Dialectologia 35 *(2025), 259-284.*
ISSN: 2013-2247

Received 12 February 2023.

Accepted 30 March 2023.

Published July 2025.

DOI: 10.1344/DIALECTOLOGIA.35.11

VOWEL QUALITIES OF THE GAYONESE LANGUAGE PRODUCED BY SPEAKERS IN ACEH, INDONESIA

Yunisrina Qismullah YUSUF, Zulfadli A. AZIZ & Abdullah Syahira ANTONI [*]

Universitas Syiah Kuala, Banda Aceh, Indonesia

yunisrina.q.yusuf@unsyiah.ad.c.id / zulfadli.aziz@unsyiah.ac.id /

abdullahsyahiraantoni97@gmail.com

ORCID: 0000-0002-7187-5117 / 0000-0002-2034-1094 / 0009-0001-9160-0065

Abstract

This acoustic study describes the qualities of Gayonese ten oral vowels produced by five male and five female speakers from Takengon, Aceh, Indonesia. The vowels were put in target words and elicited from each respondent, resulting in 30 tokens for each vowel, making a total of 600 tokens from the respondents. Each monophthong was measured for their F1 and F2 and analyzed using PRAAT version 6.1.04. Meanwhile, the Rate of Change as produced by the speakers was measured to identify the diphthong. The results showed that the monophthongs /i/, /e/, and /ɛ/ are the front vowels of Gayonese; hence the female speakers produce /i/ approximating /ɨ/ in the vowel space. The central vowels are /əː/, /ə/, and /a/, in which /əː/ and /ə/ are claimed to be differentiated by duration. However, this study finds that male speakers do not make this distinction while females could. The back vowels are /u/, /o/ and /ɔ/. Finally, the diphthong /oi/ is characterized.

Keywords: acoustic phonetics, vowel qualities, monophthongs, diphthongs, Gayonese, Aceh, Indonesia

QUALITATS VOCALS DE LA LLENGUA GAIONESA PRODUÏDES PER PARLANTS D'ACEH, INDONÈSIA

Resum

Aquest estudi acústic descriu les qualitats de les deu vocals orals del gaionès produïdes per cinc parlants

[*] Universitas Syiah Kuala, Jalan T. Nyak Arief, Darussalam, Banda Aceh 23111, Indonesia.

masculins i cinc parlants femenines de Takengon, Aceh, Indonèsia. Les vocals es van col·locar en paraules clau i es van extreure de cada enquestat, donant un resultat 30 mostres per a cada vocal, amb un total de 600 mostres dels enquestats. S'ha mesurat la F1 i la F2 de cada monoftong i s'ha analitzat mitjançant PRAAT versió 6.1.04. Mentre, s'ha mesurat la taxa de canvi produïda pels parlants per identificar el diftong. Els resultats han mostrat que els monoftongs /i/, /e/ i /ɛ/ són les vocals anteriors del gaionès; per tant, les parlants femenines produeixen /i/, tot aproximant-se a /ɨ/ a l'espai vocàlic. Les vocals centrals són /ə:/, /ə/ i /a/, en les quals s'afirma que /ə:/ i /ə/ es diferencien per la durada. Tanmateix, aquest estudi conclou que els homes no fan aquesta distinció, mentre que les dones sí. Les vocals posteriors són /u/, /o/ i /ɔ/. Finalment, es caracteritza el diftong /oi/.
Paraules clau: fonètica acústica, qualitats vocàliques, monoftongs, diftongs, gaionès, Aceh, Indonèsia

CALIDADES VOCALES DEL LENGUAJE GAYONÉS PRODUCIDO POR HABLANTES EN ACEH, INDONESIA

Resumen

Este estudio acústico describe las cualidades de las diez vocales orales del gayonés producidas por cinco hablantes masculinos y cinco femeninos de Takengon, Aceh, Indonesia. Las vocales se colocaron en palabras clave y se obtuvieron de cada encuestado, lo que resultó en 30 muestras para cada vocal, lo que hace un total de 600 muestras de los encuestados. Para cada monoftongo se calculó su F1 y F2 y se analizó utilizando PRAAT versión 6.1.04. Mientras, la tasa de cambio producida por los hablantes se midió para identificar el diptongo. Los resultados mostraron que los monoftongos /i/, /e/ y /ɛ/ son las vocales anteriores del gayonés; por lo tanto, las hablantes femeninas producen /i/ aproximándose a /ɨ/ en el espacio vocálico. Las vocales centrales son /ə:/, /ə/ y /a/, en las que se afirma que /ə:/ y /ə/ se diferencian por la duración. Sin embargo, este estudio revela que los hombres no hacen esta distinción, mientras que las mujeres sí. Las vocales posteriores son /u/, /o/ y /ɔ/. Finalmente, se caracteriza el diptongo /oi/.
Palabras clave: fonética acústica, cualidades vocálicas, monoftongos, diptongos, gayonés, Aceh, Indonesia

1. Introduction

Gayonese is one of the languages spoken by the Gayonese ethnic in the central part of Aceh Province, Indonesia. Gayonese is part of the Austronesian language, spoken by people in the central highlands of Aceh Province on the north-western side of Sumatra (Eades 2005) (see Figure 1). There are about 336,856 speakers, and the people live predominantly in the mountain area (Ananta et al. 2015). Gayonese is categorized into four main groups: Gayo Lut, who lives around Lake Laut Tawar; Gayo Deret or Gayo Lues, who lives around Gayo Lues; Gayo Alas, who lives around Southeast Aceh; and Gayo Serbejadi, who lives around Serbejadi-Sembuang Lukup area (Sari et al. 2021). Accordingly, Gayo Lut is the dialect with the largest number of

Dialectologia 35 *(2025), 259-284.*
ISSN: 2013-2247

speakers in Central Aceh, spoken by 155,758 people (Dardanila 2005, Melalatoa et al. 1985).

Figure 1. The Gayo Highlands (shaded area) within Aceh, Indonesia, where the Gayo Lut dialect is spoken

Gayonese is a minority language in Indonesia that consists of 600 languages spoken by different ethnic groups (Paauw 2009). As one of the local languages spoken in Aceh, Gayonese has received little attention among linguists. Gayonese oral vowels have not been appropriately described, at least not as much as Acehnese, which Acehnese and non-Acehnese scholars have extensively described. Using auditory analysis, the vowels in different Acehnese dialects have been described as early as the 1800s by Hurgronje (1893), then by Sulaiman et al. (1977), Sulaiman et al. (1983), Hanafiah & Makam (1984), Durie (1985) and Asyik (1987). In the meantime, the study of the Acehnese vowels in different dialects using acoustic analysis has been carried out by Pillai & Yusuf (2012) on the North Acehnese dialect, Yusuf et al. (2018) on the East Acehnese dialect, Yusuf et al. (2022) on the West Acehnese dialect, and Yusuf et al. (2022) on the Pidienese dialect.

Several researchers have conducted studies on Gayonese dialect differences. Tamaya (2017) studied the dialect differences of Gayonese spoken by speakers from Takengon and Gayo Lues, Central Aceh. From 207 words of the Indonesian Swadesh list, which had been designed beforehand to be inquired to ten informants through interviews, it was found that there were 61 distinctive words, of which 27 words are in the lexical aspect, 33 words in the phonological aspect, and one word in the morphological aspect. Meanwhile, Baihaqi et al. (1981), Dardanila (2005), Zainuddin (2011) and Shaumiwaty (2012) have also discussed the vowels of Gayonese; hence they all focused on analyzing the vowels using the auditory approach. Until now, no studies using acoustic analysis on vowels have been conducted. Therefore, this study intends to fill in this gap. It is deemed important that an acoustic phonetic study on the vowels produced by the Gayonese is to be documented because language is dynamic. Records for historical linguistics documentation, variation in language studies, comparative linguistics studies, and merely in the field of phonology itself (i.e. the study of vowel characteristics) are then essential for linguists to conduct. One of the ways is by investigating its sound system in phonetic studies.

Phonetics is a subdivision of linguistics that studies speech sounds. It also measures the physical attributes of speech sounds, such as describing precisely how specific sounds are produced. In addition, it also discusses the characteristics of sound waves (Fromkin et al. 2003). The oral sound is phonologically divided into two; monophthong and diphthong. Monophthong is a vowel with little change in quality during a single syllable production. It is a single vowel change inappreciably in quality during a syllable or called a stable vowel (Almurashi 2016, Fromkin et al. 2003, Ladefoged & Disner 2012). While a diphthong is a vowel in which there is a change in quality during a single syllable (Ladefoged & Disner 2012).

Hence, this research describes the vowels of the Gayonese by answering the following research question: “What are the oral vowels of the Gayonese as produced by the male and female speakers?”. This research is intended to describe how male and female Gayonese speakers produce the oral monophthong and diphthong vowels. It is expected that the results of this study have an impact by providing new resources

in phonology and phonetic studies, language documentation, preservation, variation, and change.

1.1 Vowels in Gayonese

According to Baihaqi et al. (1981), there are nine monophthongs, one diphthong, and 20 consonants in Gayonese. The samples of the vowels in words and the gloss are provided in Table 1, and the tongue positions of the vowels are shown in Table 2.

Vowel	Word	Gloss
/i/	*tipak* /tipak/	kick
/e/	*gep* /gep/	far
/ɛ/	*ket* /kɛt/	bite
/ə/	*edet* /ədət/	custom
/ə:/	*dede* /də:də:/	chest
/a/	*mepat* /mepat/	certain
/u/	*tutu* /tutu/	pound
/o/	*tok* /tok/	shout
/ɔ/	*opop* /ɔpɔp/	prone/lying flat

Table 1. Nine monophthongs in Gayonese (Baihaqi et al. 1981) with word samples and gloss (Melalatoa et al. 1985)

Positions	Front	Central	Back
High	i		u
Mid	e	ə:[1)]	o
		ə	
Low	ɛ	a	ɔ

Table 2. Tongue positions of the Gayonese vowels (Baihaqi et al. 1981)

To determine whether the phonemes are different or not, it is necessary to find the minimal pair of each phoneme. Table 3 provides an example of minimal pairs for oral monophthongs.

Vowels	Examples
/i/-/e/	*ari* [ari] 'from'- *are* [are] 'measuring tool for a liter of rice'
/e/-/ɛ/	*we* [we] 'rattan' - *we* [wɛ] 'he/she'
/a/-/ə/	*para* [para] 'shelf' - *pere* [pərə] 'a little'
/u/-/o/	*karu* [karu] 'screwed up' - *karo* [karo] 'hunt'
/ɔ/-/o/	*tos* [tɔs] 'make' - *tos* [tos] 'broken off'
/a/-/ə:/	*dere* [dere] 'virgin' - *dere* [də:rə:] 'hit'

Table 3. Minimal pairs of the Gayonese oral monophthongs (Baihaqi et al. 1981)

1.2 Distribution of monophthongs in Gayonese

There are some examples of Gayonese monophthong phonemes distribution that are present at the beginning, middle, or ending of a word in Gayonese; they are shown in Table 4 (i.e. beginning), Table 5 (i.e. middle), and Table 6 (i.e. ending).

Vowels	Word	Gloss
/i/	*ine* [ine]	mother
/e/	*eleh* [eleh]	spittle/saliva
/ɛ/	*eyat* [ɛyat]	pull
/ə/	*entah* [əntah]	come on
/ə:/	*ere* [ə:rə:]	eldest
/a/	*awal* [awal]	banana
/u/	*umah* [umah]	house
/o/	*olong* [oloɱ]	leaf
/c/	*ongot* [ɔŋɔt]	silent

Table 4. Vowels at the beginning of words (Baihaqi et al. 1981)

Vowel	Word	Gloss
/i/	*tingkem* [tiŋkəm]	a type of wood
/e/	*reng* [reŋ]	groaning
/ɛ/	*perah* [pɛrah]	look for
/ə/	*ger* [gər]	handle
/ə:/	*peres* [pə:rəs]	sugarcane water
/a/	*male* [male]	will do something
/u/	*suyen* [suyan]	pole
/o/	*kol* [kol]	big
/ɔ/	*gotol* [gɔtɔl]	fat

Table 5. Vowels in the middle of words (Baihaqi et al. 1981)

Vowel	Word	Gloss
/i/	*ruwi* [ruwi]	thorn
/e/	*re* [re]	comb
/ɛ/	*we* [wɛ]	she/he
/ə/	*sine* [sinə]	just now
/a/	*rowa* [rowa]	two
/u/	*pitu* [pitu]	seven
/o/	*belo* [balo]	betel
/ɔ/	*selo* [selɔ]	when

Table 6. Vowels at the end of words, except /ə:/ (Baihaqi et al. 1981)

1.3 Syllable patterns in Gayonese

Gayonese language has four syllable patterns. A vowel accompanies each syllable as an opening or a consonant accompaniment. However, there is also a syllable that consists of only one vowel. Table 7 shows the syllable structure of Gayonese.

Pattern	Example
V	*ara* /a·ra/ ‘there is’
	ilang /i·laŋ/ ‘red color’
	uran /u·ran/ ‘rain’
VC	*ampa* /am·pa/ ‘empty’
	antak /an·tak/ ‘eat’
	ungke /uŋ·ke/ ‘mini-eggplant’
CV	*si* /si/ ‘where’
	konol /ko·nol/ ‘sit’
	kumpu /kum·pu/ ‘grandchild’
CVC	*rom* /rɔm/ ‘paddy’
	tulan /tu·lan/ ‘bone’
	lungkap /luŋ·kap/ ‘face down’

Table 7. The syllable structure of Gayonese (Baihaqi et al. 1981)

2. Methods

2.1 Design

The research design of this present study is qualitative. Qualitative research aims to understand social phenomena from the human participants' perspective of the study (Ary et al. 2010). Consequently, this research describes the vowel qualities of the oral monophthongs and the diphthong as produced by the Gayonese respondents based on acoustic analysis.

Acoustic analysis is one of the main methods and has become an inexorably essential skill in linguistics (Boersma 2013). This analysis usually uses software to break down data with software, such as PRAAT among them, to perform the acoustic analysis (Misnadin 2020, Yusuf et al. 2021, Yusuf et al. 2022). PRAAT is software that manipulates, synthesizes, and analyzes speech and different sound packaging into a single integrated computer program (Boersma & Weenink 2016). Acoustic phonetics likewise interpret the science of how the speaker produces the articulation signal, how the listener perceives it, and how the language phonology organizes it. By acoustic analysis in vowel production, the vowels are described moderately in thick horizontal bands known as formants on spectrograms for better and more accurate measurements (Milroy & Gordon 2003).

2.2 Respondents

The respondents of this research were selected as five males and five females of Gayo Lut dialect speakers. They were freshmen at the universities in Banda Aceh, originally from the Silih Nara sub-district, Central Aceh Regency. Their ages ranged from 17-25 years old. The respondents are within the following criteria (Yusuf et al. 2018), which are: native speakers of Gayonese, especially in the Gayo Lut dialect, who had not lived outside of their residence during their lives except when they started their university years in Banda Aceh, did not have any dental problems, no lips deformation (i.e. harelip or orofacial cleft), and did not have hearing problems. This is

to obtain the expected monophthong and diphthong vowel productions of the Gayonese.

2.3 Data collection

The respondents were recorded at the Phonetics Lab at the Department of English Education, Faculty of Teacher Training and Education, Universitas Syiah Kuala, Banda Aceh. The tape recorder used was the Marantz version PDM660 Solid State Sound Recorder with a built-in Logitech G PRO. Moreover, the data of the oral monophthongs and diphthong vowels were elicited from a word list (see Table 8 for monophthongs and Table 9 for the diphthong). This is to ensure that all target sounds are collected (Yusuf et al. 2022). Each target word that contained a target sound/vowel was in a CVC or CV environment, where C is a stop or fricative consonant (King 2006).

Vowel	Word	Gloss
/i/	*tipak* /tipak/	kick
/e/	*gep* /gep/	far
/ɛ/	*ket* /kɛt/	bite
/ə/	*edet* /ədət/	custom
/ə:/	*dede* /də:də:/	chest
/a/	*mepat* /mepat/	certain
/u/	*tutu* /tutu/	pound
/o/	*tok* /tok/	shout
/ɔ/	*opop* /ɔpɔp/	prone/lying flat

Table 8. Word list for monophthongs in Gayonese (adapted from Melalatoa et al. 1985)

Vowel	Word	Gloss
/oi/	/woi/	Hey!

Table 9. Word list for diphthongs in Gayonese adapted from Baihaqi (1981)

The participants were asked to say the target vowels by inserting them in the blank space of the carrier sentence (Hamzah et al. 2020, Verhoeven & van Bael 2002) during the recording for comparable data. The carrier sentence is *Aku nucep … segermi*

'I say … one more time'. Each respondent read the carrier sentences six times to produce 30 tokens for each vowel. The recordings were then saved into a WAV file in PRAAT to determine the F1 and F2 of each vowel for further analysis.

2.4 Data analysis

After elicitation, the data were saved in a WAV file. Later on, the researchers transcribed and categorized the measurement in Hertz by using the TextGrid function in Praat software version 6.1.04. The formants (F1 and F2) in the spectrogram were used to measure the central point of the target monophthong produced by each respondent (see Figure 2). First, the border of the onset and offset of vowel production were determined in the spectrogram. Then, the mid part of the vowel was further determined to obtain its F1 and F2 values.

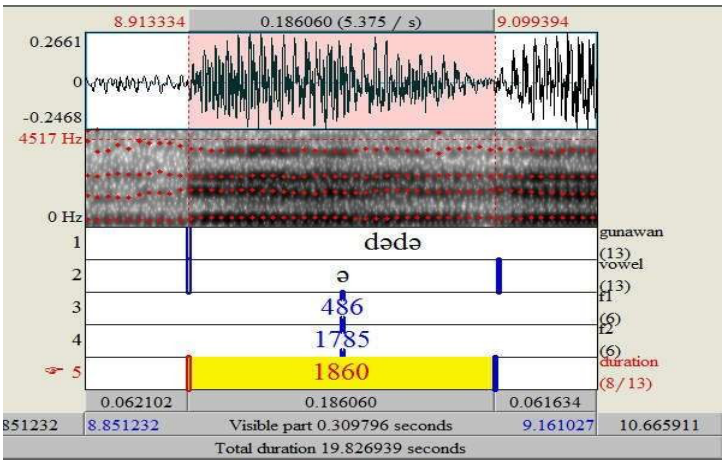

Figure 2. Sample measurements for a monophthong

Meanwhile, the diphthong measurement applied the Rate of Change (ROC) (Behr 2022, Deterding 2000). This provides plot trajectories of the diphthong production. To gain a visual graphic of the diphthong's trajectory, the F1 and F2 values at the onset and offset of the diphthong (see Figure 3) in Bark Scale were plotted in a vowel chart (Man 2007, Mayr & Davies 2011, Pillai & Yusuf 2012).

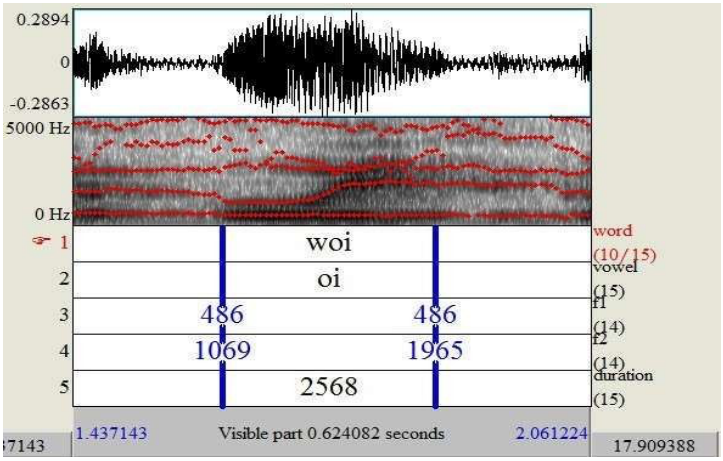

Figure 3. Sample measurements for a diphthong

Figure 3 shows that Tier 3 is the F1 of the onset and offset of the vowel at the start, and Tier 4 is the F2 of the onset and offset of the vowel at the end. Tier 5 is the duration of the vowel in milliseconds. The diphthong was measured at the onset and offset for both the F1 and F2 to reduce the influence of neighboring sounds (Tsukada 2008).

Afterward, the data were transferred into Microsoft Excel, and the frequency in Hertz was converted to Bark Scale by using the formula proposed by (Zwicker & Terhardt 1980): Zc = 13 arctan (0.76*F) + 3.5 arctan (F/7.5)2. Based on the measurements in Bark, vowel charts for the vowels were made based on Deterding (2003). Moreover, the male and female vowels were analyzed separately because there are differences between male and female speakers in vowel production. Females have relatively shorter pharyngeal cavities and smaller laryngeal cavities than males (Cox 2006, Jacobi 2009). The vocal tract differences between female and male speakers impact their vowel qualities, making it impossible to combine the results of their vowel productions.

3. Results and discussion

The ten vowels in Gayonese being investigated were each incorporated in the carrier sentence and repeated six times by each respondent, resulting in 30 tokens for each vowel, making a total of 600 tokens from both male and female respondents. The respondents' average measurements for each monophthong and the diphthong in Hertz and Bark are presented in the following sub-sections.

3.1 Gayonese monophthongs: Male respondents

Each vowel's average duration and F1 and F2 produced by the Gayonese male respondents are shown in Table 10.

Vowel	Word	Ave. Dur. (sec)	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1(Bark)	Ave. F2(Bark)
/i/	*tipak* /tipak/	1263	325	2066	3.15	13.31
/e/	*gep* /gep/	1346	409	2122	3.93	13.48
/ɛ/	*ket* /kɛt/	1381	512	1964	4.84	12.98
/ə/	*edet* /ədət/	1272	516	1661	4.87	11.88
/ə:/	*dede* /də:də:/	1404	443	1816	4.23	12.47
/a/	*mepat* /mepat/	1644	670	1484	6.15	11.13
/u/	*tutu* /tutu/	1070	361	1459	3.49	11.00
/o/	*tok* /tok/	1490	468	1236	4.46	9.89
/ɔ/	*opop* /ɔpɔp/	1413	559	1071	5.24	8.95

Table 10. The average values of F1 and F2 for Gayonese oral monophthong vowels produced by male respondents

The placement of the Gayonese vowels in the vowel space for the male respondents can be seen in Figure 4.

Dialectologia 35 *(2025), 259-284.*
ISSN: 2013-2247

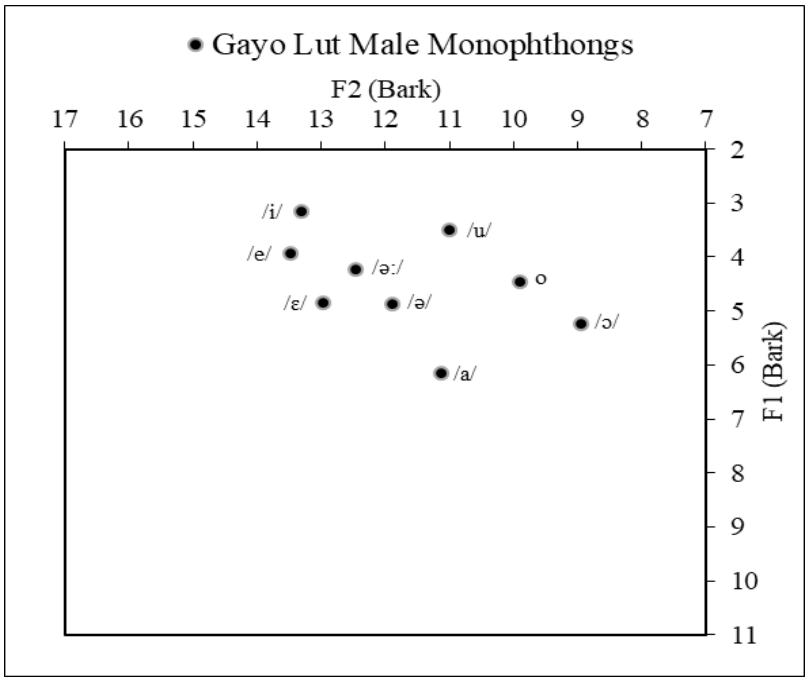

Figure 4. Plots of Gayonese oral monophthong vowels produced by male respondents

The positions of the /i/, /e/, and /ɛ/ vowels in Figure 4 are categorized as front vowels, where /i/ is located as the highest front vowel. Meanwhile, /ə:/, /ə/, and /a/ are produced as central vowels in the vowel space, with /a/ as the lowest-produced vowel. For the back vowels, there are /u/, /o/, and /ɔ/, where /ɔ/ is produced the most back in the vowel space.

3.2 Gayonese monophthongs: Female respondents

Each vowel's average duration and F1 and F2 produced by the Gayonese female respondents are shown in Table 11.

Vowel	Word	Ave. Dur. (sec)	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1(Bark)	Ave. F2(Bark)
/i/	*tipak* /tipak/	877	410	1954	3,94	12,95
/e/	*gep* /gep/	1213	515	2278	4,87	13,93
/ɛ/	*ket* /kɛt/	1422	637	1962	5,88	12,98
/ə/	*edet* /ədət/	1150	573	1904	5,36	12,78
/ə:/	*dede* /də:də:/	1549	496	2010	4,70	13,13
/a/	*mepat* /mepat/	1038	849	1666	7,49	11,89
/u/	*tutu* /tutu/	1236	468	1537	4,45	11,34
/o/	*tok* /tok/	1707	598	1286	5,57	10,12
/ɔ/	*opop* /ɔpɔp/	1012	635	1100	5,87	9,12

Table 11. The average values of F1 and F2 for Gayonese oral monophthong vowels produced by female respondents

The placement of the Gayonese vowels in the vowel space for the female respondents can be seen in Figure 5.

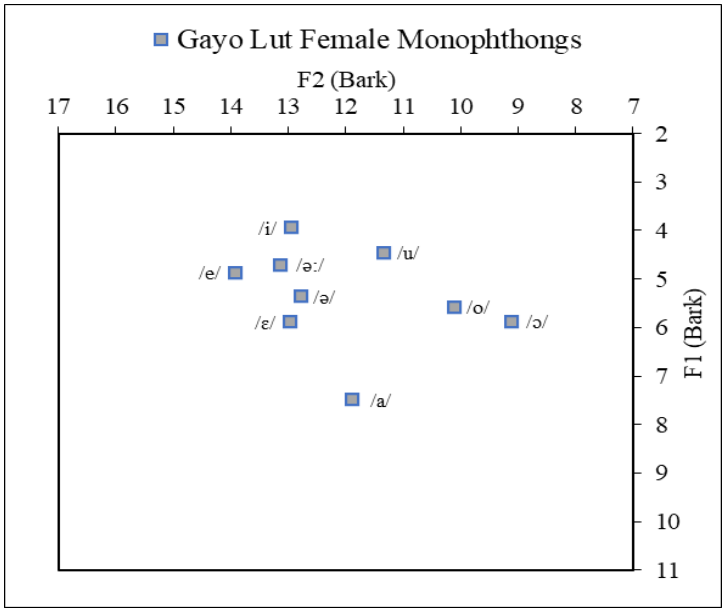

Figure 5. Plots of Gayonese oral monophthong vowels produced by female respondents

In Figure 5, it is shown that the positions of /e/ and /ɛ/ vowels are categorized as front vowels where /e/ is located as the most fronted vowel and /ɛ/ produced more back. The vowel /i/, however, produced as a front vowel by the male respondents, is seen more back as produced by the female respondents, approximating /i/. The

females' central vowels are seen as /i/, /əː/, /ə/, and /a/, with /a/ as the lowest produced vowel. The vowels /u/, /o/ and /ɔ/ are back vowels where /ɔ/ is produced more back.

3.3 Front vowels

To further illustrate the scatter plots of the front vowel production by male and female respondents, this section illustrates how they are plotted in the vowel space. Figure 6 shows the scatter plots of the front vowels by the male respondents, and Figure 7 shows the scatter plots of the front vowels by the female respondents. Figure 6 shows the production of /i/, /e/, and /ɛ/ as front vowels. T-tests were conducted to study whether the male respondents produced each of these front vowels differently. The results show that the high front vowel /i/ with the front middle vowel /e/ are well distinguished because there are significant differences between the F1 average values (i.e. height), where $t(29) = -11.35$, $p = <.0001$, but no significant differences in the F2 average values (i.e. fronting), where $t(29) = -3.36$, $p = 0.0007$. This means both are front vowels where /i/ is produced higher than /e/. Meanwhile, there is a different finding for the female respondents. The t-test result for both the F1 average values and the F2 average values show significant differences (F1: $t(29) = -12.92$, $p = <.0001$; F2: $t(29) = -17.26$, $p = <.0001$). The scatter plots of /i/ in Figure 7 are seen to be produced more back than /e/, approximating /i/. For the female respondents, /i/ is not the most fronted vowel, but /e/ is.

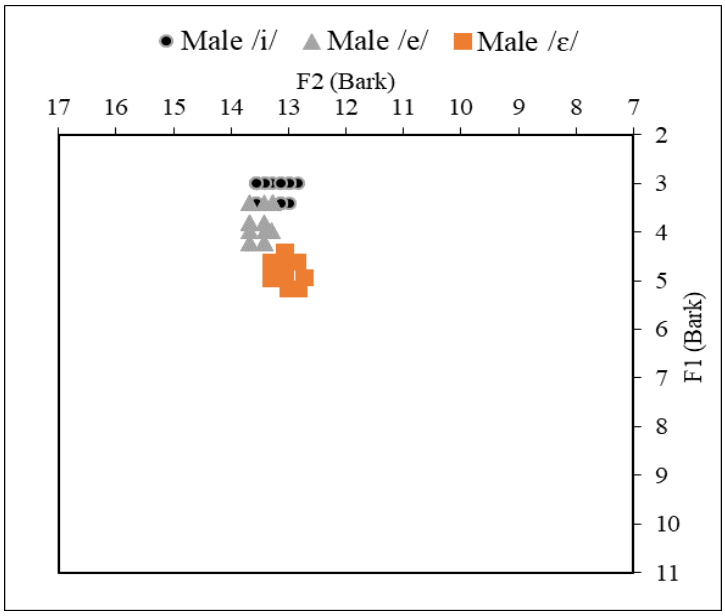

Figure 6. The scatter plots of the front vowels by the male respondents

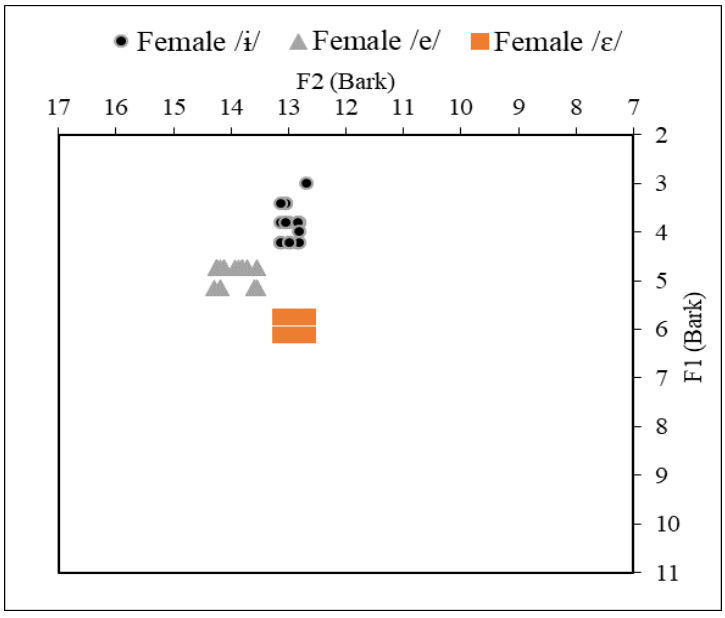

Figure 7. The scatter plots of the front vowels by the female respondents

T-tests were also conducted between the front middle vowel /e/ and the front low vowel /ɛ/. The results for the male respondents show that there are significant differences between the F1 and F2 average values of these vowels by the male respondents (F1: t(29) = -12.41, p= <.0001; F2: t(29) = +11.75, p= <.0001), meaning that they are distinguished quite well by the respondents as illustrated by the scatter plots in Figure 6. Here, the vowel /e/ is more fronted than /ɛ/ in the vowel space. Similarly,

the female respondents could produce the vowels differently, as illustrated in Figure 7. The t-test results also showed significant differences between the F1 and F2 average values of these vowels by the female respondents (F1: t(29)= -21.05, p= <.0001; F2: t(29)= +17.73, p= <.0001).

3.4 Central vowels

This section illustrates how the central vowels are plotted in the vowel space. Figure 8 shows the scatter plots of the central vowels by the male respondents, and Figure 9 shows the scatter plots of the central vowels by the female respondents. Figure 8 shows the production of /ə/, /ə:/, and /a/ as central vowels. T-tests were conducted to study whether the male respondents produced each of these central vowels differently. The results show that the high central vowel /ə/ with the central middle vowel /ə:/ are well distinguished because there are significant differences between the F1 average values (i.e. height), where t(29)= -10.51, p= <.0001, and in the F2 average values (i.e. fronting), where t(29)= +15.1, p= <.0001. This means both /ə/ and /ə:/ are well differentiated by the male respondents. Despite Baihaqi et al. (1981) claim that the phoneme /ə:/ is produced longer than /ə/, the t-test indicates otherwise where t(29) = +1.52, p=0.0697, meaning that these two vowels are not distinguished by duration by the male respondents. For the female respondents, /ə:/ and /ə/ are also produced differently as there are significant differences between the F1 and F2 average values (F1: t(29)= -11.11, p= <.0001; F2: t(29)= -7.73, p= <.0001). Nevertheless, the females produced these two vowels differently in terms of duration, where /ə:/ is produced longer than /ə/ (t(29)= +6.91, p= <.0001). This confirms Baihaqi et al. (1981) that /ə:/ and /ə/ are two distinct central phonemes in Gayonese. The scatter plots of /a/ for male and female respondents are shown to be the lowest central vowel in the vowel space (see Figures 8 and 9).

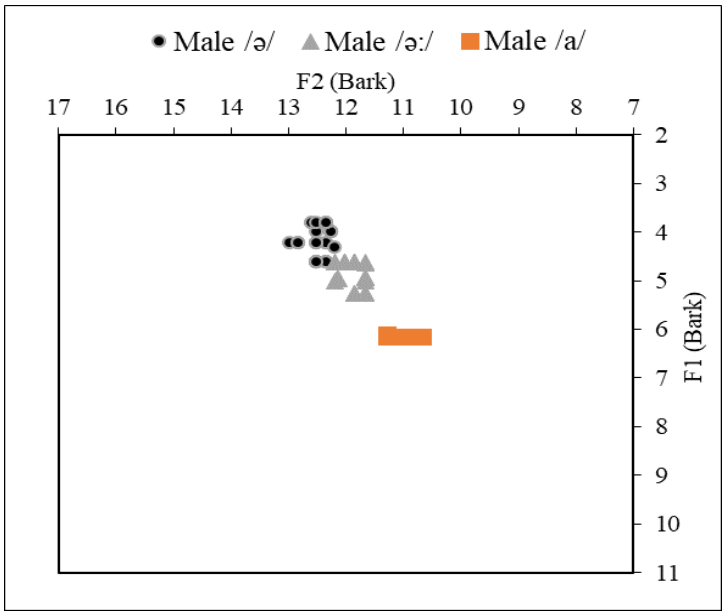

Figure 8. The scatter plots of the central vowels by the male respondents

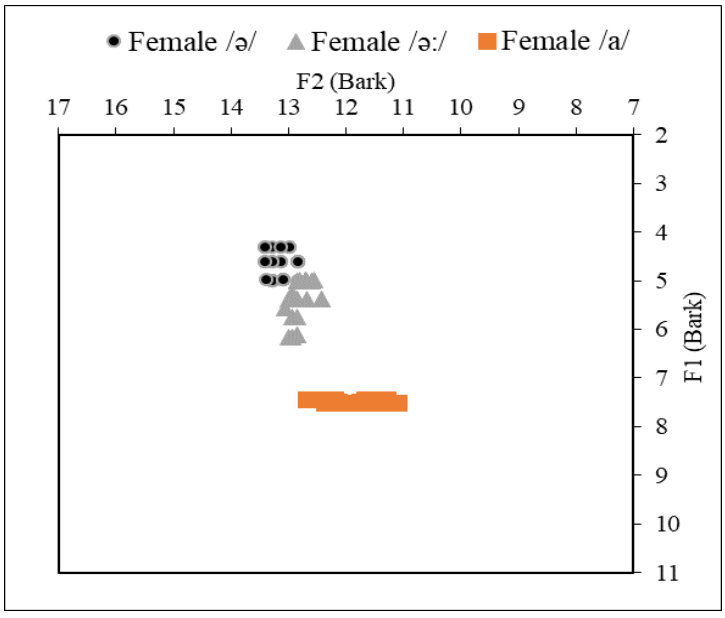

Figure 9. The scatter plots of the central vowels by the female respondents

3.5 Back vowels

This section illustrates how the back vowels are plotted in the vowel space. Figure 10 shows the scatter plots of the back vowels by the male respondents, and Figure 11 shows the scatter plots of the back vowels by the female respondents. These figures show that the production of /u/, /o/, and /ɔ/ are back vowels. The scatter plots

of /u/ from male and female respondents show that this vowel is indeed the high back vowel. Hence, the vowels /o/ and /ɔ/overlap in some cases for both the male and female respondents. Therefore, t-tests were conducted to study whether /o/ and /ɔ/ are produced differently by both of these groups of respondents. The results for the male respondents show that between /o/ and /ɔ/, there are significant differences in the F1 average values (t(29)= -139.19, p= <.0001) and the F2 average values (t(29)= -11.99, p= <.0001). This is also the case for female respondents (F1: t(29)= -5.23, p= <.0001; F2: t(29)= -8.08, p= <.0001). The findings indicate that /o/ and /ɔ/ are produced differently.

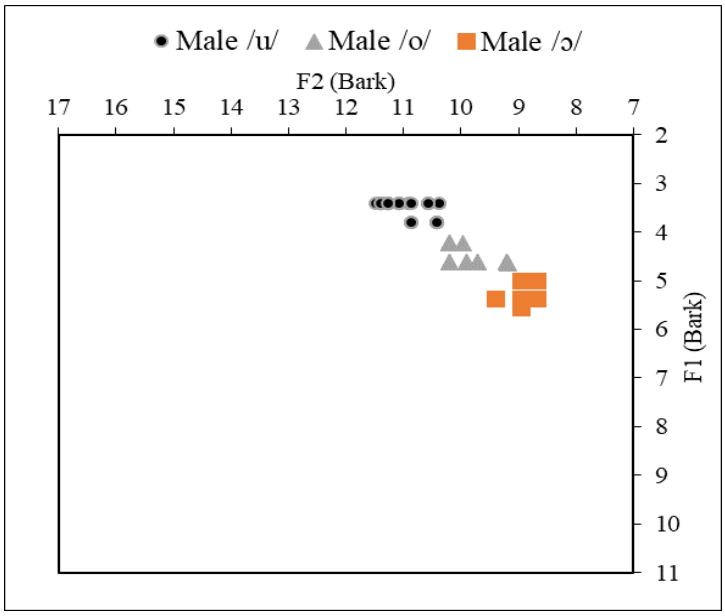

Figure 10. The scatter plots of the back vowels by the male respondents

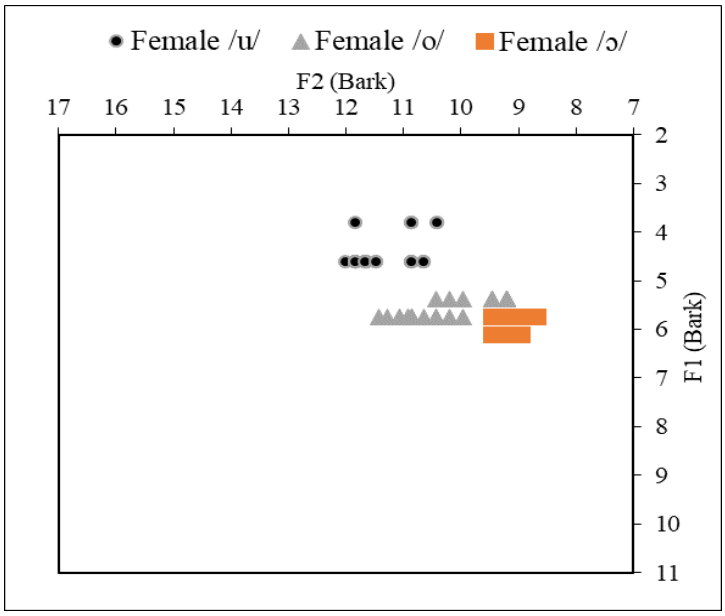

Figure 11. The scatter plots of the back vowels by the female respondents

3.6 Gayonese diphthong: Male respondents

Every respondent repeated the diphthong /oi/ in *woi* six times, with a total of 30 tokens produced by the male respondents. Table 12 presents the F1 and F2 ROC average values for the diphthong produced by the male respondents of Gayonese.

Diphthong	Extracted from the word	F1ROC (Hz/sec)	F2ROC (Hz/sec)
o --> i	*woi*	0	7610

Table 12. The F1 and F2 ROC average values for the diphthong produced by the male respondents

The placement and movement of the diphthong /oi/ in the vowel space for the Gayonese respondents can be seen in Figure 12.

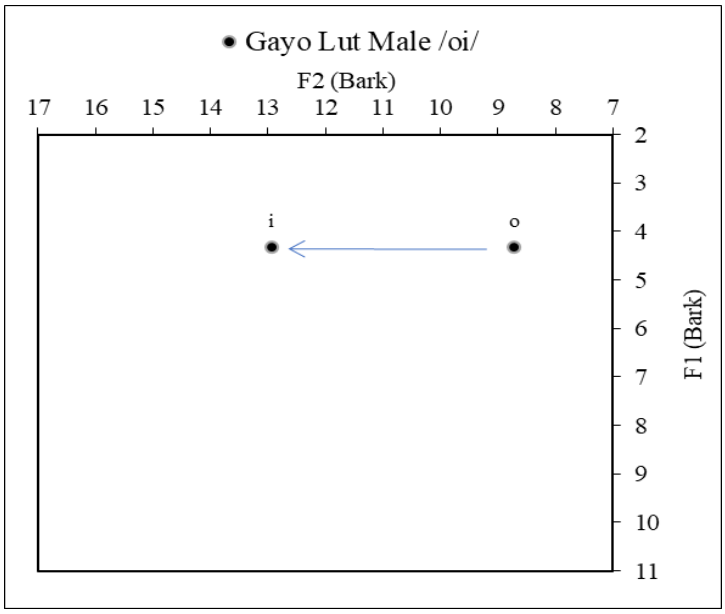

Figure 12. Diphthongal movement of /oi/ as produced by Gayonese male respondents

For [oi] in *woi*, the male respondents produced it with an average value of 0 Hz/sec for F1 ROC and 7610 Hz/sec for F2 ROC. Figure 12 indicates that the /oi/ diphthong moves from the back to the front, and thus, the positive F1 ROC average value of [oi] indicates a rising trajectory.

3.7 Gayonese diphthong: Female respondents

Every female respondent also repeated the diphthong /oi/ in *woi* 6 times, with a total of 30 tokens produced by the female respondents. Table 13 presents the F1 and F2 ROC average values for the diphthong produced by the Gayonese female respondents.

Diphthong	Extracted from the word	F1ROC (Hz/sec)	F2ROC (Hz/sec)
o --> i	*woi*	-137	7836

Table 13. The F1 and F2 ROC average values for the diphthong produced by the female respondents

The placement and movement of the oral diphthong in the vowel space for the Gayonese female respondents can be seen in Figure 13.

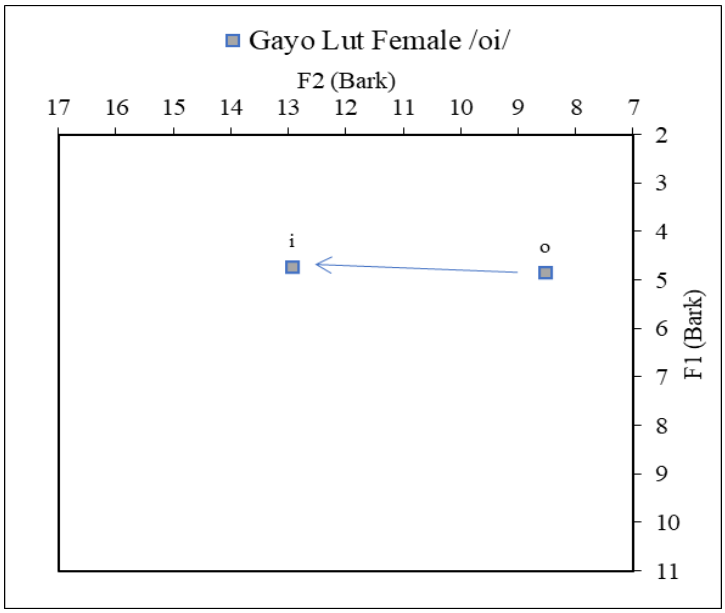

Figure 13. Diphthongal movement of /oi/ as produced by the Gayonese female respondents

For [oi] in *woi*, as produced by female respondents, the average value of F1 ROC is –137 Hz/sec, while the average value of f2 ROC is 7836 Hz/sec. As shown in Figure 13, the /oi/ diphthong of the female respondents moves from the back to the front. The negative F1 ROC average value of [oi] also indicates a rising trajectory.

From the diphthong/oi/, it is solely found in the poetic language of the Gayonese, which is similar to what Eades (2005) has previously described. This diphthong is categorized as non-productive because it is only found in one interjection word of *woi* (Baihaqi et al. 1981) and is not used in other words in the Gayonese. Eades (2005) elaborates that there are no phonemic diphthongs in the everyday language of Gayonese. It is heard only in literary works such as poetry, song, etc.

4. Conclusions

The results of this study have highlighted the qualities of the Gayonese oral vowels, especially of the Gayo Lut dialect, in the vowel space. Different qualities of vowels were found between male and female respondents on the nine monophthong vowels and in one diphthong vowel of Gayonese. The vowels /i/, /e/, and /ɛ/ are the

front vowels of this language; hence the female respondents produced/i/ approximating /ɨ/ in the vowel space. The central vowels are /ə:/, /ə/, and /a/, in which /ə:/ and /ə/ are claimed to be differentiated by duration in the previous studies. However, this study finds the male respondents to not make this distinction while the females could. The back vowels are /u/, /o/ and /ɔ/. Finally, the diphthong /oi/ is characterized as non-productive because it is only found in the interjection of woi and not in other words of Gayonese.

Despite this present study having presented the acoustic properties of the Gayonese oral vowels, the results are based on vowels that occurred within CVC environments where C is a stop or fricative to attain better measurements from the formants in PRAAT. Therefore, this present study suggests the analysis of an even larger data set to investigate vowels that may appear in other environments. Future research should also consider examining the production of Gayonese vowels from generation to generation because changes may have occurred over time. Since Gayonese is spoken as a mother tongue amid other local and national languages (e.g. Acehnese, Alas, Tamiang, Aneuk Kamee, Kluet, Indonesian, etc.), influences from these languages can also be explored

Acknowledgement

We would like to thank *Lembaga Penelitian dan Pengabdian kepada Masyarakat* (LPPM, or Institute for Research and Community Service) of Universitas Syiah Kuala for funding this research with Grant No. 357/UN11/KPT/2021 (*Skim Penelitian Berbasis H-Index*).

References

ALMURASHI, W. A. (2016) “Analysis and critical reflection of Acehnese language”, *International Journal of English Language and Linguistics Research*, 4(2), 43-55.

ANANTA, A., E. N. ARIFIN, M. S. HASBULLAH, N. B. HANDAYANI & W. PRAMONO (2015) *Demography of Indonesia's Ethnicity*, Singapore: Institute of Southeast Asian Studies.

ARY, D., L. C. JACOBS, C. K. S. IRVINE & D. WALKER (2010) *Introduction to Research in Education*, Belmont, CA: Wadsworth.

ASYIK, A. G (1987) *A contextual grammar of Acehnese*, Doctoral dissertation, Ann Arbor, MI: University of Michigan.

BAIHAQI, A. K., A. G. ASYIK, S. N. LATIF & S. SANUSI (1981) *Bahasa Gayo* [Gayonese language], Jakarta: Pusat Pembinaan dan Pengembangan Bahasa.

BEHR, N. S (2022) "English diphthong characteristics produced by Thai EFL learners: Individual practice using PRAAT", CALL-EJ*,* 23(1), 401-424.

BOERSMA, P. (2013) "Acoustic analysis", in R. J. Podesva & D. Sharma (eds.), *Research Methods in Linguistics*, Cambridge: Cambridge University Press, 375-396.

BOERSMA, P. & D. WEENINK (2016) Praat: Doing Phonetics by Computer [Computer program] (version 6.1.38) <http://www.fon.hum.uva.nl/praat/>.

COX, F. (2006) "The acoustic characteristics of /hVd/ vowels in the speech of some Australian teenagers", *Australian Journal of Linguistics,* 26(2), 147-179.

DARDANILA, D. (2005) "Bunyi vokal Bahasa Gayo dialek Gayo Lut [Gayonese vowel sounds of the Gayo Lut dialect]", *Logat: Jurnal Ilmiah Bahasa dan Sastra,* 1(1), 1-5.

DETERDING, D. (2000) "Measurements of the /eɪ/ and /əʊ/ vowels of young English speakers in Singapore", in D. Deterding, A. Brown, & L. E. Ling (eds.), *The English Language in Singapore: Research on Pronunciation*, Singapore: Singapore Association for Applied Linguistics, 93-99.

DETERDING, D. (2003) "An instrumental study of the monophthong vowels of Singaporean English", *English World-Wide,* 24(1), 1-16.

DURIE, M. (1985) *A Grammar of Acehnese: On the Basis of a Dialect of North Aceh*, Dordrecht: Foris.

EADES, D. C. (2005) *Grammar of Gayo: Language of Aceh, Sumatra*, Canberra: Australian National University.

FROMKIN, V., R. RODMAN & N. HYAMS (2003[7]) *An introduction to Language*, Boston: Thomson/Heinle.

HAMZAH, M. H., A. E. S. MADBOULY, H. A. HALIM & A. H. ABDULLAH (2020) "The production of the English stop voicing contrast by Arab L2 speakers of English", *Indonesian Journal of Applied Linguistics,* 10(2), 434-444.

HANAFIAH, M. A. & I. MAKAM (1984) *Struktur Bahasa Aceh* [Acehnese language structure], Jakarta: Pusat Pembinaan dan Pengembangan Bahasa.

HURGRONJE, C. S. (1893) *De Atjehers* [The Acehnese], Batavia: Landsdrukkerij.

JACOBI, I. (2009) *On variation and change in diphthongs and long vowels of spoken Dutch*, Doctoral dissertation, Amsterdam: University of Amsterdam.

KING, P. (2006) "An acoustic description of central vowels in three Austronesian languages of New Ireland", *SIL Electronic Working Papers 2007*, 1-21.

LADEFOGED, P. & S. F. DISNER (2012[3]) *Vowels and Consonants*, Hoboken, NJ: Wiley-Blackwell.

MAN, C. Y (2007) "An acoustical analysis of the vowels, diphthongs and triphthongs in Hakka Chinese", *Proceedings of the International Congress of Phonetic Sciences 2007 (ICPhS XVI),* 16, Saarbrücken: Univ. des Saarlandes, 841-844.

MAYR, R. & H. DAVIES (2011) "A cross-dialectal acoustic study of the monophthongs and diphthongs of Welsh", *Journal of the International Phonetic Association,* 41(1), 1-25.

MELALATOA, M. J., H. KRIDALAKSANA, A. BANTA, A. B. MELALATOA & A. D. BENERSELAM (1985) *Kamus Bahasa Gayo-Indonesia* [Gayonese-Indonesian dictionary], Jakarta: Pusat Pembinaan dan Pengembangan Bahasa.

MILROY, L. & M. GORDON (2003) *Sociolinguistics: Method and Interpretation*, Hoboken, NJ: Wiley-Blackwell.

MISNADIN (2020) "Phonetic realisations of Madurese vowels and their implications for the Madurese vowel system", *Indonesian Journal of Applied Linguistics,* 10(1), 173-183.

PAAUW, S. (2009) "One land, one nation, one language: An analysis of Indonesia's national language policy", *University of Rochester Working Papers in the Language Sciences*, 5(1), 2-16.

PILLAI, S. & Y. Q. Yusuf, (2012) "An instrumental analysis of Acehnese oral vowels", *Language and Linguistics,* 13(6), 1029-1050.

SARI, C. K., Z. ZAINUDDIN & A. H. PULUNGAN (2021) "Address system of Gayonese Lut and Deret in Bener Meriah", *Linguistik Terapan,* 18(2), 96-100.

SHAUMIWATY, S. (2012) *Fonologi Bahasa Gayo: Suatu Analisis Fonologi Generatif* [Gayonese language phonology: A generative phonological analysis], Doctoral dissertation, Medan: Universitas Sumatera Utara.

SULAIMAN, B., H. YUSUF, S. HANOUM & R. C. LANI (1977) *Struktur bahasa Aceh* (lanjutan) [Acehnese language structure (continued)], Jakarta: Pusat Pembinaan dan Pengembangan Bahasa.

SULAIMAN, B., H. YUSUF, S. HANOUM & R. C. LANI (1983) *Struktur Bahasa Aceh: Morfologi dan Sintaksis* [Acehnese language structure: Morphology and syntax], Jakarta: Pusat Pembinaan dan Pengembangan Bahasa.

TAMAYA, T. R (2017) *Dialect Differences of Gayonese Spoken in Takengon and Gayo Lues*, Bachelor's thesis, Banda Aceh: Universitas Syiah Kuala.

TSUKADA, K. (2008) "An acoustic comparison of English monophthongs and diphthongs produced by Australian and Thai speakers", *English World-Wide,* 29(2), 194-211.

VERHOEVEN, J., & C. VAN BAEL (2002) "Acoustic characteristics of monophthong realisation in Southern Standard Dutch", *Antwerp Papers in Linguistics: Phonetic Work in Progress,* 100, 149-164.

YUSUF, Y. Q., I. A. FATA & T. M. AULIA (2018) "Acoustic description of Acehnese monophthong vowels: Female vs. male speakers from East Aceh", *Proceedings of the International Seminar on Sociolinguistics and Dialectology*, Jakarta: Universitas Indonesia, 271-277.

YUSUF, Y. Q., I. A. FATA & S. KARWINDA (2021) "Oral monophthong vowel qualities of the Jamee language in Aceh", *Indonesian Journal of Applied Linguistics,* 10(3), 794-803.

YUSUF, Y. Q., I. A. FATA, Z. A. AZIZ, D. SURYA & S. PILLAI (2022) "Acoustic analysis of an Acehnese dialect: Pidienese oral monophthong vowels", *Dialectologia,* 28, 203-223. <http://www.edicions.ub.edu/revistes/dialectologia28/>

YUSUF, Y. Q., D. F. SARI, I. IKHWANI, F. MUSTAFA, M. MAHMUD & I. A. FATA (2022) "Acoustic characteristics of oral monophthong vowels of the West Aceh dialect", in Z. A. Aziz, Y. Q. Yusuf, S. S. Fitriani & D. Fitrisia (eds.), *The Acehnese Language and Society*, Banda Aceh: Syiah Kuala University Press, 17-40.

ZAINUDDIN, Z. (2011) "Fonotaktik dan tekanan dalam bahasa Gayo Lut [Phonotactics and stress in Gayo Lut]", *Bahas*, 82, 1-6.

ZWICKER, E. & E. TERHARDT (1980) "Analytical expression for critical bandwidths as a function of frequency", *The Journal of the Acoustical Society of America,* 68, 1523-1525.