The Differences Between the Jersey and Holstein Breeds of Rumination in Early Lactation Using the Activity Monitoring System

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ABSTRACT

The objective of this study is to determine the differences between the Jersey and Holstein breeds of rumination in early lactation. The rumination is being monitored with the MICRO Dairy Logic HR-Tags. Data collected is from 48 to 0 hours prior to milk data collection testing for once a month for three months, including energy corrected milk as well. The three months that were used for the data gathering were December 2011, January 2012 and February 2012. These tags have been placed around the cow's necks and contain a microphone that is used to monitor the jaw movements of the cow. It records the total number of movements in a twenty-four hour period. This technology keeps a record of the head movement of the cows, on a twenty-four hour basis for up to reporting periods (forty-eight hours). Most of the collars placed on the dairy cows contained sufficient data used to gather information; several collars were not functional and therefore the data collected from these collars were not used. There were twenty-nine Holsteins and twenty-eight Jerseys used though out the three month period. Not all were used in certain months.

The MICRO Dairy Logic system was utilized to analyze the differences between the two breeds rumination and lactation activities during the study period, including the differences in energy corrected milk. The data collected and evaluated appeared to show no significant difference in rumination efficiency between the Holstein and Jersey cows. Differences in data were less than 1 percent on average between the two data sets, with no statistical difference.

Previous studies had suggested that Jersey cows maybe more proficient in the rumination process and thus, had higher milk yields per pound of body weight. However,

some of these studies utilized more rudimentary observation techniques for data collection. Utilization of the MICRO Dairy Logic system provided more accurate and easier to analyze data. An important item to note is the smaller sample size of cows (around 30) used in the study. As a verification of the results of this study, a larger sample size of cows could be utilized over a longer period of time (e.g. six months instead of three). However, the study appeared to provide sufficient data to demonstrate that there wasn't a significant difference between the two breeds. This study utilized the smaller sample size and shorter timeframe to due to time constraints for available cows.

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INTRODUCTION

Effective milk yields on a dairy farm is directly related to feed efficiency and its effect on rumination. Farms that are not efficiently using feed appropriately (under feeding or over feeding) can negatively affect rumination and run the risk of decreasing revenues from lower than expected milk yields at higher costs. As a result, knowledge of the rumination process (how milk cows utilize their dry matter intake and how long they spend chewing their cud) is critical to efficient and productive dairy operations.

This study seeks to observe the rumination process in two different breeds of dairy cows: Jerseys and Holsteins. Historically, visual observation of the rumination process is necessary to evaluate the milk yields in dairy cows. Put simply, if a milk cow is allowed to chew her cud for longer periods of time and therefore improving the rumination process, the resulting milk quality and quantity should also improve. If rumination is interrupted or otherwise not properly provided for, yields will suffer and quality may also be negatively affected. Additionally, since farmers do not want to overspend on feed, providing enough quality feed without under feeding their cows is a key consideration. Only by providing cows the time they need to properly ruminate and providing sufficient quality feed will produce cost effective milk yields. In order to gain such results, careful observation of the rumination process is necessary.

In general, it has been observed that dairy cow comfort and resting time is helpful for the rumination process. The longer the time allowed for her to chew her cud the more efficiently nutrients are broken down and thus increasing milk yields. This timing aspect,

combined with sufficient feed (but not overfeeding which increases cost) improves the dairy farmer's bottom line.

Understanding the differences in dairy cow breeds is also important for dairy farmers. If necessary, greater yields can be obtained by adjusting feeds and rumination times for various breeds of dairy cows. Some previous studies for instance have shown that Jerseys can have an efficient ruination process, breaking down nutrients faster than Holstein cows. Holstein cows, as a result, were found to consume more feed with less milk yields per pound of feed. The observation and resulting data collection and evaluation process is what is necessary to find the right balance between the amount per cost of feed and the amount of time necessary to allow for proper rumination.

Newer technologies are emerging that allow dairy farmers to more effectively gather and evaluate the effects of feed and cow rumination. Simple observation of the process, e.g. monitoring rumination times by jaw counting, are time consuming and prone to inaccuracy. However, digital cameras and other high tech devices placed on the jaws or collars of dairy cows can be used to collect rumination data that is more accurate and easier to obtain. This data is better evaluated by computer systems as a result. Such technologies allow different breeds of dairy cows and their resulting yields to be compared and different approaches to feeding and rumination applied to positively affect yields. These "activity monitoring systems" are growing in popularity in many dairies in the United States.

LITERATURE REVIEW

What is Rumination?

The cow has a stomach organized into four sections to take care of food that is difficult to digest. (Hall and Silver, 2009). When the cow first takes in food, she chews it just enough to moisten it. Once swallowed, the food goes to the stomach's first section, where it is mixed with chemicals and softened. This softened food is called the "cud," which means small balls of food (Cullen, 2009). We can tell a lot about a cow's rumination by observing her jaw movements. It is extremely important to keep dairy cows constantly ruminating. It is a priority in maintaining healthy and productive animals.

Cows, like other ruminants (such as goats, camels, sheep, and others), obtain most energy from plant cell walls (McDonald et al., 2002) and the end products mainly consist of acetic, propionic, and butyric acid; which are all volatile fatty acids (Lindgren, 2009). They allow the rumen to break down and for the digestive process to gather the nutrients. When ready, the rumen forms a bolus, called "rumen content," which is regurgitated back up for further chewing to reduce the particle size in order to allow it to pass though to the omasum (Lindgren, 2009). The time it takes before the re-chewed feed can be passed depends on the particle size/shape, density and digestibility (Sjaastad et al., 2003)(Lindgren, 2009).

In the omasum, (the third stomach compartment), the bolus is further broken down and again more nutrients are absorbed from the smaller particles. When the cow brings up a bolus to be masticated, she is increasing her saliva production and mixing it

throughout the bolus, which acts as a buffer to the acidic feed (Sjaastad et al., 2003). Since the feed consumed is normally acidic, it allows her to keep a stable rumen pH at about 5.5-5.6 (Lindgren, 2009) (McDonald et al., 2002). If the cow did not create a bolus and chew it, it would cause the pH in her rumen to increase, causing the rumination process to shut down. This can cause multiple problems like ruminal acidosis.

Differences in density cause the particles to form on the bottom of the rumen, while a gaseous layer forms on the top, due to the carbohydrates being fermented (Lindgren, 2009) (Sjaastad et al., 2003). The particles that form around the top tend to be fibrous and long and partially broken down, while sitting on the other fluids like layers. When this happens, the gas pressure starts to dwindle because the organic matter is the cause of the fermentation process and it basically expires, resulting in the particles to sink to the bottom of the rumen. Particles that are greater in size and length tend to take a longer time period to be digested compared ones that are smaller with similar density (Lindgren, 2009) (Jaster and Murphy, 1983). With the particle size in consideration, Erika Lindgren has stated, "small particles increase passage rate and dry matter (DM) intake while decreasing digestibility since the particles are subjected to fermentation during shorter time" (Lindgren, 2009) (Jaster and Murphy, 1983).

Once smaller particle sizes are ready to be transported into the omasum, Lindgren stated, "Contractions of the reticulum and rumen provide mixing of fore stomach contents and a transfer of particles to the omasum. The contractions also facilitate regurgitation and aid in belching of gases" (Lindgren, 2009). Lindgren also stated that, "the digesta water content is mainly absorbed in the omasum prior to the abomasum transfer where enzymes continue the digestion" (Lindgren 2009). This is where the

digestion process continues though the next two stomachs sections.

How we can determine differences with rumination?

More studies are being conducted to focus on early lactation and consuming forages that contain neutral detergent fiber (NDF). The quality of the feed also plays a role of how the cow will ruminate and what the feed contains. In one scientific study, it was shown, "that the main factor that restricts voluntary DMI by lactating cows is high dietary NDF content, which reduces DM digestibility of the diet" (Van Soest, 1994)(Adin et al., 2009). Van Soest also stated that, "when DM digestibility values in the diets of lactating cows are below 67%, the rumen fill mechanism is predominant in determining DMI" (Van Soest, 1994)(Adin at al., 2009). Many other studies have been conducted and they too have found similar results to this one.

An average in dry matter intake (DIM) varies between breeds of cows. Holsteins have an average between 3.5-4.0 and Jerseys have an average between 3.75-4.25, all depending on the body weight of the animal. Jerseys normally consume more then the larger breeds of cows, as studies have shown.

In a study done by Aikman along with other authors found that, the feed that was passed and processed though a Jersey cow was much faster and more efficient, than that of the Holsteins. They noticed that even though the time of passage was faster, everything in the feed was the same but the NDF was found to be higher in Jerseys compared to the Holsteins (Aikman et al., 2008). In the study they also noticed that the Jerseys had a longer period of time to ruminate, due to the fact that they allowed more feed to be supplied to the rumen though out the day. This was possibly due to the fact that there was feed available for the Jerseys more often than the Holsteins and likely

stimulated saliva flow. They also noticed that Holsteins were faced with a time constraint because they consume more feed than the Jersey cows and were not able to get enough in, with the time given (Aikman et al., 2008). So this time hinders the amount that the Holsteins can chew and ruminate, whereas the Jerseys can take the smaller amounts of feed and process it all father and have more time for rumination (Aikman et al., 2008). So as a result the Jerseys were able to spend most of their time ruminating, rather than trying to consume more feed. This is yet another indicator that there is a marked difference in the eating and ruminating behavior between these two breeds. Overall the Jerseys seem to have a better way of breaking materials down and utilizing all the feed properly. Jerseys tend to be more efficient than the Holsteins as this study shows.

MATERIALS AND METHODS

Data Collection

This project used the MICRO Dairy Logic activity monitoring system, which is located at the Cal Poly Dairy in San Luis Obispo, CA. This technology keeps a record of the head movement of dairy cows, on a twenty-four hour basis for two reporting periods (up to forty-eight hours). This system uses collars (called an HR-TAG collar), that have been placed around the cow's necks that will gather rumination information, using a small microphone to record the sound she makes while grinding her teeth. The rumination HR-TAG is the same as the one that is collecting the estrus data. Most of the available Cal Poly milking Jerseys and Holstein cows will be used for this project to gather information and if data is available, data collected from past months will be included. All zero data sets will be excluded and collars that may produce inaccurate or suspect data will not be used.

Twenty-eight (28) milking Jersey cows and twenty-nine (29) milking Holstein cows are utilized for the study. In some cases not all cows will available for each reporting period. The focus of the study is rumination in early lactation to compare the efficiency of the Jersey and Holstein breeds. On these test days we gathered information on feed intake and energy corrected milk, also dry matter intake per pounds of body weight will be noted, if there is time. This information will be taken from the activity monitoring systems program monthly to compile a statistical analysis between the two breeds. The hours were divided amongst computer work and putting the collars on the cows involved. Verification of all data will occur to ensure accurate results; my college and I did this with the help of Zach Beutler looking from the technical side. Data will be

entered on a weekly basis in order to keep the program up to date and working efficiently. Also, the addition and subtraction of cows throughout the study will be accounted for. Professor Dr. Stan Henderson, fellow student Jason Borges, and myself worked with the system, setting collars, and gathering test data information from the collars. Three months of test days will be used for this data collection; December 6, 2011, January the 13 and February 10, 2012. Other workers at the Cal Poly Dairy will also keep an eye out for missing or improperly placed collars. With accurately verified data, the data was extracted from the MICRO Dairy Logic system and transferred to a Microsoft Excel document. Also, using DHI Plus a report was developed and analyzed to get the energy corrected milk. The final Excel spreadsheet contains the numbers from energy corrected milk, rumination times of both breeds, and cow numbers.

MICRO Dairy Logic's Data Collection

About two years ago the Cal Poly Dairy added a product that has multiple uses and are detected by using collars that were donated by MICRO Dairy Logic. Trevor Nutcher, a former student from Cal Poly, started the use of the system at the dairy. A number of subsequent students have used the system since that time, including for this study.

The data collars are innovative and long lasting. The collars are battery operated, with the battery that can last up to ten years, if used properly. They are extremely low maintenance and all that really has to be done, is to ensure that they are placed on the cows properly. The collars, called HR-TAGs, work by being correctly positioned on a cow to record and recognize all movement the animal makes. These devices go around

the cow's neck in a particular direction with an accelerometer, so that data will not be recorded incorrectly. If placed incorrectly then the data will be upside down.

The HR-TAGs also have a way to monitor rumination by monitoring the sound that is made from the grinding of the cow's teeth. The collar listens for constant chewing sounds for a few seconds, then a short rest and again followed by more chewing. The tags do this by having a small microphone that is placed against her neck to pick up the sound of chewing but not be affected by outside noise. The rumination process is recorded in minutes every day. This feature allows us to look at any potential issues as the rumination process occurs, monitoring any changes in how the cows react to the feed in front of them. The monitoring also allows for unusual circumstances, such as sick or injured cows. The tags record data continually up to 24 hours and it is then uploaded to the sending units and is recorded twice a day, using infrared scanners. Data is recorded twice to coincide with the twice-daily feeding and milking schedule of the dairy cows. When placing the collars on a new cow they require a period of time to develop a standard deviation for each individual cow, which is usually seven days.

Figure 1. Picture of Collar used on the cows at Cal Poly Dairy (Nutcher 2010).

Data Analysis

Data was analyzed from three different test days using the ECM weight and 48 to 0 hours prior to test day's rumination, off of the activity monitoring system. The data was then analyzed and broken into two categories for comparison of the two different breeds. From there it was further broken down into Top Ten for each group, also including ECM and Rumination. All zero data was excluded, along with any other situations where data was comprised or otherwise not properly gathered (such as a

malfunctioning collar or human error). Such data was marked with a N/A and kept in the study to account for its existence but not counted toward the averages utilized in the monthly analysis.

RESULTS AND DISCUSSION

Table 1, shown below, summarizes the results from the three test days, based on energy corrected milk (ECM) and rumination. It shows the variance in rumination and ECM activity for the Holstein cows at the Cal Poly dairy. The arithmetic mean (average) was taken for each test indicator. A comparison of the averages shows very little variance between the three days for both rumination and ECM. The combined Holstein average rumination from the three test dates was 863.7 minutes within a 48-hour period. The combined ECM average was 89.1 pounds (lbs.).

Table 1. Results from all three-test days on rumination and EMC for Holsteins

HOLSTEIN						
TEST DAY	**2/10/12**		**1/2/12**		**12/9/11**	
Cow ID	Rumination(0-48h)	ECM(lbs)	Rumination(0-48h)	ECM(lbs)	Rumination(0-48h)	ECM(lbs)
2136	718	70.5	642	66.4	757	74.6
2266	729	113.5	733	113.2	873	121.9
2300	667	65.2	614	46.1	N/A	57.8
2303	1,002	92.9	945	42.2	N/A	72.3
2309	898	98.8	820	142.8	802	100.6
2316	1,006	93.8	942	104.9	1,036	77.5
2326	829	107.9	781	107.6	N/A	115.7
2338	659	88.9	642	97.6	N/A	123.0
2340	576	85.9	813	98.1	709	85.2
2343	967	97.4	1,012	124.5	996	102.9
2348	647	115.7	584	112.1	N/A	116.6
2354	556	62.1	664	104.5	N/A	100.0
2362	987	104.4	1,096	98.7	873	111.6
2364	938	61.2	840	75.2	864	86.3
2377	1,012	105.4	N/A	62.3	N/A	70.6
2382	1,146	85.5	1,005	97.3	N/A	67.3
2394	898	109.9	1,000	118.4	N/A	N/A
2410	798	58.2	928	87.0	N/A	N/A
2411	674	88.7	757	91.5	722	85.9
2414	974	104.1	1,026	88.3	902	84.8
2422	984	113.1	1,093	86.4	N/A	N/A
2429	994	64.6	902	57.9	N/A	47.2
2430	896	100.0	860	87.7	855	86.1
2431	892	78.7	904	97.2	878	76.1
2435	968	83.0	915	81.8	861	99.0
2436	904	96.5	1,046	96.6	N/A	97.9
2443	855	84.1	808	83.6	N/A	N/A
2444	1,033	71.0	1,082	71.3	N/A	N/A
2445	782	71.0	885	73.2	N/A	61.4
TOTAL COWS	29	29	28	29	13	24
SUM	24,989.0	2,572.0	24,339.0	2,614.4	11,128.0	2,122.3
AVERAGE	861.7	88.7	861.4	90.2	856.0	88.4

	Rumination(0-48h)
TOTAL COWS	70
SUM	60,456.0
AVERAGE TOTAL	863.7

ECM(lbs)
82
7,308.7
89.1

Table 2 below summarizes the Jersey dairy cow activity. A slight trend in increased rumination is noted as the testing proceeds into the year. Conversely, ECM levels are slightly decreased over the same testing period. The combined average of Jersey rumination is 787.9 minutes, while their average EMC is 81.3 lbs. Overall there is not much difference between them over the months tested.

Table 2. Results from all three-test days on rumination and EMC for Jerseys

JERSEY						
TEST DAY	**2/10/12**		**1/6/12**		**12/9/12**	
Cow ID	Rumination(0-48h)	ECM(lbs)	Rumination(0-48h)	ECM(lbs)	Rumination(0-48h)	ECM(lbs)
203	942	123.4	777	98.1	N/A	97.7
234	842	81.6	815	83.7	760	113.3
243	654	85.7	N/A	86.7	649	76.4
281	651	24.3	743	70.6	748	87.0
282	875	85.6	998	96.4	891	139.3
294	812	89.9	887	70.2	725	83.5
298	689	113.3	670	66.6	N/A	60.3
304	816	52.5	845	65.7	N/A	108.3
309	747	81.1	516	70.5	375	92.0
311	783	77.3	1,010	84.2	879	75.5
322	1,017	77.0	930	97.5	998	92.6
331	914	97.0	831	99.1	935	117.6
334	759	79.7	939	80.4	907	105.2
338	903	113.4	774	94.0	N/A	N/A
345	804	32.0	722	62.9	800	75.8
349	819	86.4	761	81.0	N/A	91.6
360	1,011	107.7	N/A	98.2	N/A	N/A
368	702	66.7	762	68.9	658	79.9
375	804	43.6	799	49.0	830	73.3
398	839	73.6	899	81.8	841	75.2
399	906	88.2	933	79.4	N/A	83.1
405	1,003	83.6	1,062	100.7	995	85.0
410	547	60.1	746	53.8	N/A	45.5
412	493	93.4	N/A	53.9	N/A	N/A
636	596	39.5	817	59.7	770	84.9
814	876	74.0	891	87.0	775	86.9
870	682	80.6	658	92.4	548	109.7
903	699	56.1	762	66.2	702	78.1
TOTAL COWS	28	28	25	28	20	25
SUM	22,185.0	2,167.3	20,547.0	2,198.6	14,786.0	2,217.7
AVERAGE	792.3	77.4	821.9	78.5	778.2	88.7

	Rumination(0-48h)
TOTAL COWS	73
SUM	57,518.0
AVERAGE TOTAL	787.9

ECM(lbs)
81
6,583.6
81.3

Data from the two tables were further broken down to rank the top ten in cows in both rumination and ECM by each breed. Table 3 below indicates that rumination rates grew over time, but ECM production appeared to be slightly inconsistent between the two breeds. The Holsteins were always higher than the Jerseys on every test day and throughout the results.

Table 3. Top 10 Holstein and Jersey cows in both rumination and ECM

Holstein Top 10 ECM					
Cow ID	February	Cow ID	January	Cow ID	December
2348	115.7	2309	142.8	2338	123.0
2266	113.5	2343	124.5	2266	121.9
2422	113.1	2394	118.4	2348	116.6
2394	109.9	2266	113.2	2326	115.7
2326	107.9	2348	112.1	2362	111.6
2377	105.4	2326	107.6	2343	102.9
2362	104.4	2316	104.9	2348	100.6
2412	104.1	2354	104.5	2354	100.0
2430	100.0	2362	98.7	2435	99.0
2309	98.8	2340	98.1	24436	97.9
SUM	1,072.8		1,124.8		1,089.2
AVERAGE	107.3		112.5		108.9

Jersey Top 10 ECM					
Cow ID	February	Cow ID	January	Cow ID	December
203	123.4	405	100.7	282	139.3
338	113.4	331	99.1	331	117.6
298	113.3	360	98.2	234	113.3
360	107.7	203	98.1	870	109.7
331	97.0	322	97.5	304	108.3
412	93.4	282	96.4	334	105.2
294	89.9	338	94.0	203	97.7
399	88.2	870	92.4	322	92.6
349	86.4	814	87.0	309	92.0
243	85.7	243	86.7	349	91.6
SUM	998.4		950.1		1,067.3
AVERAGE	99.8		95.0		106.7

Holstein Top 10 Rumination					
Cow ID	February	Cow ID	January	Cow ID	December
2382	1,146	2362	1,096	2316	1,036
2444	1,033	2422	1,093	2343	996
2377	1,012	2444	1,082	2414	902
2316	1,006	2436	1,046	2431	878
2303	1,002	2114	1,026	2266	873
2429	994	2343	1,012	2362	873
2362	987	2382	1,005	2364	864
2422	984	2394	1,000	2435	861
2414	974	2303	945	2430	855
2343	967	2316	942	2309	802
SUM	10,105.0		10,247.0		8,940.0
AVERAGE	1,010.5		1,024.7		894.0

Jersey Top 10 Rumination					
Cow ID	February	Cow ID	January	CowID	December
322	1,017	405	1,062	322	998
360	1,011	311	1,010	405	995
405	1,003	282	998	331	935
203	942	334	939	334	907
331	914	399	933	282	891
399	906	322	930	311	879
338	903	398	899	398	841
814	876	814	891	375	830
282	875	294	887	345	800
234	842	304	845	814	775
SUM	9,289.0		9,394.0		8,851.0
AVERAGE	928.9		939.4		885.1

When comparing the two breeds, it was noted that the Holsteins were slightly higher in both rumination and ECM, but not significantly. It is possible that the weather could be affecting the cows and how much they are ruminating because San Luis Obispo saw unusually good weather with little rain and slightly warmer temperatures during these months. February in particular saw temperatures in the 70s and mostly dry allowing higher comfort levels for the cows. Typically the cows that are able to relax

more will be more efficient in ruminating. For the EMC, many factors could have taken place. Variances in feeding practices could have occurred due the large number of employees and volunteers on the Cal Poly Dairy or simply from differences between cows themselves, including the health of the cows.

There was a great of consistency in the test data using the MICRO Dairy Logic system. Large variances in data were due mainly to malfunctioning collars, improper placement or in a few cases, where a few cows were sick enough decrease rumination significantly.

There are limitations to this study. Available testing data was only from the three dates as shown due to the project's deadline and other activity at the dairy. Additionally, there are other factors to consider when comparing rumination and milk yields that could not be evaluated quantitatively by the system (such as cow health as an example). Increasing the sample size, retrieving data on more available test days and including other breeds of bovine could improve the results of the study. With that I would also look at using a bigger set of cows to get more numbers in the data. Better testing of the collars and better training for their placement will also increase accuracy of the data, along with students consistently working with the program and keeping the data updated weekly.

CONCLUSION

The study evaluated the data gathered by the MICRO Dairy Logic system that is currently being utilized on the Cal Poly Dairy. The MICRO Dairy Logic system gathers information using electronic collars that are placed around the necks of dairy cows to gather data on the rumination process of both Jersey and Holstein breeds during the early lactation process. The author's current research will evaluate the efficacy of the MICRO Dairy Logic system when compared to more traditional evaluation techniques.

Three months of data were gathered using the MICRO Dairy Logic system. In general, the MICRO Dairy Logic system was found to be extremely reliable with only a few inconsistencies in data when compared to visual observation. These problems were from improper placement of the data collars on the cows by workers at the Cal Poly Dairy and not from the system itself. Additionally, some of the collars were found to not be working correctly and provided inaccurate data; as a result, data from these cows were not be used in the study.

In contrast to the earlier studies performed by others, the results of data evaluation in this study found that there was no significant difference between the Holstein and Jersey breeds during rumination or ECM. The study found that the data between the two breeds were so close that is appears that both breeds were working the same amount, no matter how much dry matter was observed at intake. While accuracy of the data could possibly be improved by increasing the sample size of cows, I believe the sample size utilized in this study was large enough to have significant and relevant data and that the results would not yield a significant difference in data or result in a different outcome.

In conclusion, the project objective was accomplished in determining the differences between the Jersey and Holstein breeds of rumination in early lactation. The data showed that there was virtually no difference between the two breeds, even with a smaller sample size utilized with the MICRO Dairy Logic system. Comparing the numbers on a top ten basis (top ten cows in terms of milk yields), it was noticed that there are about a 100 minutes difference of rumination between the top ten cows and the calculated average (arithmetic mean) between the two breeds. During the three month study period, the top ten ruminating cows would change from month and from breed to breed. This observation, along with the evaluation of data overall demonstrates that there is no significant difference between the two breeds in rumination and resulting milk yields.

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