

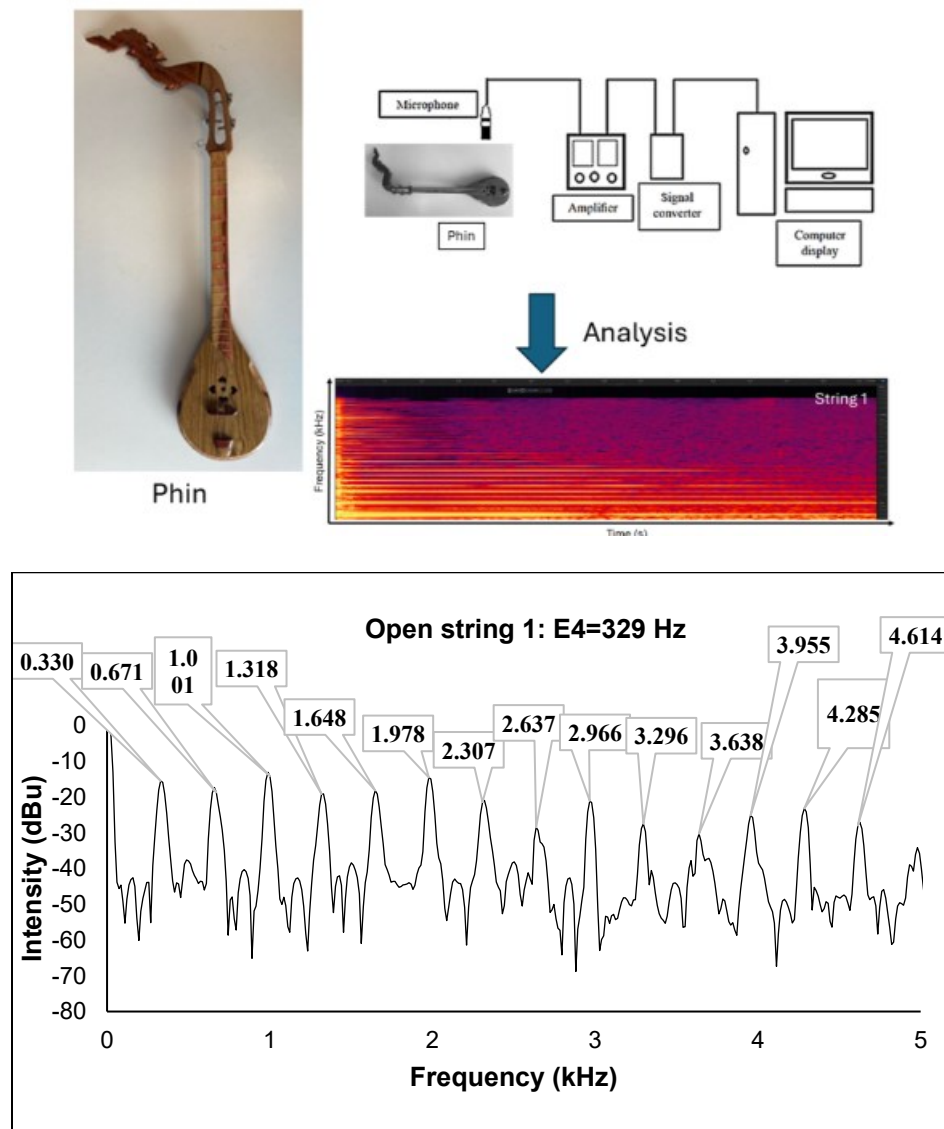
Phin: A Lute of the Isan Region of Thailand

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DOI: 10.15376/biores.20.4.9699-9719

GRAPHICAL ABSTRACT



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The phin is a lute that originated in Thailand's Isan region. The strings 1, 2, and 3 for the phin is E4, A3, and E3. It was tuned to the key of G major. The strings 1, 2, and 3 running notes are E4, F4, F4#, G4, A4, B4, C5, D5, E5, F5, G5, A5, B5, C6, D6, and E6; A3, A3#, B3, C4, D4, E4, F4, G4, A4, A4#, C5, D5, E5, F5, G5, and A5; and E3, F3, F3#, G3, A3, B3, C4, D4, E4, F4, G4, A4, B4, C5, and D5, respectively. The keys F4#, B3, and F3# appear in the first octave only from strings 1, 2, and 3, respectively. In this study, the sound was analyzed with a PicoScope oscilloscope and Adobe Audition. The equation for the polynomial (*i.e.*, the fret number *versus* the partial frequency) for open strings 1, 2, and 3 is $y_{\text{string1}} = 3.14x^2 + 9.10x + 316.07$, $y_{\text{string2}} = 2.15x^2 + 5.51x + 214.55$, and $y_{\text{string3}} = 1.51x^2 + 6.53x + 146.24$. The changes in frequency (the multiplication factor of the x^2) increased gradually with the pitch. Strings 3 (E3), 2 (A3), and 1 (E4) showed the multiplication factor of 1.51, 2.15, and 3.14.

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Keywords: Phin; Fast Fourier transform (FFT); Harmonics; Musical instruments; Stringed instruments

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INTRODUCTION

The phin is a pear-shaped lute that originated in Thailand's Isan region and is mostly played by ethnic Laotians in both Thailand and Laos. During performance, a pick is held in the right hand to pluck two or three metal strings across the frets on the neck. It is commonly played alongside with the *luk thung* and the khene mouth organ in *mor lam* music (Musib *et al.* 2025). After World War II, a type of Thai music known as *luk thung* emerged in central Thailand. The genre developed in the early 20th century and was derived from *Phleng Thai Sakon*. Notably, Suphan Buri became the epicenter of *luk thung* music, producing a number of well-known musicians, such as Suraphol Sombatcharoen and Pumpuang Duangjan. According to Sattar (2012) the genre has become increasingly popular in the Northeast. Since its inception, it has made use of the Isan language spoken in the area, as well as the musical traditions of the Northeastern 'mor lam'. The lyrics of *luk thung* songs usually depict Thailand's rural way of life, cultural traits, and social dynamics. 'Luk thung' is a Thai music genre that uses traditional and Western instruments. Traditional instruments used in *luk thung* include *klong yao* (a long drum), *ranat* (a Thai xylophone), *ching* (a cymbal), *krab* (wooden clappers), and *saw sam sai* (a stringed instrument with three silk strings and a coconut shell bowl). 'Luk thung' may also incorporate Western instruments, such as the guitar and drum.

The songs' lyrics cover a wide range of topics, many of which were related to Thai rural life, including religious beliefs, traditional culture, political unrest, romantic love, rural poverty, and the beauty of the countryside. 'Mae Saa Chao Rai' (Lady Farmer), written by Hem Vejakorn for Suraphol Sombatcharoen in 1938 as the music for the radio play *Saa Chao Rai* (Lady Farmer), was the first recording of what was considered *luk thung*. Chamnong Rangsikul first used the term *luk thung* on May 1, 1964, when he launched the *Phleng Luk Thung* television program on Channel 4.

The phin, as shown in Fig. 1, typically has three strings and is regarded as a national instrument of Northern Thailand. The phin uses the same fret mechanism as the *seung* (Duin *et al.* 2025b), *chapei dang veng*, and a number of other Asian instruments. Phin musicians rely on unique phrasing and modes because they are limited to a single key. This involves pull-offs, hammer-ons, quick trills, and calculated pauses. While the tuning can be adjusted to suit a particular song or genre, it is not strictly fixed. On the phin, creative rock and blues riffs can be created by experimenting with different tuning. No part of the instrument is more visually striking than the phin's *naga*, or headstock. Many examples are beautifully crafted and have dragon or bird shapes. Figure 1 shows that there are fewer frets than on a traditional guitar. Certain intervals are purposefully too long, giving the impression that the spacing is haphazard.



Fig. 1. The 3 strings phin

Made of hardwood, the phin is classified as a chordophone (Terry and Sean 2018). A typical wood for making phin is jackfruit wood. The Moraceae family includes the jackfruit (*Artocarpus heterophyllus*) as one of its tree species. As a popular crop in the Philippines, Thailand, India, Bangladesh, Sri Lanka, Indonesia, Malaysia, and Australia, it thrives in tropical lowlands. After the Portuguese arrived on Kerala's Malabar Coast in 1499, the common term for jackfruit is derived from the Portuguese jaca, which is thought to have originated from chakka in Malayalam. The Proto-Dravidian root *kā(y)*, which means fruit or vegetable, is the source of the Malayalam phrase. According to Janick and Paull (2008), jackfruit is also referred to as jacquier in French, nangka in Java and Malay, langka in Filipino, khnaor in Cambodia, makmi, khanum, banum in Thai, and mit in Vietnamese. Jackfruit has a small canopy and a relatively short trunk. It may easily reach heights between 9 and 21 m, and trunk diameters between 30 and 80 cm. The leathery leaf blade is between 20 and 40 cm long and between 7.5 cm and 18 cm wide. At 15% moisture content, the density of jackfruit wood normally ranges between 505 and 645 kg/m³. Regarded as a medium hardwood, it is renowned for its resilience against termites and

marine worms, as well as its capacity to withstand polish. The wood is yellow and turns orange-gold with age. The tree's growth and morphology can be described by a number of characteristics that are observable at the annual ring level, including as branching patterns, crown shape, and leaf morphology, even though it does not have distinct annual rings like certain temperate trees do. These physical traits can be utilized to characterize the growth and development of jackfruit trees at the annual level, even though they do not have distinct annual rings.

The typical tuning for a phin is E-A-E. As shown in Fig. 2, this tuning configuration aligns the fretboard's notes, where all of the notes (except A#) fall within the G major key (G, A, B, C, D, E, F#, G). This means that it is impossible to create a wrong note as long as the composition is in G major. The phin is very different from a guitar or other Western instrument, even if there are certain fundamental rules. There are several tunings, but E-A-E is the most common. For an electric phin, string gauges of 0.11 for the high E, 0.16 for the A, and 0.24 for the low E are recommended. Together with a set of regular guitar strings, these gauges are identical. It is generally more enjoyable to play an acoustic phin with somewhat heavier strings; the recommended gauges are 0.13 for the high E, 0.17 for the A, and 0.26 for the low E. The phin was first used for courting and vocal accompaniment. Phin is currently done with distortion and boosted electronically. The 'do re mi fa so la ti' method is commonly used for this instrument and is inappropriate for non-Thai music. The strings are E (below the staff), A (on the staff), and E (above the staff) when played in an open manner. Without any flats or sharps, the lowest note is E (below the staff), which extends to the second B above the staff. Figure 2 shows the additional frets that contribute to the note F#. The addition of this note F# opens the possibilities of the phin to play in varied tuning. Table 1 show the notes available in G Major (relative key-E minor), C Major (relative key-A minor), and D Major (relative key-B minor).



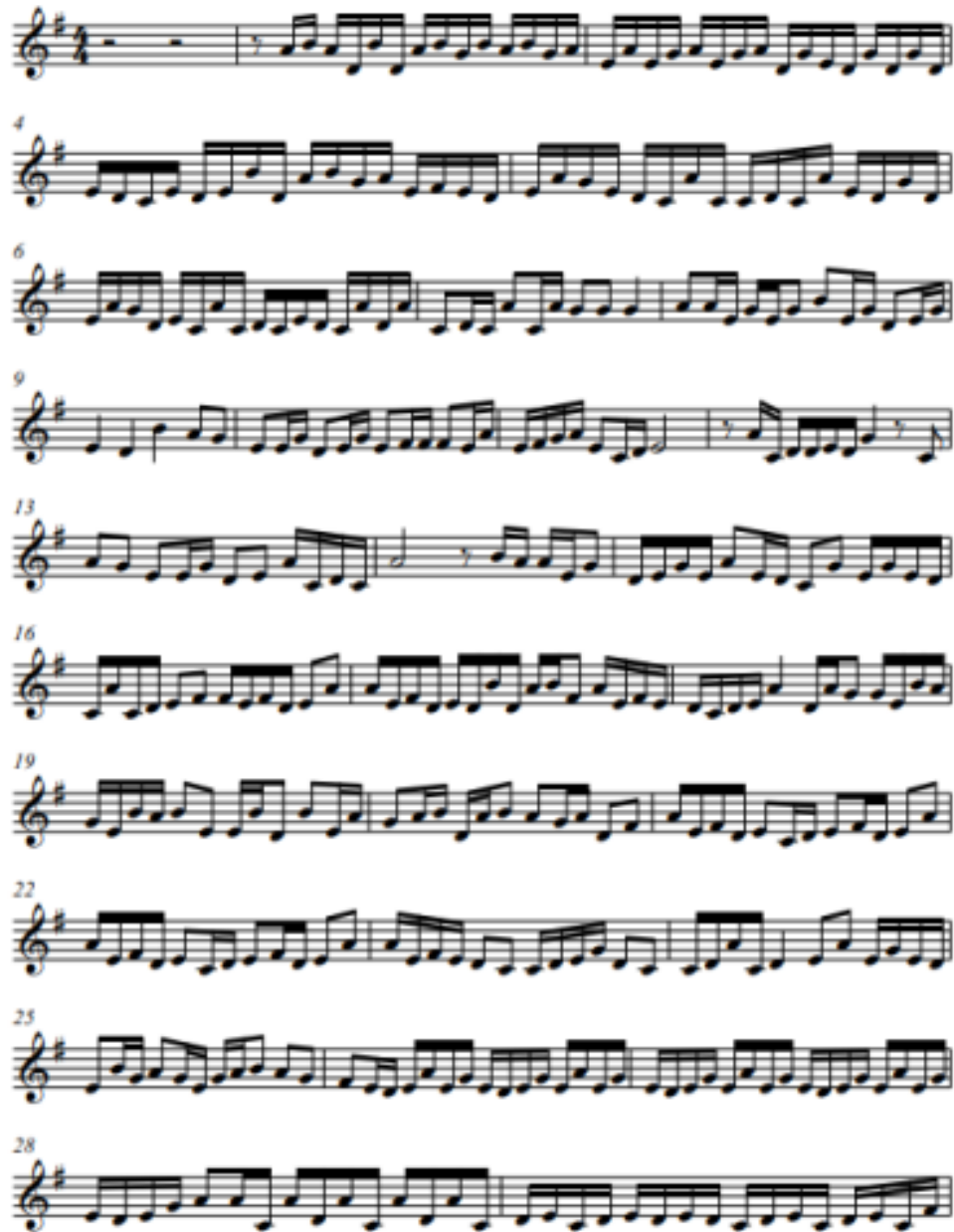
Fig. 2. One octave of notes on an E-A-E tuned Phin

Table 1. The Note Available in G Major (relative key-E minor), C Major (relative key-A minor), and D Major (relative key-B minor)

Key	Note Available	Scales
G Major (relative key-E minor)	G, A, B, C, D, E, F#, G	Diatonic (G, A, B, C, D, E, F#, G) Pentatonic (G, A, B, D, E) Peloq (G, B, C, D, F#)
C Major (relative key-A minor)	C, D, E, F, G, A, B, C	Diatonic (C, D, E, F, G, A, B, C) Pentatonic (C, D, E, G, A) Pelog (C, E, F, G, B) C Lydian Modes (C, D, E, F#, G, A, B, C)
D Major (relative key-B minor)	D, E, F#, G, A, B	Pentatonic (D, E, F#, A, B) D Mixolydian Modes (D, E, F#, G, A, B, C, D) D Dorian Modes (D, E, F, G, A, B, C, D)

The access of the phin with additional frets gives the opportunity for the player to improvise and create vase motifs in the context of musical compositions. Hence, it also provides the opportunity of the phin to be merged and fused with other genres. The phin was traditionally used to accompany storytelling, dance, and joyous occasions where musicians perform complex tunes using quick picking methods. However, the fusion style known as *phin prayukt* has given this instrument fresh life in contemporary music in recent years. Khun Narin electric phin band took this opportunity to create a *molam* sound, a modified traditional Thai music. According to Faturrahman (2024), his interview with Khun Narin, the term *phin prayukt* refers to *molam* sound. It refers to a traditional phin band that has been modified. *Phin prayukt* is therefore unique to their area. The phin is the focal point of the contemporary musical group *phin prayukt*, which has its roots in the traditional Wong Phin band. The group's repertoire has grown over time to incorporate keyboards, cymbals, bass drums, bongo drums, and more (Faturrahman 2024). *Phin prayukt* is a creative method that combines modern musical styles like jazz, rock, and electronic music with the unique sounds of the phin. While maintaining the original nature of the phin, this approach encourages improvisation and adaptability, enabling performers to experiment with new musical possibilities. Phin players produce dynamic and emotive performances that appeal to a broader audience by incorporating contemporary effects such as distortion, delay, and looping. By experimenting with cross-genre collaborations, Thai musicians have promoted this fusion and brought the instrument into the public while preserving its traditional uniqueness. The ability of *phin prayukt* to adapt traditional Thai melodies in contemporary musical contexts is one of its fundamental features. Phin riffs are frequently combined with electronic beats, funk grooves, or rock rhythms by musicians to provide a novel and captivating sound. In addition to showcasing the phin's versatility, this fusion unites the past and present, appealing to both younger listeners interested in contemporary music forms and older generations used to traditional *molam*. As phin-infused works become more well-known outside of Thailand, the world music scene has also taken note, presenting audiences to this unusual instrument and its changing function in contemporary music.

A few flats and sharps are shown in Fig. 2. As long as they do not utilize any accidentals, they can play any song in the following keys; C major (C, D, E, F, G, A, B); A minor (A, B, C, D, E, F, G), as long as it does not use the G# from harmonic minor; G major (G, A, B, C, D, E, F#, G); E minor (E, F#, G, A, B, C, D), as long as it does not use the D# from harmonic minor; F major (F, G, A, Bb, C, D, E), as long as the only Bb you need is the one that is near the nut of the instrument; D minor (D, E, F, G, A, Bb, C), as long as it does not use the C# from harmonic minor. Phin can be played on any mode in these keys. The majority of Western instruments are diatonic (meaning they can only play seven notes), or chromatic, (meaning that they can play every note). There is a bit more leeway to play with nine notes (two sharps and a diatonic). If the music could be played on a phin instrument, it may be identified. It is not hard to determine what key something is in, highlight any accidentals, and transpose it to one of the keys that can be play in, and see if can be access to those accidentals. Figure 3 shows a creative Patterns Enjoy applying and creating the technique of playing the harp of Mr. Boonma Khao Wong, a master artist of Isan folklore in the international note format. Figure 4 shows a creation of *Toei* pattern using the harp playing technique of Mr. Thongsai Thap Thanon Khao Wong, the original Isan folk artist in international note format.



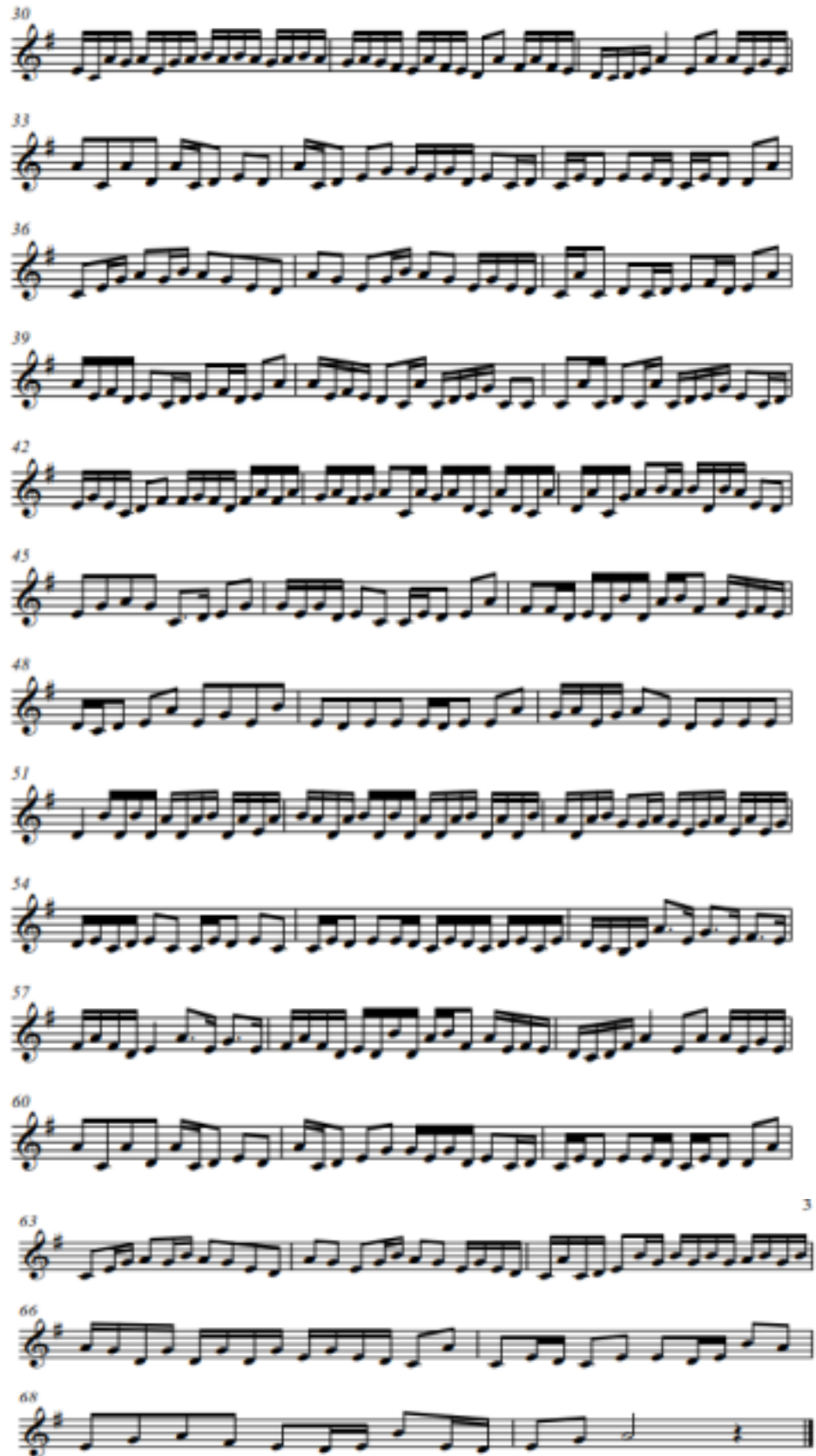


Fig. 3. Creative Patterns Enjoy applying and creating the technique of playing the harp of Mr. Boonma Khao Wong, a master artist of Isan folklore in the international note format

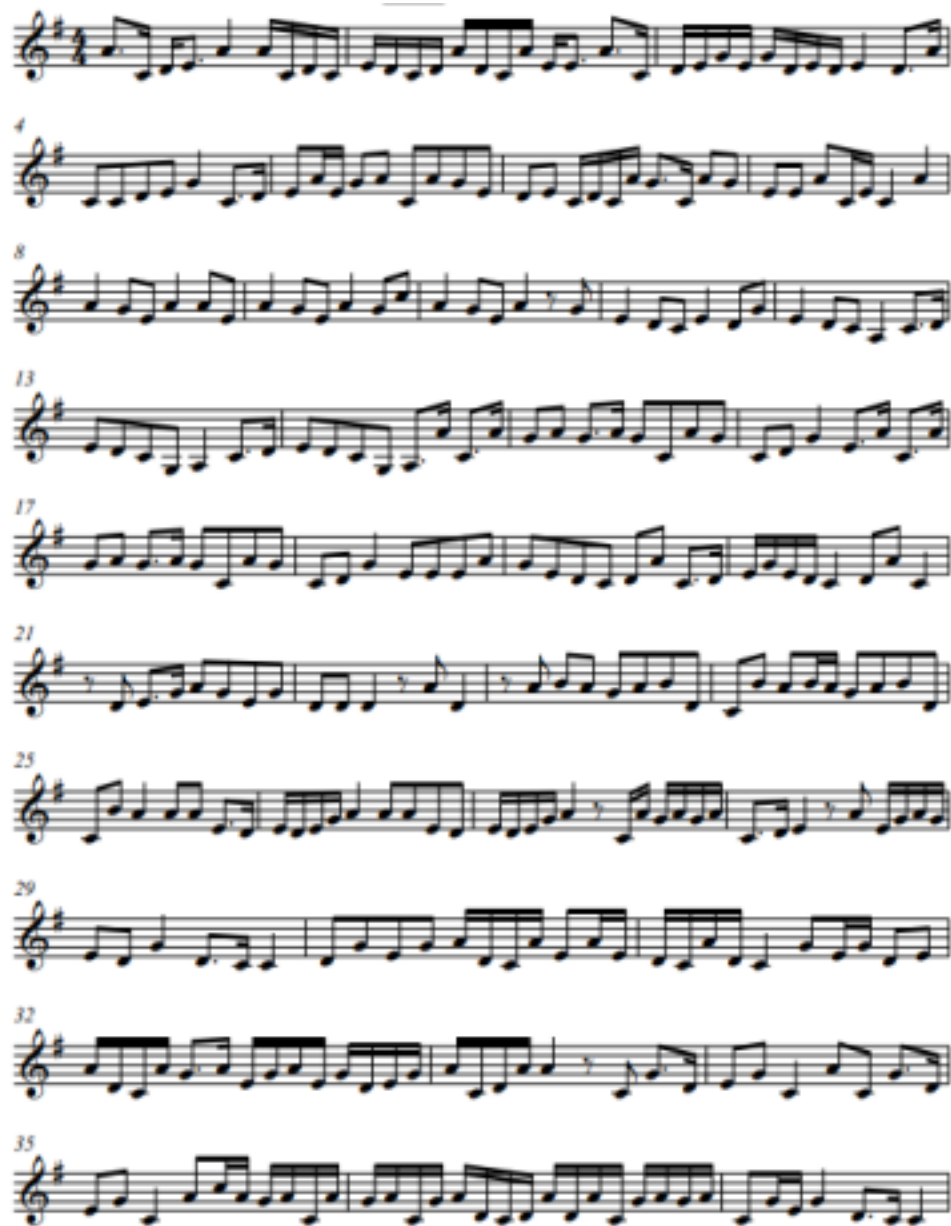


Fig. 4. Creation of Toei pattern using the harp playing technique of Mr. Thongsai Thap Thanon Khao Wong, the original Isan folk artist in international note format

In this study it was hypothesized that the tonal and acoustic characteristics of the phin can be systematically analyzed using frequency and time-frequency methods, and that its fret-based pitch system produces measurable polynomial relationships between fret position and frequency across all three strings. Additionally, it was hypothesized that variations in harmonic content between the strings reflect the physical structure and tuning of the instrument, offering new insights into its musical adaptability and acoustic identity.

EXPERIMENTAL

Figure 5 illustrates the schematic design of microphone data collections. The phin sound was digitally recorded using a PicoScope oscilloscope and microphone data collecting systems. The microphone was situated 20 cm from the string. The Pico Technology 3000 series oscilloscope (Eaton Socon, UK) was employed to do the Fast Fourier Transform (FFT) focusing, voltage-based triggers, and spectrum analysis. The audio recordings were acquired at a sample frequency of 48 kHz. The experiment was done in the Music Department of Universiti Malaysia Sarawak (UNIMAS) within an anechoic chamber. The Time Frequency Analysis (TFA) was performed using Adobe Audition, concentrating on the specific intensity in hertz to distinguish the power of partial frequencies, utilizing measurements in seconds. Tone systems are often examined in sound analysis and re-synthesis with this methodology (Hamdan *et al.* 2020).

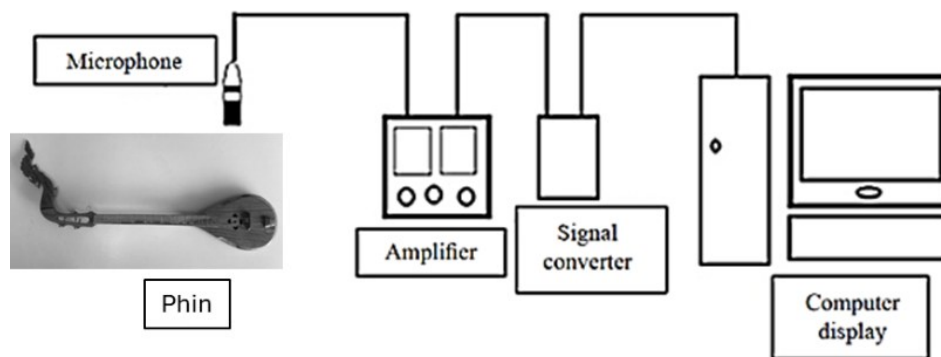


Fig. 5. Schematic diagram of microphone data acquisitions

The vibrations generate sound waves that produce the notes perceived in music. The audio signals were recorded in monaural format with a 24-bit resolution of and a 48 kHz sampling rate. The audio profile was preserved in “.wav” format for further processing. A calibration was performed before the session to guarantee proper settings. The calibration test tone was restricted to a 1.0 kHz sine wave, adhering to the European Broadcasting Union (EBU) methodology. The EBU stipulates that the device must provide a digital recording level of 0 VU at either +4 dBu or -18 dBFS in analog or digital format. No other devices nearby might have affected the signal amplitude during the calibration process. The recording equipment comprised the Steinberg UR22mkII audio interface, Audio-Technica AT4050 microphone, Behringer Powerplay Pro XL amplifier, and XLR cable. The microphone was set to record with a low-cut filter.

RESULTS AND DISCUSSION

Figures 6a, 7a, and 8a show the sound envelope to observe the ADSR (Attack, Decay, Sustain, and Release) of phin sound for the open strings E4, A3, E3 from strings 1, 2, and 3 respectively. Figures 6b, 7b, and 8b show the fundamental and the higher partials frequencies for the open strings E4, A3, E3 from strings 1, 2, and 3, respectively.

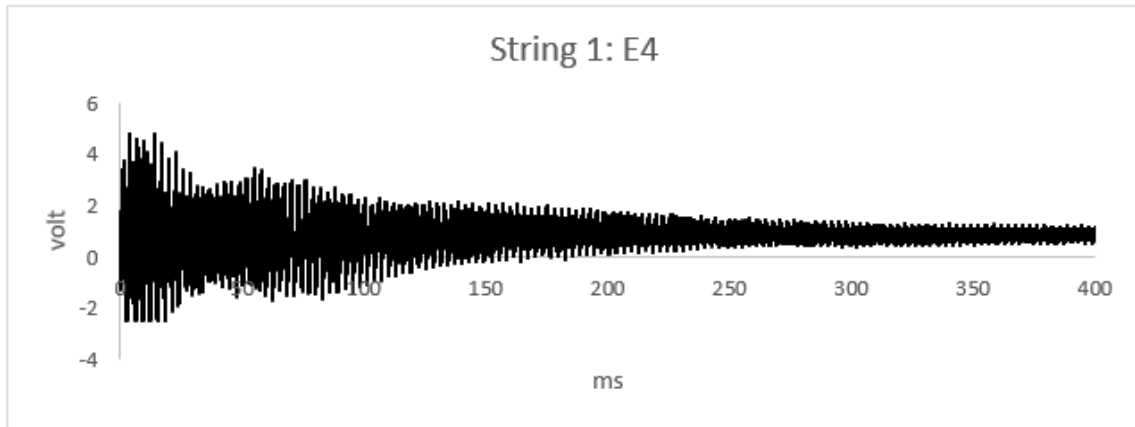


Fig. 6a. The voltage *versus* time from open string 1.

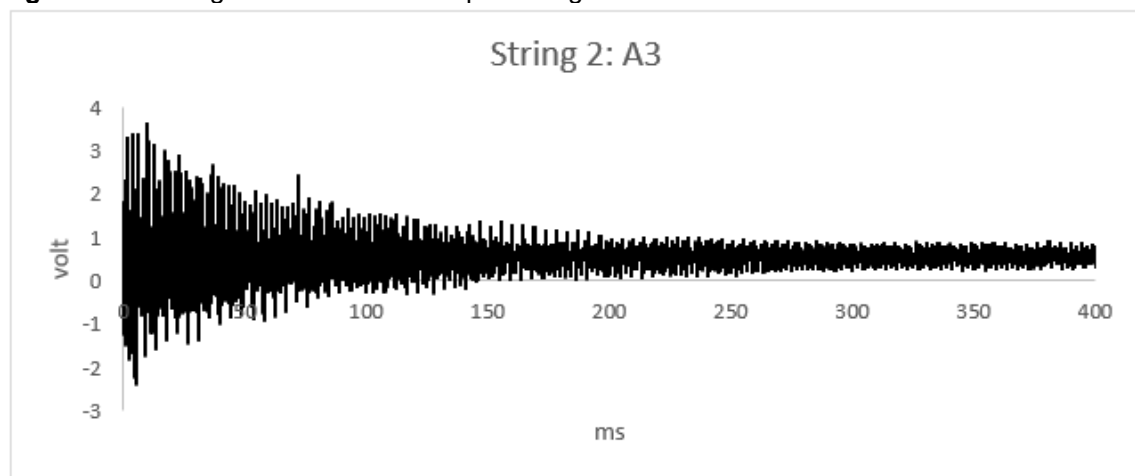


Fig. 7a. The voltage *versus* time from open string 2

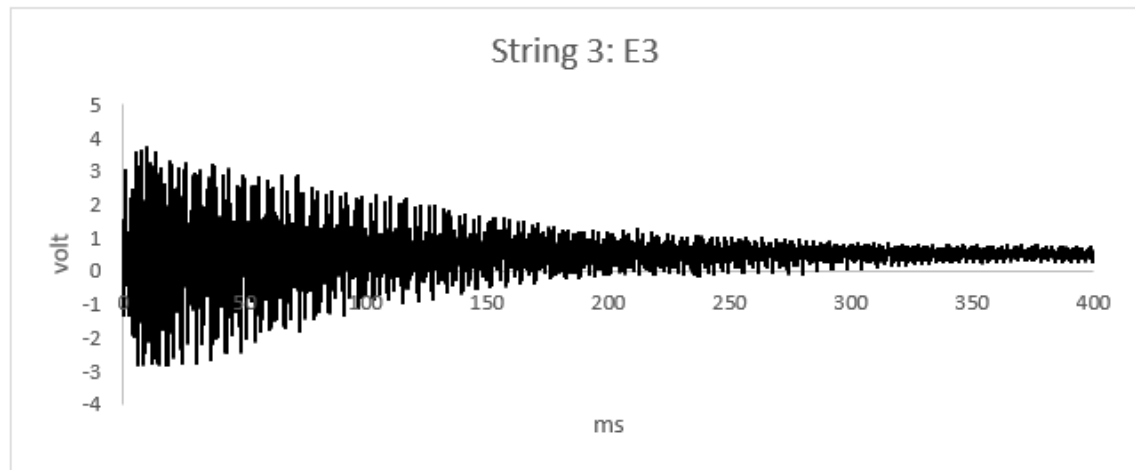


Fig. 8a. The voltage *versus* time from open string 3

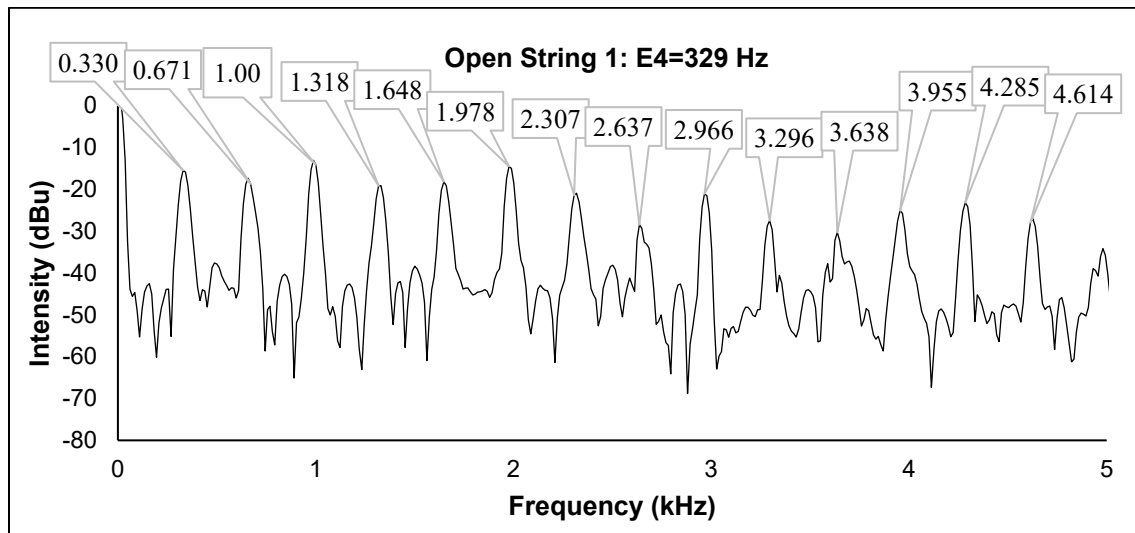


Fig. 6b. The fundamental and the higher partials frequencies from open string 1

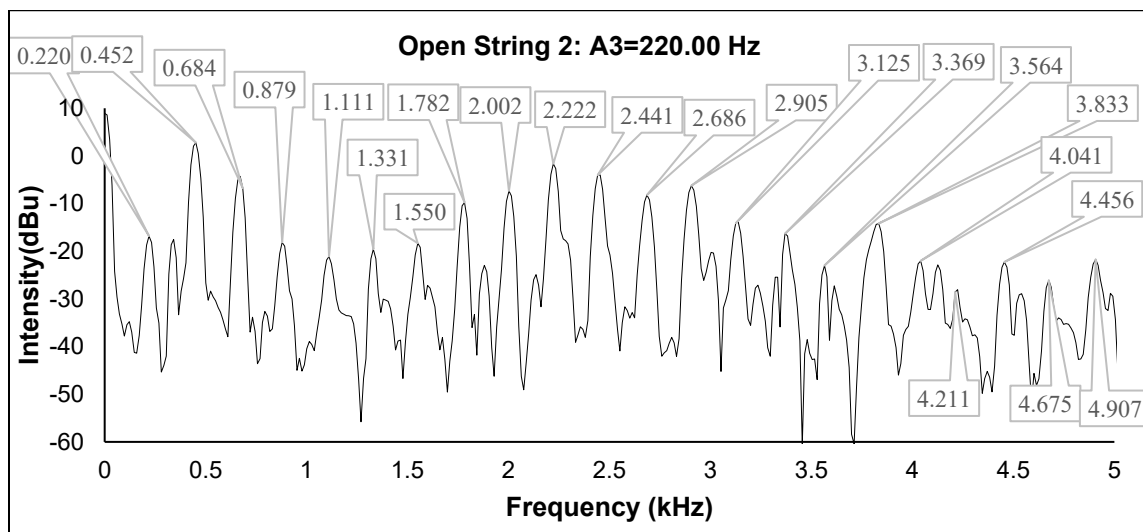


Fig. 7b. The fundamental and the higher partials frequencies for open string 2

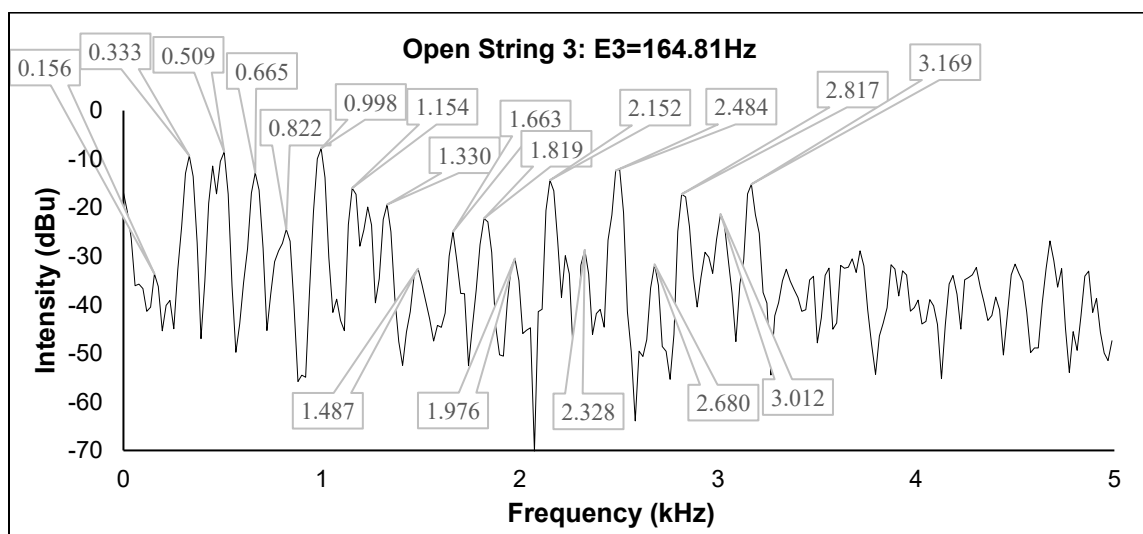


Fig. 8b. The fundamental and the higher partials frequencies for open string 3

Figures 9 to 23 show the fundamental and the higher partials frequencies for the fret 1 to fret 15 from string 1. Using the same procedure, the measured frequency from open string and fret 1 to fret 15 for string 1, 2, and 3 are displayed in Table 2.

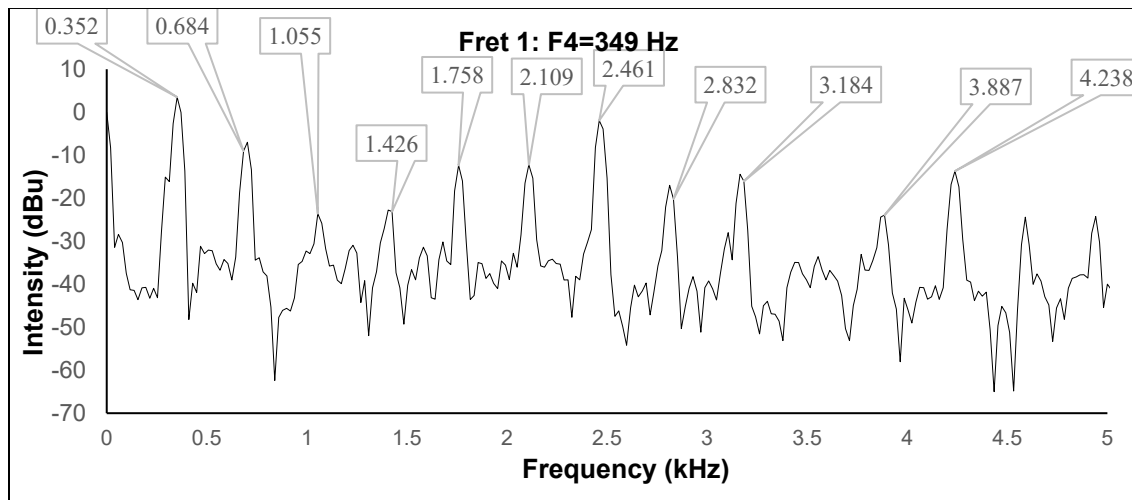


Fig. 9. The fundamental and the higher partials frequencies for the string 1 fret 1

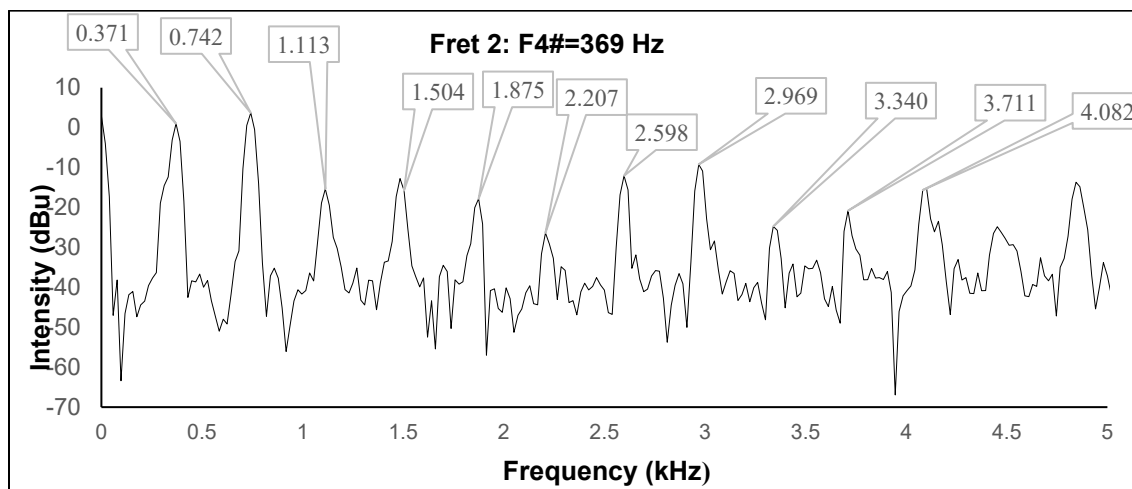


Fig. 10. The fundamental and the higher partials frequencies for the string 1 fret 2

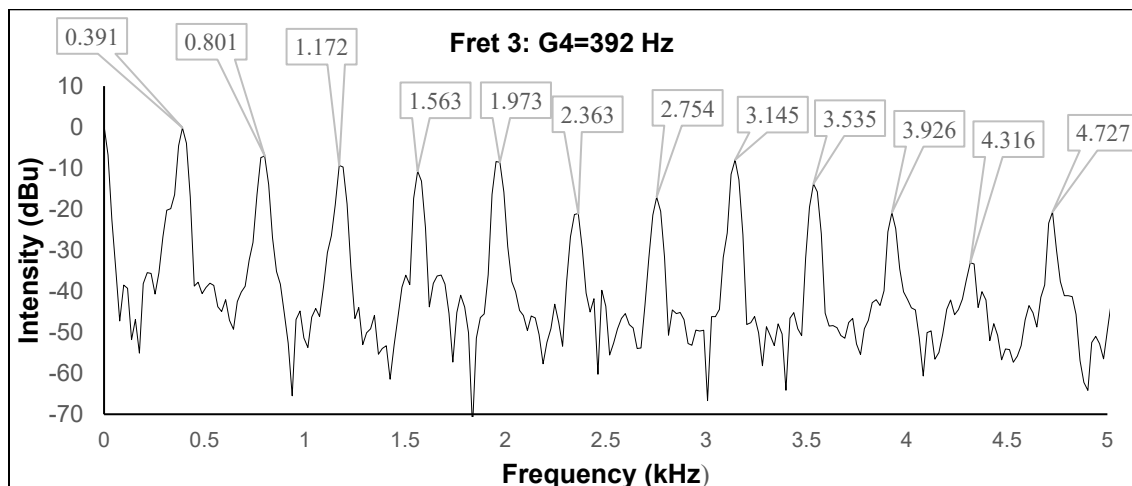


Fig. 11. The fundamental and the higher partials frequencies for the string 1 fret 3

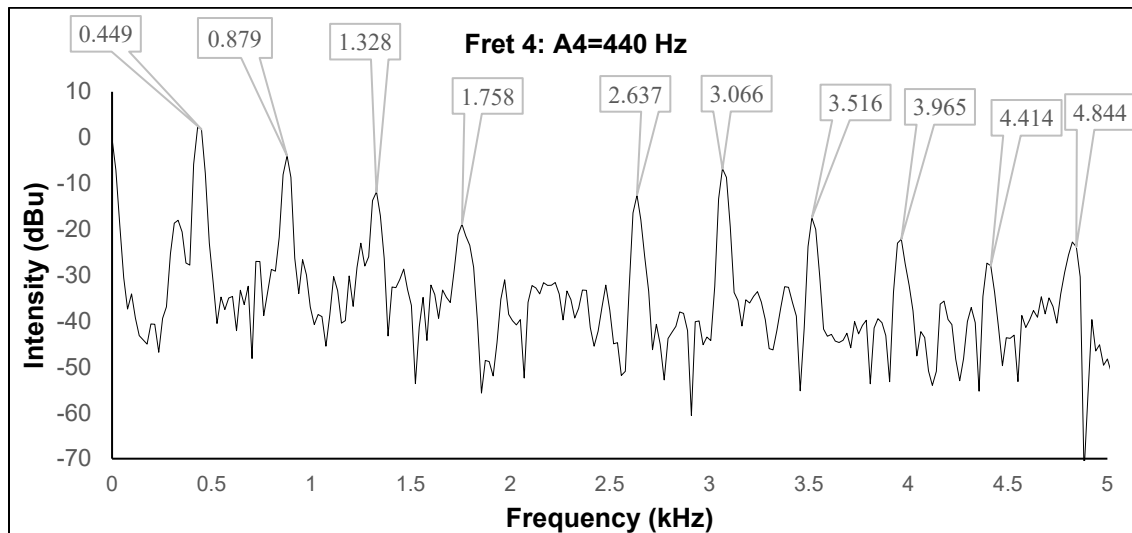


Fig. 12. The fundamental and the higher partials frequencies for the string 1 fret 4

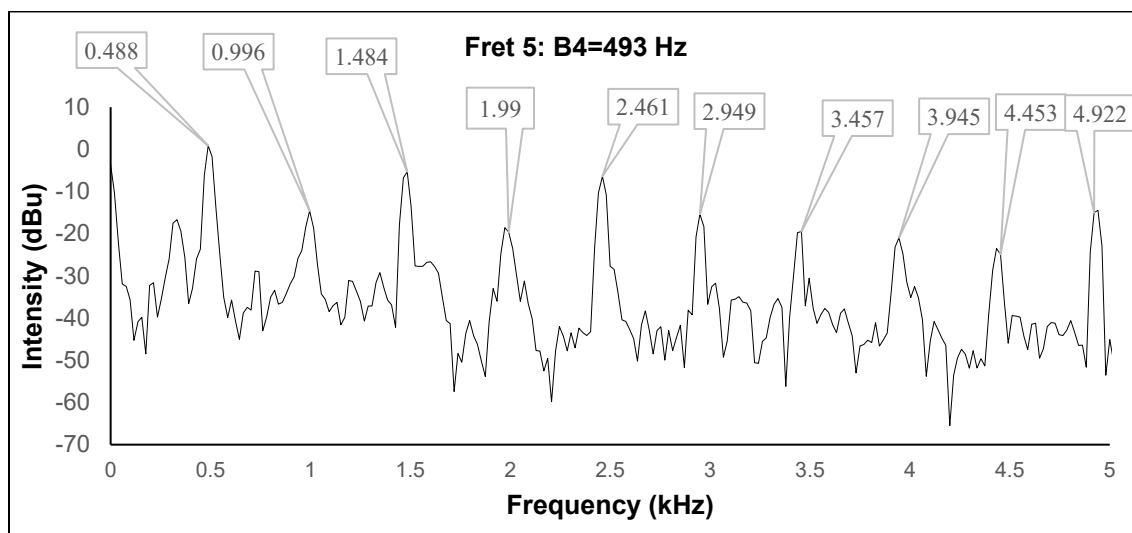


Fig. 13. The fundamental and the higher partials frequencies for the string 1 fret 5

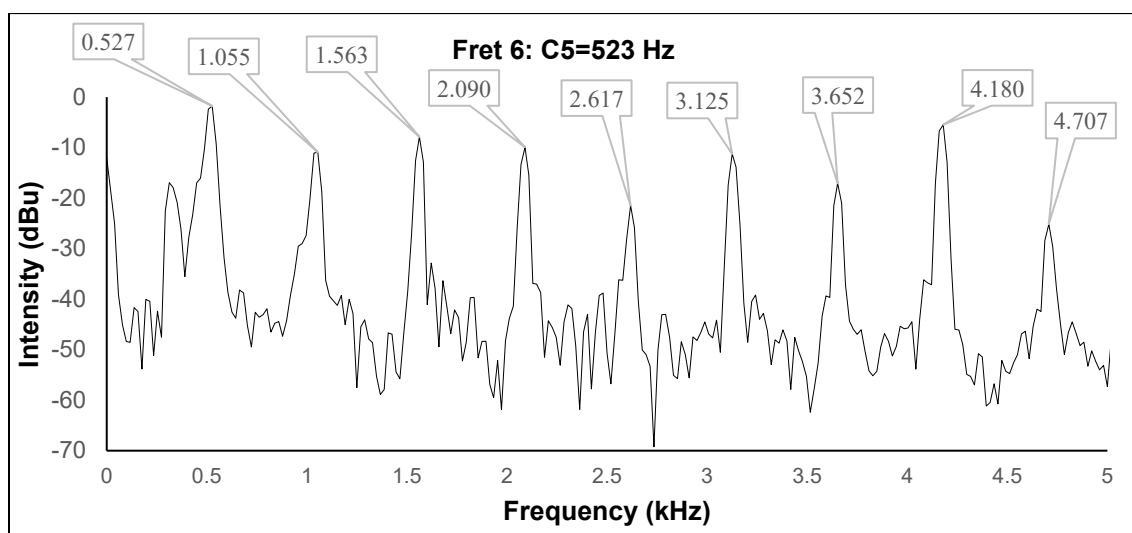


Fig. 14. The fundamental and the higher partials frequencies for the string 1 fret 6

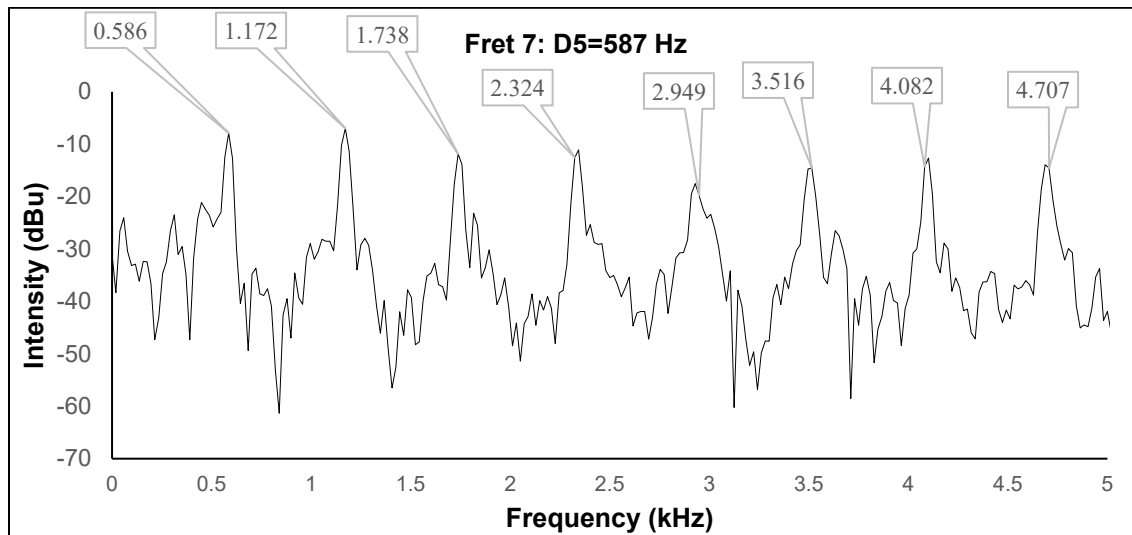


Fig. 15. The fundamental and the higher partials frequencies for the string 1 fret 7

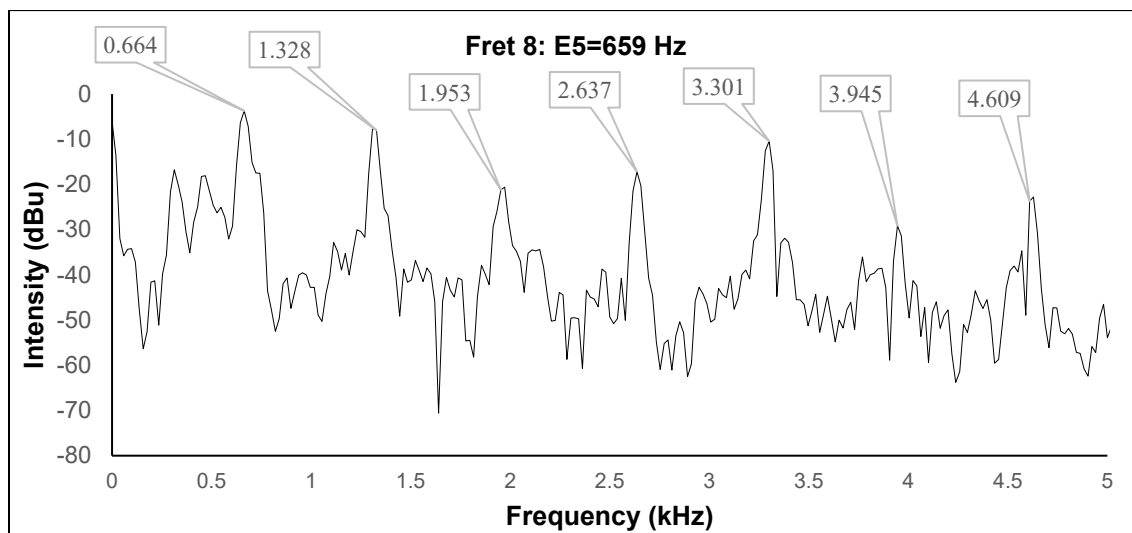


Fig. 16. The fundamental and the higher partials frequencies for the string 1 fret 8

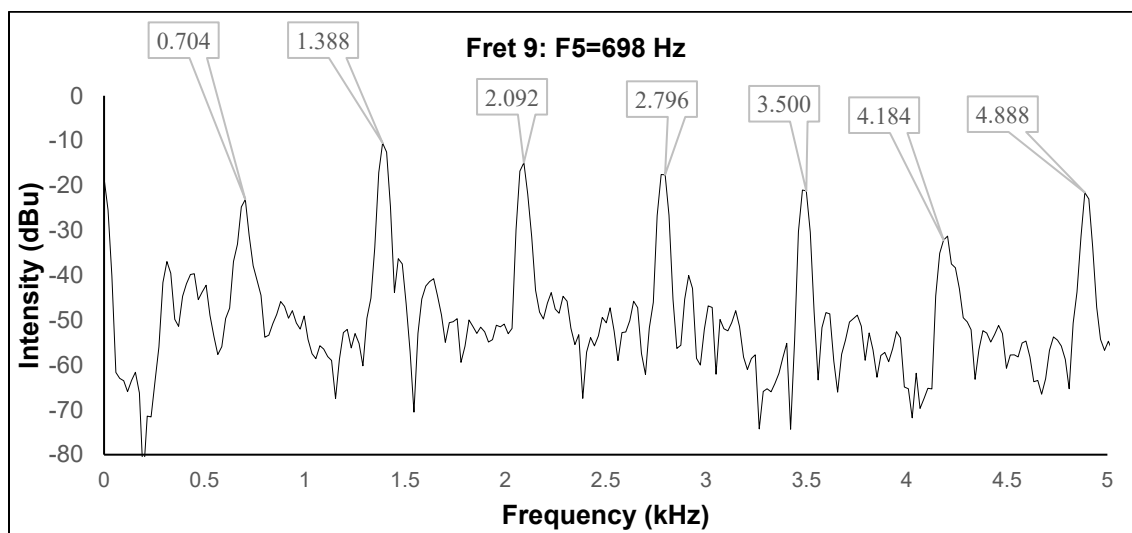


Fig. 17. The fundamental and the higher partials frequencies for the string 1 fret 9

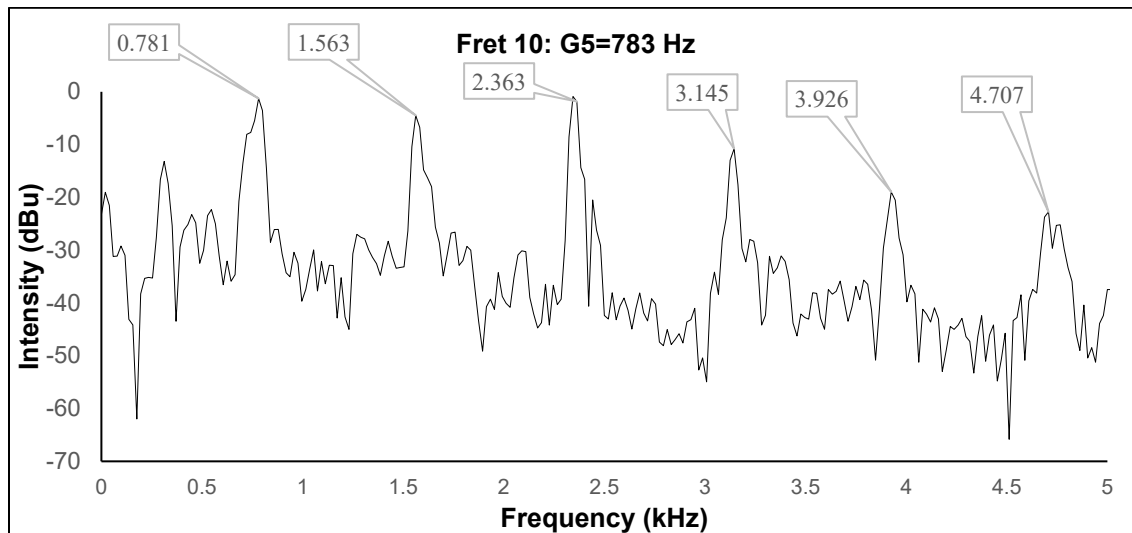


Fig. 18. The fundamental and the higher partials frequencies for the string 1 fret 10

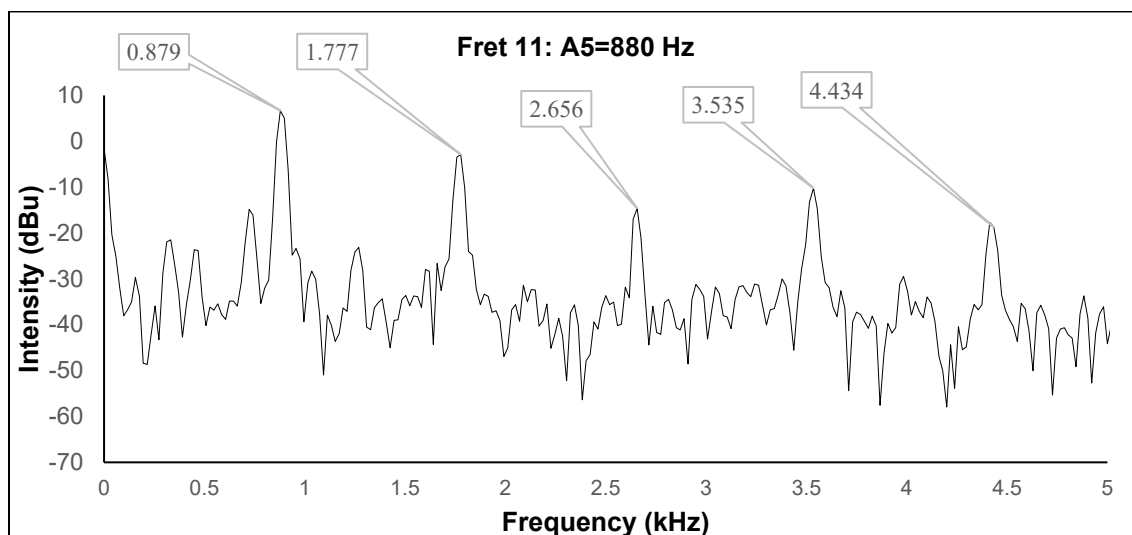


Fig. 19. The fundamental and the higher partials frequencies for the string 1 fret 11

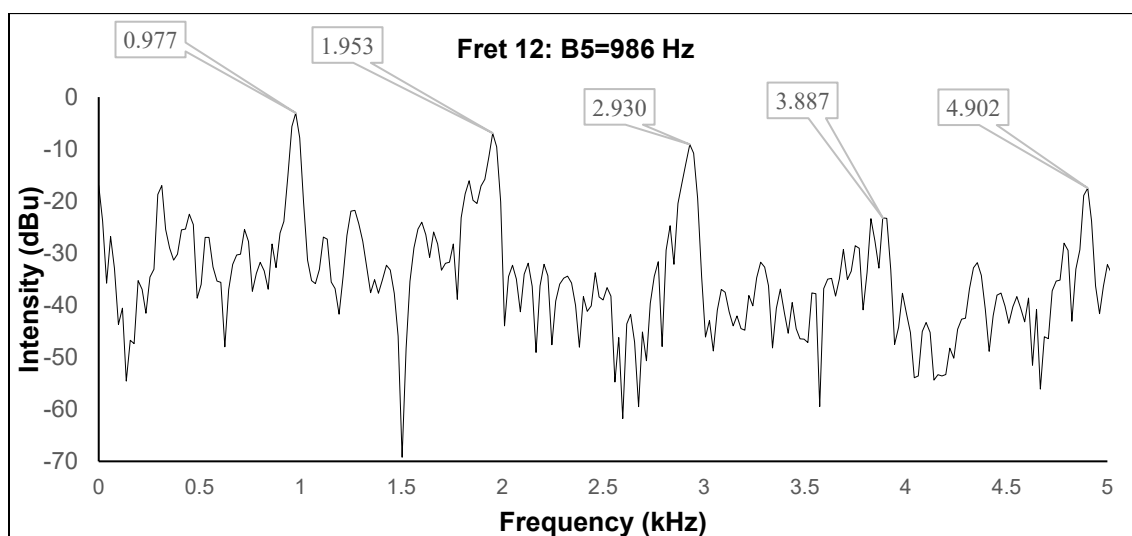


Fig. 20. The fundamental and the higher partials frequencies for the string 1 fret 12

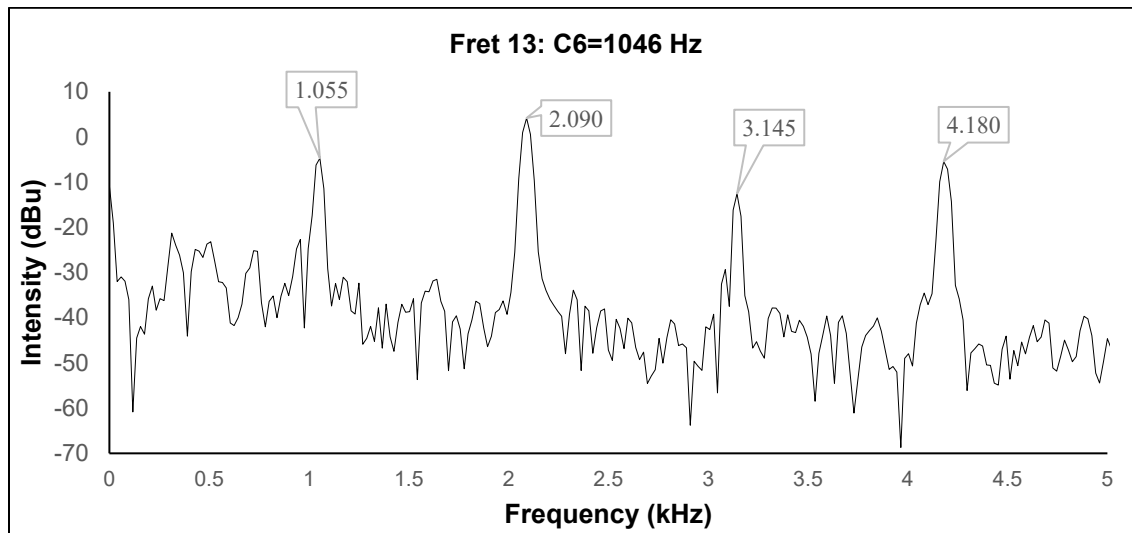


Fig. 21. The fundamental and the higher partials frequencies for the string 1 fret 13

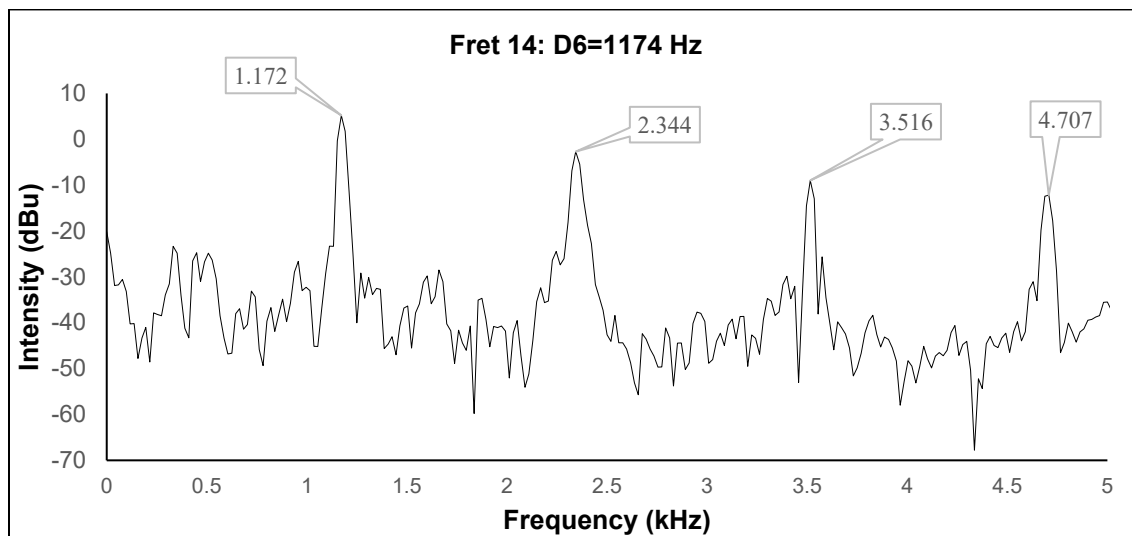


Fig. 22. The fundamental and the higher partials frequencies for the string 1 fret 14

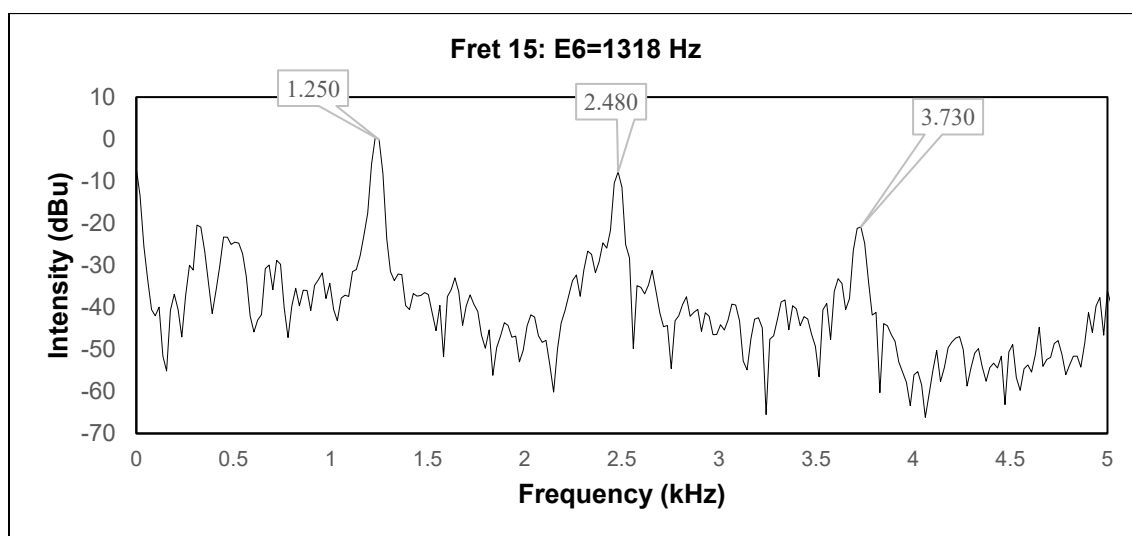


Fig. 23. The fundamental and the higher partials frequencies for the string 1 fret 15

Table 2. The Fundamental Frequency of the Open String and the 15 Frets for Strings 1, 2, and 3

Fret Number	String 1 ($\pm 2\text{Hz}$)	String 2 ($\pm 2\text{Hz}$)	String 3 ($\pm 2\text{Hz}$)
Open string	332	215	136
Fret 1	351	243	176
Fret 2	371	253	195
Fret 3	390	273	195
Fret 4	449	292	215
Fret 5	488	332	254
Fret 6	527	351	254
Fret 7	575	390	293
Fret 8	664	449	332
Fret 9	703	469	351
Fret 10	800	527	391
Fret 11	898	605	449
Fret 12	976	664	508
Fret 13	1054	703	527
Fret 14	1171	800	586
Fret 15	1250	839	-

The open string had the highest partials (14 partials), followed by frets 1, 2, and 3 with 11, 11, and 12 partials respectively. Frets 4, 5, and 6 had 10, 10, and 9 partials respectively. Frets 7, 8, and 9 had 8, 7, and 7 partials respectively. Frets 10, 11, and 12 had 6, 5, and 5 partials respectively. Frets 13, 14, and 15 had 4, 4, and 3 partials respectively. The number of partials decreased with the fret number.

Table 2 shows that string 1 running notes were E4, F4, F4#, G4, A4, B4, C5, D5, E5, F5, G5, A5, B5, C6, D6, E6, with F4# appearing in the first octave only. The 16 notes up to the 15th frets were E4 to E6. String 2 running notes were A3, A3#, B3, C4, D4, E4, F4, G4, A4, A4#, C5, D5, E5, F5, G5, and A5, with B3 appearing in the first octave only. The 16 notes up to the 15th frets were A4 to A6. String 3 running notes were E3, F3, F3#, G3, A3, B3, C4, D4, E4, F4, G4, A4, B4, C5, and D5, with F3# appearing in the first octave only. The 16 notes up to the 14th frets were E3 to D5. The fundamental frequency of the open string and the 15 frets for strings 1, 2, and 3 are plotted in Figs. 24, 25, and 26 respectively.

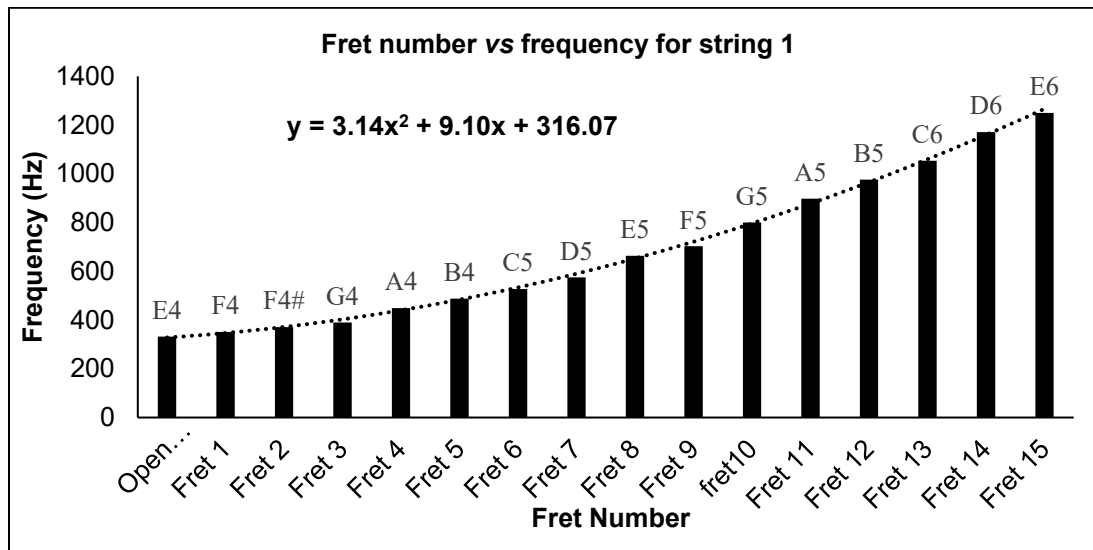


Fig. 24. The fundamental frequency of open string and the 15 frets for string 1

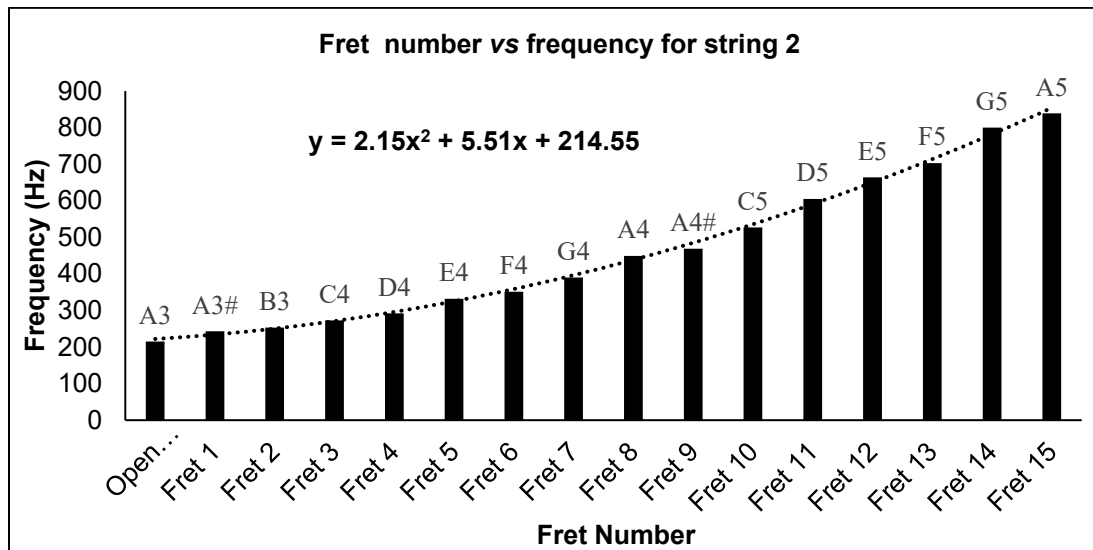


Fig. 25. The fundamental frequency of open string and the 15 frets for string 2

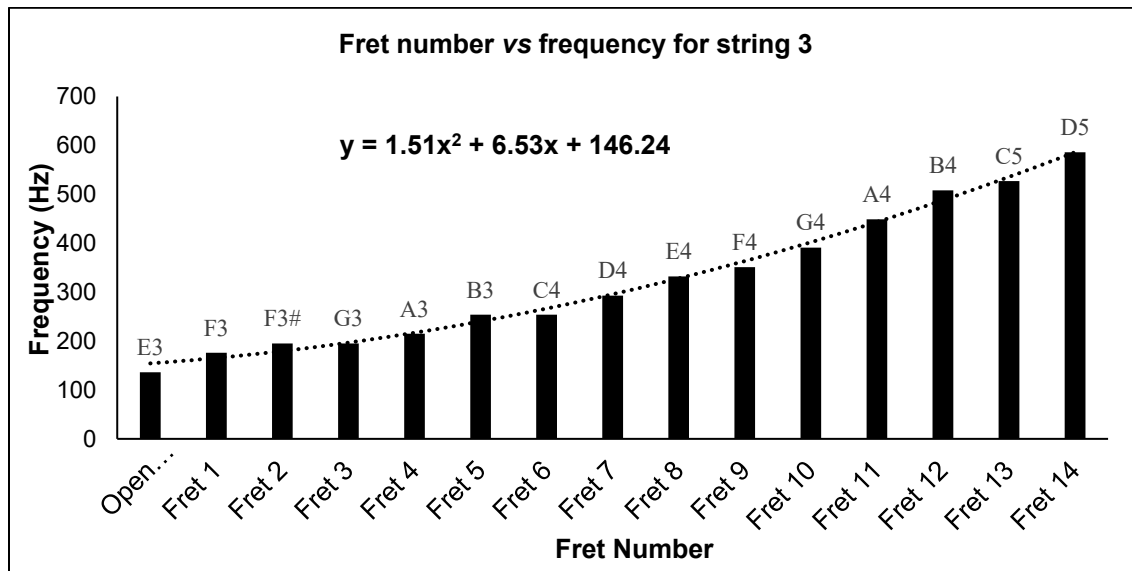


Fig. 26. The fundamental frequency of open string and the 14 frets for string 3.

Figures 24, 25, and 26 show the fret number *versus* the partial frequency (Hz) for open strings 1, 2, and 3. The equation for the polynomial in open string 1, 2, and 3 is:

$$\begin{aligned}
 y_{\text{string1}} &= 3.14x^2 + 9.10x + 316.07. \\
 y_{\text{string2}} &= 2.15x^2 + 5.51x + 214.55. \\
 y_{\text{string3}} &= 1.51x^2 + 6.53x + 146.24.
 \end{aligned}
 \tag{1}$$

The changes in frequency increased (the multiplication factor a of the x^2) gradually increased with the pitch. String 3 (E3) showed the multiplication factor of 1.51, string 2 (A3) showed the multiplication factor of 2.15 and string 1 (E4) showed the multiplication factor of 3.14.

Figure 27 shows the TFA for strings 1, 2, and 3 from Adobe Audition. Previous studies had been done using FFT and TFA methodologies in Nirai guitar (Duin *et al.* 2025a), Seung (Duin *et al.* 2025b), Hasapi (Sinin *et al.* 2025), Pratuokng (Hamdan *et al.* 2024a) and Tongkungan (Hamdan *et al.* 2024b) musical instruments. The uniform higher partials from the 1st string in Fig. 6b is reflected as bright distinct spectra by TFA in Fig. 27. The less consistent partials intensity from the 2nd string in Fig. 7b is reflected as bright but less distinct spectra by TFA in Fig. 27. The inconsistent partials intensity from the 3rd string in Fig. 8b is reflected as bright but non-distinct spectra by TFA in Fig. 27. Figure 27 also highlight a very clear distinction of the TFA from the lower partials from the 1st string compared with higher partials. The partials from Picoscope are clearly display as distinct partials in TFA.

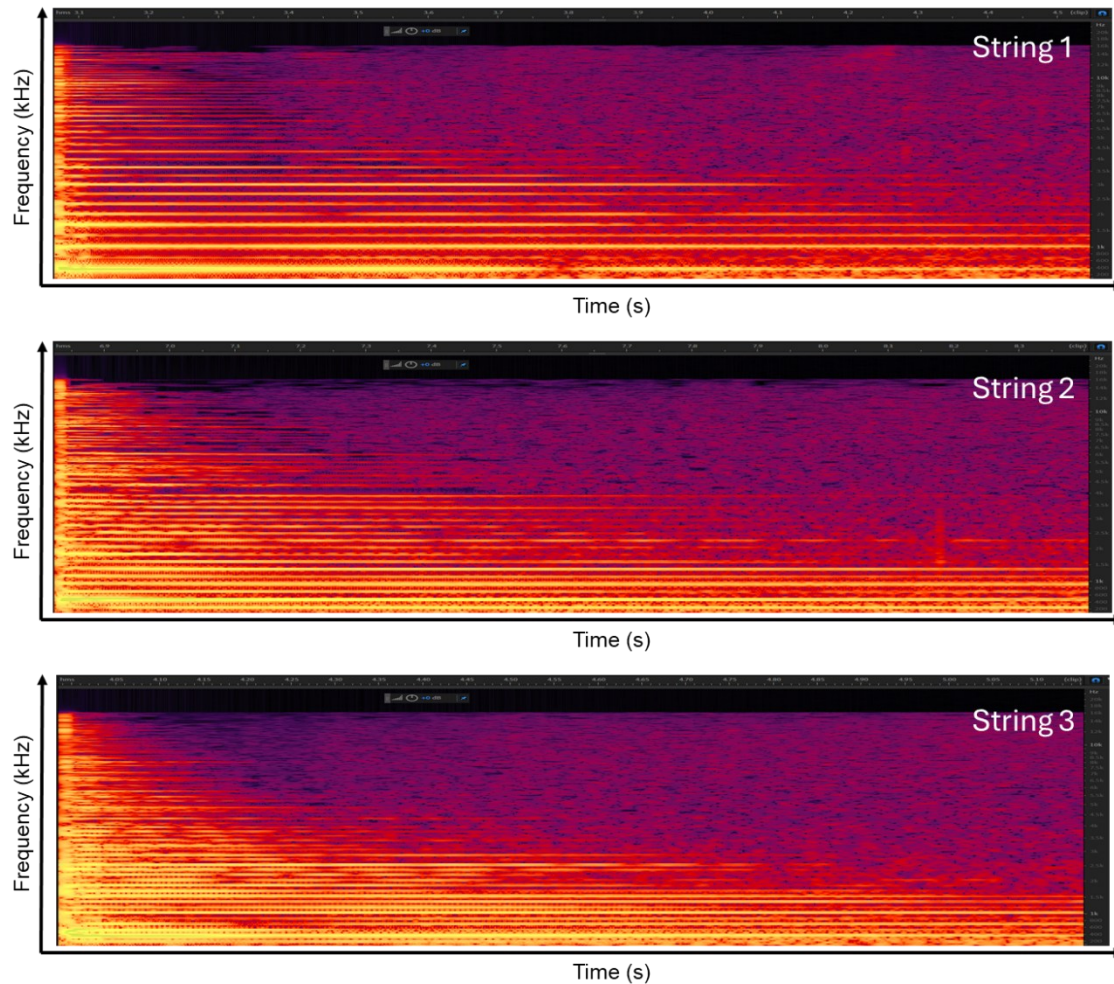


Fig. 27. The time frequency analysis (TFA) for 1st, 2nd and 3rd strings from adobe audition

The sound analysis procedure made it clearer how the results relate to acoustics, in particular on how each string's partial frequencies, harmonic content, and polynomial fitting of pitch frequencies help us comprehend the instrument's tonal structure and intonation behavior.

CONCLUSIONS

1. The string 1 running notes are E4, F4, F4#, G4, A4, B4, C5, D5, E5, F5, G5, A5, B5, C6, D6, E6 with F4# appear in the first octave only.
2. The string 2 running notes are A3, A3#, B3, C4, D4, E4, F4, G4, A4, A4#, C5, D5, E5, F5, G5, A5 with B3 appear in the first octave only.
3. The string 3 running notes are E3, F3, F3#, G3, A3, B3, C4, D4, E4, F4, G4, A4, B4, C5, D5 with F3# appear in the first octave only.
4. The equation for the polynomial (*i.e.*, the fret number *versus* the partial frequency) for open strings 1, 2, and 3 is:

$$y_{\text{string1}} = 3.14x^2 + 9.10x + 316.07.$$

$$y_{\text{string2}} = 2.15x^2 + 5.51x + 214.55.$$

$$y_{\text{string3}} = 1.51x^2 + 6.53x + 146.24.$$

5. The changes in frequency (the multiplication factor a of the x^2) increased gradually with the pitch. String 3 (E3), string 2 (A3), and string 1 (E4) showed the multiplication factor a of 1.51, 2.15, and 3.14 respectively. String1 (E4) with a larger a means a narrower parabola *i.e.* small progression in frequency changes. String 3 (E3) with a smaller a means a wider parabola, *i.e.*, big progression in frequency changes.
6. From the hypothesis above the following conclusion is made:
 - a. The tonal and acoustic characteristics of the phin can be systematically analyzed using frequency and time-frequency methods.
 - b. Its fret-based pitch system produces measurable polynomial relationships between fret position and frequency across all three strings.
 - c. The variations in harmonic content between the strings reflect the physical structure and tuning of the instrument, offering new insights into its musical adaptability and acoustic identity.

ACKNOWLEDGMENTS

The authors would like to acknowledge Universiti Malaysia Sarawak (UNIMAS) and Universiti Putra Malaysia, Sarawak, Malaysia for the technical and financial supports.

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Article submitted: March 12, 2025; Peer review completed: June 29, 2025; Revised version received: July 8, 2025; Accepted: August 26, 2025; Published: September 19, 2025.

DOI: 10.15376/biores.20.4.9699-9719