The Effects of Feeding Brown Midrib Corn Silage Compared to Conventional Corn Silage in High Producing Dairy Cows

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Abstract

The objective of this study was to determine if supplementing Brown Midrib Corn Silage into a high cow feed ration could improve digestibility in the rumen, add savings into the feed ration, and improve milk production. Beginning in June of 2012 two hundred high producing Holstein cows were selected from Johnny Mendonca & Sons Dairy in Tulare, Ca to estimate the difference between feeding Conventional Corn Silage compared to Brown Midrib Corn Silage. This test trial was conducted over the span of 4 months and was hypothesized by the author. To achieve this, the author conducted three analyses to determine if there was a significant difference between the two corn silages. First, *in vitro* digestibility tests were taken to examine the difference in digestibility between the two corn silages. After 30 hours of *in vitro* testing, digestibility was markedly higher in the Brown Midrib Corn Silage (69%) when compared with the conventional corn silage (52%). This concluded a difference of 17% digestibility between the two corn silages. Next, two separate rations were developed and fed to two separate testing groups, which both contained one hundred high producing milking cows. The first group was fed a ration that implemented conventional corn silage while the second ration and testing group implemented brown midrib corn silage. A ration containing the brown midrib corn silage was conceived to utilize the brown midrib corn silage based on its digestibility features by the dairy's nutritionist. The distinct digestibility features of the Brown Midrib Corn Silage led to a reduced amount of needed grain corn. The second testing group and feed ration required three pounds less grain corn, creating a savings in cost. Over a course of a year this resulted in a potential savings of $ 16,917.75. To determine the difference in milk production between the two testing pens, milk composition tests were obtained

during a course of three months. At peak milk production the Conventional Corn Silage group produced 82 lbs. per cow per day whereas the Brown Midrib Corn Silage group produced 87 lbs per cow per day.

Key Words: Conventional Corn Silage, Brown Midrib Corn Silage, digestibility, ration, dairy, milk production

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Introduction

It is evident that the dairy industry has experienced drastic changes in the last decade. Recently a rise in feed costs has emerged and due to this dairy farmers around the world have begun to focus more on what they are feeding their cows. Terms such as neutral detergent fibers (NDF) and Neutral Detergent Fiber Digestibility (NDFD) is meaning much more to dairy people and nutritionists than ever before. Corn silage in many US states has become a main component in the Dairy ration. Studies have shown that Forage quality and digestibility can affect energy intake and availability in care of maintenance, milk yield, reproduction, and health in dairy cows (Castro 2010). This has caused many dairymen to look into their rations with thorough detail to investigate if feeding greater digestible forages will benefit their cows. This is where benefits of the Brown Midrib corn gene can come into play and could possibly affect the dairy ration in a positive and effective way. I hypothesized that feeding BMR corn silage to high producing milking cows would result in increased milk production, higher digestibility and lead to savings in the feed ration. The objective of this study was to determine the effects of feeding BMR corn silage on milk productivity, digestibility, and savings in feed rations compared to conventional corn silage.

Literature Review

Background on Conventional Corn Silage

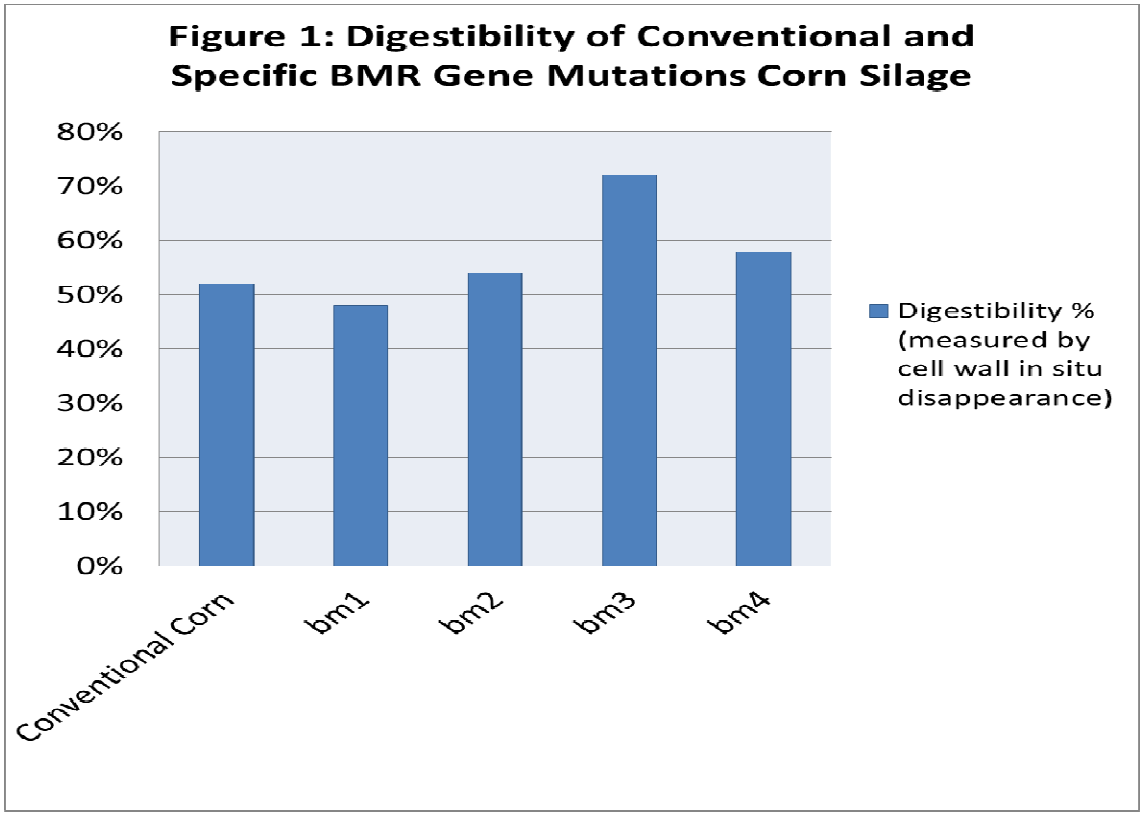
Many corn hybrids have a dual purpose, meaning that they are grown for both grain production and for silage production (Ramirez 2012). Throughout the United States these corn hybrids are typically used primarily for corn grain instead of silage. Conventional corn hybrids tend to produce large yields and great starch values but lack in digestible values. Conventional corn hybrids primarily have thick stalks which contain high levels of lignin. It has been found that lignin is essentially indigestible by most ruminant animals and believed to play a major role in how much of the plant that can be digested by rumen microbes. (Jung and Allen 1995) The BMR gene has been reported to produce less lignin concentration in plants which contributes to increased fiber digestion in ruminants.

Background on the Brown Midrib Corn Gene Mutation

The BMR corn gene is a naturally occurring mutation in the corn stalk that was discovered in 1924 (Ostrander 2010). There are four different BMR gene mutations which are bm1, bm2, bm3 and bm4. Over the past 3 decades various studies have been conducted to determine the differences between the BMR gene mutations. Brown midrib hybrids have been developed primarily for corn forage production. To date research, shows that the bm3 gene contains the least amount of lignin and has the highest digestibility (Ostrander 2010). A study conducted in 1999 measured the lignin content and digestibility of BMR and conventional hybrids. This study concluded that the Bm3

gene had the lowest lignin content and highest digestibility, shown in Figure 1 (Ostrander 1999).

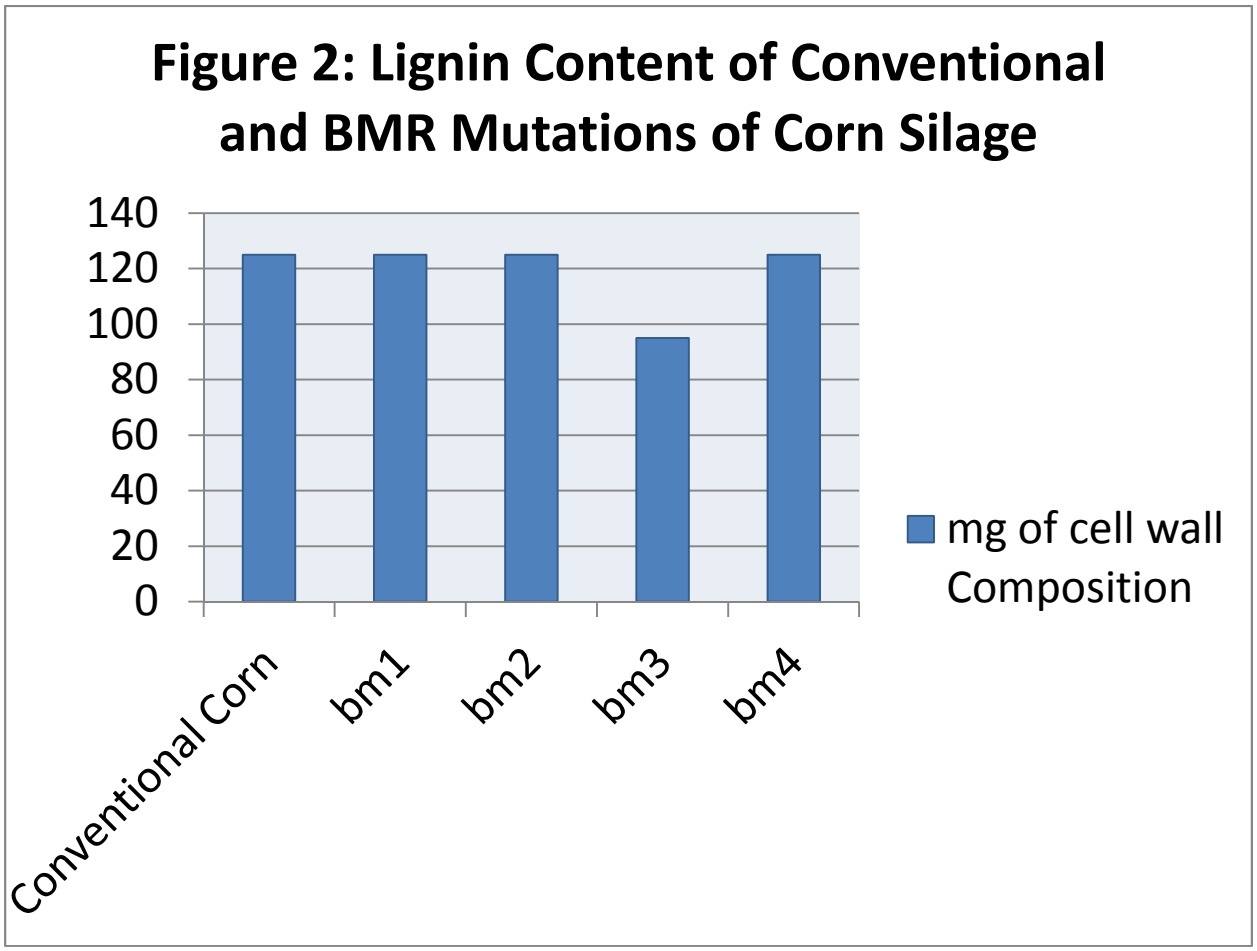
Figure 1. Digestibility of Conventional and Specific BMR Gene Mutations Corn Silage



Redrawn from Ostrander , 1999

Another study conducted by Marita (2003) showed that the BM3 gene had the lowest components of lignin compared to conventional and all BMR gene mutations, shown in Figure 2. This, in turn, suggests that the BM3 gene would be most digestible compared to conventional corn hybrids and all other BMR gene mutations.

Figure 2. Lignin Content of Conventional and Brown Midrib Mutations of Corn Silage. Redrawn from (Marita, 2003)



In Vitro True Digestibility

In vitro true digestibility (IVTD) is a common method scientist's use to test digestibility in ruminant stomachs. It is an anaerobic fermentation used in laboratories to simulate digestion as it occurs in the rumen stomach. Rumen fluid is collected from deceased high producing dairy cows consuming a typical TMR ration. Chosen forage samples can be incubated in rumen fluid and buffer for a specific period of time at 39

degrees C. During this time, the microbial population in the rumen fluid digests the sample as would occur in a live rumen. The end result of the IVTD procedure is the undigested fibrous residue. This value is the undigested particles of the forage which in turn, can be used to determine the digestibility of the forage. Both the IVTD and NDFD can be used to relatively rank and compare forages. (Der Bedrosian 2013)

Difference in the Brown Midrib Corn Gene

Brown midrib corn silage (BMRCS) has lower lignin levels than conventional corn silage (CCS) resulting in a constant improvement in NDF digestibility *in vitro* (Oba and Allen, 1999). *In Vitro* True Digestibility (IVTD) tests have proven that brown midrib corn hybrids contain less lignin in the stalks and leaves than conventional hybrids (Cox and Cherney 1993). Oba and Allen have concluded that the BMR corn genes have a lower concentration of lignin, which allows greater digestibility of NDF. The lower concentration of lignin in BMR corn silage is the primary factor responsible for improvements in fiber digestibility (Oba and Allen 1999). They included that NDF digestibility has been suggested to reduce ruminal fill by increasing ruminal turnover time so that cows can consume more dry matter (DM). This typically results in an improvement in dry matter intake (DMI) and milk production (Oba and Allen 1999). In the study conducted by Oba and Allen, large figures were determined to estimate the advantage of feeding higher digestible corn silage. They concluded that factoring digestibility into the ration can have a large effect on farm profitability. A one-unit increase in *in vitro* NDF Digestibility can be associated with a 0.55 lb increase in 4% fat-corrected milk. In most conventional corn hybrids, digestibility may vary by 5 percentage units of IVNDFD when averaged over numerous growing situations. In their studies

Brown midrib mutants have shown increases in this variation by another 5%. These fairly minor alterations in IVNDFD can have outstanding effects on animal performance; a 5-unit difference in IVNDFD among corn hybrids can result in a difference of milk yield of 2.75 lb per cow per day. This effect relies upon the amount of corn silage in the ration. Responses may increase as the amount of corn silage NDFD increases. These studies have shown that high producing cows are often limited by gut fill due to feeds that aren't as digestible (Olba and Allen 1999).

In a recent study conducted by Stone the difference in digestibility factors between conventional corn silage (CCS) and Brown midrib corn silage (BMRCS) was tested. Conventional corn silage and BMRCS were very similar in chemical composition. The CCS (31.2% of DM) was more mature than the BMRCS (29.8% of DM), which may have contributed to its lower NDF (44.1 vs. 45.5%) and considerably higher starch (26.2 vs. 23.5%) levels. Tests showed that there was a higher 7-h starch digestibility in the CCS than the BMRCS (82.0 vs. 76.1%). As expected, lignin levels were lower, and 30-h NDF digestibility was higher in the BMRCS than in the CCS (2.3 and 3.1% for lignin, and 73.8% and 56.8% for NDF digestibility). Lactate, VFA, and particle size were very similar between corn silages. In pretrial analyses of the corn silages, the NDF had been higher and potassium content lower in the CCS than in the BMRCS (Stone 2012). This study shows a great range of difference in digestibility in corn silage which could mean a great breakthrough for dairy rations.

In another study Brown midrib hybrids averaged 52 g/kg greater *in vitro* true digestibility (IVTD) and 135 g/kg greater NDF digestibility compared with mean values of about 25 hybrids in a 3-yr test in New York (Cox and Cherney, 2001). Brown midrib

hybrids also had 20% less DM yields when compared with hybrids of similar relative maturity (RM) in these trials. Oba and Allen (1999), however, reported that cows produced 2.6 kg/d greater milk yield when fed silage from a brown midrib hybrid vs. its normal counterpart. Leafy hybrids had similar DM yields when compared with hybrids of similar Relative Maturity the same IVTD, 35 g/ kg more NDF, and 30 g /kg more NDF digestibility compared with mean values in the New York hybrid test (Cox and Cherney, 2001). Furthermore, Ballard in (2001) reported that cows produced similar milk yields when fed silage from leafy and dual-purpose hybrids. However, he did report that cows produced 1.5 kg/d more milk when fed silage from a leafy vs. a dual-purpose hybrid.

Lactating cows fed forages with similar NDF levels but different digestible values have produced more milk and had higher DMI when fed higher digestible forages (Oba and Allen 1999) The faster ruminal passage rate of NDF from BMRCS has allowed cows that are more limited by reticulorruminal (RR) fill to consume more feed, leading to increased production (Oba and Allen 1999).

Additionally a recent study reported that when cows consume BM3 silage, they may excrete less manure nitrogen compared with those consuming a dual-purpose control hybrid. It was speculated that this was a result of improved ruminal fermentation of carbohydrates in bm3 corn silage that, in turn, improved rumen microbial protein synthesis and Nitrogen utilization causing less manure outflow (Weiss and Wyatt, 2006). Feeding bm3 corn silage can improve fiber digestibility and nitrogen utilization and that feeding dried distiller's grain and bm3 corn silage would further improve milk yield and N utilization and a shift in bacterial population would occur. (Ramirez Ramirez 2012)

In conclusion this research has determined that BMR corn silage fed to cows increase DMI due to higher digestibility which can cause more milk production. It is also beneficial to the ration due to its low expense and high quality. The development of improved corn hybrids specific for silage offers an alternative strategy to improve the nutrition of the high-producing dairy cows. It is important to understand how dairy cows respond to high inclusions of these feed products to develop strategies that ease utilization of bm3 corn silage, and produce a healthy cow.

Methods and Materials

Silage

Two corn hybrids were used in this experiment. The first hybrid used in this experiment was the 33V14 conventional corn silage manufactured by Pioneer Seeds. Its relative maturity is 115 days which was harvested at 70.3% moisture and bagged in a separate silage pile. Its average tonnage was 29 tons per acre. Analysis samples were taken from the pile and tested by Cumberland Valley Analytical Services, Inc. The second corn hybrid was the F2F714 BMR corn silage containing the bm3 gene manufactured by Mycogen Seeds. Its relative maturity is 112 days which was harvested at 70.4% moisture and bagged in a separate silage pile. Its average tonnage was 27 tons per acre. Both varieties were chopped at equal heights at about 5 inches from the ground. Piles were allowed to ferment for 6 months before feed out.

Rations

Two separate rations were used in this experiment. The author sat down with the dairy nutritionist to configure a separate ration that included the BMR corn silage. They were able to construct a ration that was capable of reducing grain corn while sustaining nutrient values that was capable of producing high milk yields. They were able to apply this ration by knowing that since the cows were able to digest more of the nutrients from the BMR corn silage that we would not need to apply the same amount of grain corn into the ration. The first ration contained the conventional 33V14 Pioneer Seed corn silage. The second ration contained the BMR F2F714 Mycogen Seed corn silage. Both rations contained the same ingredients but we decreased the amount of grain corn in the BMR

ration to aid in animal health and assist in ration savings. (Table 1). Each ration was fed to a group of 100 different high cows separated between two pens and was consistently fed for 90 days.

Table 1: Ration Formula from John Mendonca Dairy

Ration With Conventional Corn Silage	**Amount: Pound Per Day Per Cow**	**Ration With BMR Corn Silage**	**Amount: Pound Per Day Per Cow**
Ingredient		***Ingredient***	
Alfalfa Hay	13	Alfalfa Hay	13
Canola	4	Canola	4
DDG	7	DDG	7
Mineral	1	Mineral	1
Salt	.02	Salt	.02
Almond Hulls	6	Almond Hulls	6
Grain Corn	11	Grain Corn	8
Conventional Corn Silage	44	BMR Corn Silage	44
Total	**86.2**	**Total**	**83.2**

Data Collection

Data was not collected until after feeding the rations for more than 4 weeks to high producing milk cows. The cows were chosen by milk production, with an average production of 65-80 lbs. per cow per day. Time was permitted to 4 weeks to ensure that the high cows had adjusted to the new rations. Milk tests were collected monthly through regularly scheduled testing procedures. Three months of data were compiled to examine if feeding the BMRCS produced a difference in milk production, percentage digestibility, and or savings in feed costs.

Results

Silage Composition

Four samples of each corn silage were taken to draw an average of the total amount of composition. The nutrient composition and *In Vitro* True Digestibility sample is shown in table 2. When referring to the table it is evident that the Dry Matter was relatively the same making the two samples very compatible for an adequate comparison. Two striking differences in the comparison are shown. The Pioneer 33V14 had a much higher lignin value compared to the Mycogen BMR F2F714. A difference of 1.22% shows a deficit of allowable nutrient sources to the ruminant stomach. The second striking difference was between the NDF Digestibility. After 30 hours of *in vitro* testing, digestion was markedly higher for Mycogen BMR F2F714 (69%) when compared with Pioneer conventional corn 33V14 (52%). These shows a difference of 17% which in turn shows the differences in the two hybrids are very distinct from each other when it comes to digestibility shown in Table 2.

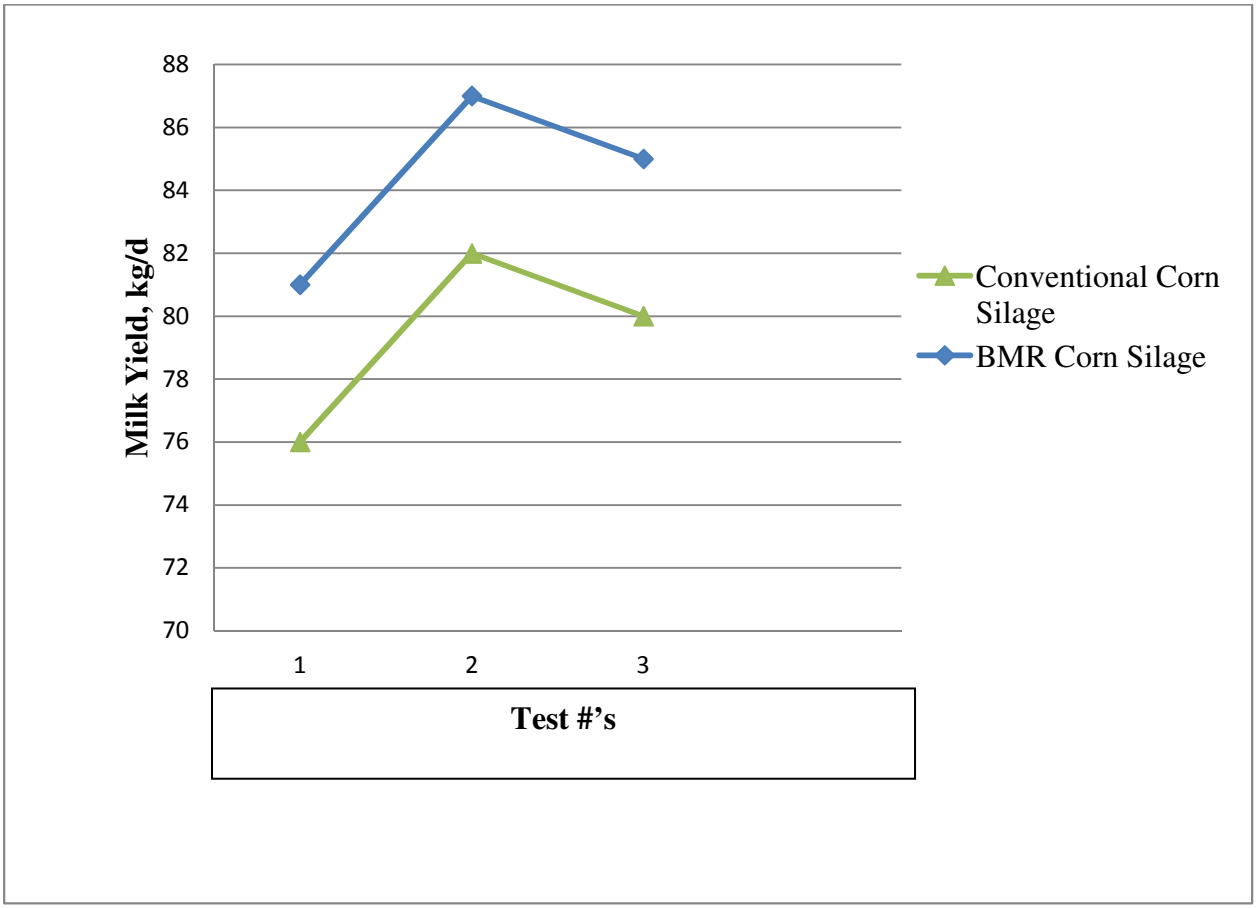
Table 2. Silage Composition Results from John Mendonca Dairy

Item	Pioneer 33V14	Mycogen BMR F2F714
Dry Matter %	29.7	29.6
Crude Protein %	7.6	8.6
Allowable Digestible Fiber %	28.3	38.8
Neutral Detergent Fiber %	42.3	41.6
Lignin %	3.47	2.25
Starch %	3.9	26.7
Ph	3.9	4
Neutral Detergent Fiber Digestibility, *in vitro* 30 hr.	53	69

Milk Production

Three monthly milk tests were taken to draw an average of the total amount of milk production between the two pens fed conventional corn silage and BMR corn silage. The milk production data is shown in Figure 3.

Figure 3. Milk Production Response to Conventional and BMR Con Silage from John Mendonca Dairy



Milk testing results were calculated between each pen. Of the hundred cows the average of each pen was used to demonstrate the difference between milk productions between cows fed Conventional Corn Silage and BMR Corn Silage. On the first milk production test, cows fed conventional corn silage averaged a milk production of 76 lbs. On the first day cows that were fed BMR corn silage averaged 81 lbs. On the second day of testing both groups peaked. The cows fed Conventional corn silage peaked at 82 lbs. On the second test day Cows fed BMR corn silage peaked at 87 lbs. of production. On the third

testing day cows fed conventional corn averaged 80 lbs whereas cows fed BMR corn silage produced 85 lbs. of milk.

Over the course of the three tests day's cows averaged an increase of 5lbs of milk when consuming BMR corn silage compared to cows fed conventional corn silage. In table 3 the amount of earnings was calculated to show the difference in milk production inputs. Cows fed BMR corn silage showed a boosted income of .88 cents per cow per day showing an annual increase of $32,120.

Table 3. Milk Production Inputs Increase Between Corn Silages

	Cows Fed Conventional Corn Silage	Cows Fed BMR Corn Silage
Numbers of Cows	100	100
Average Pounds Increase (Per Cow Per Day)	0	5
Milk Price ($ Per CWT)	$17.50	$17.50
Extra Income (Per Cow/ Day)	$-	$ .88
Extra Income (Per Year)	$-	$32,120

Feed Savings

Table 5 demonstrates the amount of possible savings when comparing the two rations after reducing the total amount of grain corn out of the ration containing BMR corn silage. Conserving three pounds of grain corn in the ration over a course of a year resulted in a potential savings of $ 16,917.75. This figure was calculated using the price

of grain corn X the total pounds of grain corn fed per cow X 100 cows then subtracted from the price of the ration containing conventional corn silage.

Table 4. Feed Savings Input Between Corn Silages

	Conventional Corn Silage	BMR Corn Silage
Pounds Per Day of Silage Fed	44	44
Tons/Day	2.2	2.2
Tons/Year	803	803
Dry Corn (Pounds as Fed/Corn)	11	8
Bushels/ Day	19.64	14.29
Bushels/Year	7168.6	5215.85
Tons/ Year	200.75	146
Price Per Ton ($)	$309.00	$309
Total Annual Expense on Crain Corn	$62,031.75	$45,114.00
Total Annual Savings	$-	$16,917.75

Discussion

The author's results compared very closely to other studies which have confirmed that when feeding BMR corn silage to high producing cows you will see an increase in milk production, increase in digestibility, and savings in feed costs. When analyzing the rise in milk production with cows fed BMR corn silage, the increase can be explained in part by increased nutrient digestibility. It is evident that when increasing milk production you will see an increase in income. When reducing the amount of grain corn out of the ration a definite savings will occur. Although my studies have shown a production increase is possible, others may have different results. Variables such as cow comfort, ration efficiency, and overall maintenance all contribute to whether BMR can influence the dairy's bottom line.

Conclusion

In conclusion feeding forages with higher than average digestibility provides an opportunity to formulate diets with greater amounts of forage while reducing the amount of additional energy required supporting milk synthesis. Incorporating these types of forages into the forage production system would also provide more flexibility in meeting nutrient management and conservation program needs. Rations containing higher digestible forages into diets could potentially improve milk production, increased digestibility and savings in feed rations.

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