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The Effects of Music on Dairy Production

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The Effects of Music on Dairy Production

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Abstract

The purpose of this research is to find which genre of music dairy cows produce the most milk to in order to aid dairy farmers in yielding maximum product while also keeping their cattle as comfortable as possible. During each lactation a different genre of music will play, basic vital signs, and behavioral observations of the cows will be taken, then the amount of milk produced during that genre will be measured. First, no music will be played, base line vitals will be taken, and milk yield will be measured. This will give an estimate to how positively or negatively the music affects the cows. Results showed that the cows were least stressed while lullaby music played, though the highest milk yield was collected when no music played.

Acknowledgments

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Introduction

My thesis will research which genre of music cows respond most positively to. Music can affect the mood of humans, and research will show if music also has an effect on the productivity of cows during lactation. It is expected that the milk production will maximize while listening to songs with a slow tempo, thus the cows should produce the most milk while listening to genres like lullaby, classical, opera, or reggae. The importance of this research is to provide dairy farmers with information that will help them maximize their product while keeping their cows comfortable and happy. To collect data for this research a Bluetooth speaker will be placed in the middle of the milking parlor to play a different genre of music during each milking. The cows will be milked once a day in the morning. The heart rate and respiration rate of each cow will be measured, and her physical behaviors will be observed to assess stress levels. Then, the total milk yield will be measured after each milking to assess the affect that genre has on how much milk the cows produced.

Introduction to the dairy cow

The term “cow” refers to a female bovine that has had a calf. Cattle have been utilized in agriculture in everything ranging from food to transportation. Dairy cows, *Bos Taurus*, have been utilized because they provide milk suitable for human consumption with health benefits such as growth and development. Dairy farming began in the Middle East around 11,000 years ago when hunting and gathering harvests failed. Dairy farmers would milk cattle and reduce the level of lactose in milk product by fermenting it. Then, thousands of year later a genetic mutation spread around Europe that made humans produce lactase which is the enzyme that breaks down lactose (Curry). Thus, began human consumption of dairy.

Music and humans

Music has a wide range of purposes covering everything from entertainment to medicine to religious praises. A study done by the *Journal of Clinical Nursing* in 2011 studied the effect of music on hospitalized patients receiving ventilatory support. The study was conducted on two groups of randomized patients, one group did not listen to music while being ventilated while the second group did. The results showed that music had a significant difference in physiological effects including blood pressure, respiration rate, and oxygen saturation. Findings suggest that music therapy had a positive effect on patients receiving ventilators (Korhan). In 2016, research was published by the Cambridge University Press that investigated the effect music therapy had on palliative care patients. Palliative care is medical assistance given to someone undergoing a life threatening illness in order to improve their quality of life. As quoted in the article entitled "Music Therapy for Palliative Care: A Realistic Review," "Music therapy may be an effective nonpharmacological approach to managing distressing symptoms in palliative care patients. The findings also suggest that group music therapy may be a cost-efficient and effective way to support staff caring for palliative care patients." Not only did the finding suggest a positive effect on the patients themselves but also the staff. From these studies, it is evident that music can have a positive effect on humans both emotionally and physiologically. Music therapy is also finding its way into the veterinary field.

Students of the Sydney School of Veterinary Medicine published an article in 2020, "Musical Dogs: A Review of Influence of Auditory Enrichment on Canine Health and Behavior." For their research, these students searched PubMed for articles relating the terms "music" and "dog" and after 111 results the students filtered down to just nine articles to review for the final dataset. After reviewing these articles, the students concluded, "The use of music in

domestic animal contexts shows great potential as an effective and easy-to-implement therapeutic measure with many flow-on benefits to animal health and welfare." This means that music can also benefit animal species.

Both humans and animals alike can benefit from listening to music. Music can be used to improve health and reduce anxiety. Based on literary research, it is expected that listening to music will improve dairy production in cattle.

Baselines

Baseline measurements give an estimate of how a cow normally lactates comparing measurements found from each genre of music to the normal lactation. The baselines include heart rate, respiratory rate, and milk yield. If a cow is stressed, heart rate and respiratory rate will increase. Physical signs of stress include vocalization, kicking, tail swishing, abnormal gait, reduced milk let down, and alertness (Cow). If a cow is relaxed, she will have vitals at or below her baseline and will display physical signs of relaxation such as: lowered head, lowered eyelids, chewing cud, and grooming (Cow). The average cow produces approximately 9 gallons of milk per day (Milking) and the average vital signs for cow are as followed: heart rate 48-84 bpm, respiratory rate 26-50 bpm (Eley). Data will be collected in the wintertime so vital signs may range below the average.

Lactation

Once a cow has given birth, or calved, she begins a lactation cycle which means she produces milk for her calf. The first 24-48 hours the milk produced is called colostrum and it contains antibodies for the offspring. It is vital for the offspring to receive this colostrum. After colostrum the cow secretes milk produced by the aveoli cells; milk is released from the aveoli cells by a hormone called oxytocin (Milking). Oxytocin is produced in the hypothalamus and targets the mammary glands and uterus. Lactation is broken up into five phases that make up the lactation curve: early lactation, mid lactation, late lactation, and the dry period (Figure 1). Early lactation

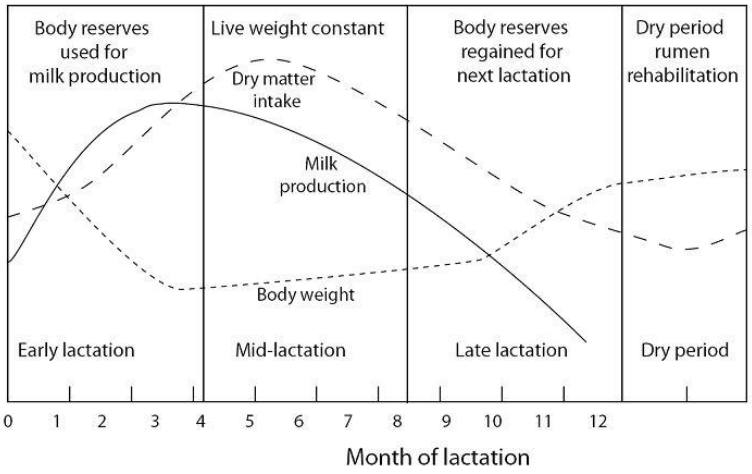

Figure 1. Dry matter intake, milk yield and live weight changes in a cow during her lactation cycle

Figure 1. Lactation curve (Milking).

occurs from day 14-100 of the lactation cycle. This is when peak milk production occurs and the optimal time to breed the cow is between days 60-70 of lactation. Mid lactation occurs between day 100-200 and the goal of this period is to maintain peak lactation for as long as possible before milk production begins to decline. Late lactation takes place from day 200-305, and this is when milk production continues to decline. The dry period is the period between the end of

milking and the next lactation, and this phase should last about 45-60 days (Milking). During the lactation cycle cows can develop reproductive and metabolic diseases.

Metabolic and reproductive diseases

While cows lactate, they can fall ill due to varying diseases including mastitis, hypocalcemia, and ketosis.

"Mast" is a root word which refers to "mammary glands" and "-itis" is a suffix meaning "inflammation" so mastitis means inflammation of the mammary glands. According to the Merck Veterinary Manual, "almost any microbe that can opportunistically invade tissue and create an infection can cause mastitis." If an udder comes in contact with a microbe it can become infected which means it is important to keep the udders clean with proper milking equipment.

Symptoms of mastitis may depend on the severity of the infection. An animal with acute mastitis may present swollen and painful udders. An animal with more severe mastitis may present fever, anorexia, and even shock (Erskine).

The Merck Veterinary Manual emphasizes that prevention with proper hygiene and milking technique is important. Treatment for mastitis includes NSAIDS and antibiotic therapy (Erskine). NSAID stands for non-steroidal anti-inflammatory drug and is used to ease the swelling of the udder. The antibiotic therapy used is determined based on the bacteria infecting the udder.

Hypocalcemia, parturient paresis, or more commonly known as milk fever, is "an acute to preacute, afebrile, flaccid paralysis of mature dairy cows that occurs most commonly at or soon

after parturition" as defined by the Merck Veterinary Manual. Milk fever occurs when calcium is secreted in the production of colostrum and milk. The secretion of calcium for colostrum and milk causes the calcium level in serum to decline which excites the nervous system while reducing strength of muscle contraction, thus leading to tetany and paresis (Aiello).

Milk fever generally occurs about 72 hours after parturition and presents in three stages if not treated (Allen). Symptoms of stage one include hypersensitivity, excitability, mild ataxia, fine tremors, ear twitching, head bobbing, restlessness, bellowing, and shuffling of feet. Symptoms of stage two include anorexia, dry muzzle, hypothermia, tachycardia, obtundation, weakened pulse, and smooth muscle paralysis. When in stage two, cows may also lay in sternal recumbency, they tend to either tucks their heads towards their flank or extend their heads so an S shape can be observed on the neck. Symptoms of stage three include unconsciousness, paralysis, unresponsiveness, bloat, extreme tachycardia, undetectable pulse, and death within a few hours after presenting symptoms (Allen).

The proper treatment for milk fever is "slow IV administration of calcium gluconate salt. 1g Ca/ 45kg bw." (Aiello). It is extremely important to administer the treatment slowly in order to avoid dysrhythmia, and while administering the treatment one must auscultate the heart to access the rhythm (Allen).

Another common ailment of lactating cows is called ketosis. "Keto" is a root word referring to "ketone" while "-osis" is a suffix meaning "state or condition of". Ketosis is the state or condition of ketone bodies in urine or milk. Ketosis can be prevented with proper nutritional management.

Ketosis typically occurs in early lactation with peak risk being at week two of lactation. The common symptoms associated with ketosis include reduced milk production, lethargy, and "empty" abdomen. Less common symptoms include dehydration, abnormal rumen motility (may be hyperactive or hypoactive), aggression, bellowing, incoordination, gait abnormalities, and abnormal chewing habits (Herdt).

If a cow develops ketosis the treatment is "IV bolus of 500 ml of 5% dextrose solution." (Aiello). Another treatment option is orally administering 250-400 g/dose of propylene glycol. This should be done with caution as an overdose of propylene glycol can cause depression of the central nervous system (Herdt). If ketosis occurs in the first two weeks of lactation long term insulin may be a beneficial treatment option, and 150-220 IU/day should be administered IM (Herdt).

Automatic milker

The automatic milker was invented in 1963 by Lorell John Schilling and Orville Oanes to create a milker that automatically shuts off when milk flows ceases. A milker is a device used to extract milk from an udder. This device works by attaching to each of the four teats via a teat cup and creating a vacuum like suction to extract the milk while also providing a pulsation to stimulate the milk let down. This device automatically shuts off the suction and pulsation when the milk let down ceases. Milk then travels through flexible tubes connected to the teat cup and is collected through a pipe system (L. J. Schilling). A picture of the automatic milker in use is demonstrated by figure 2. The automatic milker should be removed from the udders once milk let down stops to avoid irritation and damage to the mammary glands (L. J. Schilling).

Figure 2. Automatic Milker.

Song Choices

A wide range of music including country, rock, opera, jazz, reggae, pop, lullaby, classical, rap, heavy metal, and hip-hop will be chosen. The genres differ in aspects such as rhythm, tempo, and frequency which will give a variety of aspects for the cows to respond to. It is predicted that the cows will respond most positively to slow tempo music. To choose songs, Spotify will randomize songs that fit into the desired category. For example, “hip-hop” will be searched and Spotify will make a playlist of songs that fit into the hip-hop category. This method will be repeated each milking for each genre.

Methodology

Research will be conducted at Fountain Fresh Dairy Farms located in Sedalia, KY. Fountain Fresh Dairy Farms is a family operated dairy farm owned by the Trout family. This

farm is home to many animals including dairy cattle, beef cattle, dogs, cats, ducks, chickens, and pheasants. The milk produced by these cattle is sold in herd shares to local buyers. The milking herd includes 10 Jersey cows and Jersey- Holstein crosses that are milked once a day in the morning. Data will be recorded over a course of four weeks. Research will begin with a control day meaning no music is played during milking, a heart rate and respiration rate are taken from each cow, physical behaviors are observed, and the total milk yield will be measured. These same steps will be repeated each milking while a different genre of music play for the cows. Each morning of milking the milking parlor and equipment is flushed and sanitized with soap and water. This means each pipe and automatic milker will have soap and water run through it every morning to ensure clean equipment. The pipes will then be rinsed and flushed once more. Then, the cows will be gathered to the parlor and each placed to a milker. Before milking, a Bluetooth speaker will be set in the middle of the milking parlor and Spotify will be used to play the desired genre. Then, the udders will be treated with an iodine solution to avoid bacteria collecting in the mammary glands and causing mastitis. Next, the automatic milker will be placed on the udders and the milking process will begin. After each milking, the udders will be post treated with another iodine solution and the milk yield will be measured. Finally, each pipe and piece of equipment will again be sanitized and rinsed.

Results

Just like humans, each cow had their personal preference in music, so to gather results as a whole species the average heart rate, the average respiration rate, observational behaviors, and the total milk yield was measured while each genre played. Data collection began with a control day where no music was played. The milk yield for the control day was 13 5/8 gallons (g), the average heart rate was 65 beats per minute (BPM), and the average respiration rate was 22

breaths per minute (BPM). Eight cows exhibited relaxed behavior meaning their heads were lowered and eyelids were relaxed, four of which were also chewing cud. A cow chewing cud is a sign of happiness and relaxation. Two cows were slightly alert meaning their eyes were wide open and their heads were raised. During the next milking, country music was played. While country music played the average heart rate was 60 BPM, the average respiration rate was 18 BPM and the milk yield was 12 ¼ g. Nine cows displayed relaxed behavior, four cows were chewing their cud. Only one cow was slightly alert. Another control yield was taken before the next genre of music played and measured 10 7/8 g. Then, rock music was played during milking. The cows responded to the rock genre with an average heart rate of 66 BPM an average respiration rate of 16 BPM, and a milk yield of 12 1/8 g. Only three cows exhibited relaxed behavior and chewed cud while seven cows were alert with their heads raised and eyes wide. Jazz music was the next genre played for the cows and the average heart rate while jazz music played was 57 BPM, the average respiration rate was 16 BPM, and the milk yield was 11 ¾ g. Seven cows showed signs of relaxed behaviors, none of which were chewing cud, and three cows were slightly alert. During the next milking, reggae music played. Behaviorally, the cows responded well to the reggae genre. Each of the ten cows had their heads down and eyelids relaxed, four of these cows where chewing cud. No cows showed signs of stress during this milking. However, the milk yield for this day was only 12 g, the average heart rate was 61 BPM, and the average respiration rate was 18 BPM. Another control was taken before the next genre was played for the cows and measured 12 ¾ g. The night before pop music played a beef calf had escaped into the dairy barn which means the calf could have nursed on the dairy cows before the milking. While the pop genre played the average heart rate was 63 BPM, the average respiration rate was 19 BPM, and the milk yield was 10 ¼ g. During this milking, six cows were

slightly alert, though they did not look entirely offended; these cows had their heads raised, occasionally looking around, but would also return their heads to a lowered position. Four cows were relaxed, two cows were chewing cud. Classical was the next music played during milking which brought a milk yield of 11 ½ g, an average heart rate of 59 BPM, and the lowest average respiration rate of 14 BPM. Again, the night before this milking the beef calf had escaped into the dairy barn. While classical music played all ten cows displayed relaxed behavior, five of which were chewing their cud. Again, behaviorally the cows enjoyed classical music, but the milk yield was not the highest. Another control was measured before the next genre and the milk yield was 11 g. The next genre played for the cows was opera. The opera genre roped in a milk yield of 9 1/8 g, an average heart rate of 63 BPM, and an average respiration rate of 15 BPM. Nine of the ten cows really enjoyed the opera music they illustrated relaxed behavior. Five of these nine cows were chewing cud. One cow had a very strong negative opinion about opera music. She was restless, alert, and ornery. Possibly, she was just having a bad day. Rap was the next genre for the cows and they certainly differed in their opinions. The rap genre collected a milk yield of 11 1/8 g, an average heart rate of 59 BPM, and an average heart rate of 18 BPM. Once again, the beef calf had escaped into the dairy barn the night before this milking. Three cows were relaxed and chewing cud, three other cows were slightly alert, but four cows seemed more confused than upset by the music; their heads were raised but their eyes were not wide, instead, their eyes and ears were wandering as they listened to the quick tempo. Before the next genre another control was taken and measured 10 ½ g. Hip hop was the genre played during milking. While this genre played the average heart rate was 64 BPM, the average respiration rate was 20 BPM, and the milk yield was 12 g. In response to the hip hop music, seven cows were relaxed, six of which were chewing cud, and three cows were slightly alert. During the next

milking the lullaby genre played and showed to be a crowd favorite. Lullaby music gathered an average heart rate of 56 BPM which was the lowest of the data collected, an average respiration rate of 15 BPM, and a milk yield of 12 ¾ g. All ten cows were extremely relaxed while the music played, one of which was beginning to fall asleep with her head rested on her neighbor. Heavy metal was the next genre played and had quite the opposite results; this was not a crowd pleaser. The average heart rate measured during the heavy metal milking was the highest of the data collected at 67 BPM, the highest average respiration rate at 21 BPM, and a milk yield of 12 3/8 g. Only one cow was relaxed and chewing cud during this milking. The other nine were alert, one was even swishing her tail.

The chart below summarizes the data results to show the effects each genre of music had on the cattle (figure 3). It should be noted that the X axis indicates the music played during that milking and is also organized over time. Data collection started the control day 2/9/2020 and ended on 3/8/2020 with heavy metal. The X axis does not indicate the week of lactation the cattle were in.

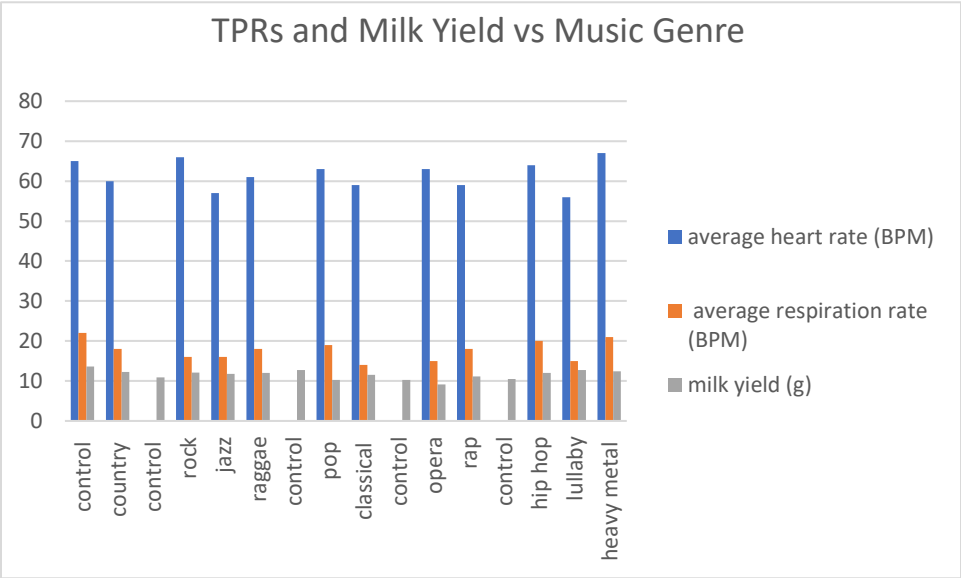

Figure 3. Data Results.

Discussion

Based on the results, it is difficult to determine whether any specific genre of music has an effect on dairy production. This is because some of the data points are contradictory. For example, the cows showed the most physical signs of relaxation while listening to lullaby music, however the milk yield while lullaby music was played was not the highest milk yield of the data collection. The highest milk yield was collected during a control week when no music was played. Of course, other factors come into play that may interrupt proper data. These other factors may include mood, weather, feed, and unexpected interruptions.

Just like humans, cows have good days and bad days. They may wake up in a good mood or they may have a rough start to the day. Even if they enjoyed the music, they may not have had a good morning. Cows also tend to produce less milk in the colder weather, and since the data collection took place in wintertime some mornings were much colder than others and could have affected the dairy production. For example, the milk yield for the opera day was the lowest yield at 9 1/8 g, but it was snowing the morning of that milking. The low yield may have been due to the cold weather rather than the music.

Cows rely on proper nutrition to produce milk. If a cow does not eat enough the night before milking, she will not produce her maximum yield. These cows are grass fed so some nights a cow may have grazed less than she normally does meaning she would produce less milk the following morning.

There were other unforeseen occurrences that may have intervened with proper data collection. On multiple nights, a beef calf had escaped into the dairy field. This may have affected the data because the beef calf could have nursed on the dairy cows before milking which would decrease their milk yield for the data collection. Advertisements and Wi-Fi connection

was another inconvenience. Since Spotify was used to play the music, frequent ad breaks occurred which could have interrupted the mood the cows were in while listening to the music. Spotify also requires Wi-Fi to work and sometimes the Wi-Fi connection would cut out so the music would stop until the issue could be resolved. Again, this could have interrupted the mood of the cows while listening to music. To more accurately study the effects of music on dairy production, some aspects of this research could be improved.

It is predicted that the effects of music on dairy production may be long term so instead of data collection lasting a matter of weeks, data collection should last a matter of years. This would track milk production through multiple lactation cycles, allowing a comparison in milk yields between cycles. The lactation cycles should also be tracked and ideally synchronized so the researcher knows at what period of the cycle the cows are in. A more consistent milking schedule may also improve accuracy of results, ideally data should be collected everyday and music should be played more frequently. Playing music consistently would allow the cows to get used to hearing music as well as allow them to respond to the same genre of music more than once. Cows are very apprehensive towards things they are unfamiliar with, so it is important that they cows are familiar with seeing and interacting with the researcher and the music. Assessing the cortisol levels of each cow while music plays may improve data regarding stress level measurement. This could be done by collecting a saliva sample during the milking process and analyzing the cortisol level in the sample. Having more control over environmental factors could also improve the accuracy of results. Having the cows in a temperature and feed controlled environment would take out physiological responses to weather and nutritional status. Thus, the milk yield would reflect the cows' responses to the music rather than environment. Lastly, having a more accurate way to measure milk yield would be beneficial. Perhaps measuring the

weight of the yielded milk in grams rather than the amount of milk in gallons would be more precise.

Though research data was inconclusive on how music affects dairy production it does point out that music has an effect on the stress levels cattle. It is predicted that slow tempo music for cattle may have a long-term effect on stress to eventually increase milk yield over time by decreasing overall stress. Dairy farmers can still use this information to help keep their herds happy and healthy.

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