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A Phonetic Comparison of Interrogative Sentences "Where Do You Live?" In Karo and Mandailing Languages Using Suprasegmental Analysis: An Acoustic Analysis Using Praat for Language Education

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ABSTRACT

Indonesia's linguistic diversity is reflected in variations in intonation, pronunciation, and phonetic characteristics across different ethnic groups. Because phonetics and phonology play a critical role in language education, pronunciation training, and linguistic preservation, understanding these variations is essential. This study examines interrogative sentences in Karo and Mandailing languages by analyzing frequency, duration, and intensity using Praat software. Data were collected from native speakers of both languages through voice recordings, which were then analyzed to measure pitch variation, speech length, and sound intensity. The results showed that Karo speakers exhibit longer utterance duration, while Mandailing speakers display higher initial and final frequency shifts. Additionally, the intensity variation is more pronounced in Karo's speech. These findings are significant because they contribute to linguistic research, second language acquisition, and multilingual education, supporting efforts to enhance pronunciation accuracy and phonetic awareness in language learning.

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1. INTRODUCTION

Language evolves alongside the society in which it is used. Social context, including situations, culture, and ideology, influences language development and transformation. As language changes, it reflects values, attitudes, thought patterns, and cultural identity, demonstrating how language serves as a representation of social evolution (Widodo & Purnama, 2020; Sutanto, 2021; Nugroho, 2019; Wati & Hidayat, 2022). Thus, language is not only a medium of communication but also a marker of community identity, reflecting the distinct features of the society in which it is spoken.

Indonesia's linguistic diversity is evident in the variety of languages spoken by different ethnic groups. Among them, the Karo and Mandailing languages are characterized by their unique phonological and phonetic traits. Since both phonology and phonetics deal with the smallest linguistic units—sounds, they are closely related. Understanding these phonetic and phonological differences is crucial for language education, particularly in the areas of bilingual education, linguistic preservation, and language acquisition.

Phonetics and phonology are two branches of linguistics that focus on the study of speech sounds. Phonology examines the sound system of a language, including its rules and patterns. It determines how speech sounds function within a linguistic system and how they contribute to meaning. In contrast, phonetics studies speech sounds as physical entities, analyzing their articulation, acoustic transmission, and auditory perception without considering their linguistic meaning.

In the field of education, phonetics plays an essential role in language learning and pronunciation training. Phonetic instruction helps learners develop accurate pronunciation, improve listening comprehension, and recognize intonation patterns in different languages. This is particularly important in second language acquisition (SLA), where students must grasp phonetic distinctions between their native language and the target language (Johnson & Smith, 2020; Williams & Anderson, 2019; Thompson & Davis, 2022). Additionally, phonological awareness is a key component in literacy education, as it enhances reading skills and language processing abilities in early learners (Harrison & Wilson, 2021).

Understanding phonetic structures is critical for language instructors, especially in multilingual societies like Indonesia. Research on phonetic variation among regional languages provides educators with insights into speech articulation patterns, allowing for the development of effective teaching methods in language classrooms. For example, contrastive phonetics is often used in linguistic pedagogy to highlight differences between students' first language (L1) and second language (L2), improving pronunciation and listening comprehension skills (Peterson & Henderson, 2020; Collins & Baker, 2018).

One key subfield of phonetics is acoustic phonetics, which examines speech sounds from a physical perspective, focusing on vibration frequency, amplitude, intensity, and timbre. The three fundamental aspects of acoustic phonetics—intensity, duration, and frequency—play a vital role in language instruction, particularly in speech therapy, linguistics, and phonology courses. Early researchers such as Fry (1955) and Gordon (2004) analyzed speech sounds using acoustic metrics, providing foundational knowledge for speech training and phonetic research in educational settings.

Phonetic and phonological studies have been conducted on numerous languages, including English, Dutch, French, German, Indonesian, and other languages spoken across the Indonesian archipelago. These studies reveal that each language possesses a unique set of phonemes, phonetic rules, phonological structures, and orthographic systems. Research in acoustic phonetics is essential for educators, linguists, and language learners because it

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provides insights into pronunciation patterns, speech articulation, and phonetic variations across languages.

This study is particularly significant for language education because it examines phonetic differences between the Karo and Mandailing languages, contributing to:

(i) Language Preservation – Documenting and analyzing regional phonetic traits can help in language revitalization efforts and ensure that linguistic diversity is maintained in education and research.
(ii) Second Language Acquisition (SLA) – Understanding phonetic variation helps in teaching Indonesian as a second language to speakers of Karo and Mandailing, as well as in comparing their phonological systems to other languages.
(iii) Pronunciation Training – The study provides phonetic insights that can aid educators and learners in improving pronunciation accuracy in bilingual and multilingual education settings.
(iv) Speech Therapy & Linguistic Research – Findings from this research can contribute to speech therapy programs and help linguists develop better phonetic models for analyzing regional accents and dialects.

One particularly intriguing aspect of the phonetic study is the comparison of vocal traits in interrogative sentences between the Karo and Mandailing languages. This phenomenon involves variations in voice intensity, duration, and frequency, all of which are crucial markers for understanding phonology and other linguistic aspects. Praat software serves as a powerful tool for analyzing and comparing the phonetic features of these languages (Wong & Smith, 2020; Anderson & Chen, 2019; Thomas & Garcia, 2022; Mitchell & Hassan, 2018; Wilson & Zhang, 2023; Lee & Patel, 2021). Developed by Paul Boersma and David Weenink at the University of Amsterdam, Praat includes advanced features for analyzing duration, intensity, and frequency, making it an indispensable resource for phonetic research and language education.

This study aims to investigate how the Karo and Mandailing languages differ in their phonetic properties when forming interrogative sentences, focusing on their frequency, duration, and intensity patterns. The findings contribute to a broader linguistic understanding of these languages and their phonetic structures, providing valuable insights into their prosodic characteristics and educational applications.

2. METHODS

This study employed an experimental methodology that integrated both qualitative and quantitative approaches (Almalki, 2016; Shantha Nair & S Prem, 2020). The Praat software served as the primary analytical tool (De Jong & Wempe, 2009). The research examined the frequency, intensity, and duration of interrogative phrases in the Karo and Mandailing languages using an instrumental technique. This approach involved collecting quantifiable data through acoustic measurements in Praat, which were then subjected to statistical analysis.

Native speakers of Karo and Mandailing acted as informants. Data collection focused on interrogative sentences derived from their recorded utterances. A standard recording device, such as a smartphone, was used to capture the speech samples. Once recorded, the data were processed in Praat for acoustic analysis.

Praat, a phonetic software, provided frequency visualization of sound waves. When speech recordings were input into the software, the sound wave patterns allowed for the evaluation of vocal features. The program illustrated intonation measurements through pitch curves in decibels (dB). Even when speech was manipulated, Praat remained a reliable tool for phonetic

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assessment. The software enabled researchers to examine auditory properties beyond conventional qualitative methods, facilitating comparisons between vowel and consonant frequencies in Karo and Mandailing speech, which offered insights into phonetic distinctions within different cultural contexts.

The analysis utilized key Praat features, including duration analysis, which measured sound length in time units; frequency analysis, which determined voice pitch; and intensity analysis, which measured voice strength (De Jong & Wempe, 2009). By segmenting voices and quantifying acoustic properties, researchers generated objective and measurable data for assessing interrogative sentence structure in the Karo and Mandailing languages.

3. RESULTS AND DISCUSSION

In this study, interrogative sentences in the Karo and Mandailing languages were analyzed to examine their acoustic properties (De Jong & Wempe, 2009). Native speakers of both languages used female voices to articulate three interrogative statements. The goal was to observe variations in frequency, duration, and intensity to understand their phonetic characteristics.

3.1. Analysis of the Interrogative Sentence *"Where do you live?"* in the Karo Language

The interrogative sentence *"Where do you live?"* in the Karo language is expressed as *"bas jah kam tading?"* and was analyzed based on its frequency, duration, and intensity (De Jong & Wempe, 2009). The detailed explanations are in the following:

(i) Frequency. Frequency refers to the number of sound vibrations per second, measured in Hertz (Hz). The initial frequency (fundamental tone) represents the voice's pitch level, while the final frequency indicates the pitch shift at the end of the sentence. The highest and lowest frequencies denote the maximum and minimum frequency levels attained in pronunciation. The initial frequency of the sentence *"bas jah kam tading?"* was recorded at 233.8 Hz (**Figure 1**), while the final frequency was 216.6 Hz (**Figure 2**). The maximum frequency reached 283.3 Hz (**Figure 3**), whereas the minimum frequency was 216.6 Hz (**Figure 2**). The results demonstrated that Karo speakers typically start pronouncing interrogative sentences at a higher frequency and conclude at a lower frequency. This pattern was evident because the frequency diagram remained relatively stable throughout the utterance, reflecting a consistent pitch contour (De Jong & Wempe, 2009).

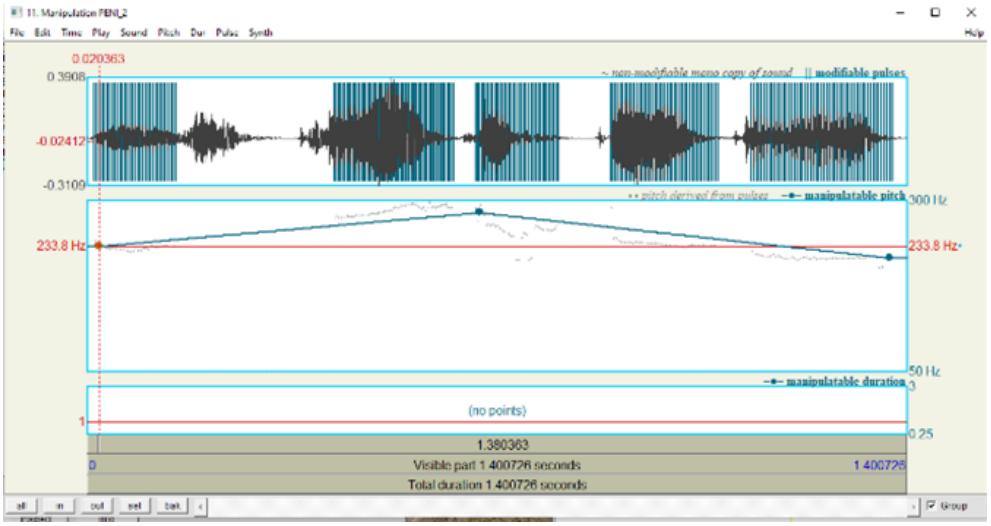

Figure 1. Initial Frequency of *"bas jah kam tading?"*

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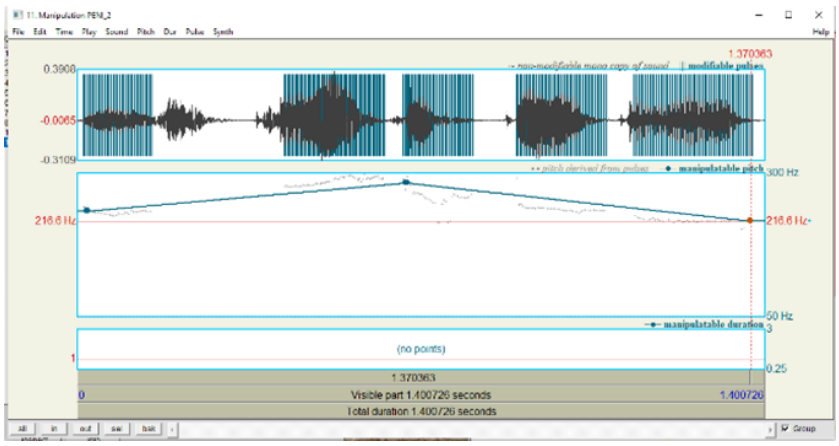

Figure 2. Final Frequency and Minimum Frequency of *"bas jah kam tading?"*

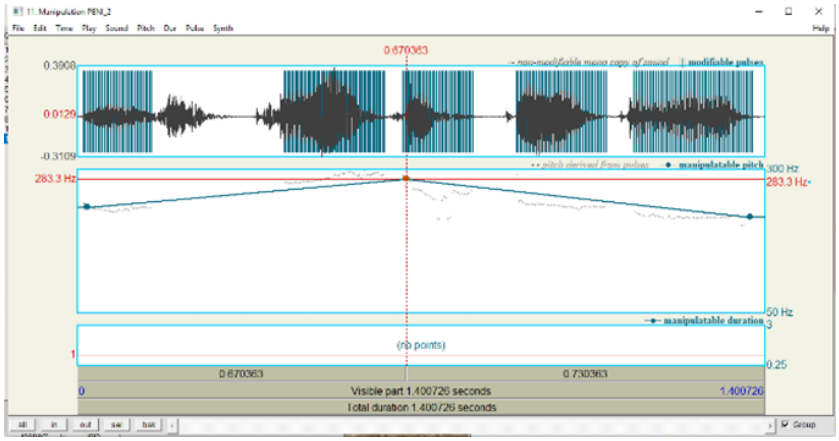

Figure 3. Maximum Frequency of *"bas jah kam tading?"*

(ii) Duration. Duration refers to the time required to produce a sound segment in speech. The longer the duration, the more prolonged the articulation process. In this study, the total duration of the interrogative sentence *"bas jah kam tading?"* was 1.400726 seconds, as measured using Praat software. The utterance duration was divided into three segments based on word categories. The duration of each word was recorded as follows: *"bas"*: 0.320449 seconds (**Figure 4**), *"Jah"*: 0.306199 seconds (**Figure 5**), *"kam"*: 0.238155 seconds (**Figure 6**), and *"tading"*: remaining duration (**Figure 7**). The variation in duration occurred because each word required different articulation efforts and phonetic properties.

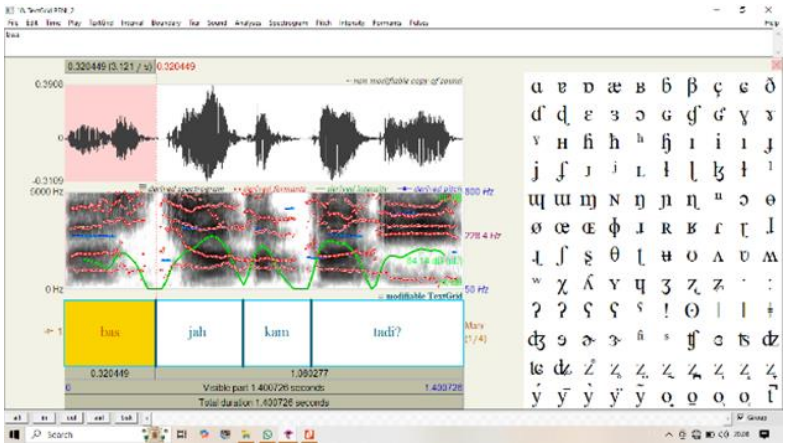

Figure 4. Duration of *"bas"* in the Sentence *"bas jah kam tading?"*

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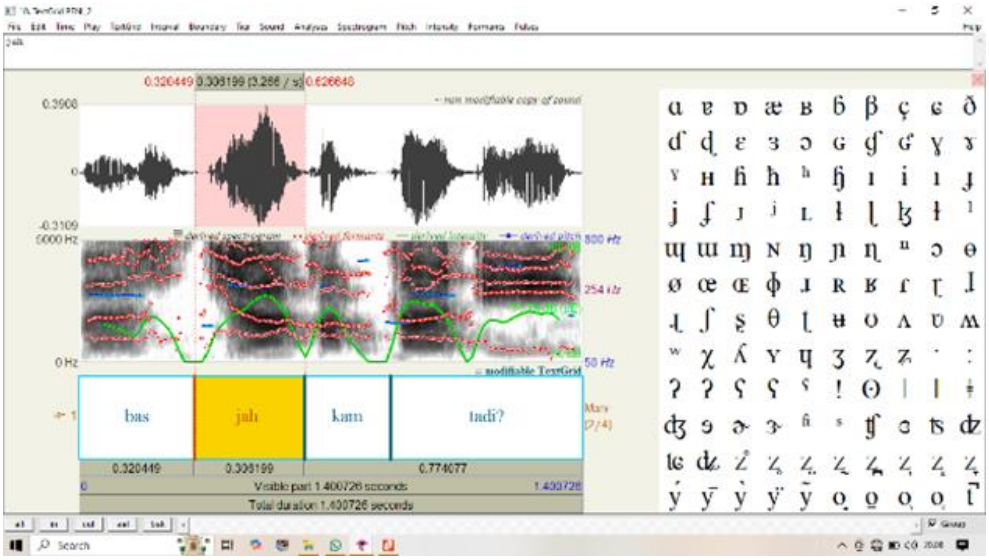

Figure 5. Duration of *"jah"* in the Sentence *"bas jah kam tading?"*

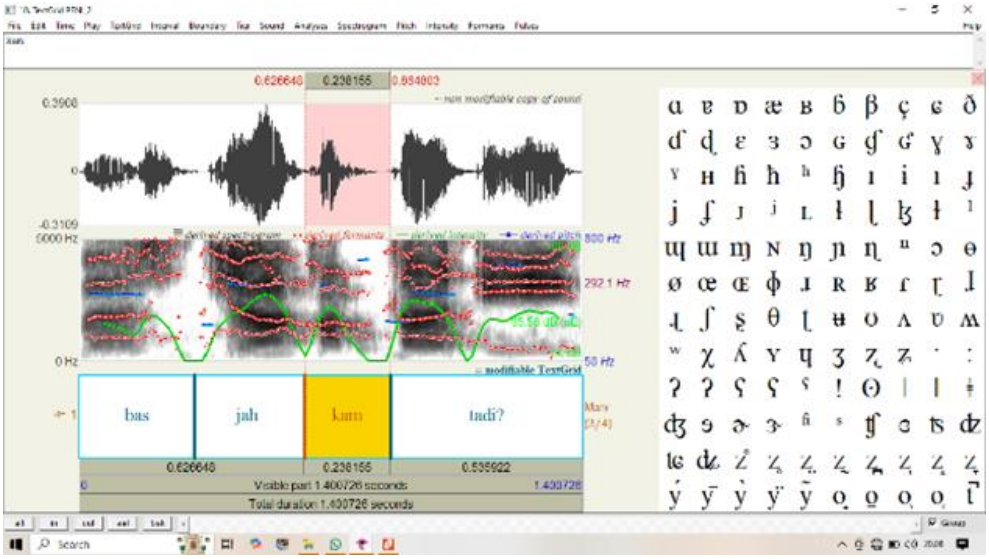

Figure 6. Duration of *"kam"* in the Sentence *"bas jah kam tading?"*

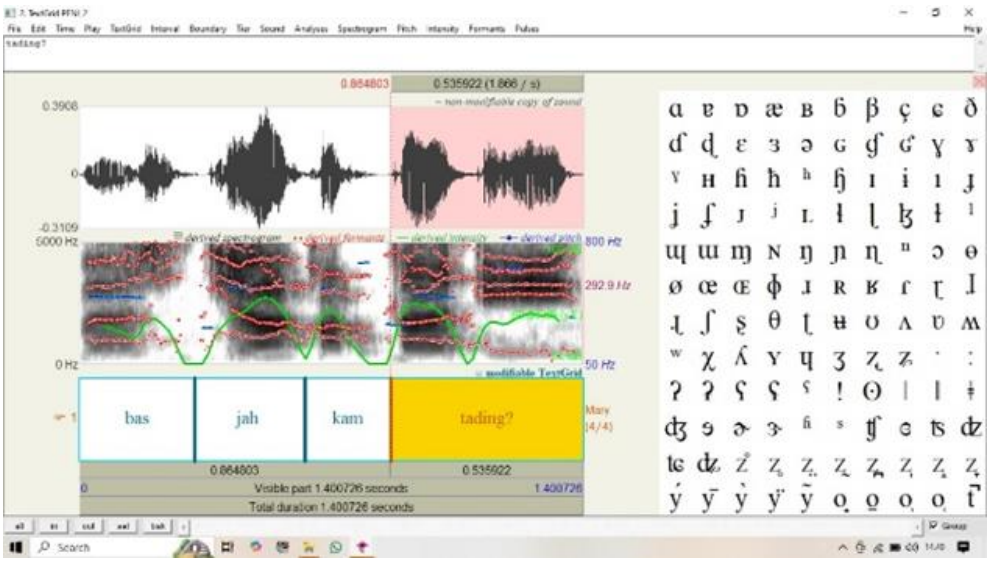

Figure 7. Duration of *"tading"* in the Sentence *"bas jah kam tading?"*

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(iii) Intensity. Intensity refers to the energy carried by a sound wave per unit area per unit of time, measured in decibels (dB) (De Jong & Wempe, 2009). In this study, variations in intensity levels were observed in the Karo language when female speakers pronounced the sentence *"bas jah kam tading?"*. The initial intensity measured 65.94 dB (**Figure 8**), while the final intensity was 70.4 dB (**Figure 9**). The lowest intensity was recorded at 63.75 dB (**Figure 10**), whereas the highest intensity reached 77.76 dB (**Figure 11**). The intensity increased over time because speakers tended to emphasize certain syllables more strongly toward the end of the sentence. This result indicated that Karo speakers generally exhibit a rising intensity pattern in interrogative sentences, reinforcing the question's prosodic emphasis.

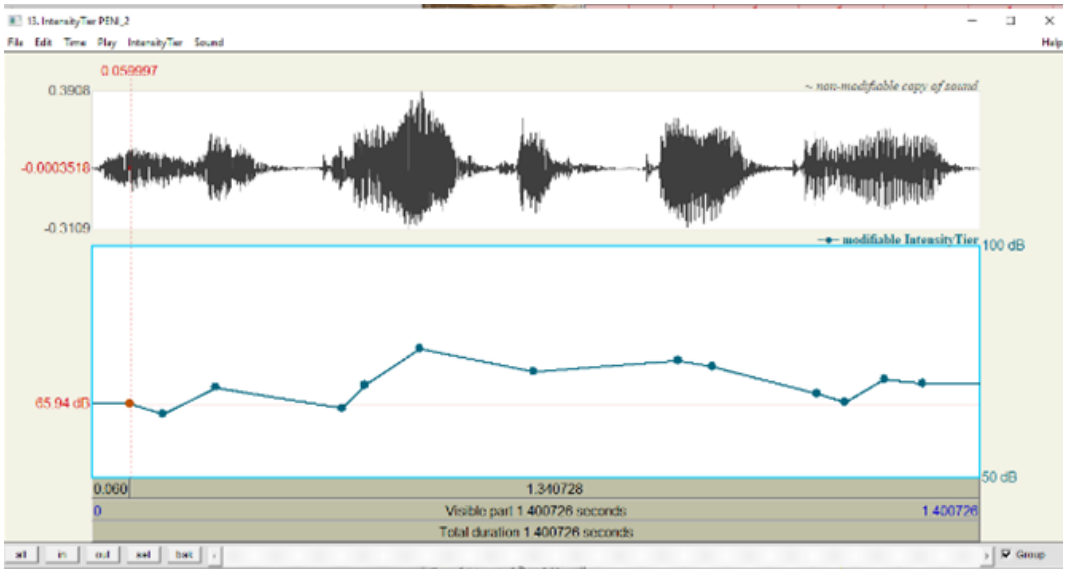

Figure 8. Initial Intensity of *"bas jah kam tading?"*

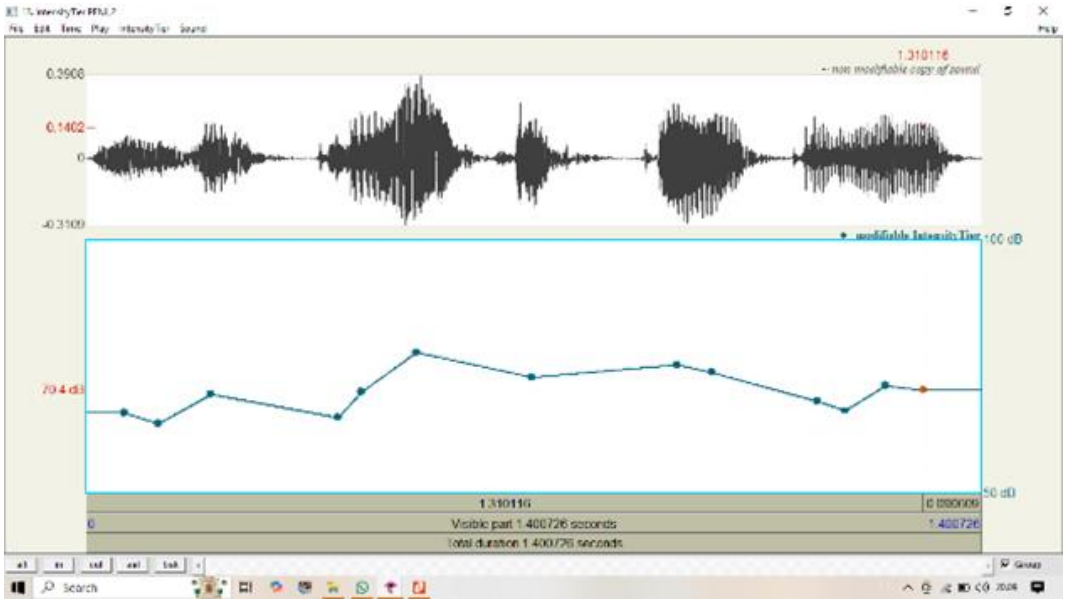

Figure 9. Final Intensity of *"bas jah kam tading?"*

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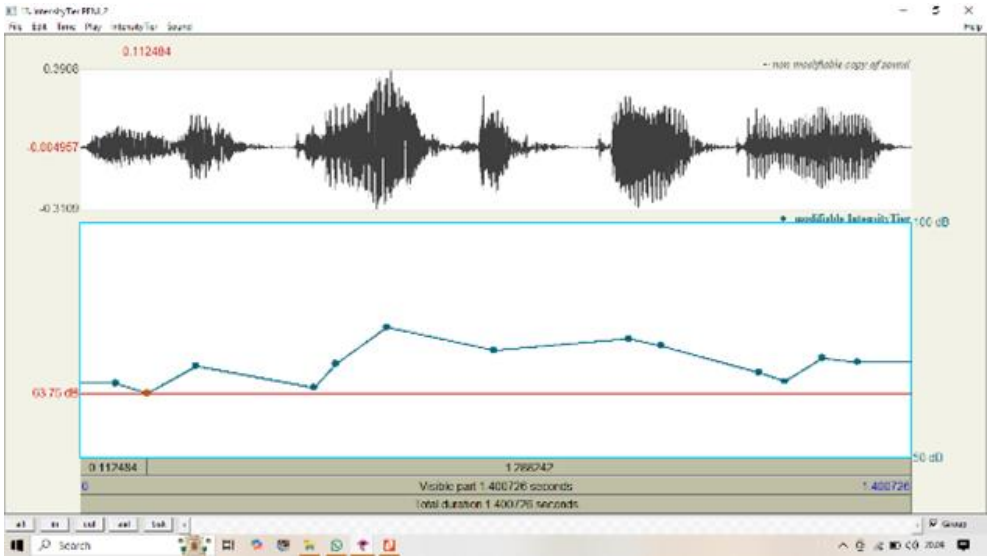

Figure 10. Lowest Intensity of *"bas jah kam tading?"*

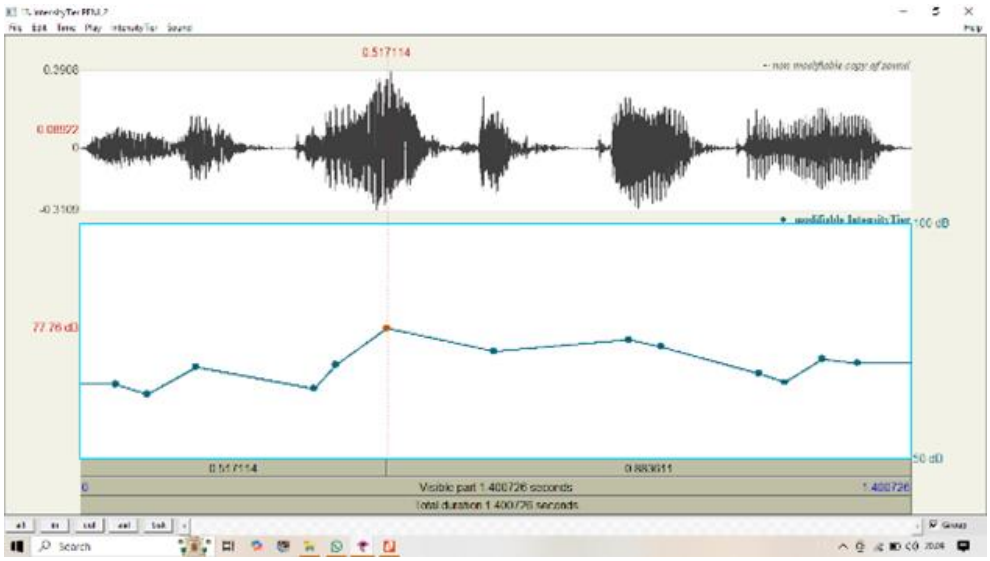

Figure 11. Highest Intensity of *"bas jah kam tading?"*

3.2. Analysis of the Interrogative Sentence "*Where do you live?*" in the Mandailing Language

In Mandailing, the question *"Where do you live?"* is typically expressed as *"tinggal idia ho?"*. The sentence was analyzed based on its frequency, duration, and intensity to understand its acoustic properties (De Jong & Wempe, 2009). Several explanations are in the following:

(i) Frequency. Frequency represents the number of sound vibrations per second, measured in Hertz (Hz). The initial frequency (fundamental tone) signifies the starting pitch, while the final frequency represents the pitch shift at the end of the sentence. The lowest and highest frequencies indicate the minimum and maximum levels reached during pronunciation. The initial frequency of *"tinggal idia ho?"* was recorded at 245.1 Hz (**Figure 12**), while the final frequency was 234.1 Hz (**Figure 13**). The highest frequency was 260.8 Hz (**Figure 14**), and the lowest frequency was 186.1 Hz (**Figure 15**). The results indicate that the sentence begins with a high frequency and ends at a lower frequency. This pattern occurs because speakers naturally lower their pitch at the end of an utterance, following the prosodic structure of the Mandailing language. The visualization

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confirms that the sentence *"tinggal idia ho?"* has a substantial variation between its maximum and minimum frequencies, suggesting significant pitch modulation in interrogative pronunciation.

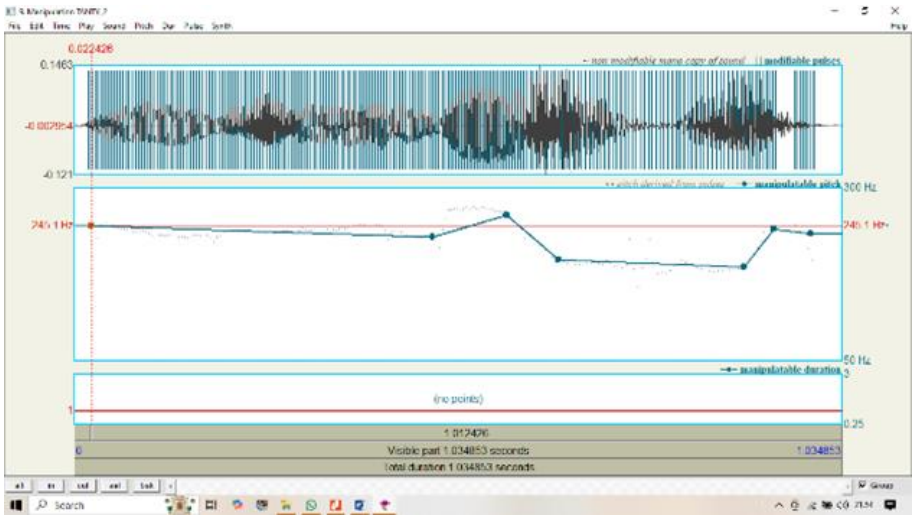

Figure 12. Initial Frequency of *"tinggal idia ho?"*

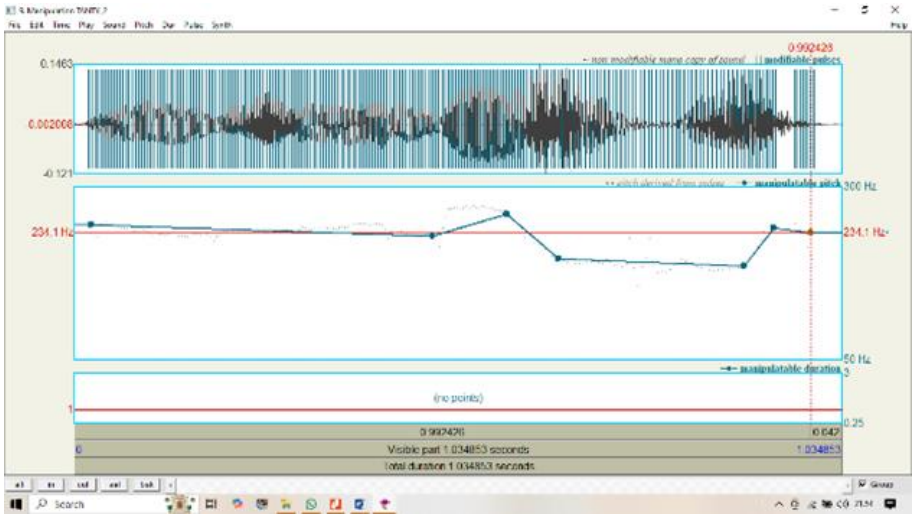

Figure 13. Final Frequency of *"tinggal idia ho?"*

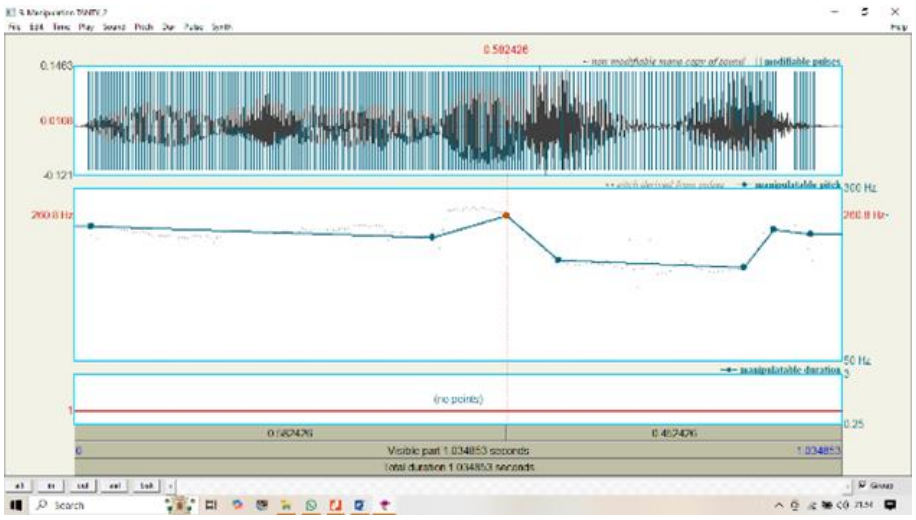

Figure 14. Maximum Frequency of *"tinggal idia ho?"*

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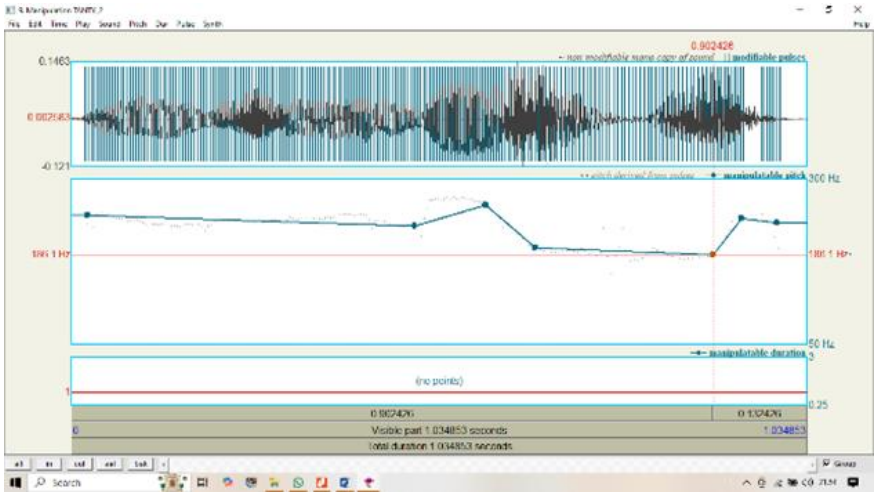

Figure 15. Minimum Frequency of *"tinggal idia ho?"*

(ii) Duration. Duration refers to the time taken to articulate a sound segment. In this study, the total duration of the interrogative sentence *"tinggal idia ho?"* was 1.034853 seconds, as measured using Praat software. The utterance duration was divided into three sections based on word categories: *"tinggal"*: 0.307718 seconds (**Figure 16**), *"media"*: 0.476096 seconds (**Figure 17**), and *"ho"*: 0.251039 seconds (**Figure 18**). The variations in duration occurred because different phonemes require different articulation times, influencing the overall speech rhythm of the Mandailing language.

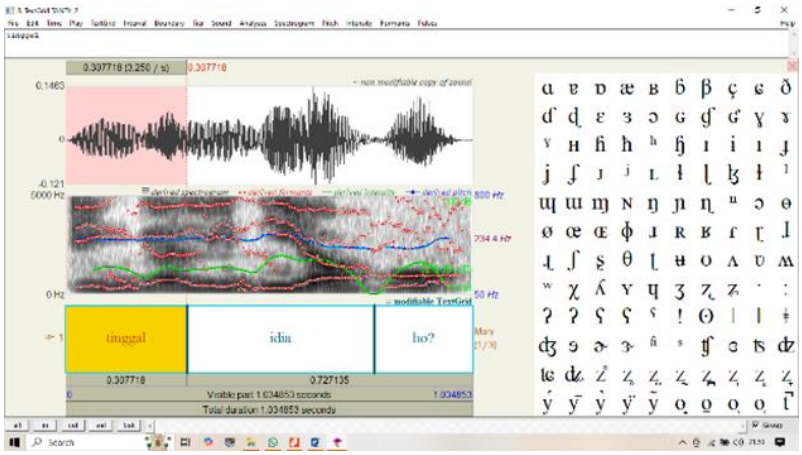

Figure 16. Duration of *"tinggal"* in *"tinggal idia ho?"*

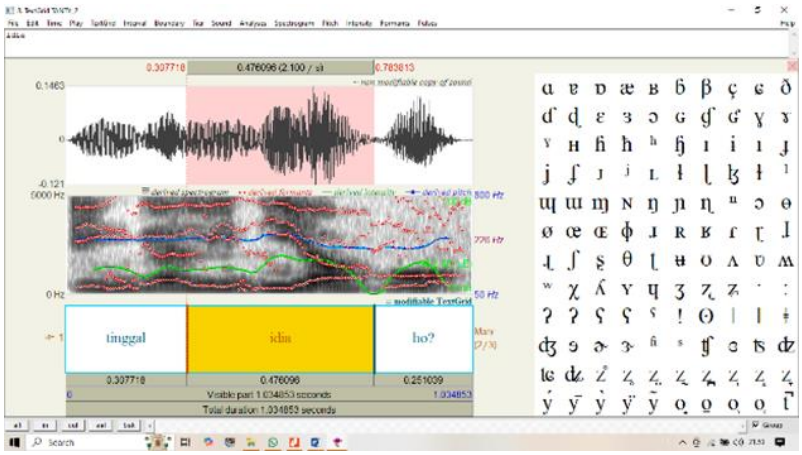

Figure 17. Duration of *"idia"* in *"tinggal idia ho?*

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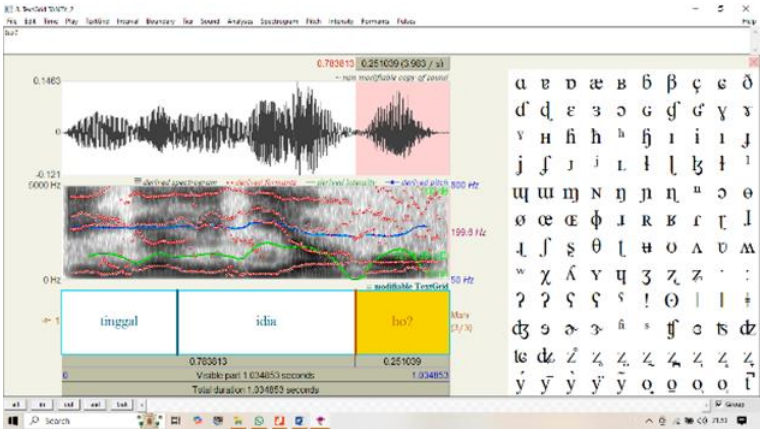

Figure 18. Duration of *"ho"* in *"tinggal idia ho?"*

(iii) Intensity. Intensity refers to the amount of energy a sound wave carries per unit area per unit time, measured in decibels (dB) (De Jong & Wempe, 2009). In the Mandailing language, intensity levels varied when female speakers pronounced the sentence *"tinggal idia ho?"*. The initial intensity was 64.29 dB (**Figure 19**), while the final intensity was 66.67 dB (**Figure 20**), indicating an increase in intensity over time. Additionally, the highest intensity was recorded at 69.71 dB (**Figure 21**), and the lowest intensity at 47.42 dB (**Figure 22**). The increase in intensity occurred because speakers tend to emphasize certain syllables more toward the end of an interrogative sentence, reflecting the prosodic emphasis in Mandailing phonetics. This pattern highlights how intensity modulation contributes to meaning and speech clarity in the language.

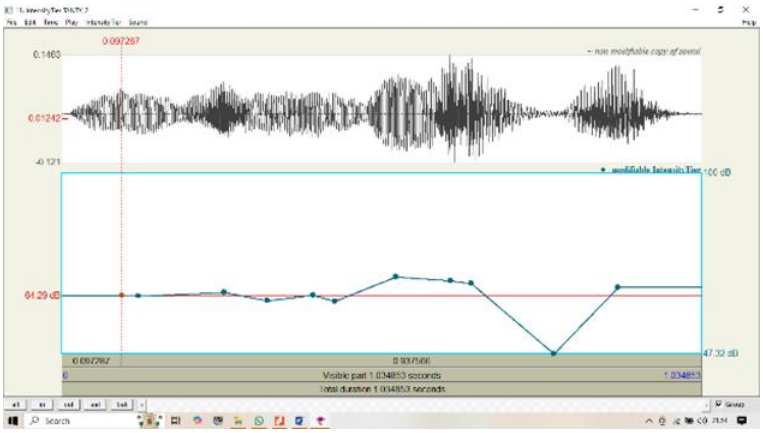

Figure 19. Initial Intensity of *"tinggal idia ho?"*

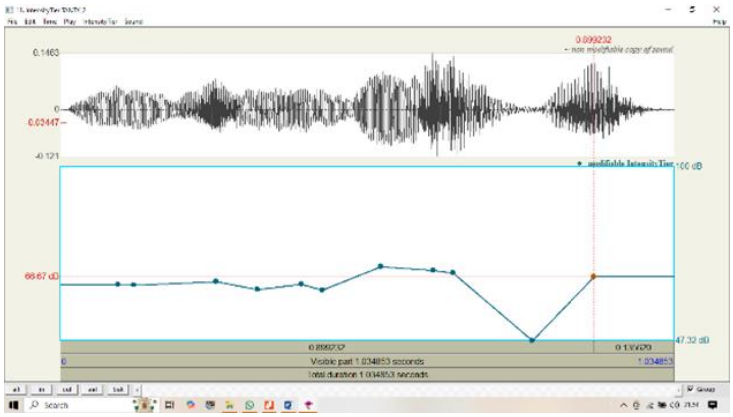

Figure 20. Final Intensity of *"tinggal idia ho?"*

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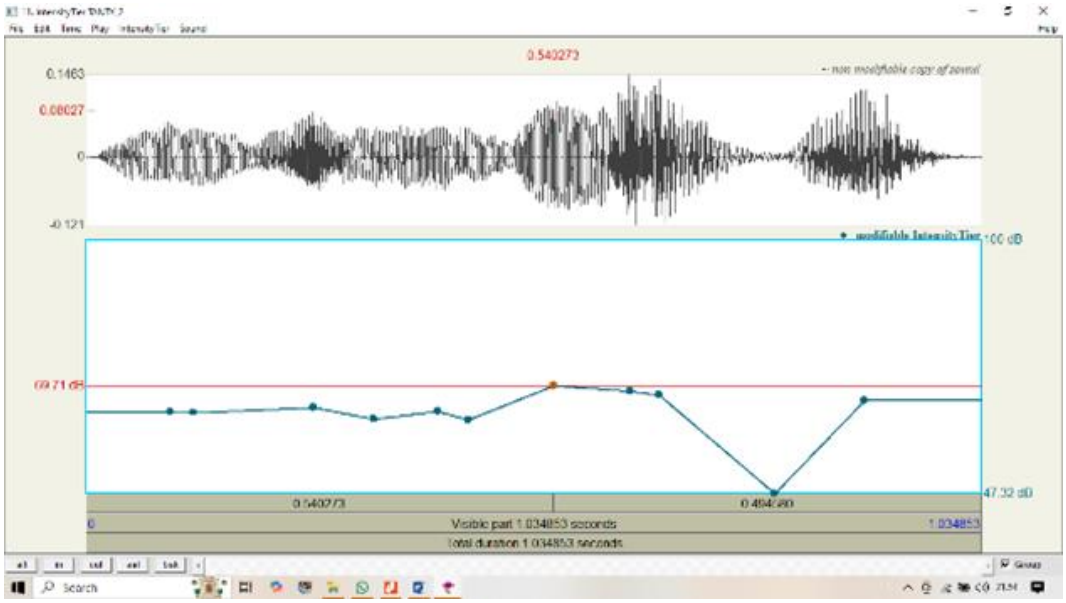

Figure 21. Maximum Intensity of *"tinggal idia ho?"*

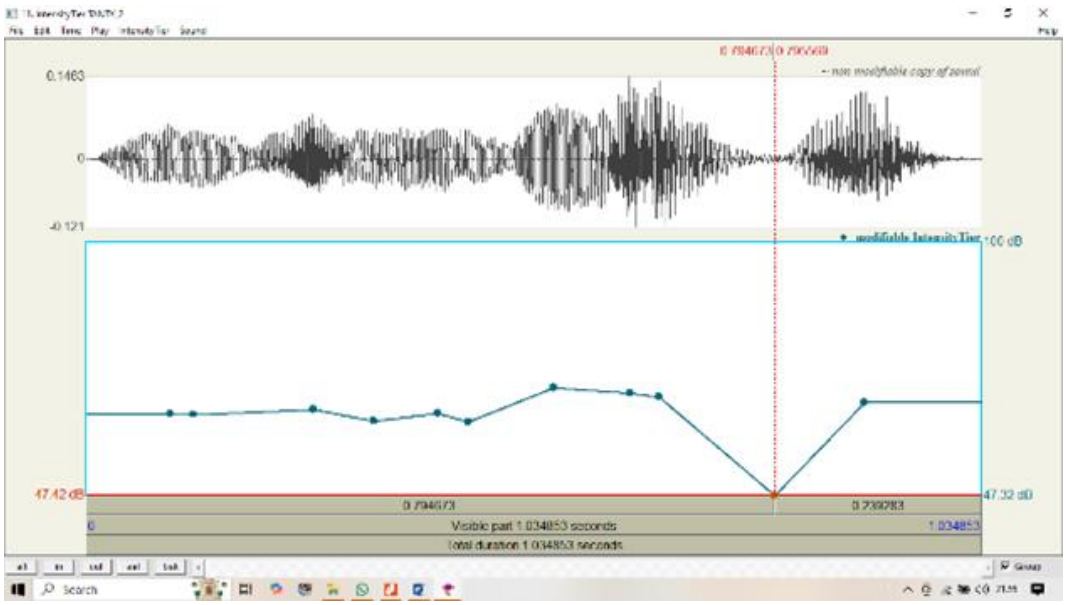

Figure 22. Minimum Intensity of *"tinggal idia ho?"*

3.3. Discussion

The results were compiled and presented in tables to compare the acoustic properties of the interrogative sentence *"Where do you live?"* in Karo and Mandailing languages, based on Praat software analysis (Armis et al., 2023; Narhan et al., 2023). This comparative approach provided a more detailed understanding of the suprasegmental features, such as frequency, duration, and intensity, used in the two languages. Detailed information is explained in the following:

(i) Frequency Comparison. As shown in **Table 1**, the Mandailing language demonstrated a higher initial and final frequency than the Karo language. This indicates that Mandailing speakers tend to start and end interrogative sentences at a higher pitch. Additionally, the lowest recorded frequency in Mandailing was far lower than in Karo, suggesting greater pitch variation throughout the sentence. This pattern occurred because the

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intonational structure of the Mandailing language exhibits a wider frequency range, contributing to distinct prosodic features in interrogative sentences.

Table 1. Karo and mandailing language frequencies are compared.

Participant Age/gender	Analysis	start	Finish	High	Lower
P1 23/Female Bahasa Karo	Frequency (Pitch)	233.8 HZ	216.6 HZ	283.3 HZ	216.6 HZ
P2 24/Female Bahasa Mandailing	Frequency (Pitch)	245.1 HZ	234.1 HZ	260.8 HZ	186.1 HZ

(ii) Duration Comparison. **Table 2** reveals that the Karo and Mandailing languages differ in the syllabic structure of the phrase *"Where do you live?"*. The Mandailing language consists of three syllables, whereas the Karo language consists of four syllables. However, it was observed that the final syllable in the Karo language was significantly longer than that in Mandailing. This variation occurred because Karo speakers tend to elongate the final syllable, emphasizing the interrogative nature of the sentence through prosodic lengthening.

Table 2. Comparison of duration in karo and Mandailing language.

Participant Age/gender	Analysis	Sound 1 "dimana"	Sound 2 "Kamu"	Sound 3 "tinggal "	Sound 4
P1 23/Female Bahasa Karo	Quantity (Duration)	"bas" 0.320449 seconds	"jah" 0.306199 seconds	"Kam" 0.238155 seconds	"tadi?" 0.535922 seconds
P2 24/Female Bahasa Mandailing	Quantity (Duration)	"tinggal" 0.307718 seconds	"idia" 0.476098 seconds	"ho?" 0.251039 seconds	-

(iii) Intensity Comparison. According to **Table 3**, the Karo language exhibited a higher overall intensity than the Mandailing language. This was evident in both maximum and minimum intensity levels. The higher intensity values in Karo suggest that speakers exert greater vocal effort, possibly to enhance clarity and emphasis when forming interrogative sentences. This finding is significant because it highlights the phonetic distinction between the two languages in terms of speech articulation and vocal energy distribution.

Table 3. Intensity comparison in Karo and Mandailing language

Participant Age/gender	Analysis	Start	Finish	High	Lower
P1 23/Female Bahasa Karo	Intensity (Spectrum)	65.94 dB	70.4 dB	77.76 dB	63.75 dB
P2 24/Female Bahasa Mandailing	Intensity (Spectrum)	64.29 dB	66.67 dB	69.71 dB	47.42 dB

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4. CONCLUSION

Based on the analysis, several conclusions can be drawn regarding the acoustic characteristics of interrogative sentences in the Karo and Mandailing languages.

(i) Frequency Comparison: Both languages exhibited a similar pattern in intonation, where interrogative sentences began with a high frequency and ended with a low frequency. However, the Karo language demonstrated a higher maximum frequency compared to Mandailing, indicating a more pronounced pitch variation in Karo pronunciation. This difference occurred because Karo speakers tend to emphasize pitch shifts more significantly.

(ii) Duration Comparison: The time required to pronounce the sentence "Where do you live?" varied between the two languages. The Karo language required a longer duration than the Mandailing language. This variation occurred because Karo speakers tend to extend syllable articulation, especially toward the final part of the utterance.

(iii) Intensity Comparison: The Karo language exhibited a higher maximum intensity than the Mandailing language, indicating that Karo speakers exerted more vocal effort during pronunciation. In contrast, the Mandailing language had the lowest intensity, suggesting a softer articulation. This distinction occurred because the two languages employ different speech dynamics to convey emphasis in interrogative sentences.

Overall, these findings highlight the phonetic and prosodic differences between the Karo and Mandailing languages, contributing to a deeper understanding of their linguistic structures and speech characteristics.

5. ACKNOWLEDGMENT

We extend our gratitude to the University of Sumatra Utara and the course lecturers who provided valuable guidance throughout the journal writing process. Appreciation is also expressed to the participants who generously contributed research data. This study was conducted independently, with all research processes carried out solely by us without external funding. The selection of informants was conducted directly by us, taking into account our ethnic background, which aligned with the research subjects' cultural identity. This familiarity allowed us to conduct fieldwork effectively, ensuring that the selected sources met the necessary research criteria.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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