Sundatang-Sabah's Lost Lute of Borneo

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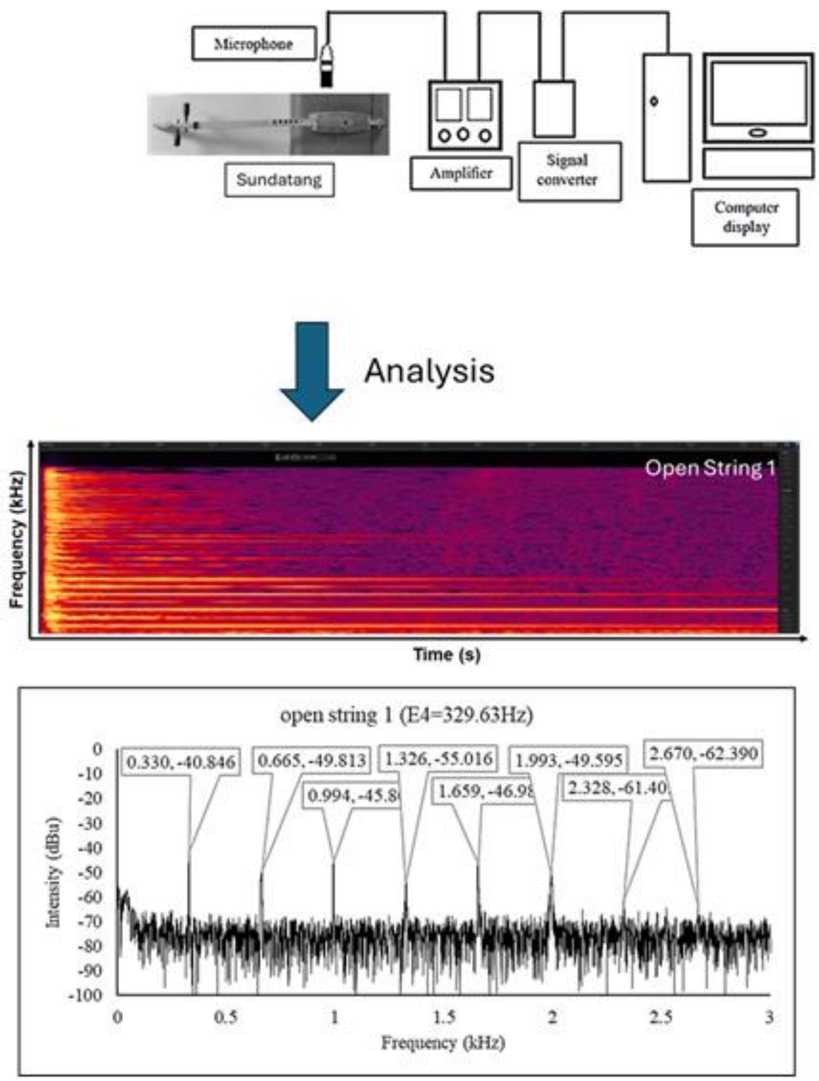
DOI: 10.15376/biores.20.3.5331-5347

GRAPHICAL ABSTRACT



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This study determines the note for a sundatang, a traditional musical instrument in Borneo. The sundatang originated from two different ethnics so the strings were tuned differently as well as frets and it clearly produces more than one note. The sound was recorded using a microphone which was connected to a PicoScope and analyzed using Fast Fourier Transform (FFT). The string 1 and 2 for sundatang A are tuned to E4(330Hz) and E3(161Hz) respectively, and sundatang B are tuned to C4#(277Hz) and C3#(138.59Hz) respectively. Open string 1 and the fret from sundatang A was tuned to E4(330), G4#(410), A4#(465), C5#(546), D5(569), and F5(692) where E4-G4#:2Tone, G4#-A4#:1Tone, A4#-C5#:2Tone, C5#-D5:1Tone, D5-F5:2Tone, simplified become 2TT2TT2T. Open string 1 and the fret from sundatang B it was tuned to C4#(277), E4(329), F4(340), F4#(361), G4(389), G4#(425) where C4#-E4:1.5Tone, E4-F4:1Semitone, F4-F4#:1Semitone, F4#-G4:1Semitone, G4-G4#:1Semitone simplified become 1.5TSSSS. The note interval for string 1 and 2 for sundatang A and B can be formulated as $y = 67.6x + 332.8$ and $y = 30.2x + 272.1$, respectively. The time frequency analysis of the open strings 1 and 2 displayed a dense distribution of partials while fret 1 to 5 showed a distinct distribution which decrease with fret number.

DOI: 10.15376/biores.20.3.5331-5347

Keywords: Borneo lute; Sundatang; Fast Fourier transform; Note interval

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INTRODUCTION

The sundatang is a prevalent instrument among the KadazanDusun of Tambunan and the Rungus of Kudat people in Sabah, Malaysia. It is played mostly for amusement and non-ritualistic contexts. Sundatang belongs to the boat lute family indigenous to Southeast Asia. The primary distinction from the sape, as noted by Hamdan *et al*. (2023), lies in the structure. The sundatang possesses an elongated, slender neck, but the sape is devoid of a neck. The sundatang frequencies have been examined by several studies (Batahong *et al*. 2014; Batahong and Dayou 2016), although understanding of the note and key remains insufficient. The sundatang belongs to the category of stringed musical instruments and resembles a guitar in basic design, with two strings, as shown in Fig. 1 (Ferrarese 2023).

Fig. 1. The various boat lute in Borneo

The instrument is often constructed from jackfruit, which is abundantly found in Sabah, Malaysia. The jackfruit (*Artocarpus heterophyllus*) is a tree species belonging to the Moraceae family. It is ideally adapted to tropical lowlands and is extensively farmed in the Philippines, India, Bangladesh, Sri Lanka, Indonesia, Malaysia, and Australia. Botanist Ralph Randles Stewart proposed that it should be named in honor of William Jack (1795 to 1822), a Scottish botanist associated with the East India Company in Bengal, Sumatra, and Malaya. Jackfruit possesses a rather brief trunk and a compact canopy. It readily attains elevations of 9 to 21 m and trunk sizes of 30 to 80 cm. The leathery leaf blade is 20 to 40 cm in length and 7.5 to 18 cm in width. Fig. 2 illustrates the jackfruit tree.

Fig. 2. Jackfruit tree

Jackfruit wood was selected due to its widespread availability and ease of being worked. A typical wood for making *phin* is from jackfruit wood (Hamdan *et al*. 2025). The *seung* with nine frets is also commonly made from jackfruit wood (Duin *et al.* 2025). Today, jackfruit trees are used for *hasapi*, a fretless chordophone with two strings (Sinin *et al.* 2025). In Indonesia, hardwood from the trunk is carved out to form the barrels of drums used in the gamelan, and in the Philippines, its soft wood is made into the body of the *kutiyapi*, a type of boat lute. Tropical woods are also used for manufacturing traditional musical instrument such as sape, gendang, rebana, beduk, and tar (Chong 2000). The acoustic properties of tropical wood species suitable for manufacturing musical instruments are determined by the specific dynamic Young's modulus (E/γ), internal friction (Q^{-1}), and acoustic conversion efficiency (ACE) of several tropical wood species (Sedik *et al.* 2010).

According to Pugh-Kitingan (2020), the sundatang is varied in different regions and tribes. There are the KadazanDusun sundatang from Tambunan, the Rungus sundatang and the Lotud *gagayan*. According to Pugh-Kitingan (2020), the sundatang was traditionally performed for amusement purposes at home in the KadazanDusun community in Tambunan. Its melodies imitate the *tinondot* music of the *sopogandangan* gong ensemble, which consists of a drum and many gongs, but at a slower tempo. Occasionally, someone else would join in by playing the *koritikon*, a hand-held gong. The *magarang* sundatang, a slow and delicate dance done by a pair with few arm and foot motions, was also accompanied by the sundatang. This dance was perfect for small areas, such as longhouse areas. This tradition shows the personal and cultural significance of the sundatang in daily life, even though it is hardly practiced today. However, according to Pugh-Kitingan (2020), the Rungus of Kudat perform traditional instruments in a way that clearly distinguishes between genders. In Tambunan, the sundatang is played only by men and is usually played alone for personal enjoyment or to entertain other members of the longhouse, including children. Rungus women, on the other hand, prefer the *turali,* a nasal flute. The sundatang maintained to be a male-dominated instrument in Rungus society, whilst the *turali* became culturally associated with women. Moreover, in Lotud community, the women often play the *turali* nose flute, while men usually play the *gagayan* lute of the Lotud people in Tuaran, Sabah, which is comparable to the Rungus sundatang. In the past, *gagayan* musicians frequently played in duets, a custom known as *batangkung* (Pugh-Kitingan, 2020).

The sundatang is associated with a few folklore stories and culture. According to the interview from Razif Sundatang (Juanis 2023), the sundatang, a traditional musical instrument of the Rungus people, originated in an encounter with nature during agricultural activities. As the Rungus community cleared forest land for hill paddy farming, they felled a big tree known locally as *Korumanggalang*, which had a vine plant twisting up its trunk. The vine was still taut and hanging in midair as the tree collapsed, making melodies when the wind blew on it. Inspired by this natural event, the villagers attempted to replicate the sound by extending strings over a piece of wood, and they were successful in creating a pleasing tone. They learned how to make a musical instrument that could produce pleasant and harmonious sounds under the guidance of the *Bobolian*, a spiritual leader, and after communicating with *Osundu*, a spiritual being that is key to the Rungus belief system. The sundatang eventually developed as a result of this process. Furthermore, according to Rungus oral tradition, the sundatang are also connected to legends that emphasize their mystical power and authenticity through a legendary tale about a supernatural creature called *bubuha* (Juanis 2023). According to Razif, a Rungus warrior was challenged to a musical duel by the *bubuha*, a ghostly being thought to frighten people. The battle had a clear condition: if the *bubuha* lost, it would stop causing trouble and leave people alone. The goal of the challenge was to use the sundatang to produce the most captivating songs (Juanis 2023). As the narrative progresses, the warrior expertly performed a variety of tunes on the sundatang, leading up to the song *Mongolowodit*. The *bubuha* eventually conceded defeat, since this particular rhythm was so profound. This occasion not only reaffirmed the sundatang's celebrated place in Rungus culture but also represented the triumph of human creativity and spiritual harmony against evil powers. In addition to being a cultural myth, the story attests to the instrument's artistic and spiritual value in the community (Juanis 2023).

In addition to its mythical and spiritual significance, the sundatang was essential to the Rungus community's social and cultural life, especially for the young people. In the past, young men would utilize the instrument to show young women how much they loved and admired them. Playing the sundatang was a delicate and creative way to express love and interest through tunes (Juanis 2023). The end of the longhouse, a gathering location where everyday interactions took place, was usually where these performances took place. Young men sought to win the hearts and attention of the girls they admired by performing mesmerizing songs on the sundatang. The practice shows how music served as an instrument of communication in Rungus society, not only for ceremonial or amusement but also for social interaction and self-expression. The use of the sundatang in courtship illustrates its deep integration into the daily and spiritual lives of the communities.

EXPERIMENTAL

In this study, two different sundatangs were used. These sundatangs were labelled as sundatang A and sundatang B. Both strings in sundatang A are made from metal of 0.2 mm thick. Whereas both strings in sundatang B are made from nylon of 0.4 mm thick. The string was excited by plucking manually using index finger. The experiment was conducted in anechoic chamber at Department of Music, Universiti Malaysia Sarawak (UNIMAS), Malaysia. There are 5 frets installed under string 1 as shown in Figs. 3 and 4.

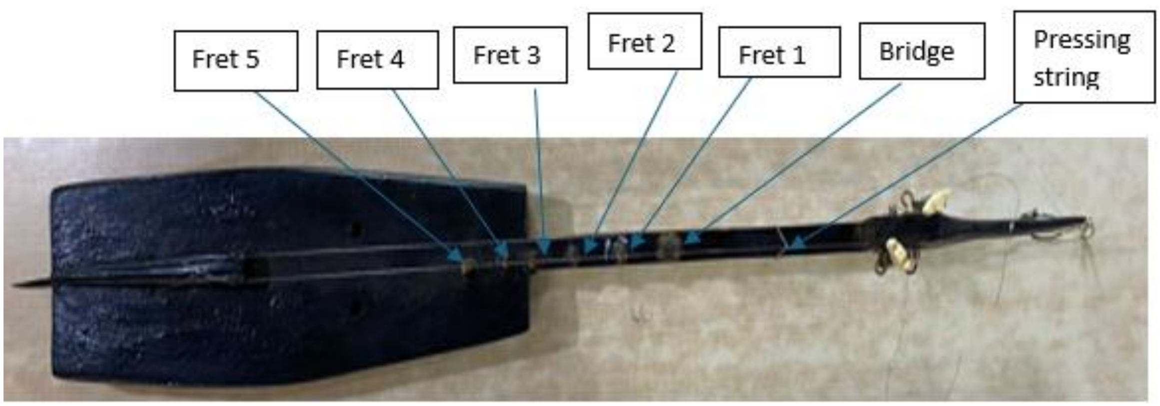


Fig. 3. The five frets and one bridge installed under string 1 in sundatang A.

In sundatang A, the frets are labelled as the 1st, 2nd, 3rd, 4th, and 5th fret started from the fret nearest to the bridge. A small pressing string is tied to string 1 to ensure it is pressed on the bridge. The height of the bridge, 1st, 2nd, 3rd, 4th and 5th fret is 27, 25.5, 23.5, 21.5, 20.5, 19.2 mm, respectively. In sundatang B, the frets are labelled as the 1st, 2nd, 3rd, 4th, and 5th fret started from the fret nearest to the post (acting as a bridge for open string 1).

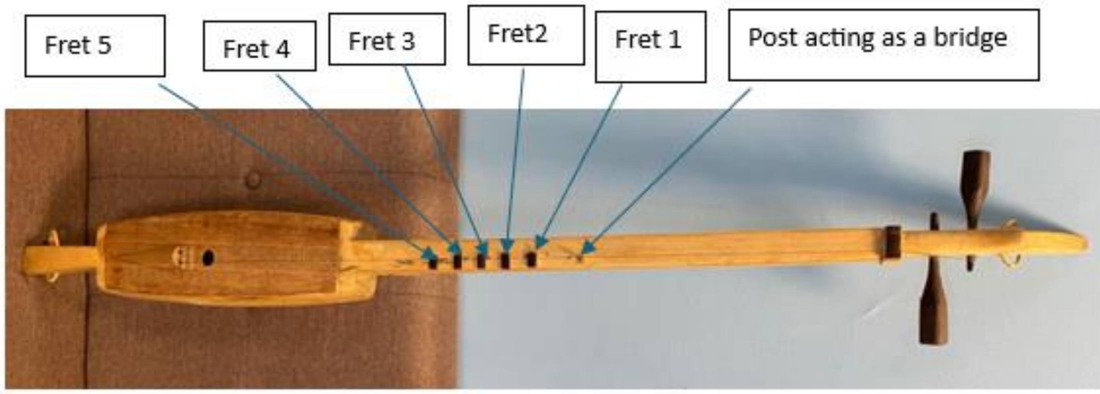


Fig. 4. There are five frets and one post installed under string 1 on sundatang B

The heights of the post, 1st, 2nd, 3rd, 4th, and 5th fret in sundatang B are 8, 3.5, 3.0, 2.7, 2.5, and 2.0 mm, respectively. The purpose of this study is to determine the note (pitch) for the open string 1, the frets on string 1, and open string 2 in sundatang A and sundatang B. The sundatang originated from two different ethnic traditions, so the strings were tuned differently as well as frets and it clearly produces more than one note.

Fig. 5 shows a schematic diagram of the experimental setup. The recorded sounds were analyzed using Fast Fourier Transform (FFT). The sounds for open strings and at different frets were recorded using microphone which is positioned at 20 cm from the top plate of the instrument. This 20 cm microphone position promotes natural sound generation and resonance and is most realistic of normal playing situations. To capture the authentic acoustic qualities, the microphone was positioned in front at a constant distance and angle during the recording process. With this setup, distortion is avoided and the recordings are guaranteed to accurately capture the tonal qualities. The instrument was played and recorded under identical circumstances to minimize any anomalies or variations. The microphones were positioned above them at the same height and angle to guarantee that the recordings accurately captured the acoustic qualities of the instrument without adding any bias.

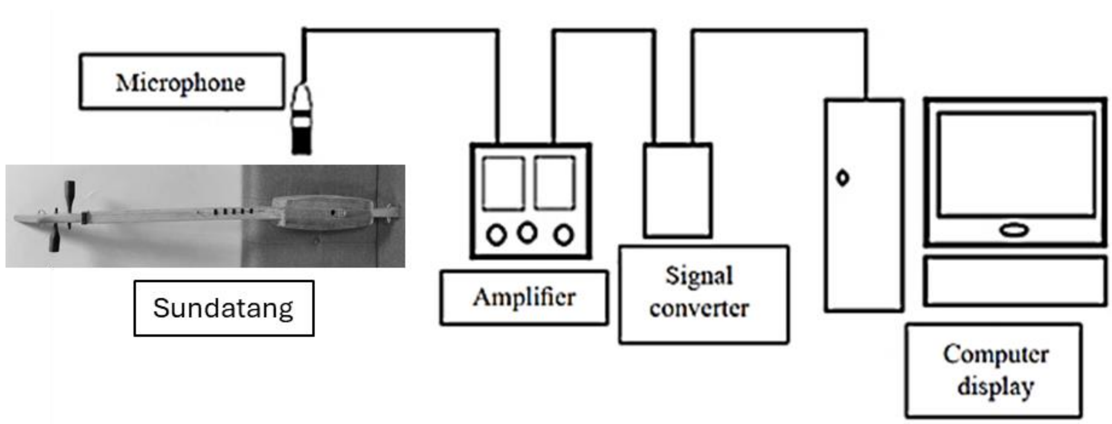


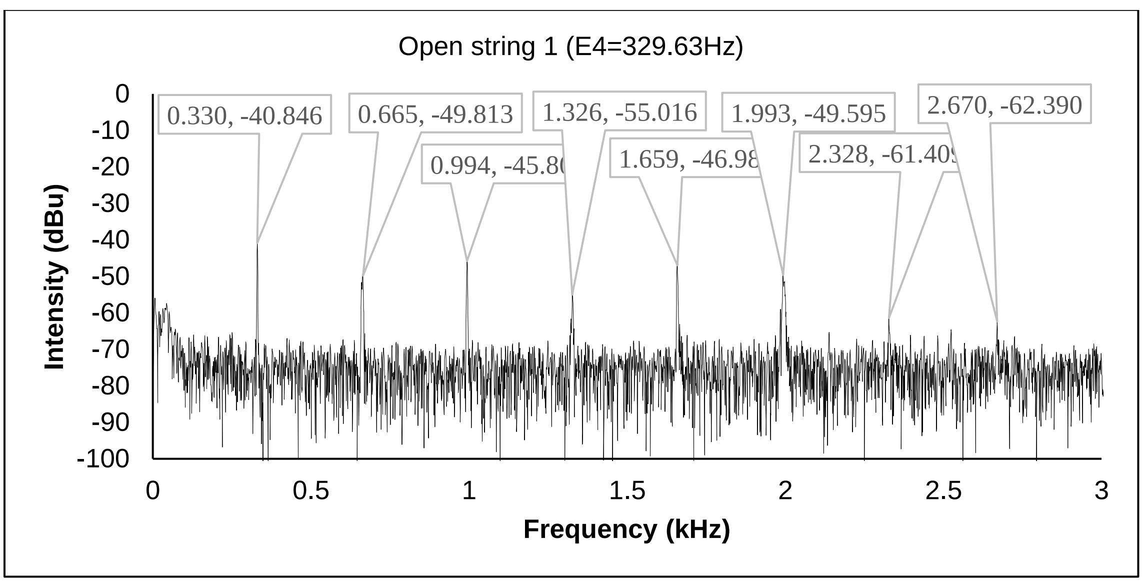
Fig. 5. Schematic diagram of microphone data acquisitions

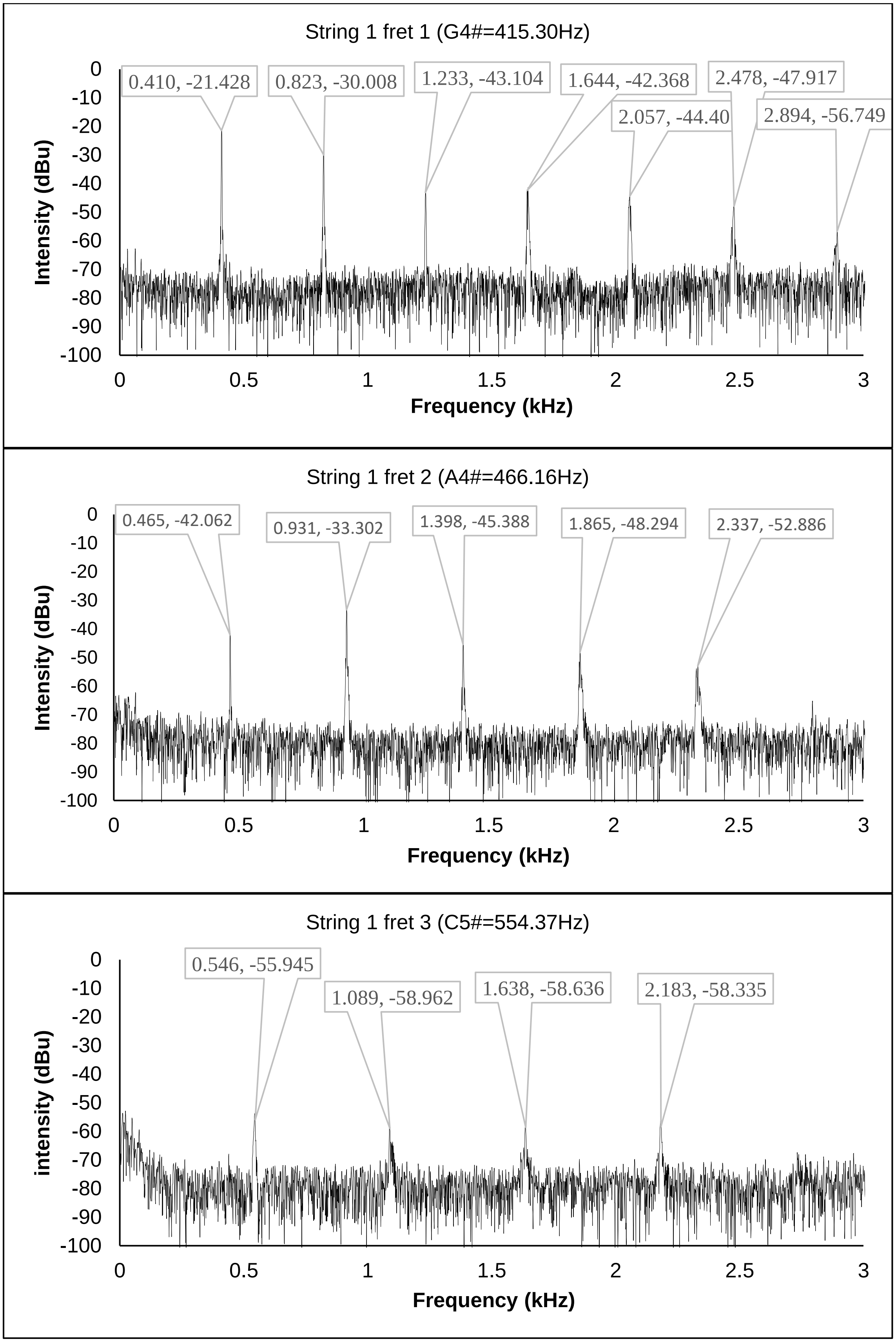
The model of the PicoScope was PicoScope 4224, 2 Channel, USB powered, 12-bit resolution and 20 MHz bandwidth. PicoScope software (Pico Technology, 3000 Series, Eaton Socon, UK) was utilized to visualize and analyze time signals from PicoScope oscilloscopes and data recorders for real-time signal capture. The PicoScope software facilitates analysis using Fast Fourier transform (FFT), a spectrum analyzer, voltage-based triggers, and the capability to store and load waveforms to a disk. The sundatang was positioned to record sound with little interference. The Behringer Powerplay Pro XL amplifier (Behringer, Zhongshan, Guangdong, China) guaranteed that the sound capture was sufficiently loud for detection by the signal converter. The sound spectra are derived from PicoScope readings. Subsequent to the acquisition and recording of the data sound, the FFT was evaluated utilizing Adobe Audition to ascertain the dominant frequency for each tone at designated intervals. The Fourier transformation identifies fundamentals, harmonics, and subharmonics.

The frequency was measured at the studio hall of Universiti Malaysia Sarawak (UNIMAS). The audio signal was recorded in mono, at 24-bit resolution, and 48 kHz sampling rate. The signal was calibrated using a 1 kHz sine wave. The signal was recorded using the Steinberg UR22mkII (audio interface), Audio-Technica AT4050 (microphone) and XLR cable (balance). To ensure a fair comparison, the sundatang was played in the conventional seated position. In order to capture the true acoustic qualities of the sound, this posture is most indicative of normal playing settings and promotes natural sound output and resonance throughout the recording process. This arrangement guarantees that the recordings accurately capture the tonal qualities of the sound without adding bias or distortion from different microphone positions.

RESULTS AND DISCUSSION

The sounds spectra of the open string 1, at different frets, and the open string 2 from sundatang A and sundatang B are shown in Figs. 6 and 7. The fundamental and the higher partials frequency for open string 1 and at different frets from sundatang A and B are shown in Tables 1 and 2, respectively. The fundamental frequency for open strings 1 and 2 from sundatang A is 330 (E4) and 161 Hz (E3), respectively.




String 1 fret 1 (G4#=415.30Hz)
Intensity (dBu)
Frequency (kHz)
0.410, -21.428
0.823, -30.008
1.233, -43.104
1.644, -42.368
2.057, -44.40
2.478, -47.917
2.894, -56.749
String 1 fret 2 (A4#=466.16Hz)
Intensity (dBu)
Frequency (kHz)
0.465, -42.062
0.931, -33.302
1.398, -45.388
1.865, -48.294
2.337, -52.886
String 1 fret 3 (C5#=554.37Hz)
intensity (dBu)
Frequency (kHz)
0.546, -55.945
1.089, -58.962
1.638, -58.636
2.183, -58.335

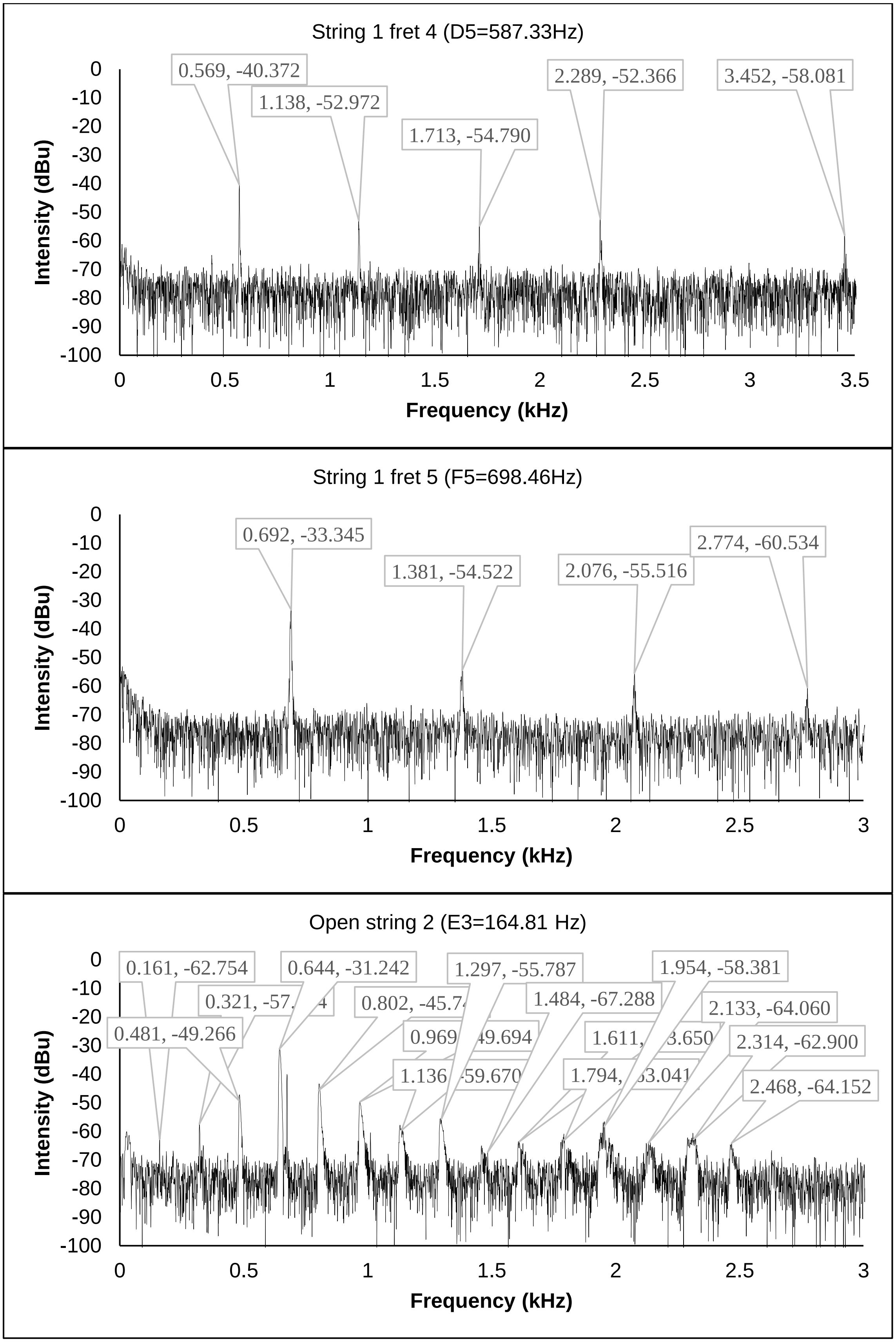
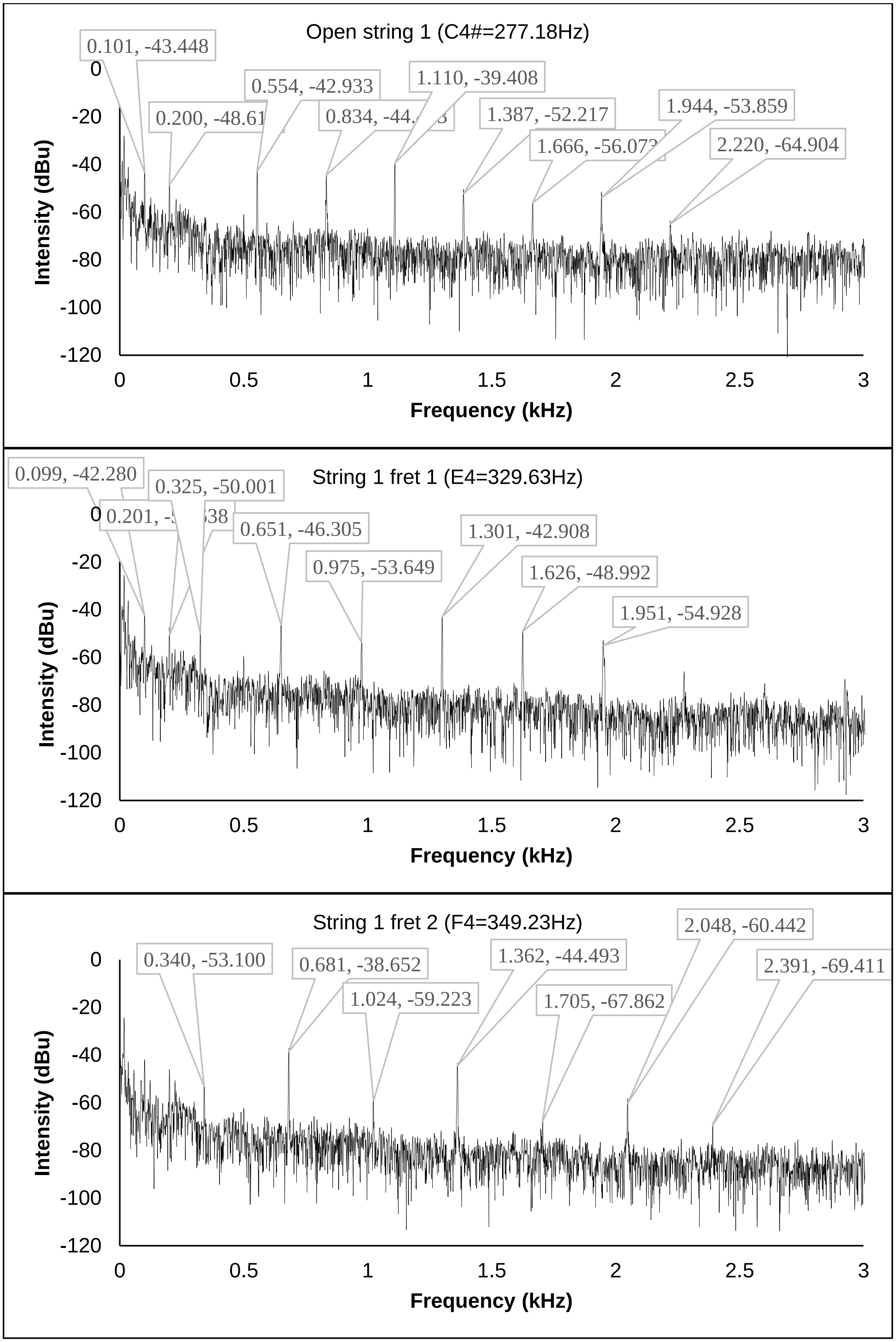
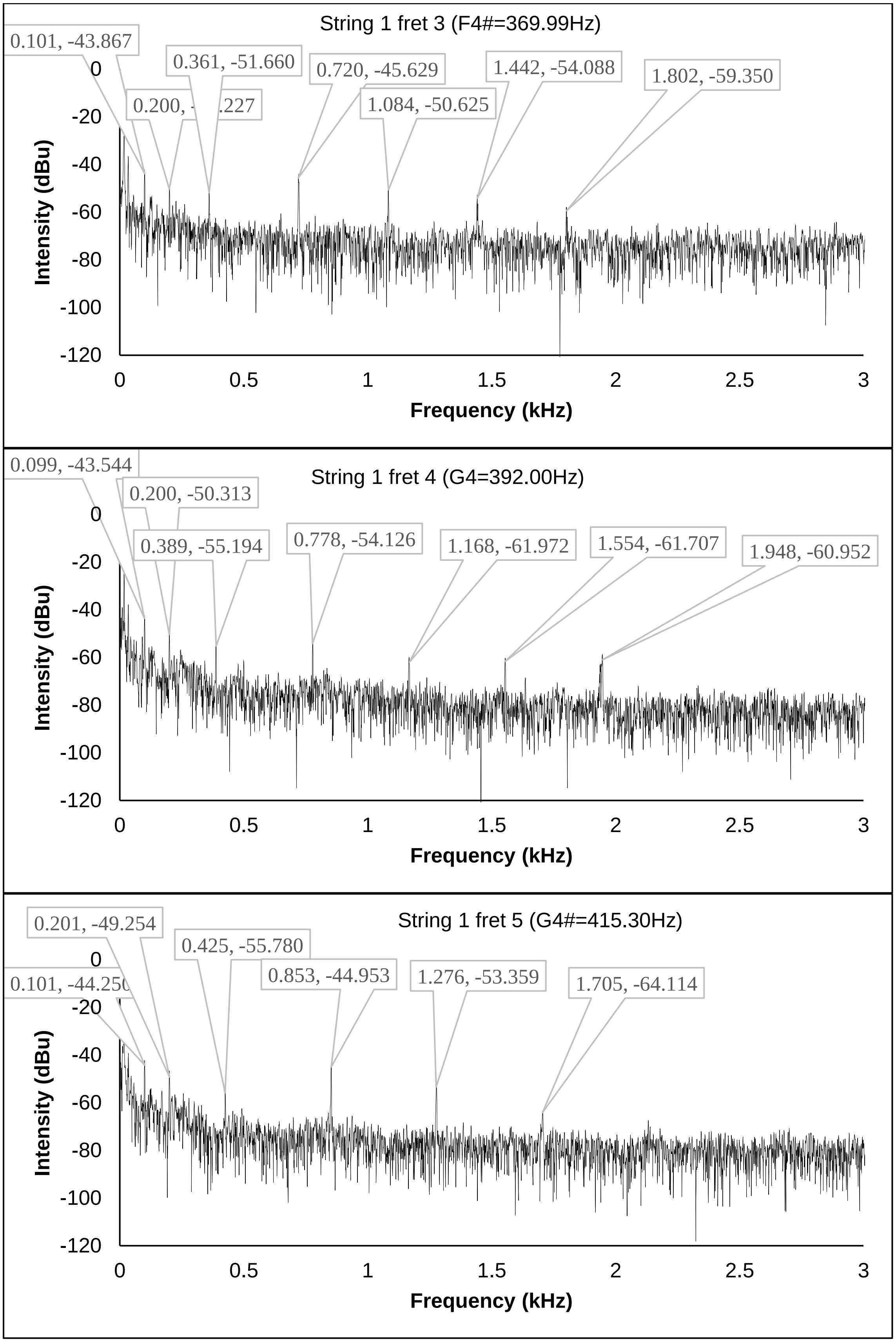


Fig. 6. The sounds spectra of the open string 1, at different frets and open string 2 from sundatang A


Open string 1 (C4#=277.18Hz)
0.101, -43.448
0.554, -42.933
1.110, -39.408
1.387, -52.217
1.944, -53.859
2.220, -64.904
Intensity (dBu)
Frequency (kHz)
String 1 fret 1 (E4=329.63Hz)
0.099, -42.280
0.325, -50.001
0.651, -46.305
1.301, -42.908
0.975, -53.649
1.626, -48.992
1.951, -54.928
Intensity (dBu)
Frequency (kHz)
String 1 fret 2 (F4=349.23Hz)
0.340, -53.100
0.681, -38.652
1.024, -59.223
1.362, -44.493
1.705, -67.862
2.048, -60.442
2.391, -69.411
Intensity (dBu)
Frequency (kHz)


String 1 fret 3 (F4#=369.99Hz)
0.101, -43.867
0.200,
.227
0.361, -51.660
0.720, -45.629
1.084, -50.625
1.442, -54.088
1.802, -59.350
Intensity (dBu)
Frequency (kHz)
String 1 fret 4 (G4=392.00Hz)
0.099, -43.544
0.200, -50.313
0.389, -55.194
0.778, -54.126
1.168, -61.972
1.554, -61.707
1.948, -60.952
Intensity (dBu)
Frequency (kHz)
String 1 fret 5 (G4#=415.30Hz)
0.201, -49.254
0.101, -44.25
0.425, -55.780
0.853, -44.953
1.276, -53.359
1.705, -64.114
Intensity (dBu)
Frequency (kHz)

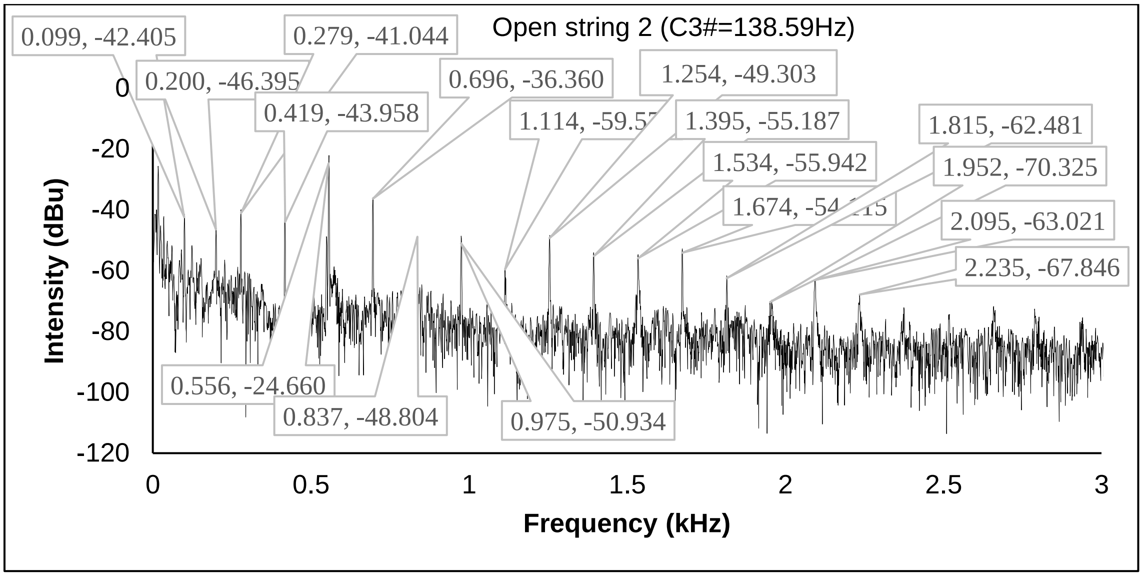


Fig. 7. The sounds spectra of the open string 1, at different frets and open string 2 from sundatang B

The fundamental frequency for open string 1 and 2 from sundatang B is 277 (C4#) and 139.5 Hz (C3#), respectively. The fundamental frequency for open string 1 from sundatang 1, 2, 3, and 4 from Batahong and Dayou (2016) is 325, 384, 276, and 392 Hz, respectively. The sundatang 1 and 2, are made from acacia wood while sundatang 3 and 4 are from vitex wood (Batahong and Dayou 2016).

Open strings 1 and 2 from sundatang B were tuned to C4#=277.18 Hz and C3#=138.59 Hz, respectively (see Fig. 7). It appears that both open strings 1 and 2 from sundatang B displayed the first overtone at 554 Hz (*i.e.*, 2×277 Hz) and 279 Hz (*i.e.*, 2×138.5 Hz). In sundatang A, metal strings density is greater and stiffer, which allows for more defined and consistent fundamental, as shown in Fig. 6. In sundatang B, nylon is less dense and more flexible leading to differences in how strings vibrate. The flexibility might suppress or diminish the fundamental frequency causing the first overtone to become more prominent. When plucking open string 1 from sundatang B, C4# (277 Hz) become C5# (display only 554 Hz), and when plucking open string 2 from sundatang B, C3# (138.5 Hz) become C4# (display 279 Hz) (see Fig. 7).

Table 1. The Fundamental and the Higher Partials Frequency for Open String 1 and at Different Frets for String 1 from Sundatang A. Bold Frequency are from Sundatang 1 (Batahong and Dayou 2016)

Open String 1		Fret 1		Fret 2		Fret 3		Fret 4		Fret 5	
frequency	f/f_0	frequency	f/f_0	frequency	f/f_0	frequency	f/f_0	frequency	f/f_0	frequency	f/f_0
330(E4) **326(E4)**	1	410(G4#) **377(F4#)**	1	465(A4#) **422(G4#)**	1	546(C#) **506(B4)**	1	569(C5#) **569(C5#)**	1	692(F5) **651(E5)**	1
665	2	823	2	931	2	1089	2	1138	2	1381	2
994	3	1233	3	1398	3	1638	3	1713	3	2076	3
1326	4	1644	4	1865	4	2183	4	2289	4	2774	4
1659	5	2057	5	2337	5			3452	5		
1993	6	2478	6								
2328	7	2894	7								
2670	8										

Table 2. The Fundamental and the Higher Partials Frequency for Open String 1 and at Different Frets for String 1 from Sundatang B

Open String 1		Fret 1		Fret 2		Fret 3		Fret 4		Fret 5	
Frequency	f/f_0	Frequency	f/f_0	Frequency	f/f_0	Frequency	f/f_0	Frequency	f/f_0	Frequency	f/f_0
277 (C4#)	1	329 (E4)	1	340 (F4)	1	361 (F4#)	1	389 (G4)	1	425 (G4#)	1
554	2	651	2	681	2	720	2	778	2	853	2
834	3	975	3	1024	3	1084	3	1168	3	1276	3
1110	4	1301	4	1362	4	1442	4	1554	4	1705	4
1387	5	1626	5	1705	5	1802	5	1948	5		
1666	6	1951	6	2048	6						
1944	7			2391	7						
2220	8										

Open string 1 and the fret for string 1 from sundatang A was tuned to E4(330), G4#(410), A4#(465), C5#(546), D5(569), and F5(692). Open string 1 and the fret for string 1 from sundatang B was tuned to C4#(277), E4(329), F4(340), F4#(361), G4(389), and G4#(425). Open string 1 and the fret for string 1 from Batahong and Dayou (2016) was tuned to E4(326), F4#(377), G4#(422), B4(506), C5#(569), and E5(651). Using symbol S for semitone dan T for tone (*i.e.*, 2 semitone) therefore the note interval for:

i. Sundatang A can be presented as symbol series 2T, T, 2T, T, 2T. For example, E4-G4#-A4#-C5#-D5-F5 where E4-G4#: 2tone, G4#-A4#: 1tone, A4#-C5#: 2tone, C5#-D5: 1tone, D5-F5: 2 tone, simplified become 2TT2TT2T.
ii. Sundatang B can be presented as symbol series 1.5T, S, S, S, S. For example, C4#-E4-F4-F4#-G4-G4#: where C4#-E4: 1.5tone, E4-F4: semitone, F4-F4#: semitone, F4#-G4: semitone, G4-G4#: semitone, simplified become 1.5TSSSS.
iii. Sundatang 1 from Batahong and Dayou (2016) shows a symbol series TT2TT2T.

The frequency of the open string 1 and fret 1 to fret 5 from string 1 for sundatang A and sundatang B is plotted against the harmonic number in Figs. 8 and 9, respectively.

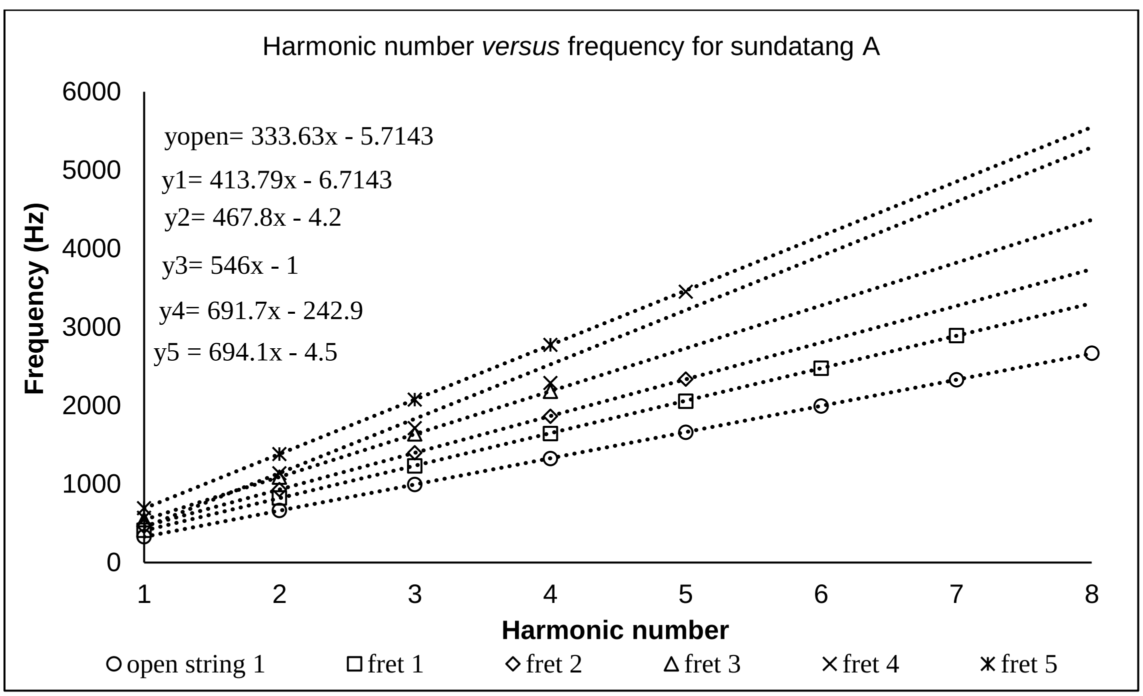


Fig. 8. Harmonic number *versus* frequency for the open string 1 and fret 1 to fret 5 for string 1 from sundatang A

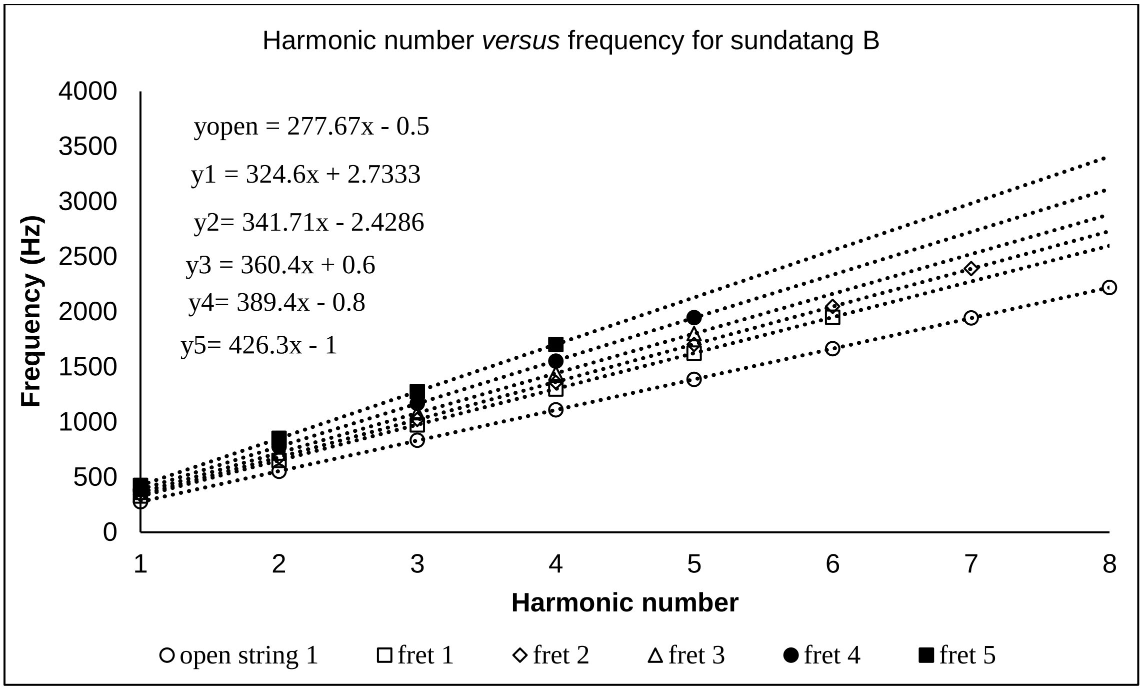


Fig. 9. Harmonic number *versus* frequency for the open string 1 and fret 1 to fret 5 for string 1 from sundatang B.

From Figs. 8 and 9 the linear equation for open string 1 and fret 1 to fret 5 from sundatang A and B are shown in Table 3:

Table 3. The Linear Equation (Harmonic number *versus* frequency) for Open String 1 and Fret 1 to Fret 5 from Sundatang A and Sundatang B

Open String and Fret Number	Sundatang A	Sundatang B
Open string 1	Y = 333.6x - 5.7	Y = 277.6x - 0.5
Fret 1	Y = 413.7x - 6.7	Y = 324.6x + 2.7
Fret 2	Y = 467.8x - 4.2	Y = 341.7x - 2.4
Fret 3	Y = 546x – 1	Y = 360.4x + 0.6
Fret 4	Y = 691.7x - 242.9	Y = 389.4x - 0.8
Fret 5	Y = 694.1x - 4.5	Y = 426.3x - 1

The open string 1 and fret number *versus* frequency for sundatang A, sundatang B and sundatang 1, 2, 3 and 4 from Batahong and Dayou (2016) are shown in Fig. 10.

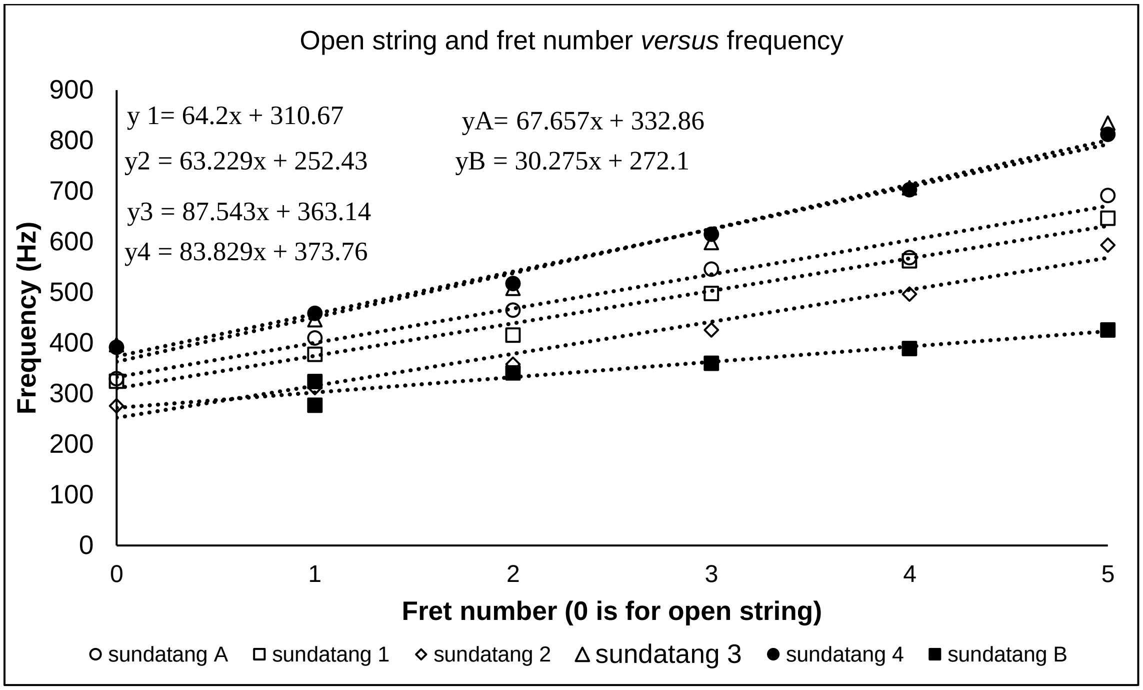


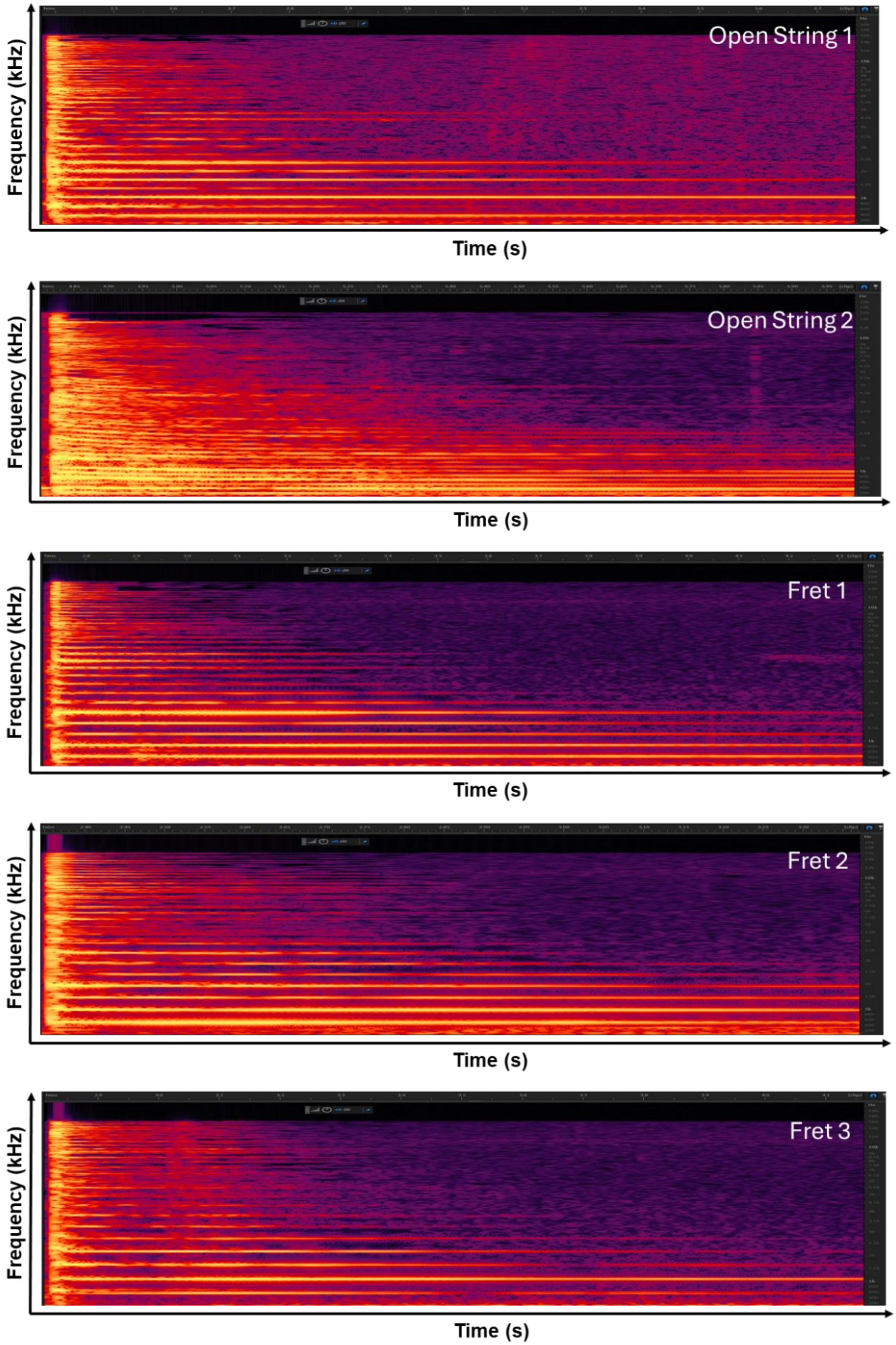
Fig. 10. The open string and fret number *versus* frequency for sundatang A, sundatang B, and sundatang 1, 2, 3, 4 from Batahong and Dayou (2016)

From Fig. 10, the equations for open string 1 and fret number *versus* frequency for sundatang A, sundatang B, and sundatang 1, 2, 3, 4 from Batahong and Dayou (2016) are given as below in Table 4.

Table 4. The Linear Equations for Open String 1 and Fret Number *versus* Frequency for Sundatang A, Sundatang B, and Sundatang 1, 2, 3, 4 from Batahong and Dayou (2016)

Sundatang	The Equations for Open String 1 and Fret Number *versus* Frequency
A	Y = 67.6x + 332.8
B	Y = 30.2x + 272.1
1	Y = 64.2x + 310.6
2	Y = 63.2x + 252.4
3	Y = 87.5x + 363.1
4	Y = 83.8x + 373.7

Sundatang B indicates that the frets are very closely spaced. The similar gradient of fret number *versus* the frequency for sundatang A, sundatang 1 and sundatang 2 indicates that the frets are equally closely spaced and produce similar lower frequency interval (similar to low pitch interval). Sundatang 3 and sundatang 4 indicate that the frets are equally distantly spaced and produce similar higher frequency interval (similar high pitch interval). Fig. 11 shows the time frequency analysis (TFA) of open string 1, open string 2, and fret 1 to fret 5 using Adobe Audition. The open string 1 and open string 2 displayed a dense distribution of partial frequencies. The TFA of fret 1 to fret 5 clearly showed a distinct distribution of partial frequencies with the decrease of partials with the fret number.


Frequency (kHz)
Open String 1
Time (s)
Frequency (kHz)
Open String 2
Time (s)
Frequency (kHz)
Fret 1
Time (s)
Frequency (kHz)
Fret 2
Time (s)
Frequency (kHz)
Fret 3
Time (s)

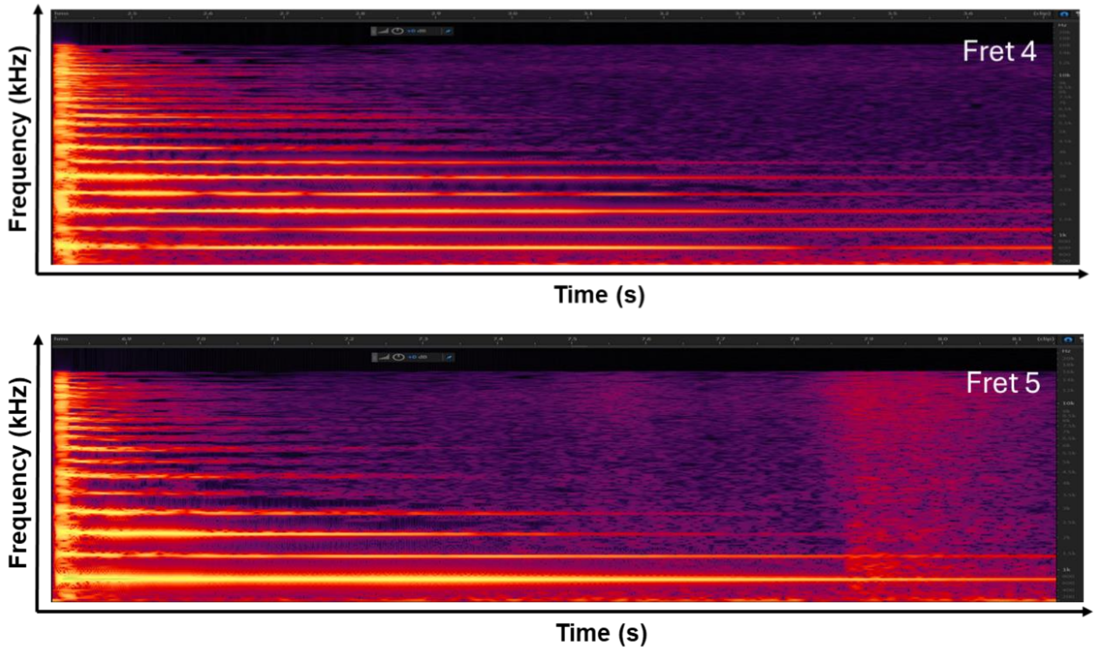


Fig. 11. The time frequency analysis of open string 1, open string 2, and fret 1 to fret 5

CONCLUSIONS

1. In this study, the effects of the frets towards the sound frequencies of sundatang A and B were determined. The result shows that the note interval of open string 1 and the frets of sundatang A can be presented as 2T, T, 2T, T, 2T, which is simplified to become 2TT2TT2T.

2. The note interval of open string 1 and the frets of sundatang B can be presented as 1.5T, S, S, S, S, which become 1.5TSSSS.

3. The note interval of open string 1 and the frets of sundatang 1 from Batahong and Dayou (2016) can be presented as T, T, 2T, T, 2T, which simplified to become TT2TT2T.

4. The formulated equations in this study can be used to develop a standard musical notation for sundatang. The frequencies from the scale are formulated as:

   Sundatang A: $y = 67.6x + 332.8$

   Sundatang B: $y= 30.2x + 272.1$

   Sundatang 1 from Batahong and Dayou (2016): $y = 65.2x + 311.9$

ACKNOWLEDGMENTS

The authors would like to acknowledge Universiti Malaysia Sarawak (UNIMAS) and Universiti Putra Malaysia Bintulu Campus for the technical and financial support.

REFERENCES CITED

Batahong, R. Y., Dayou, J., Wang, S., and Lee, J. (2014). "Vibrational properties of sundatang soundboard," *Arch. Acoust.* 39(2), 177-187. DOI:10.2478/aoa-2014-0021

Batahong, R. Y., and Dayou, J. (2016). "Basic relationship formulation of the sundatang physical characteristics," *Trans. Sci. Tech*. 3(1-2), 68-76.

Chong, J. (2000). "Traditional musical instruments of Sarawak," Kuching Museum Department, Sarawak, Malaysia.

Duin, M. E. A., Hamdan, S., Mohamad Said, K. A., Ab Razak, M. S., and Sinin, A. E. (2025). "The seung (sueng or sung), a plucked fretted lute from the northern region of Thailand," *BioResources* 20(2), 3234-3251. DOI: 10.15376/biores.20.2.3234-3251

Hamdan, S., Mohamad Said, K. A., Rahman, M. R., Sawawi, M., and Sinin A. E. (2023). "Borneo lute 'sape': The frequency spectrum and time frequency analysis (TFA)," *BioResources* 18(4), 6761-677. DOI:10.15376/biores.18.4.6761-6771

Hamdan S., Sinin A. E., M. Duin E. A., Mohamad Said K. A., Ab Razak M. S., and Musib, A. F. (2025). "The Phin: A lute of the Isan region of Thailand," submitted to *BioResources*.

Ferrarese, M. (2023). "Bringing Borneo's unique 'boat lutes' in tune with 21st century," Nikkei Asia, (https://asia.nikkei.com/Life-Arts/Arts/Bringing-Borneo-s-unique-boat-lutes-in-tune-with-21st-century), accessed on 2nd January 2025.

Juanis, J. (2023). "Sundatang alat muzik penting kaum KDMR (Sundatang an important music instrument for ethnic KDMR)," (https://www.dailyexpress.com.my/news/226138/sundatang-alat-muzik-penting-kaum-kdmr/), accessed on 2nd January 2025.

Pugh-Kitingan, J. (2020). "Revisiting the Dusunicboat lutes of Sabah: Disappearing musical traditions," *Malaysian Journal of Music* 9, 115 -137. DOI: 10.37134/mjm.vol9.9.2020

Sedik, Y., Hamdan, S., Jusoh, I., and Hasan M. (2010). "Acoustic properties of selected tropical wood species," *J. Nondestruct. Eval*. 29, 38-42, DOI 10.1007/s10921-010-0063-7).

Sinin, A. E., Hamdan, S., Mohamad Said, K. A. M., Duin, E. A., and Musib A. F. (2025). "The Hasapi of the Batak Toba from Sumatra Indonesia," *BioResources* 20(1), 1110-1126. DOI: 10.15376/biores.20.1.1110-1126

Article submitted: January 20, 2025; Peer review completed: March 9, 2025; Revised version received: April 14, 2025; Accepted: April 24, 2025; Published: May 9, 2025.
DOI: 10.15376/biores.20.3.5331-5347