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Sprouting to the Beats: Fenugreek Germination under different Music Genres

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Abstract

This research explores the influence of sound vibrations generated by different music genres on seed germination and key physiological parameters in Fenugreek (*Trigonella foenum-graecum* L.). The experiment involved three groups: seeds exposed to the Soft Music, the Rap Music, and a control group with no sound exposure. Sound tracks were played daily for fixed durations under controlled conditions during the germination period. Parameters analyzed included Radicle Length, Plumule Length, Fresh weight and Dry weight in seedlings. The results revealed a significant enhancement in germination parameters and metabolic activity in the music treated groups compared to the control. Seeds exposed to the Rap Music exhibited the most pronounced improvements. Soft music treated group also showed positive effects, though to a lesser degree. These findings suggest that specific music vibrations can act as biophysical stimuli, potentially serving as eco-friendly enhancers of seed vigor and early plant development in sustainable agriculture

Keywords: *Trigonella foenum-graecum*, Seed germination, Music, Soft Music, Rap Music.

Introduction

Musical sound, a subset of audible sound, consists of organized sequences that form continuous compositions.(Chowdhury & Gupta, 2015; Das & Ghosh, 2022). The beneficial effects of music on both humans and animals, as well as plants, have been acknowledged for many years, particularly in music therapy. Sir Jagdish Chandra Bose was among the first to explore how plants react to various stimuli as well as various environmental factors (Bose, 1902, 1906; White, 2015; Chandrakala & Trivedi, 2019; Chandrakala, 2020). Research indicates that multicellular

organisms (Benford, 2002; Dossey, 2001; Kristen, 1997) respond to sound vibrations (Braam & Davis, 1990).

In the past, scientists believed that plants cannot hear and process sound waves because plants do not possess structural organs that allow them to detect sound. However, it is now known that plants can detect the vibration generated from sounds, and that these vibrations act as a stimulus to plants (Jung et. al., 2018). Not only this, plants have also been shown to be able to communicate through acoustic vibration (Gagliano et. al., 2012; Mishra et. al., 2016).

Need & Importance of the Study:

Sound is a powerful, invisible force that influences both animate and inanimate matter. While traditionally associated with communication and emotional expression in humans, recent scientific studies have begun to unravel the ways in which sound—particularly musical vibrations—can also affect plant life. This burgeoning field of plant bioacoustics suggests that plants are capable of perceiving and responding to sound waves in their environment, thereby opening up exciting new possibilities for non-invasive agricultural enhancements.

Music, a structured form of sound, varies widely in tempo, rhythm, frequency, and emotional tone. Different genres may therefore elicit unique responses in biological systems. Previous studies have shown that certain sound frequencies can stimulate seed germination, influence enzymatic activity, enhance water uptake, and modify growth patterns (Hassanien et al., 2014; Mishra et al., 2016). However, limited research exists on the specific influence of contrasting musical genres—such as soft (calm, harmonic) versus rap (rhythmic, high energy) music—on plant development, particularly during the critical germination phase.

Fenugreek (*Trigonella foenum-graecum*) is a widely cultivated legume with culinary, medicinal, and agricultural significance. It serves as a suitable model for bioacoustic studies due to its rapid germination, uniform growth pattern, and sensitivity to environmental conditions. Investigating how musical genres affect its germination could not only expand our understanding of plant responses to auditory stimuli but also contribute to the development of sustainable and energy-efficient techniques for enhancing seed vigor and early plant development.

This study explores the effects of two contrasting music genres—soft music and rap music—on the germination of fenugreek seeds under controlled conditions. By comparing parameters such as germination rate, mean germination time, and early growth traits, the research aims to assess whether music can serve as an effective biophysical stimulus. Through this exploration, the study bridges the gap between traditional knowledge, modern acoustics, and agricultural science, offering novel insights into the hidden sensitivity of plants to their sonic environment.

Statement of Problem:

Despite growing interest in plant bioacoustics, the influence of auditory stimuli, particularly music, on plant growth and development remains an underexplored area of scientific inquiry. While some studies have demonstrated that sound vibrations can enhance seed germination and vegetative growth, most of this research has focused on classical music or generalized sound frequencies. There is a significant lack of empirical data comparing the effects of different modern music genres, especially soft music versus rap, on the germination and early development of economically important crops.

Fenugreek (*Trigonella foenum-graecum*), known for its fast germination and wide agricultural use, presents an ideal candidate for exploring these effects. However, no substantial studies have been conducted to investigate how the contrasting acoustic properties of soothing, slow-tempo soft music and fast-paced, rhythmic rap music influence fenugreek seed germination.

This gap in the literature raises key questions: Can music act as a viable, non-chemical growth stimulant for seeds? Do different music genres have distinct impacts on germination efficiency and early seedling vigor? Addressing these questions is essential for expanding our understanding of plant responsiveness to sound and potentially developing novel, eco-friendly strategies for improving crop performance.

Aims & Objectives:

The present study aims to evaluate the influence of exposure to music genres such as Soft Music and Rap Music on the germination behavior of fenugreek seeds by analyzing germination and seedling growth. The findings could contribute to a deeper understanding of the subtle interactions between sound energy and plant biology, potentially leading to innovative, non-invasive techniques to promote crop health and vitality.

Materials and Methods

Seed Material and Experimental Setup:

Healthy seeds of *Trigonella foenum-graecum* (fenugreek) were selected for the study. A total of 50 seeds were used, divided equally among five sterile, clean Petri dishes (10 seeds per dish), each lined with Whatman No. 1 filter paper. The filter papers were moistened with distilled water to provide the necessary moisture for germination.

Three experimental sets were prepared:

- Set I (Control – in Silence)
- Set II (Soft Music Exposure)
- Set III (Rap Music Exposure)

Each set consisted of multiple Petri dishes placed in laboratory conditions at ambient room temperature. During the daily sound exposure sessions, each set was placed in separate, acoustically isolated areas of the lab to prevent cross-contamination of sound vibrations.

Sound Treatment:

Mantra exposure was conducted for 1.5 hours daily, from 7:00 AM to 8:30 AM:

- Set I (Control) was kept in silence under identical environmental conditions.
- Set II was exposed to a tracks of Soft Music.
- Set III was exposed to a tracks of Rap Music.

Germination and Growth Conditions:

Seeds were allowed to germinate under room temperature with regular monitoring. Distilled water was added daily to maintain adequate moisture levels, ensuring the filter papers remained damp but not waterlogged. Lids of the Petri dishes were opened every day for a short duration to allow proper aeration and avoid fungal growth.

Data Collection and Observations:

Observations were recorded daily for six consecutive days. The following parameters were measured:

- Radicle length (cm)
- Plumule length (cm)
- Fresh weight (g)

For dry weight, seedlings were collected and dried in a hot air oven at 80°C until a constant dry weight was achieved, which was then recorded.

Experimental Replication and Data Analysis:

The entire experiment was repeated three times to ensure reliability and reproducibility. Average values for each parameter were calculated, and standard error (SE) was computed to assess the variability among replicates.

Results and Discussion

(A) Radicle Length:

Table – 1 shows Root length (in cm) for Fenugreek seeds under different music.

Days	Control (cm)	Soft music (cm)	Rap music (cm)
1	0.37±0.0448	0.42±0.0359	0.39±0.0359
2	1.84±0.1415	2.07±0.1140	2.25±0.0908
3	3.18±0.3441	3.78±0.1787	4.37±0.0883
4	3.56±0.2897	4.45±0.1031	5.86±0.2661
5	4.8±0.3896	5.39±0.1819	7.1±0.3417

Table-1 shows average root length (in cms) of fenugreek seedlings measured every 24 hours over 5 consecutive days during the experimentation period under three different conditions - Control (no music), Soft Music, and Rap Music. It is clearly observed that Radicle length is greater in music-treated sets as compared to the control set. Out of the two treatments selected, seedlings treated with Rap music significantly enhanced root growth with upto about 47.9% longer roots. Soft music also positively influenced root elongation but to a lesser degree. This indicates that music influenced root length in Fenugreek seedlings. Gadani & Mehta (2011) also reported increased root length in *Phaseolus* saplings upon exposure of music.

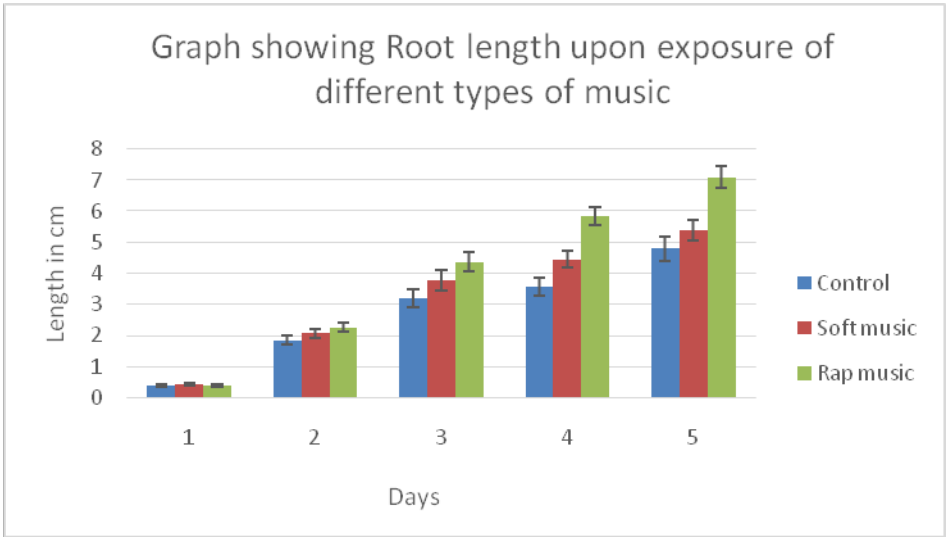
Acoustic stimulation appears to enhance root elongation, possibly due to:

- Mechanical vibrations promoting cell division and elongation in the root apical meristem.
- Upregulation of auxins or gibberellins, which are known to influence root growth.
- Sound waves might stimulate ion exchange or enzymatic activity affecting root metabolism.

Rap music, with its high beats per minute and vibrational energy, could be inducing strongermechanical stimulation, enhancing metabolic activity in root zones.

Chowdhury & Gupta (2015) reported that metabolism in plants can be influenced by music, including its frequency (Hz). A similar type of effect is also observed in the present case. According to Coghlan (1994), the production of protein increases when music at the appropriate frequency is played, which stimulates overall plant growth.

Fig: 1 Represent Root length (in cm) in Fenugreek under the different Music.



(B) Shoot Length:

Table – 2 Shows Shoot length (in cm) for Fenugreek seeds under different music.

Days	Control (cm)	Soft music (cm)	Rap music (cm)
1	-	-	-
2	1.45±0.1012	1.45±0.0192	1.48±0.0822
3	2.28±0.1206	2.53±0.1049	2.83±0.1407
4	3.36±0.2737	3.94±0.2379	4.36±0.1823
5	4.45±0.3333	5.24±0.3441	6.06±0.2665

The shoot length of fenugreek seedlings was recorded over a period of five days under three different acoustic conditions: Control (no music), Soft Music, and Rap Music. It was found that shoot length came to a measurable size after 48 hours of placing of the sets. The results revealed significant variation in shoot elongation influenced by the type of music exposure.

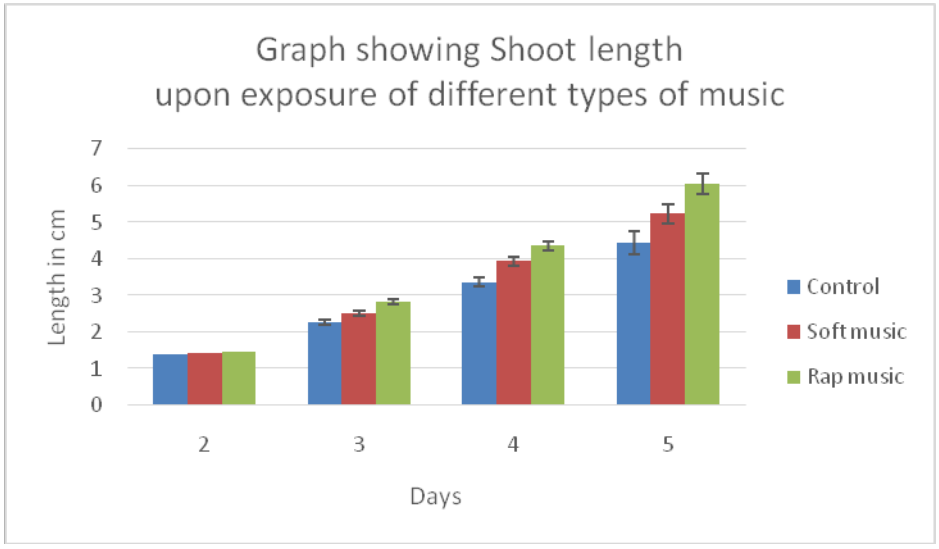
On Day 2, all treatments showed comparable shoot growth (around 1.45 cm), indicating uniform initial development across groups. However, from Day 3 onwards, plants exposed to rap music began to exhibit noticeably enhanced shoot elongation, reaching 2.83 cm, which was higher than both soft music (2.53 cm) and control (2.28 cm).

This trend continued consistently through Day 4 and Day 5, with rap music-treated plants achieving the highest average shoot length of 6.06 cm by the end of the experimental period. Comparatively, plants exposed to soft music and control conditions reached 5.24 cm and 4.45 cm, respectively.

The enhanced shoot growth in music-treated groups—particularly under rap music—may be attributed to the vibrational and rhythmic qualities of the sound waves, which can stimulate cellular signaling, hormonal activity (such as auxin distribution), and gene expression related to growth and elongation. The rhythmic pressure changes induced by high-energy music might function as a form of mechanical stimulation, influencing cell wall loosening and expansion. Here also, out of the two music treatments given, Rap music was found to be more impactful as compared to the soft music.

Moreover, the moderate improvement in shoot length under soft music suggests that even less intense auditory exposure can support plant development, though to a lesser extent than high-tempo music genres. Patel et. al (2022) while reporting the impact of various musical genres on plants documented that jazz music may speed up growth and make plants grow more fully. A similar type of impact is also observed in the present case.

Fig: 2 Represent Shoot length (in cm) in Fenugreek under the different Music.



The graphical representation also clearly demonstrates that exposure to music—particularly rap music—significantly enhances shoot elongation in fenugreek. This supports the hypothesis that acoustic frequencies can serve as abiotic enhancers of plant growth, potentially providing a novel, non-invasive method for improving crop development in controlled environments.

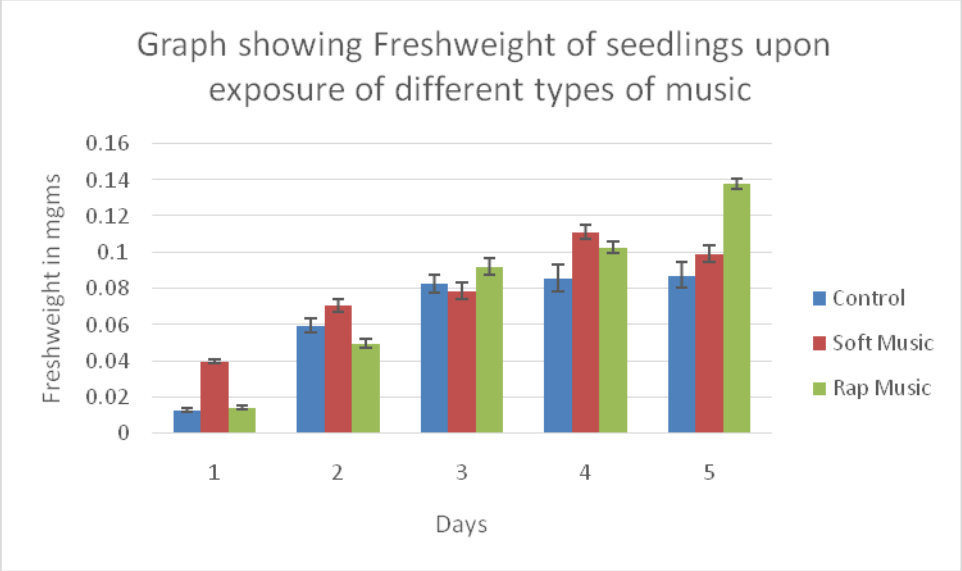
(C)Fresh weight:

Fresh weight is a critical indicator of overall biomass accumulation and reflects the combined influence of water uptake, tissue expansion, and metabolic activity in growing plants. The recorded fresh weights (in gms) of fenugreek seedlings over five days under control, soft music, and rap music conditions are presented in Table-4 above. An increasing trend in fresh weight was observed in all the sets under study, with higher values in the case of music-treated seedlings as compared to those of the control set. This shows that biomass was higher in music-treated sets in contrast to the control set, indicating a positive influence of music and sound vibrations on seedlings and their growth.

Table – 3 Shows fresh weight (in gm) for Fenugreek seeds under different music

Days	Control	Soft Music	Rap Music
1	0.0128±0.00125	0.0396±0.00109	0.0144±0.00102
2	0.0598±0.00386	0.0706±0.00385	0.0498±0.00265
3	0.0828±0.00474	0.0786±0.00447	0.0922±0.00471
4	0.0856±0.00753	0.1114±0.00422	0.1028±0.00318
5	0.0874±0.00708	0.0994±0.00482	0.1378±0.00266

Fig: 3 Represent Fresh Weight (in gm) in Fenugreek under the different Music.



On Day 1, all treatments started with very low fresh weights, with soft music (0.0396 g) slightly ahead of both control (0.0128 g) and rap music (0.0144 g). By Day 2, fresh weight increased across all groups. Interestingly, soft music treatment (0.0706 g) maintained a slight edge, possibly due to initial stimulation of hydration and metabolic activity. On Day 3, rap music-exposed seedlings showed a sudden increase to 0.0922 g, surpassing both control and soft music

treatments. This pattern continued through Day 5. On Day 5, rap music-treated plants reached the highest fresh weight (0.1378 g), followed by soft music (0.0994 g) and control (0.0874 g).

The results indicate that auditory stimulation, particularly with rap music, significantly enhances fresh weight accumulation in fenugreek seedlings over time. The sharp increase in biomass under rap music from Day 3 onward suggests an acceleration in cellular division, metabolic activity, and water uptake, possibly due to mechanical vibrations enhancing membrane permeability and enzyme activity.

Soft music, although initially beneficial, showed less consistent increases after Day 3, indicating a milder and possibly saturating effect on growth.

The control group, lacking any acoustic stimulus, displayed steady but limited growth, highlighting the potential of sound waves as abiotic stimulants in early-stage plant development.

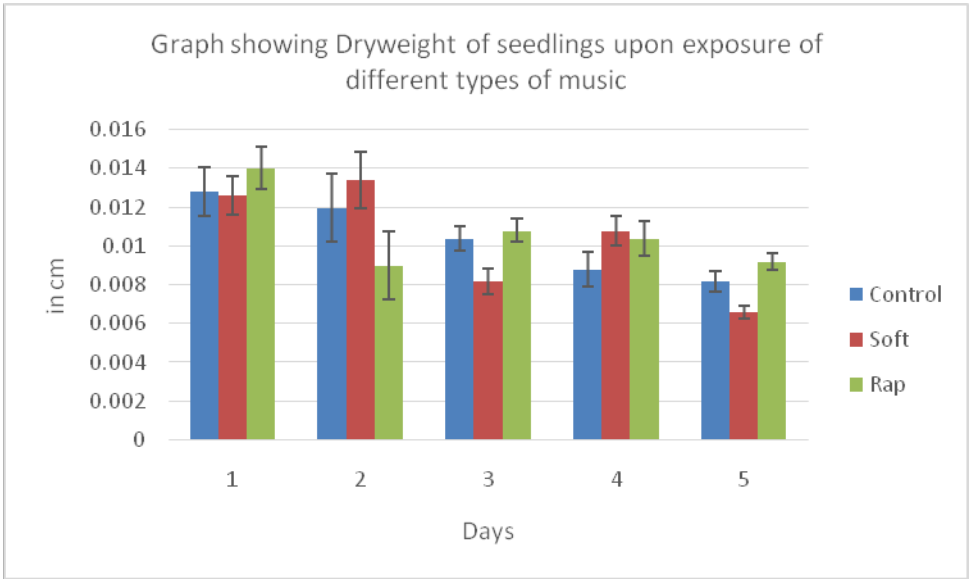
(D) Dry weight:

Table – 4 shows Dry weight (in gm) for Fenugreek seeds under different music

Days	Control	Soft Music	Rap Music
1	0.0128±0.0012	0.0126±0.0010	0.0140±0.0010
2	0.0120±0.0017	0.0134±0.0014	0.0090±0.0017
3	0.0104±0.0006	0.0082±0.0006	0.0108±0.0006
4	0.0088±0.0009	0.0108±0.0007	0.0104±0.0008
5	0.0082±0.0011	0.0066±0.0007	0.0092±0.0010

Dry weight is an important parameter reflecting the actual biomass accumulation excluding water content, giving a more accurate picture of structural growth, tissue development, and dry matter partitioning. The dry weights (in gms) of fenugreek seedlings were recorded over five days under three different treatments: Control, Soft Music, and Rap Music as shown above in Table-5. Dry weight was found to be generally more in case of music-treated sets as compared to the control sets. This indicates more metabolites and biomass in seedlings treated with sound vibrations. Sharma et. al. (2015) also reported that music not only accelerates the growth but also significantly influences the concentration of various metabolites.

Fig: 4 Represent Dry Weight (in gm) in Fenugreek under the different Music.



Unlike fresh weight, which showed consistent increase under music exposure—particularly rap—dry weight exhibited a subtle declining trend across all treatments. This may suggest that while music increased water uptake and cell expansion (fresh weight), it did not proportionally increase dry biomass accumulation (e.g., proteins, structural carbohydrates).

The initial high dry weight under rap music on Day 1 followed by a decline on Day 2 may indicate a transient metabolic response, possibly involving temporary water stress, altered respiration rates, or delayed biomass fixation.

The soft music group, despite early advantage, consistently showed the lowest dry weight by Day 5, indicating that the mild acoustic stimulation may have favored elongation and expansion over actual mass deposition.

The control group maintained the most stable dry weight, albeit with minor reductions, potentially reflecting a balanced but slower physiological activity without the influence of mechanical sound stimulation.

The dry weight data highlights that while music—especially rap—may stimulate early metabolic responses, its impact on long-term structural biomass accumulation is limited or inconsistent. This points toward a differential effect of music on water-related versus dry matter-related growth, warranting further studies to investigate the biochemical and metabolic pathways involved.

Conclusion

The findings of this study provide compelling evidence that acoustic stimulation through music types significantly influences the early germination and seedling development of *Trigonella foenum-graceum*. Both the Soft music and Rap music treatments resulted in greater radicle and plumule elongation, and increased fresh biomass compared to the control group maintained in silence. This research provides a foundational step toward integrating acoustic bio-stimulation into agricultural practice, using ancient mantra vibrations as innovative tools for improving early plant development.This study opens exciting avenues for eco-friendly, sound-based growth enhancers in agriculture. The significant improvements observed in seedling vigour suggest that mantra-based sound exposure could be harnessed as a non-invasive, sustainable technique to enhance crop performance—particularly valuable in organic or low-input farming systems.

Mechanistic Considerations

The effects observed in this study likely stem from a combination of physiological responses triggered by acoustic energy. Potential mechanisms include:

- Increased membrane permeability and ion channel activation, aiding nutrient and water uptake.
- Stimulation of growth hormones such as auxins and gibberellins.
- Activation of gene expression and protein synthesis via mechanical or vibrational resonance.
- Biophysical modulation of intracellular processes leading to improved turgor pressure and cell expansion.

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