Effects of Synchronized Sound Waves in the Form of Indian Classical Instrumental Music (Strings and Closed Pipes) on Fruit Ripening of *Psidium guajava* L. and *Manilkara zapota* (L.) P. Royen

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Abstract: ***Harmonic frequencies of octaves in Indian Classical music influence the growth of the plants; starting from germination to the fruit ripening. It has been observed that sound waves at different frequencies, sound pressure levels, exposure periods and distances of the experimental materials from the sound source influence the plant growth. In the present research work, experiments were conducted to study the effect of Indian classical Ragas (Instrumental) having different harmonic frequencies of octaves on fruit bearing plants and fruit ripening in Psidium guajava (guava) and Manilkara zapota (sapodilla). The observations showed the plants exposed to the 'dose-dependent' and 'time-dependent' soothing, harmonic frequencies of octaves of Indian Instrumental Classical music showed an earlier fruiting and earlier fruit ripening. Moreover, other biochemical analysis of some primary metabolites in the ripened fruits treated with harmonic, melodious Classical Music showed astounding results of an increased concentration of metabolites like reducing sugar which was found to be 8.12mg/ml in Psidium guajava and 8.74mg/ml in Manilkara zapota, carbohydrates which was found to be 0.38 mg/ml in Psidium guajava and 0.81 mg/ml in Manilkara zapota and proteins which was found to be 8.12mg/ml in Psidium guajava and 8.74mg/ml in Manilkara zapota inferring certain development of fruit qualities.***

Keywords: Fruit-ripening, Harmonic frequencies, Indian Classical music, Ragas, fruiting, octaves

1. Introduction

Sound, simply is a form of energy and moreover is a vibration (a transverse pressure wave) which produces a sensation of hearing in our ears. It is generally produced when a body vibrates in the frequency range of 20Hz to 20,000Hz (Chowdhury and Gupta, 2015).The two conditions that are necessary for the generation of a sound wave are a vibratory disturbance and an elastic medium, the most common of which is air (Webber, manning and White, 1959). Regarding the propagation of sound, it is known that when a body vibrates, it transfers its energy to the surroundings (Webber, manning and White, 1959). On receiving this energy, the air molecules around the body also starts vibrating about their mean position and thereby transferring the energy to their neighboring molecules (Webber, manning and White, 1959). Sound requires a medium to propagate which may be solid, liquid or gas (Webber, manning and White, 1959).The music and noise are the different forms of sound that differs from each other. Music is a melodious sound which is pleasing to our ears whereas the sound that is not pleasant, known as noise (Webber, manning and White, 1959). Musical sound has a planned, vibrant quality to it. It has movement and natural cycles (Chowdhury and Gupta, 2015). These cycles include the length of a note, the length of a phrase, and the length of a composition and the extent of an album (Chowdhury and Gupta, 2015). Plants respond to music in the same way as the human does (Dossey, 2001). Far away from the borders of conventional science lies the idea of plant perception or bio-communication in plant cells that plants are animate, that they experience pain, pleasure or emotions such as fear and affection (Reddy et al. 2013). They have the capability to communicate with humans and others forms of life in a decipherable manner (Reddy et al. 2013). Music causes radical changes in plant metabolism. Plants get pleasure from music and they respond to different type of music and its wavelength (Reddy et al. 2013). Music with hardcore vibration causes distressing situation in plants (Galston and Slayman, 1979). Only a very little data is available on the effect of sound on the plant systems (Collins and Foreman, 2001). There is a certain way of playing music to plants (Reddy et al. 2013). For example, the volume, the type of music played should be taken into consideration (Reddy et al. 2013). Different kinds of music can put different effects on plants like certain music mostly heavy metal music can put plants under stress, other music can make the plants to thrive (Reddy et al. 2013). When played at a very low volume, heavy metal music is still very harmful for plants (Reddy et al. 2013). Plants cannot withstand rock music; they show stunted growth when subjected to rock music which eventually leads to their death (Reddy et al. 2013). They too are not good fan of pop music. Classical music and devotional music on the other hand enhances growth and increases the yield (Kristen, 1997).

2. Literature Survey

After the first concept of perception of sound waves by plants as suggested by Sir Jagdish Chandra Bose, an Internationally acclaimed Indian Physicist and Plant Physiologist and a Nobel Prize winner in 1977, who was renowned for his work on the physiology of plants. Bose mentioned about how well plants responded to pleasant music and mild undertones, thus growing more quickly. When subjected to harsh music and loud speech, plants showed deprived growth. Ever since the 1970s, plants have also been exposed to almost all kinds of music.

A Colorado, USAundergraduate, Dorothy Retallack carried out one of the first experiments in 1973 to study the relationship between plants and music. While plants loved certain type of music like Mozart's music which has been proved to be their favorite because it allowed them to grow well whereas other music type caused their death. Various styles of music were used by Retallack in her experiment and she discovered that the plants showed a tendency to move away from Led Zeppelin and Jimi Hendrix but Bach organ music and jazz attracted them. Nevertheless, she found that North Indian classical music played on the *Sitar*, an Indian string Instrumental music, was their favorite but country music was seen to have no such relevance in plant life (Rettalack, 1973).

All living beings whether animals or plants respond to some sort of stimuli. Plants are multicellular organisms and respond to various types of external stimuli. Sound being a vibration is also perceived by plants as an external-stimuli. These vibrations stimulate different phytochemical and biochemical reaction in plants which in turn helps in theirgrowth and development. Animals have ears to hear different sound but plants, basically perceive and sense it. Sound waves set up vibration on our ear drum which in turn is perceived by the brain and help us to recognize that it is a sound of varying frequencies and amplitude. Plant even in a similar way receive vibrations through protoplast.

3. Materials and methods

3.1. Materials

An acoustic chamber, music system with the main unit of frequency 50 Hz-200Hz and two satellite units (with a frequency range of 200Hz-1800Hz) and grafted plant bearing very early stages of fruits of *Psidium guajava* (guava) and *Manilkara zapota* (sapodilla) were used in this experiment.

3.2. Methods

The biochemical analysis was carried out in both the selected control and experimental plant species.

1) The amount of protein was quantified by using the method of Lowry et al 1951 (Tambe et al. 2011).
2) The Anthrone method or Hedge method, 1962 (Das et al. 2010) was used for carbohydrate estimation.
3) Dinitrosalicylic acid method or Miller 1972 method (Sadasivam and Manickam 2008) was executed for the estimation of reducing sugar.
4) For lipid extraction and estimation, the method given by Vijayvargia and Kumar (2007) adapting Jayaraman method (1981) was implemented.

*All the required chemicals belong to Merck and HiMedia companies and were purchased from Mohapatra Scientific Supply Syndicate (Bhubaneswar, Odisha)

4. Results

On subjecting Indian classical Ragas to the plants and by observing them carefully, the results were found to be comprehensively surprising. For the present research work, Effect of harmonic octave consonants and their harmonic frequencies used in Indian classical Ragas on fruit ripening and fruit qualities, analyzed through biochemical tests.

In addition to seed germination, vegetative growth, early flowering, early fruiting, and the overall plant growth observed in our experiments, it was also observed that music influenced the fruit ripening period along with the increasing concentration of various important metabolites in the ripened fruits (treated) such as carbohydrate, protein, reducing sugar etc. When Indian Classical Ragas were applied to guava (*Psidium guajava*) fruit and sapodilla (*Manilkara zapota)* fruit, the fruits ripened faster usually two weeks earlier in case of guava (in general it takes around 17 weeks from fruit set to maturity but it took 14-15 weeks from fruit set to maturity in treated case) and in case of sapodilla the fruits ripened within a month (in general it takes around 4-6 months from fruit set to maturity but it took only about 2-3 months from fruit set to maturity in treated case) whereas, the control fruit (not treated with music) ripened much later under all similar environmental conditions (Figure 1&2).

Figure 1. A and B: Figures showing the size and stages of ripened fruits in treated and control plants of *Psidium guajava*

A B

Figure 1: (A) Fruit-bearing grafted plant of *Psidium guajava* not treated with Indian classical ragaas (control one) (left).
(B) Fruit-bearing grafted plant of *Psidium guajava* treated with Indian classical ragaas (treated one) (right).

Figure 2. A and B: Figures showing the Fruits in treated and control plants of *Manilkara zapota*

A B

Figure 2 (A) Fruit-bearing grafted plant of *Manilkara zapota* not treated with Indian classical ragas (control one) (left). **(B)** Fruit-bearing grafted plant of *Manilkara zapota* treated with Indian classical ragas (treated one) (right).

Regarding the biochemical analysis estimating the total carbohydrate, protein, reducing sugars and lipid contents of the music treated fruits verses control, the difference was well observed. Much higher concentrations of carbohydrates, reducing sugar and proteins were obtained in treated and early ripened fruits as compared to the control ones (Table 1&2; Table 3&4; Table 5&6 respectively). The lipid content was found to be less in the musically treated fruit as compared to the control fruit (Table 7&8).

Table 1: Effect on Indian classical *Ragaas*, on concentration of total carbohydrate in the fruits of guava *(Psidium guajava)* plant, treated with music

Serial number	Plant Name	Experimental set up	Amount of sample extract (ml)	Concentration of carbohydrates (mg)
1	*Psidium guajava*	Treated	0.5	0.29
			1.0	0.38
2	*Psidium guajava*	Control	0.5	0.1
			1.0	0.12

Table 2: Effect on Indian classical *Ragaas*, on concentration of total carbohydrate in sapodilla fruit *(Manilkara zapota)*, treated with music

Serial number	Plant name	Experimental set up	Amount of sample extract (ml)	Concentration of carbohydrates (mg)
1	*Manilkara zapota*	Treated	0.5	0.02
			1.0	0.81
2	*Manilkara zapota*	Control	0.5	0.016
			1.0	0.86

Table 3: Effect on Indian classical *Ragaas*, on concentration of total reducing sugars in guava fruit *(Psidium guajava)*, treated with music

Serial number	Plant name	Experimental set up	Amount of sample extract (ml)	Concentration of reducing sugar (mg)
1	*Psidium guajava*	Treated	0.5	8.12
2	*Psidium guajava*	Control	0.5	1.27

Table 4: Effect on Indian classical *Ragaas*, on concentration of total reducing sugars in sapodilla fruit *(Manilkara zapota)*, treated with music

Serial number	Plant name	Experimental set up	Amount of sample extract (ml)	Concentration of reducing sugar (mg)
1	*Manilkara zapota*	Treated	0.5	8.74
2	*Manilkara zapota*	Control	0.5	4.74

Table 5: Effect on Indian classical *Ragaas*, on concentration of total protein in guava fruit *(Psidium guajava)*, treated with music

Serial number	Plant name	Experimental set up	Amount of sample extract (ml)	Concentration of protein (mg)
1	*Psidium guajava*	Treated	0.5	0.23
			1.0	0.28
2	*Psidium guajava*	Control	0.5	0.08
			1.0	0.24

Table 6: Effect on Indian classical *Ragaas*, on concentration of total protein in sapodilla fruit *(Manilkara zapota)*, treated with music

Serial number	Plant name	Experimental set up	Amount of sample extract (ml)	Concentration of protein (mg)
1	*Manilkara zapota*	Treated	0.5	0.26
			1.0	0.29
2	*Manilkara zapota*	Control	0.5	0.22
			1.0	0.23

Table 7: Effect on Indian classical *Ragaas*, on concentration of total lipid in guava fruit *(Psidium guajava)*, treated with music

Serial number	Plant name	Experimental set up	Concentration of lipid (gm)
1	*Psidium guajava*	Treated	0.003
2		control	0.12

Table 8: Effect on Indian classical *Ragaas*, on concentration of total lipid in sapodilla fruit *(Manilkara zapota)*, treated with music

Serial number	Plant name	Experimental set up	Concentration of lipid (gm)
1	*Manilkara zapota*	Treated	0.02
2		Control	0.117

5. Discussion

Music influences the plant growth. The plants showed earlier seed germination, much faster vegetative growth and early flowering and moreover showed an increase concentration of metabolites in musically treated ripened fruit. Concentration of Carbohydrate, reducing sugar and protein were more in case of the treated fruits (Figure 3; Figure 4; Figure 5; Figure 6; Figure 7; Figure 8). There is also a decrease in the lipid concentration of the ripened fruit (Figure 9; Figure 10). The fact that music affects the plant growth in a wonderful way is absolute. The series of rhythmic beats in music encourages the plants activity. The sound vibration, when perceived by the plant cells, it might trigger an array of biochemical and physiological processes of the plants by causing resonance at molecular level. The plant activities are altered in response to music with great melodies and harmonies executed with emotion (Reddy et al. 2013). With our experiment of subjecting the plants to the Indian classical ragas, considering the fruit ripening, successful and positive and encouraging results were obtained, thereby, showing the absolute response of the plants to soft music as reported by Sharma et al. 2015. Moreover, the result also showed an early fruit ripening along with the increased concentrations of metabolites in musically treated ripened fruits. Further research is going on to confirm the exact mechanisms involved in it and also the nutrient contents of the experimental ripened fruits.

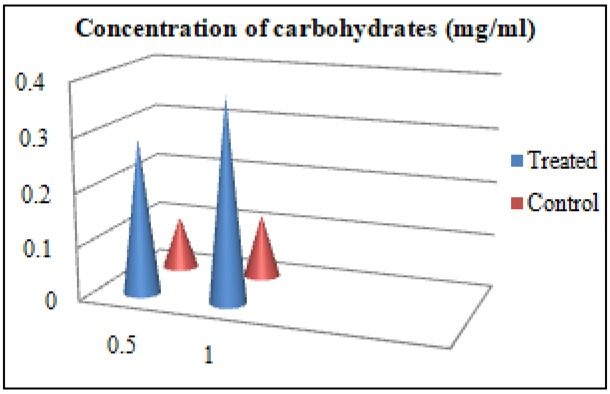

Figure 3: Showing concentration of carbohydrate in the treated and control plants of *Psidium guajava* (left)

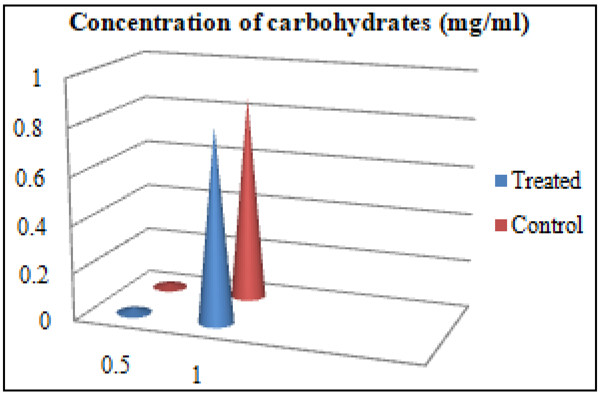

Figure 4: Showing concentration of carbohydrate in the treated and control plants of *Manilkara zapota* (right)

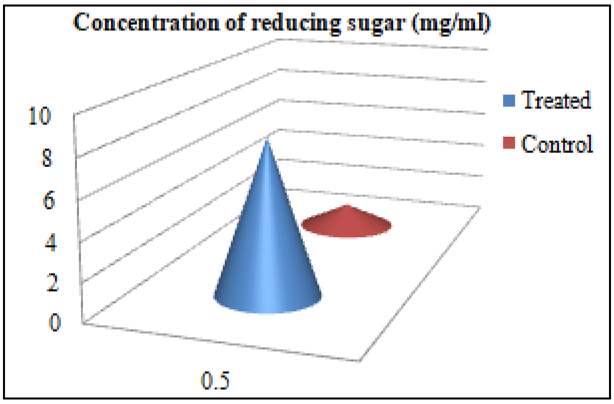

Figure 5: Showing concentration of reducing sugar in the treated and control plants of *Psidium guajava* (left)

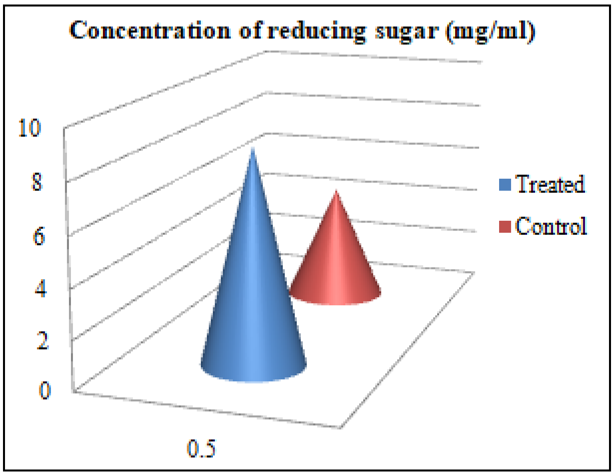

Figure 6: Showing concentration of reducing sugar in the treated and control plants of *Manilkara zapota* (right).

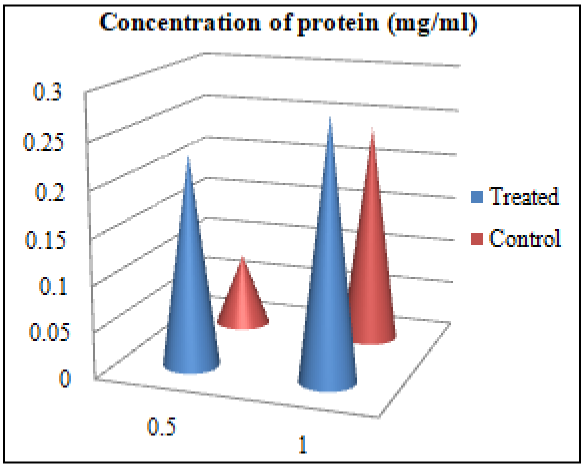

Figure 7: Showing concentration of proteins in the treated and control plants of *Psidium guajava* (left)

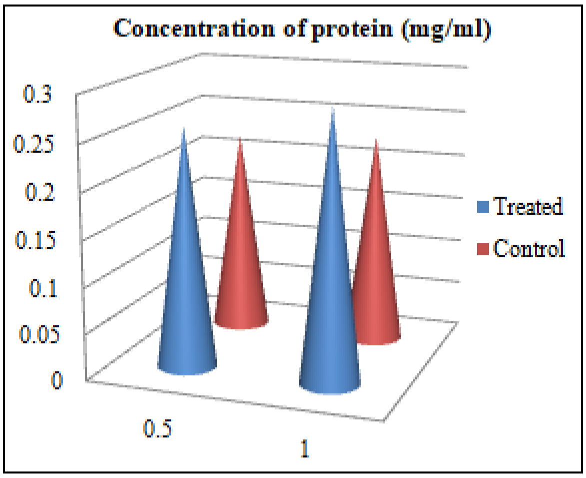

Figure 8: Showing concentration of proteins in the treated and control plants of *Manilkara zapota* (right)

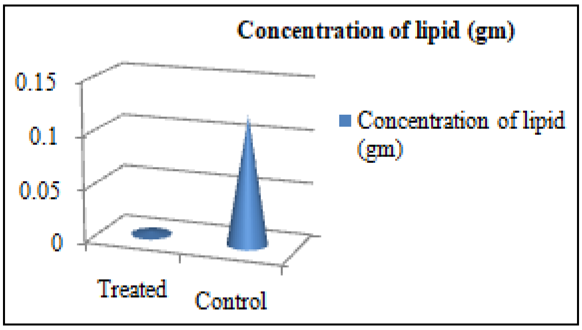

Figure 9: Showing Concentration of lipids in the treated and control plants of *Psidium guajava* (left).

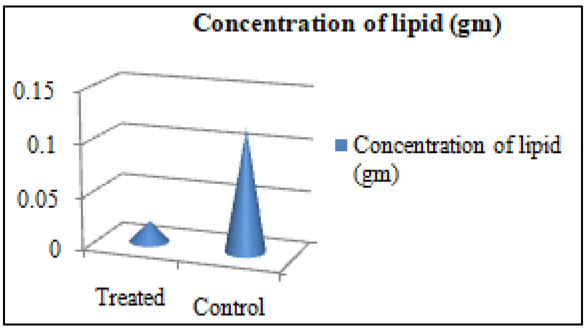

Figure 10: Showing concentration of lipids in treated and control plants of *Manilkara zapota* (right)

6. Conclusion

Synchronized sound waves in the form of Indian classical Instrumental Classical music showed an earlier fruiting and earlier fruit ripening. Classical Music showed positive impact in an increased concentration of metabolites like reducing sugar which was found to be 8.12mg/ml in *Psidium guajava* and 8.74mg/ml in *Manilkara zapota*, carbohydrates which was found to be 0.38 mg/ml in *Psidium guajava* and 0.81 mg/ml in *Manilkara zapota* and proteins which was found to be 8.12mg/ml in *Psidium guajava* and 8.74mg/ml in *Manilkara zapota* inferring certain development of fruit qualities.

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7. Future Scope

Sound vibration technology through the synchronized sound waves in the form of Indian classical instrumental music applied in the current experiments can be used in floriculture, horticulture and agriculture. The technology increases the productivity and quality of the desired flower, fruits and number of grains in terms of nutritional qualities.

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