

MUSIC FOR DAIRY CATTLE: ITS IMPACT ON PHYSIOLOGICAL CONDITIONS, BEHAVIOR, AND MILK PRODUCTION—A REVIEW

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ABSTRACT

Music, as a form of environmental enrichment, has considerable potential to enhance the welfare and productivity of dairy cattle. This study aimed to synthesize and analyze research findings from the past decade regarding the effects of music exposure on the physiological conditions, behavior, and milk production of dairy cattle. A literature review methodology was employed, involving the collection of scientific articles, theses, and conference proceedings published between 2015 and 2025, followed by descriptive analysis. The findings indicate that several studies have reported slow-tempo music typically 70–100 beats per minute (BPM), which measures beat frequency, and volumes below 70 decibels (dB), which quantify sound intensity, can reduce stress hormones such as cortisol, elevate serotonin levels, enhance feed consumption and feed efficiency, improve milking behavior, and increase milk production. However, other studies have also reported no significant effects or adverse outcomes associated with using fast-tempo or high-volume music. These inconsistencies highlight the need for more standardized research that considers factors such as individual cow variability, environmental conditions, and variations in music delivery methods. Music presents a promising, innovative, and animal-friendly strategy for improving dairy farm performance, although its successful implementation depends on stronger and more consistent scientific validation.

Key words: Animal welfare, environmental enrichment, music exposure, stress reduction, milk yield

INTRODUCTION

Dairy cattle are domesticated animals that are raised primarily for milk production. Achieving optimal and sustainable milk yield is the main objective of dairy farming operations. Milk production serves as a key indicator that positively correlates with the profitability of dairy farming enterprises (de Andrade Ferrazza et al., 2020). According to Garamu (2019), approximately 30% of a cow's milk-producing ability is determined by genetic factors, while the remaining 70% is influenced by environmental factors. This indicates that optimal milk production is not solely determined by genetics but is also significantly affected by environmental conditions, including nutrition, health, and comfort during the milking process.

Inadequate environmental conditions during housing or milking can lead to stress in dairy cattle. Stress can cause discomfort and ultimately disrupt multiple physiological mechanisms involved in the milk ejection process. When milk ejection from the alveoli of the udder is impaired by stress, incomplete milk release occurs, leading to reduced milk yield and increased risk of udder health issues. Stress responses involve complex interactions among the nervous, endocrine, and immune systems, resulting in elevated levels of

stress hormones such as cortisol and adrenaline as well as decreased levels of oxytocin, a critical hormone for milk let-down. Furthermore, stress can compromise the immune function of cows and increase their susceptibility to disease, thereby posing significant economic risks to dairy farm operations (Bobic *et al.*, 2011).

Stress in dairy cattle can be mitigated through environmental enrichment strategies. As noted by Mandel *et al.* (2016), environmental enrichment supports biological functioning as evidenced by improved reproductive success, better overall health, and enhanced coping mechanisms against stressors. Additionally, a well-designed environment helps reduce frustration, fulfills natural behavioral needs, and promotes a setting more conducive to animal welfare. One form of environmental enrichment that can be introduced is auditory stimulation through music.

Music has long been used to alleviate stress in both humans and animals. Numerous studies have reported that music can benefit animals by providing auditory enrichment that influences their natural behaviors, including those of dairy cattle. Music has been shown to impact both milk production and behavioral responses during milking (Dhungana *et al.*, 2018). As a form of environmental stimulation, music

offers an intriguing potential for optimizing milk yield; however, its effectiveness remains an area that requires further investigation. Although considerable research has explored the effects of music on dairy cattle, comprehensive reviews summarizing these findings are relatively scarce. Therefore, this literature review aims to examine and consolidate research findings from the past decade concerning the effects of music exposure on the physiological conditions, behavior, and milk production of dairy cattle.

MATERIALS AND METHODS

The method used in this study was a literature review conducted by searching scientific sources through Google Scholar. The reviewed literature included scientific articles, conference proceedings, and research theses relevant to the predetermined topic, with a publication range from 2015 to 2025. The search was conducted using keywords related to musical stimulation and its effects on dairy cattle. The collected data and information were analyzed descriptively and interpreted based on their relevance to the research topic.

RESULT AND DISCUSSION

Over the past decade, studies have shown that the use of music as a form of auditory enrichment in dairy cattle has great potential for improving both animal welfare and milk production. Based on the literature search, a total of 18 studies were identified, consisting of 11 journal articles, 6 theses, and 1 conference proceeding from various countries. The findings from these studies indicate that music exposure influences the behavior, physiological conditions, and milk production of dairy cattle.

Impact on Physiological Conditions

Music has a significant impact on the physiological condition of dairy cows, particularly on the management of stress and overall welfare. Oliveira *et al.* (2024) explained that music's ability to induce relaxation and reduce stress leads to hormonal and biochemical shifts that impact overall metabolism. This process shows the body's adaptive mechanisms to maintain homeostasis and optimize physiological functions in response to environmental stimuli. Kochewad *et al.* (2022) showed that traditional Indian music with an amplitude of 40-60 dB, such as the flute and sitar played in the raga Yamen, can lower cortisol levels in dairy cows during milking. Similar findings were reported by Contreras-Torres *et al.* (2024), who used popular and classical music (65-75 dB), which led to a decrease in cortisol levels. However, another study by Donghai *et al.* (2018) found that fast-paced music, such as rock and African percussions, led to increased

metabolic stress, which negatively affected the physiological condition of dairy cows. This suggests that the genre and tempo of music stimulation may be critical factors in regulating the stress response in dairy cows.

Research by dos Santos Lemes Lechuga *et al.* (2023) showed that music with a slow to moderate tempo (75-107 BPM) can increase serotonin levels, a neurotransmitter associated with feelings of comfort in dairy cows. Increased serotonin levels may boost milk production. Serotonin plays a crucial role in the development of the mammary gland and milk production; therefore, increasing serotonin levels can support the growth of the mammary glands and milk formation processes (Chimde, 2023). Furthermore, music stimulation can provide a stimulus to the auditory center of cows, which is connected to the emotional regulation center in the brain. As an auditory stimulus, music engages various brain areas and components simultaneously, thus significantly impacting emotions and physiological processes (Zapata-Cardona *et al.*, 2024). Cheerful music can encourage behaviors that indicate happiness, while sad music tends to elicit behaviors related to sadness. Cheerful music can also generate effects similar to the hormone oxytocin and increase the levels of neurotransmitters, such as dopamine and norepinephrine in the brain, which contribute to feelings of pleasure and comfort (Snowdon, 2021).

Tuytens *et al.* (2023) found that classical music with a low amplitude (<62 dB) triggers positive hormonal responses such as a reduction in adrenaline, which can support more efficient lactation processes. Music stimulation in dairy cows can also affect their immune system. According to Contreras-Torres *et al.* (2024), cows that received music stimulation increased the total leukocyte count, particularly lymphocytes, suggesting that music can enhance immune responses. Liu *et al.* (2017) added that the stimulation of Mozart and light music increased antioxidant capacity in the blood, which helps fight free radicals and improve cell health. However, this effect was not observed with original music, suggesting that harmoniously structured and composed music is more effective in modulating the immune system.

Other studies have reported that music can stabilize heart rate, respiration rate, and rectal temperature in dairy cows. Badaruddin *et al.* (2020) found that Javanese gamelan and Sundanese zither music decreased heart rate by 8-12%, rectal temperature by 0.5-1°C, and respiration rate by 10-15%, indicating physiological relaxation. Other music genres, such as classical music played near the milking parlor, have been reported to reduce signs of anxiety, such as increased breathing frequency in dairy cows (Kenison, 2016).

Table 1. Summary of research on the effects of music stimulation on dairy cattle

Reference		Treatment	Main result
Kamar & Yusof (2023)	Genre	Classical music	Music has the potential to improve the welfare of dairy cattle, but it does not affect milk production.
	Amplitude Playback	<85 dB 1 hour during milking and 3 hours after milking	
Contreras-Torres <i>et al.</i> (2024)	Genre	Pop and classical	Music influences an increase in the number of cows voluntarily approaching the milking area, resulting in a significant increase in total leukocyte count, showing a positive effect on the leukogram profile, and has the potential to reduce stress.
	Amplitude Playback	65-75 dB 2 hours per milking session	
Kochewad <i>et al.</i> (2022)	Genre	Traditional Indian music (flute and sitar) played with raga <i>Yamen</i>	Milk production in cows exposed to music showed no significant difference compared to the control group without music. However, music treatment had an effect on reducing milking time and significantly increased milking speed compared to the no-music treatment, while cortisol stress hormone levels decreased in the music treatment group.
	Amplitude Playback	40-60 dB 10 minutes before milking until the end of milking.	
dos Santos Lemes Lechuga <i>et al.</i> (2023)	Genre	Slow tempo music (andante) to moderate (andante moderato) 75-107 BPM.	Music can increase daily milk production by 50-65%, boost serotonin levels, and reduce milk residue to 23.8-24.6% compared to the control group.
	Amplitude Playback	No more than 75 dB Before entering the milking parlor until the end of milking.	
Zhao (2020)	Genre Amplitude Playback	Classical music, pop, rock - Played three times a day (morning, afternoon, and evening), with a duration of 30 minutes each.	The three music genres in the study had an impact on increasing milk production in dairy cows, with an average increase of 15% (classical music 13%, pop music 14%, and rock music 18%).
Ganesh (2020)	Genre Amplitude Playback	Carnatic music - During the winter and summer seasons	Certain Carnatic music can significantly increase milk production and create a more comfortable environment for the cows.
Lemcke <i>et al.</i> (2021)	Genre	Blues, rock, classical (tempo <100 BPM)	Music treatment does not affect milk production, but it helps to improve the efficiency of time and effort in guiding cows to the automated milking system, increases the frequency of cows passing through the milking area gate, increases the frequency of milking, and shortens the interval between milkings.
	Amplitude Playback	65-70 dB Played as a single shuffled playlist continuously for two days	
Contreras <i>et al.</i> (2023)	Genre	Popular and classical music (tempo <100 BPM)	Playing music during milking enhances the cooperative behavior of dairy cows and boosts the immune system through an increase in lymphocyte count.
	Amplitude Playback	65-75 dB Played as a single playlist consecutively for 2 hours during each milking session.	

Table 1 (continued)

Pinkerton (2022)	Genre	Classical, country, Latin, rock	Music playback during milking enhances more cooperative behavior in dairy cows and boosts the immune system through an increase in lymphocyte count.
	Amplitude	±46 dB	
	Playback	Each genre is played for 2-3 hours during the afternoon milking session for 5 consecutive days per music genre.	
Kemp (2020)	Genre	Country, rock, jazz, reggae, pop, classical, opera, rap, hip-hop, lullaby, heavy metal	Slow-tempo music, such as lullabies, can reduce cow stress and result in the highest milk production among other genres in the study, although it is not higher than the production without music.
	Amplitude Playback	- Played during the morning milking process.	
Kenison (2016)	Genre	Classical music	Classical music can help reduce stress levels in dairy cows, especially when played near the milking system.
	Amplitude	-	
	Playback	While the cows are in the milking parlor.	
Donghai <i>et al.</i> (2018)	Genre	Latin, <i>rock</i> , African percussion	Fast-tempo music, such as rock and African percussion, increases metabolic stress in dairy cows, thereby reducing milk production, while Latin music has no significant effect on metabolism or milk production.
	Amplitude	-	
	Playback	Played for 2 hours before the morning, afternoon, and evening milking times.	
Liu <i>et al.</i> (2017)	Genre	Mozart's music, light, original	Mozart and light music enhance milk production and antioxidant capacity, while original music does not have a significant impact on milk production but still increases antioxidant capacity
	Amplitude	68-70 dB	
	Playback	2 hours during the morning, afternoon, and evening milking.	
Widjaja <i>et al.</i> (2018)	Genre	Sundanese and classical music	Sundanese and classical music have a positive impact on increasing feed intake, milk production, and feed efficiency.
	Amplitude Playback	- During the lactation period	
Tuyttens <i>et al.</i> (2023)	Genre	Classic and pop music	Classical music increases milk production by 3% (0.97 kg/day/cow), while pop music increases milk production by 1.5% (0.49 kg/day/cow), and cows tend to prefer music with low amplitude (<62 dB) during pop music playback.
	Amplitude	<62, 62-64, 64-66, >66 dB	
	Playback	Played from 09:00 to 17:00 every day.	
(Langgoro <i>et al.</i> , 2019)	Genre	Traditional music (Javanese gamelan, Sundanese zither, and bamboo flute)	Sundanese zither and bamboo flute music influence the increase in dry matter intake, followed by a 9.42% increase in milk production.
	Amplitude Playback	- Played for 15 hours (03:00-18:00)	
Mandak <i>et al.</i> (2020)	Genre	Javanese gamelan and Sundanese zither, and bamboo flute	Javanese gamelan music and Sundanese zither and bamboo flute music do not have an effect on the behavior of eating duration, drinking duration, lying duration, and standing duration in dairy cows.
	Amplitude Playback	<85 dB 15 hours/day (03.00-18.00)	

Table 1 (continued)

Badaruddin <i>et al.</i> (2020)	Genre	Javanese gamelan, Sundanese zither and bamboo flute	Javanese gamelan music and Sundanese zither and bamboo flute music have the potential to improve the physiological response of dairy cows by reducing heart rate, rectal temperature, and respiration rate.
	Amplitude	-	
	Playback	15 hours (03.00-18.00)	

Impact on Behavior

Music played before and during milking can have a positive impact on the behavior of dairy cows. As a form of environmental enrichment, music can influence various aspects of cow behavior, ranging from feeding activities to their responses during milking. Comfort and physiological conditions play a significant role in the efficiency of dairy cows' production and welfare. Music has a significant effect on the feed consumption and its efficiency of dairy cows. This is consistent with the research by Widjaja *et al.* (2018), which revealed that classical music or Sundanese traditional music not only increased feed consumption in dairy cows but also improved feed efficiency during lactation. Feed efficiency refers to the extent to which the feed consumed by cows is utilized optimally to meet physiological needs, including milk production and overall health. This increase may be attributed to the calming effect of music, reducing stress and encouraging cows to eat in a regular rhythm, which maximizes digestion.

In addition to its effects on feed consumption and feed efficiency, music also influences behavior during the milking process. Contreras-Torres *et al.* (2024) reported that classical and popular music genres help create more cooperative behavior in cows during milking. A similar finding was shown by Lemcke *et al.* (2021), which indicated that cows exposed to music with a slow tempo (<100 bpm) helped make the process of herding cows to the automatic milking system more efficient, increased the frequency of cows passing through the milking gate, and shortened the intervals between milking sessions. This suggests that music can stimulate cows to move more easily toward the milking system. Cows that receive music stimulation become calmer, making it easier to guide them into the milking parlor, while also reducing the time and energy needed for the milking process.

Slow-tempo music, such as classical music, can help cows feel more relaxed, while fast-tempo music, such as rock, can cause stress, which may affect the milking process (Donghai *et al.*, 2018). Furthermore, the volume of music can also influence how cows respond to it. Low-volume music (below 70 dB) makes cows feel more comfortable, while music that is too loud can cause stress. Tuytens *et al.* (2023) found in their study that cows preferred music with lower volumes, especially when listening to pop music genres.

Impact on Milk Production

Milk production is a key parameter in dairy farming, and various studies have shown that music has a significant positive impact. The introduction of classical and slow-tempo traditional music has been proven to significantly increase milk production. Studies by Pinkerton (2022) and Tuytens *et al.* (2023) demonstrated that classical music can increase milk production by an average of 0.51-0.97 kg/cow/day, while pop music increases production by around 0.49 kg/cow/day. Similar findings have revealed that playing classical, pop, and rock music could increase milk production by 13-18% (Zhao, 2020).

Research by dos Santos Lemes Lechuga *et al.* (2023) reported a daily milk production increase of 50-65% when cows were exposed to slow to moderate tempo music. Another study by Langgoro *et al.* (2019) on the use of traditional Sundanese zither and bamboo flute music showed an increase in milk production by 9.42%.

Effectiveness of Music on Dairy Cattle

Although numerous studies generally indicated the positive effects of music on the physiological condition, behavior, and milk production of dairy cows, not all studies have shown similar results. Some studies, such as those by Kamar and Yusof (2023), Kochewad *et al.* (2022), and Lemcke *et al.* (2021), have reported no significant effects of music on dairy cows. Variations in these research outcomes suggest that the effectiveness of music as an auditory stimulus for dairy cows is influenced by various complex factors. These studies involved different treatments, including variations in genre, tempo, volume, duration, and frequency of exposure. The type and tempo of music have emerged as key determinants; slow-to-moderate-tempo music tends to have positive effects, while fast-paced music may lead to stress.

Mota-rojas *et al.* (2024) state that slow to moderate-tempo music (70-100 bpm) with frequencies below 70 dB is effective in reducing stress and enhancing milk production. The sound frequency during milking can affect the well-being of dairy cows. Dimov *et al.* (2023) suggest that noise levels for dairy cows should ideally range between 65-70 dB. Noise levels exceeding 70 dB can have adverse effects on cows, including increased stress that may result in reduced milk quality, often indicated by an increase in the somatic cell count in milk, a marker of disrupted

health. Other factors such as the cow's age, parity, and temperament also influence the cow's response to music. Multiparous cows (those that had calved more than once) showed different responses compared to primiparous cows (those that had calved for the first time), with multiparous cows recording higher milk production when exposed to music (Kamar and Yusof, 2023).

CONCLUSION

The provision of music has shown potential to positively influence the welfare and productivity of dairy cows when applied under certain conditions, with its effectiveness largely depending on factors such as the type, tempo, volume, and duration of the music. Slow-tempo music with low intensity generally showed the best results in reducing stress and increasing milk production. On the other hand, music with a fast tempo or high volume may have the opposite effect. The differences in results among studies highlight the importance of further structured research, not only to optimize the parameters of the music used, but also to evaluate the long-term effects on the physiology, behavior, and performance of dairy cows.

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