

## Acoustic characterization of Najdi Arabic Vowel System

Ghazi Algethami

Taif University  
[g.gethami@tu.edu.sa](mailto:g.gethami@tu.edu.sa)

### ABSTRACT

This study provides an acoustic description of the vowel system of Najdi Arabic, a major dialect spoken in Saudi Arabia. It aims to go beyond the phonological description provided by Ingham (1994) and offer an acoustic description of Najdi Arabic vowels. Fifteen native speakers of Najdi Arabic were recorded reading CVC words containing all the Najdi Arabic vowels described by Ingham (1994). As expected, Najdi Arabic vowels were found to occupy a narrow acoustic space. Temporally, the long vowels /i:/, /u:/ and /a:/ were almost double the length of their short counterparts /i/, /u/ and /a/. The long and short vowels also differed spectrally, with short vowels being significantly more centralized than their long counterparts. The classical Arabic diphthongs /ay/ and /aw/, as in many Arabic dialects, were realized as long monophthongs, /e:/ and /o:/, respectively. The results substantiate the impressionistic analysis of Najdi Arabic vowels system by Ingham (1994).

**Keywords:** Najdi, Arabic, Vowels, Phonetics, Acoustics.

### 1. INTRODUCTION

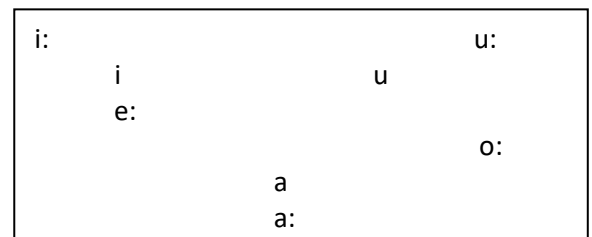
Modern Standard Arabic (MSA) is characterized by having a simple vowel system consisting of three long vowels /i:/, /u:/ and /a:/, their short counterparts /i/, /u/, and two diphthongs: /ay/ and /aw/ [1]. MSA is not used in day-to-day conversations and its use is limited to educational and formal contexts (e.g., news broadcasting) [2]. Arab speakers across the Arab world speak different regional dialects in their daily conversations. These dialects can vary widely in their phonological structure [1]. For instance, some variation exists between spoken Arabic dialects with regard to their vowel inventory and their phonetic realizations [3, 4, 5].

Najdi Arabic is one of the major dialects spoken in Saudi Arabia. It is spoken by a large population in central Saudi Arabia. Limited research has discussed the vowels system of Najdi Arabic [6,7], with no acoustic studies validating their phonological auditory description. The current study, thus, attempts to fill this gap by acoustically examining the vowel system of Najdi Arabic.

### 2. PREVIOUS STUDIES

The vowel system of Classical Arabic is traditionally described “as an example of the simplest kind of triangular vowel system” [8, p. 461]. It consists of three long vowels /i:/, /u:/ and /a:/ and their short counterparts /i/, /u/, and /a/. In addition, it has two diphthongs /ay/ and /aw/. The same can be said about MSA [2,3]. The long vowels are almost double the length of the short ones [9]. While all Arabic spoken dialects still preserve the three long vowels found in MSA, the phonetic realizations of the short vowels and diphthongs show considerable variation [3]. For example, in many colloquial spoken dialects, the two diphthongs /ay/ and /aw/ are realized as mid long vowels /e:/ and /o:/, respectively [3, 4]. A few recent studies have acoustically examined the phonetic realization of vowels in various regional dialects [4, 5]. For example, in Syrian Arabic, the short vowels /i/ and /u/ can be realized phonetically as /e/, /o/ or /ə/ [4]. Comparing Moroccan and Jordanian Arabic vowel systems, Barkat-Defradas et al [5] showed that Moroccan Arabic exhibited a more reduced short vowels than did Jordanian Arabic, leading to the emergence of /ə/ in Moroccan Arabic. It seems that a major source of variation among Arabic dialects is how they phonetically realize short vowels.

Ingham [7] listed the following vowel inventory for NA based on his auditory analysis of the dialect: /i:/, /u:/, /a:/, /i/, /u/, /a/, /e:/, and /o:/, which is illustrated in figure 1 below. On the phonetic realizations of these vowels, he mentioned that /a:/ in Najdi Arabic does not show fronting (aka *imalah*) as it does in Syrian and Egyptian Arabic. In addition, /i/ and /u/ can be centralized and have a “schwa-like quality in neutral environments” (p.15)



**Figure 1:** Najdi Arabic Vowel System; reproduced from Ingham [7], p. 15.

Given the scarcity of phonetic studies on Najdi Arabic vowels, the current study aims to acoustically corroborate the auditory description of Najdi Arabic vowels by Ingham (1994).

### 3. METHOD

Fifteen native speakers of Najdi Arabic were recruited to provide the data for the current study. They were all males and their age ranged from 19 to 37. None of them reported any speech or hearing impairment.

Each participant was met individually with the researcher in a sound-attenuated room. They were asked to read a list of CVC words (see Table 1 below), representing all the vowels described in Ingham [7], included in the carrier sentence *ʕaqra CVC wadxul lilqaʕah* (I read CVC and enter the hall). Some of the participants pointed out that they usually produce the word /kud/ as /kid/ in their local dialect, but they were asked to read it as /kud/ as illustrated to them by the use of the Arabic orthographic representation (كُد). None of them had any problem producing the word as such.

**Table 1.** The list of words used to elicit the Najdi Arabic vowels along with their IPA transcription and English translation.

Vowel	CVC word (translation)
i	/sid/ (block)
i:	/si:d/ (Master)
u	/kud/ (work hard)
u:	/ku:d/ (perhaps)
a	/bat/ (decided)
a:	/ba:t/ (slept)
e	/be:t/ (home)
o:	/so:t/ (so:t)

Although final-syllable consonants had no lengthening or shortening effect on preceding vowels in Saudi Arabic [10], an attempt was made to ensure each vowel pair of the short/long vowels is used by the same consonantal CVC environment to neutralize the effect of phonological context.

The participants were asked to read the sentences in their spoken dialect in normal speech pace. Since written Arabic is largely associated with MSA, I read all the sentences in dialectal Arabic first to set the required register for them and asked them to read the sentences as I did in their native dialect. The participants' renditions were digitized and saved into a computer drive for acoustic analysis using Praat software [11]. Spectral (midpoint F1/F2 formant

values) and temporal data were obtained for each vowel per each speaker.

### 4. RESULTS AND DISCUSSION

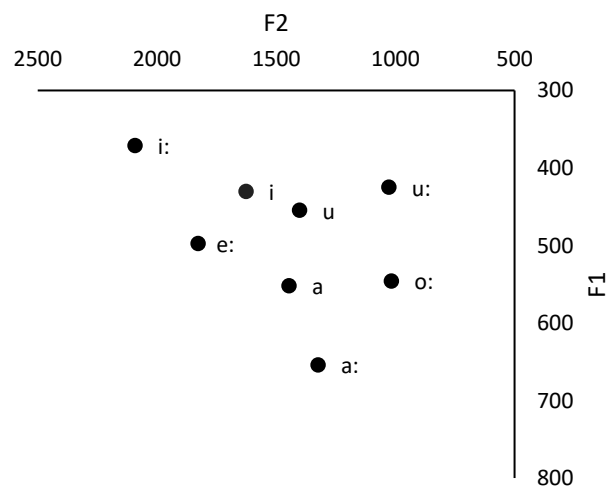
Table 2 below presents the obtained average vowel formants (F1 and F2) and duration (in millisecond) for each vowel.

**Table 2.** Average F1 and F2 values and duration for all vowels.

Vowel	F1	F2	Duration
/a:/	653.743	1324.112	138.077
/a/	552.203	1445.433	70.26097
/i:/	371.1182	2091.597	102.3378
/i/	429.99	1626.148	54.22397
/u/	454.5769	1401.49	53.12449
/u:/	424.9873	1026.86	100.749
/e:/	497.603	1826.558	125.7461
/o:/	545.8368	1016.206	123.4459

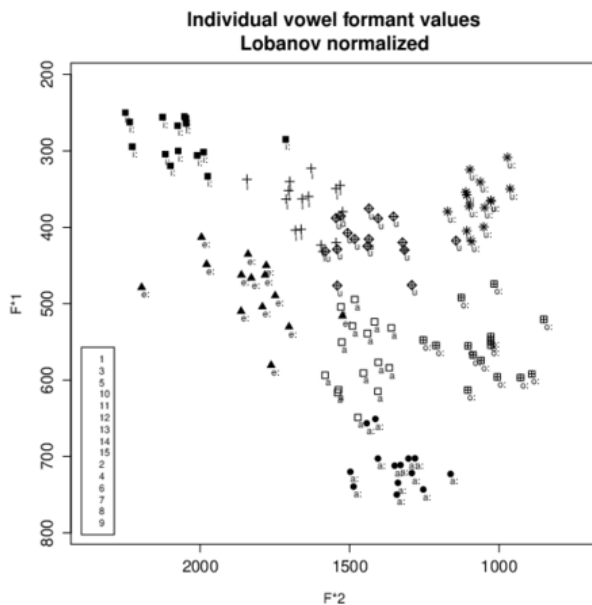
Long vowels are almost double the duration of their short counterparts. The mean durational ratio of long to short vowels for all three vowel pairs is 1.9. This is similar to the result found in Alghamdi [9] for MSA produced by Saudi Arabians. The results generally corroborate the auditory description of vowel length in Najdi Arabic demonstrated by Ingham [7].

Figure 2 below plots the mean F1 and F2 values for all vowels to examine the phonetic realization of Najdi Arabic vowels. Short vowels are more centralized and reduced in quality than their long counterparts. Similar results were obtained for Jordanian Arabic in [4]. Different from the description provided by Ingham [7], /a/ is more centralized and slightly fronted.



**Figure 2.** F1/F2 Plot for all Vowels

To capture individual speaker variation, the production of all speakers for each vowel is presented in Figure 3 below after normalization. Apart from the small spectral overlap between /i/ and /u/, the mean formant values show similar results to the individual and normalized formant values.



**Figure 3.** F1/F2 values of speakers' production of each vowel after normalization (Labov transformation).

To sum up, the vowel system of Najdi Arabic consists of three long vowels /i:/, /u:/ and /a:/ and three short counterparts /i/, /u/, and /a/, which differ in both quantity and quality. The short vowels are almost half the duration of the long ones and are significantly more centralized. Najdi Arabic also demonstrates, as many spoken Arabic dialects, the monophthongization of the MSA diphthongs /ay/ and /aw/, which resulted in the long vowels /e:/ and /o:/, respectively.

## 5. CONCLUSION

The findings of the current acoustic study corroborate the auditory description of Najdi Arabic vowels by Ingham [7]. Short vowels are almost half the length of the long vowels, and they are also more centralized or reduced in quality than long vowels. However, short vowels still form different spectral categories in their own. The only difference between the auditory description provided by Ingham [7] and the finding of the current study is that /a/ is more centralized and slightly fronted in the current study.

## 6. REFERENCES

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