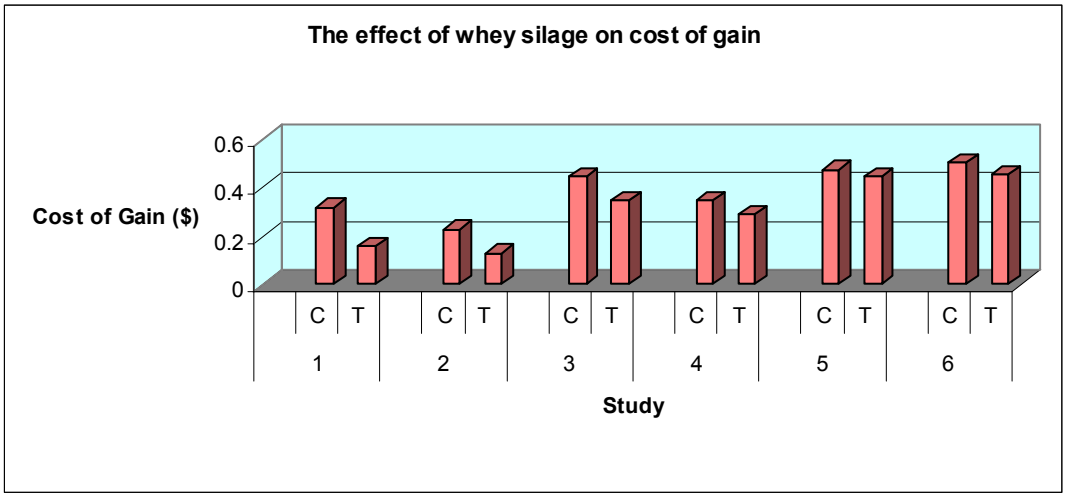

Figure 5. Cost of Gain Illustration for Cattle Fed Whey Silage in Six Studies.

CONCLUSIONS

Whey Silage was produced in these studies for less than fifty dollars a ton at a time when corn silage and alfalfa hay were priced at one hundred dollars a ton. When diets containing 55 and 80 percent Whey Silage were fed to growing steers, they were equal in digestibility to standard

diets comprised of alfalfa hay, corn silage and barley grain. The cost per pound of gain was decreased in studies with growing cattle where 55 to 98 percent of the ration was comprised of whey silage. The economic advantage was not recognized in finishing rations that contained only 12 to 18 percent Whey Silage. Nevertheless, average daily gain was equal in control and treated groups within each of the six studies indicating that animal performance is not compromised when Whey Silage is included in the ration. A decision to use Whey Silage in cattle rations would need to be made on a case by case basis after determining the cost of available feedstuffs. Studies are currently underway to determine the potential for feeding whey silage to reduce the feed cost for beef cow maintenance.

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