Phonemic Inventory of Khowar Language: An Acoustic Analysis

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Abstract *Khowar, the lingua franca of people living in district Chitral, is a rich language from a linguistic perspective, possessing links with Old Indo-Aryan (OIA) languages in its inventory and lexical similarity with the Sanskrit language. The aim of the current study is to redefine and document its phonemic inventory with the possible, latest and authentic linguistic tools. The findings of this study will benefit both native speakers and educational institutions with their Khowar language script and will provide an easy way for interested researchers. This descriptive study followed both qualitative and quantitative scales, with segment acoustic description, explanation and charting formant values. The data has been collected in the form of recording from native speakers of Khowar language for segments included in the reading list proposed by the researchers. The recorded corpus has been analyzed using Praat software (2017). The research outcomes are updated and acoustically redefined phonemic inventory of Khowar Language.*

Key Words: Khowar Language, Acoustic analysis, Phonemic Inventory, Consonants, Vowels

Introduction

The paper offers a brief acoustic description of phonemic inventory of Khowar language with related studies conducted by (Johnson, 2003; Yule, 2010; Ball & Rahily, 2013; Lisker, 1957; Shadle, 1991; Ladefoged & Maddieson, 1996; Fant, 1968; Ladefoged, 1967; Maddieson & Gandour, 1977; Fant, 1960; Bladon, 1979; Ashby & Maidment, 2005; Ladefoged, 1971; & Ladefoged and Disner, 2012) and Khowar linguistics contributions by (Endreson & Kristiansen, 1981; Munnings D, 1990b; Solan, 2006; Bashir, 2003; & Razi, 2010). The Phonemic Inventory of any language can be understood with the minimal pair analysis. However, the present study is also concerned with the acoustic representation of the minimal pair of data.

Before we discuss the phonemic inventory of Khowar language it is better to understand the concept and tools of the analysis. Acoustic phonetics deals with the physical proprieties (pitch, loudness, amplitude, quality, and spectrographic properties) of the sound waves during the process of speech production Ball and Rahily (2013). Praat is a digital software used to analyze the sound waves by playing, annotating and analyzing the sound objects in terms of acoustic properties i.e. Frequency, Pitch, Intensity etc. Formants are shown in red dotted lines in the spectrogram of Praat. Different tiers are used to segment the speech waveform for further analyses (Johnson, 2003). The spectrogram is the graphical representation of sound waves by explaining their component frequencies. It also shows three-dimensional information i.e. frequency (vertical axis), time (horizontal axis) and acoustic energy mean the formant frequencies; the dark shading bands on a spectrogram (Ball, & Rahily, 2013).

Statement of the Problem

Khowar being indigenous language, language of people living in an isolated valley of district Chitral, is not on the list of major languages of Pakistan. That is why it is always been neglected by Pakistani linguists to work on its phonemic inventory and other linguistic forms with modern linguistic theories and tools.

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The phonemic inventory has been defined many decades ago by Kristiansen (1981) with partial fulfillment, without applying modern techniques. Excessive number of retroflex affricates, less number of vowels, absence of schwa and glottal stop is being documented as phonemic inventory without using acoustic phonetics and phonological approaches. It is need of the time to preserve and define the language inventories with modern approaches for their better script presenting.

Objectives of the Research

The main objectives of the current study are:

i. To acoustically check and analyze the segments which are present in the inventory of Khowar language and to represent phonemic segments phonetically.
ii. To explore the phonemic inventory of Khowar language according to modern linguistic tools and equipment.

Research Questions

The current study answered the following questions with the acoustic-phonetic approach:

i. How many consonants segments are in Khowar language and what are their acoustic characteristics?
ii. How many vowel segments are in Khowar language and what are their acoustic characteristics?

Significance of the Study

The current study is interesting and informative for both the native speakers of Khowar language and linguists interested to study Khowar language linguistically.

Since Khowar language is being taught in educational institutions, the current study will be helpful to understand and teach phonemic segments in Khowar language. Acoustic labeling of the segment will help to construct compatible orthography for writing literature and other linguistic information according to the updated and more general criterion. Further, it will be the guide map for the linguists seeking to review the phonetics, phonology, syllable structure and other phonemic linking fields of Khowar language. The acoustic analysis will also help the corpus development for the language. Acoustic labeling of phonemic segments is the first step to study the language for systematic studies, therefore the outcomes of current analysis will support the advance linguistic studies for better results.

Literature Review

Many different studies have been conducted in the acoustic analysis of phonemes in different languages. Yule (2010) explained the airstream mechanism for the consonants sounds in the oral and nasal cavity, which is accurate picturing to differentiate the consonants from other sounds. Johnson (2003) explained the behavior of fricatives that the noise appears when the airflow with the narrow channel resulting in the acoustic irregularity in the medium and the irregular motion of molecules produced the random sound pressure waves. Shadle (1991) further elaborated on the distinction of fricatives according to different obstacles like for /x/ the source obstacle is the wall and for bilabial /f/ and /v/ are into with the lips. All type of fricatives involves different obstacles. It is very difficult to make a glottal and bilabial fricative noise loudly. Ball and Rahily (2013) explained the acoustic behavior of 'obsturents' the term covers all the fricatives, plosive and affricate sounds. Sonorant sounds in contrary to stops neither a complete break nor a release while production but they behave like vowel sounds, their spectrograms have a formants structure, they pic the adjacent vowel characteristics, trying to be vowels but they have a low level of energy (Ball & Rahily, 2013). Ladefoged and Maddieson (1996) argued about the generalization that, if a language has both an apical and a laminal stop consonant, then the laminal ones behaved more like retroflexes. In the spectrographic analysis of the Isoko for the laminal dental and apical alveolar stop, in the dental stop, the energy impact is quite longer and stronger with the comparison to the alveolar, this is because the tongue blade, which is lower for the dental stop and hence F2 is much higher. The Retroflex sounds which possess multiple articulatory properties are both the components with their individual acoustic properties and easy to distinguish and identify in the spectrograms (Ladefoged & Maddieson, 1996). Ladefoged (1968)

argued the behavior of the retroflex sound comparing Ewe and Hindi language, that these sounds are not similar in the articulation both are retroflex but the tongue curve in Hindi is curved more than Ewe. The retroflection affects the higher formats values, the F4 is relatively low when it comes to F3 in alveolar and in palatals, F3 value is low when it comes to F2 (Fant, 1968). Ladefoged and Maddieson (1996) discussed the acoustic behavior of stops, which they have clear movement of silence and sudden burst which is the result of their sudden release in their spectrographic representation. Breathy voiced in contrary to the plain voiced stops have extra energy in their spectrograms which indicates the aspiration short after the release which because of the glottal movement for aspiration overlap the following segment. Maddieson and Gandour (1977) discussed the vowel length increase before the breathy voiced stops, that is the glottal movement which tends to be near to the vocal cords. The voicing bar is visible for the following vowels in the case of unaspirated stops but it tends to be an extra distributed energy before the following vowels that shows little bit distributed energy without initial frequency are the physical properties of aspirated segments (Ladefoged,1967). Ladefoged and Maddieson (1996) identified the prolonged production of affricate stops, affricates usually have their stop or fricative companion and they have both the individual segment properties in the same time and bit of extra time in the scale in their production.

Nasal consonants usually show their closure in velic opening and release their air through the nasal cavity, simple nasal consonants are called nasal stops by some linguists. The acoustic nature of nasal consonants is somehow vowel-like with low energy as compare to vowels and their vowel adjacent segments (Ladefoged and Maddieson, 1996). Laterals are those sounds which are usually produced with little air passing from one side or from both sides in the mid vocal passage, voiced lateral approximants have formants like resonance with low F1 and somewhat energy in the second formant of the segment spectrogram, laminal dental and palatalized retroflex laterals have comparatively high F1 values (Fant, 1960; Bladon, 1979). While production of the trill sounds, a repeated pattern of opening and closing of air occurs in the flow channel, apical trills usually contain three or more than three periods of vibrations in their production and they have distributed shades in their spectrograms (Ladefoged & Maddieson, 1996).

Almost every language includes a vowel as a nucleus or central portion. These are sonorants sounds produce with a relatively wide vocal tract and because of the vibration in the vocal tract, all vowel sounds are voiced (Ashby & Maidment, 2005). Vowels are all voiced, it means they have energy in their fundamental level usually between 100-200 Hz region depending on the speaker, identification of vowels through spectrograms is a very easy task they all have formant values, which shows the clear band of energy in spectrographs. The spectra consist of the different articulatory cavities resonant energy which is labeled as shade in spectrograms. Vowel differs from one another in terms of their tongue height, tongue advancement and lip rounding features. Vowel height and F1 value are inversely proportional it means close or high vowels have low F1 value, F2 refers to the advancement of the tongue, so front vowels have grater F2 values than back vowels, and lip rounding has the negative effect of overall energy throughout vowel formants (Ball & Rahily, 2013). Ladefoged and Maddieson (1996) elaborated on the cardinal and acoustic placements of the vowels in general, and the findings are quite similar but not exactly in the same places and there could be accent difference in the production of the vowels according to different speakers. The vowels /ɪ/ and /ʊ/ are acoustically close to the /ɛ/ and /o/ rather than /i/ and /u/. Ladefoged (1971) noted the degrees of the nasality, which is the minor feature of the vowels, that nasalized vowels have clear little weaker F1 and rising F3 in comparison to the same oral vowel segment, but the nasal vowels have weaker F1 and they have very high F3 positions in comparison to their nasalized counterparts.

Ladefoged and Disner (2012) briefly discussed the English consonants' acoustic behavior and different formant pattering. The voiced plosives /b/, /d/ and /g/ can be categorized with their formant movements, /b/ having a low second and third formant, /d/ with a third high and second mid-range about 1700Hz and /g/ with formants second and third more close to each other. Voiceless plosive also has a similar formant structure with no voicing bar after the vowel sounds but they have a burst and silence structure in their spectrograms when they appear in the initial position of the word. English approximants share their unique formant patterning, like the movement away from the English vowel /i/ for /j/ and for /w/ being similar to a movement away from the vowel /u/, the /ɹ/ sound usually has a low about to 200Hz of the third formant. The last approximant /l/ have a very low intensity in a very low frequency and a notable break in the pattern when occurring before the vowels (Ladefoged & Disner, 2012). English nasal consonants share similar formant behavior with their stops

correspondents, additionally, they have F1 frequency abound 200Hz and the second formant near 2500Hz with very little energy in it as compared to the energy usually occupied by this region (Ladefoged & Disner, 2012). In English affricate naturally contain the spectrographic characteristics of their main components, it means a break for the stop followed by the high-frequency noisy component (Ball & Rahily, 2013).

Ball and Rahily (2013) represented the vowels with their first two formants, which are considered the vowel space in the vocal tract and defining vowels with these acoustic outputs, but according to (Ladefoged & Disner, 2012) the vowels can be also be classified with the movement of formants in the spectrograms, where they show slightly down movement when they come with a high front to low front vowels.

The phonemic inventory of Khowar language has been discussed by a few linguistics in their fieldwork. First Endreson and Kristiansen (1981), list down all the consonant and vowel segments in a chart. Later Munnings D (1990b) modified the chart with the help of native informant Rahmat Aziz Chitrali. The detailed discussion on the phonemic inventory of Khowar has been done by Solan (2006) in his Khowar to English dictionary.

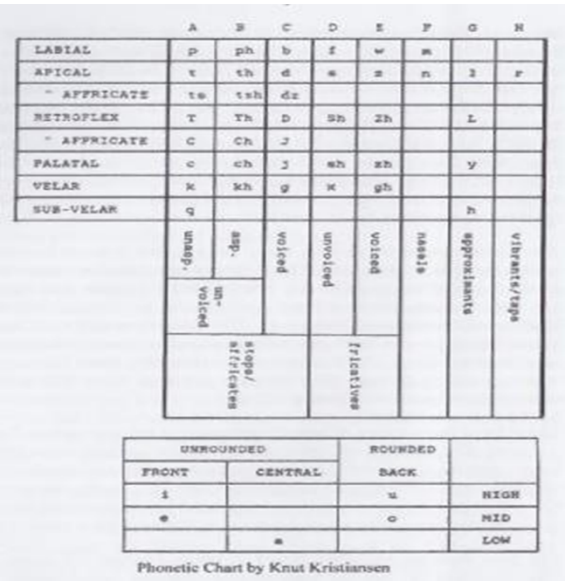

Figure 1: Phonemic Chart of Khowar language taken from (Solan, 2006).

All the study which is done in phonemic inventory of Khowar language is first of all done with little older methods of linguistic analysis, secondly, their main priority was to establish a writing system for Khowar language in Perso-Arabic script.

The most recent and more linguistic work on Khowar language is discussed by Cardona and Jain (2003), where all consonant and vowel segments are listed and also stated that "In Khowar, /q/,

/x/, / ɣ/ and /f/ often restricted in IA languages to Persio-Arabic loans, occurs frequently in native words. Although /ɬ/ has been called 'retroflex' and the Khowar writing system represents it with the character used for Urdu /r/ absent in Khowar, /ɬ/ is a velarized lateral similar to Kalasha and Palula/ɬ/".

Razi (2010) described forty-three orthographic symbols for Khowar language, these symbols exceed the number of phones in Khowar language, his most work is on the morphology and syntax of Khowar language. Solan (2006:23) argued about the number of vowels in Khowar language he stated "There are five vowels in Khowar language. I have labeled them as A, E, I, O, U. The vowel sound in the English word 'high' is symbolized by 'AY'. The conclusion that there are exactly five vowels in Khowar language was the most vexing and most difficult to reach since Captain O'Brien lists no less than fifteen vowels. Paul Mullen concluded that there were either six or seven vowels when he visited my house but have trouble with this so far the month of agonizing I decided to write only five vowels in Khowar".

In contrast to previous research objectives and methods applied to Khowar language the current study aims to analyze and redefine the phonemic segments in Khowar language with modern linguistic tool analysis and document the phonemic segments in accordance with IPA, will help linguists interested and educationist to review their language teaching data. The current study will be interesting and informative for both the native speakers of Khowar language and linguists interested to study Khowar language linguistically.

Since Khowar language is being taught in educational institutions, the current study will be helpful to understand and teach phonemic segments in Khowar language. Acoustic labeling of the segment will help to construct compatible orthography for writing literature and other linguistic information according to the updated and more general criterion. Further, it will be the guide map for the linguists seeking to review the phonetics, phonology, syllable structure and other phonemic linking fields of Khowar language. The acoustic analysis will also help the corpus development for the language. Acoustic labeling of phonemic segments is the first step to study the language for systematic studies, therefore the outcomes of current analysis will support the advance linguistic studies for better results.

Methodology

The current study is descriptive and followed a qualitative method to explain and differentiate different segments' acoustic articulatory behavior, and quantitative method to chart vowel formants with their different frequency values. The researchers obtained primary data for analysis in the form of recording of minimal pair list, which is presented by the researchers, and also looked into secondary data to relate the data with the previous phonemic inventory. Recordings of the list of minimal pairs are obtained, each for consonants and vowels and also more than one for the vowels in words, recorded by the researcher being native speaker of Khowar language and the data is analyzed using Praat software (2017). The data has been collected in the form of recording by the researcher in his own voice for the phonemic segments which have already been documented by earlier researchers and for the segments proposed by this study the recordings have been collected from the speakers studying in Quaid-i-Azam University. At least one male and female speaker of Khowar language and the sample has been taken according to the need of research for better samples. The obtained data has been analyzed using Praat (2017) and highlighted the acoustic characteristics of phonemes in Khowar language and their status in the inventory, with the measurement Praat (2017) propose to label the segments. The minimal pairs have been repeatedly analyzed to identify and differentiate their formant structure, the spectrogram has been taken for each and every segment analyzed using Praat (2017) to finalize results.

Consonants of Khowar Language

The consonantal phonemes documented by Endreson and Kristiansen, 1981; Munnings D, 1990b; Solan, 2006; & Bashir, 2003 are oral stops /p/, /pʰ/, /b/, /ʈ/, /ʈʰ/, /ɖ/, /ʈ/, /ʈʰ/, /ɖ/, /k/, /kʰ/, /g/, /q/, nasal stops /m/, /n/, fricatives /f/, /s/, /z/, /ʃ/, /ʒ/, /ʂ/, /ʐ/, /x/, /ɣ/, /h/, affricates /ts/, /tsʰ/, /dz/, /tʃ/, /tʃʰ/, /dʒ/, /tʂ/, /tʂʰ/, /ɖʐ/ a trill phoneme /r/, two approximants /ʊ/ and /j/, with lateral /l/, have been verified via both minimal pair and acoustic analysis as independent consonantal phonemes of Khowar language. But the /lˠ/ is a velarized lateral as cited by Bashir (2003) seems not the complete articulatory description for the phoneme. Here is the acoustic figure of the Phoneme.

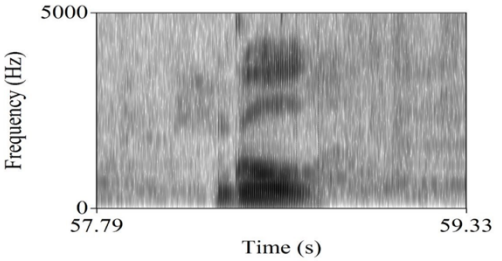

Figure 2: Voiced Dental Lateral (Velarized) Approximant /lˠ/ in the word /golˠ/.

The above spectrogram, we have noticed the low-level energy in the F1 region as compared to the previous one, this kind of acoustic behavior usually present in the dental articulation, because the impact of articulators is near the front position which causes the low energy impact on the phonemic segment. It has an extra velic impact in the region 4500Hz shorter than the consonant in the initial position, which indicates the velarized behavior of this phonemic segment, hence with these acoustic clues it is clearly identified as dental lateral velarized approximant /lˠ/ phoneme.

The current study further noticed four other consonants used by Khowar speakers and dually checked their presence with both Minimal Pair and Acoustic analysis, the details are under:

Voiceless Alveolar /t/

In the figure below, the strong energy impacts indicate the articulatory impact post from the dental place. It has a thinner plosive line that indicates the tongue tip impact, let the passage wider, and plosive closure silence which equally matching with plosive consonants. Hence with matching acoustic patterns with the plosive segments and absent of F0 in the voicing impact spot it is clearly defined as voiceless alveolar /t/ phoneme in the final position of the spectrogram.

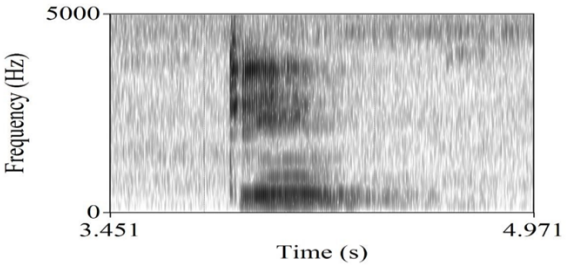

Figure 3: Voiceless Alveolar /t/ in the Word /tim/.

Unvoiced Aspirated Alveolar /tʰ/

In the following spectrogram, the acoustic behavior of initial consonant sound is similar to the acoustic patterns of figure /t/, but it has extra energy which is prolonged as compared to the previous image, which shows the aspiration effect. The energy impact is in the 4000Hz frequency range preceding the vowel sound. In the light of this acoustic evidence and with no F0 in the range between 200Hz it is clear that the segment in the initial position of the word /tʰiŋ/ is aspirated alveolar consonant /tʰn/

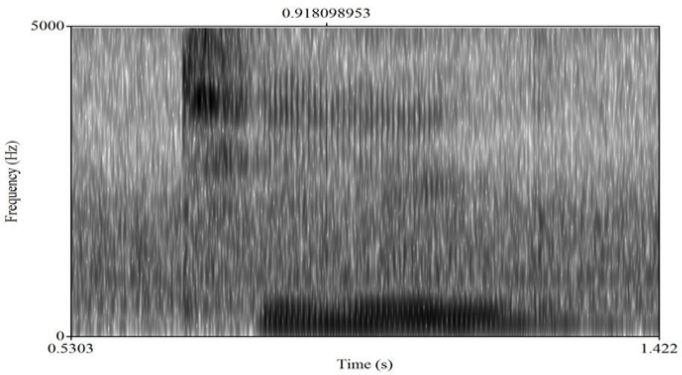

Figure 4: Unvoiced Aspirated Alveolar /tʰ/ in the word /tʰiŋg/.

Voiced Alveolar /d/

In the below acoustic figure, the initial segment of the word has a similar acoustic impact as the /t/ phoneme, but it has a clear energy impact on the 100-200Hz frequency line, which indicates the segment voicing nature. The acoustic impact is systematically equal to the /t/ segment except for the voicing bar, but the energy impact is lightly shaded usually consonants segments have, as compare to their unvoiced counterpart. Hence with the light of acoustic patterns matching with voiced phonemic segment produce in alveolar impact on is counted voiced alveolar /d/ phoneme.

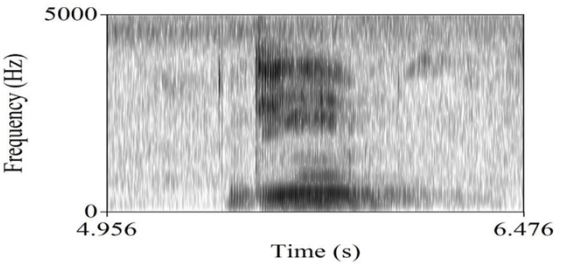

Figure 5: Voiced Alveolar /d/ in the word /dim/.

Voiced Nasal Velar Plosive /ŋ/

The following spectrogram has a closing F2 and F3 formants, which differentiate the nasal sound from the other nasal sounds. In the above spectrogram, the energy impact is distributed to the F0 range which indicates the voicing impact of the segment, and some energy is in the 1500Hz3000Hz frequency range, velar segments have similar energy in that frequency regions. Hence the segment preceding the consonant in the coda of the word /poŋg/ is a Voiced nasal velar consonant
/ŋ/.

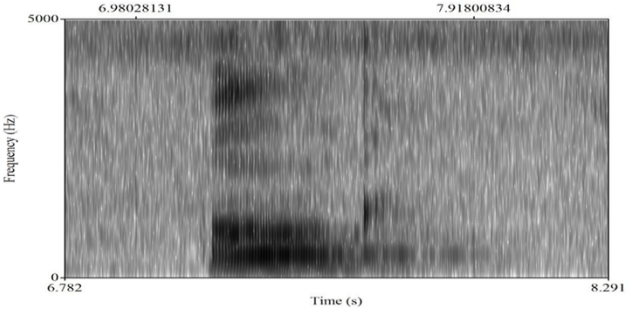

Figure 6: Voice Nasal Velar Plosive /ŋ/ in the word/poŋg/.

It has then confirmed that Khowar language has sixteen oral stops with bilabial, dental, alveolar, retroflex, velar, and uvular places of articulation. Three nasal stops bilabial, alveolar, and velar positions. Ten fricative consonants in bilabial, alveolar, post-alveolar, retroflex, velar and glottal regions. Khowar language has nine affricates, six in the alveolar and post-alveolar region and three with both retroflex segments. Khowar language also has trill sound in the alveolar region, labiodental approximants and palatal voiced segment are also part of the Khowar phonemic inventory. Lateral approximants are two in number, the first one is dental velarized lateral approximant and the other is the alveolar voiced phonemic segment. Khowar language has a total of forty-three consonantal phonemes in its inventory. In light of current research, the researcher has proposed the following updated and modified table for the Khowar language.

Table 1: IPA Symbols for Khowar language.

	Bilabial		**Labio-dental**	**Dental**		**Alveolar**		**Post-Alveolar**		**Retroflex**		**Palatal**	**Velar**		**Uvular**	**Glottal**
Stop	p	b		ʈ	ɖ	t	d			ʈ	ɖ		k	g		
	p^h			$ʈ^h$		t^h				$ʈ^h$			k^h		q	
Nasal		m					n							ŋ		
Fricative			f			s	z	ʃ	ʒ	ʂ	ʐ		x	ɣ		h
Affricate						ts	dz	tʃ		tʂ						
						ts^h		$tʃ^h$	dʒ	$tʂ^h$	dʐ					
Trill							r									
Approximant			ʋ									j				
Lateral-Approximant				(ɭ)			l									

Vowel Phonemes of Khowar Language

Vowels are those sounds that are produced with no obstruction of the air stream when it passes from the larynx to lips, and a monophthong is a single segment having perceived vowel quality, with the fixed manner of articulation and with no gliding effect on its articulation (Roach, 2009). Apart from the discussed vowel segments of Khowar language by (Endreson and Kristiansen, 1981; Munnings D, 1990b; Solan, 2006; & Bashir, 2003), as /i/, /e/,/a/, /o/, u/ there is a monophthong and three Diphthongs which are present in Khowar language with solid acoustic and linguistics means, the details are given in the following discussion.

Near High Front Vowel /ɪ/

In the spectrogram, F1 has an impact in a bit high position, and the second formant has an impact bit lower frequency line, but it has its gap which indicates the front quality of the vowel segment. The overall formant structure is with high energy impacts on all formants indicates the spread position of the lips. Hence under these acoustic pieces of evidence it is cleared that the nucleus of the word has a near high front vowel /ɪ/ in it.

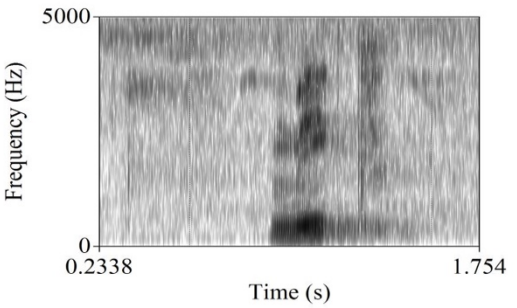

Figure 7: Near high front vowel /ɪ/ in the word /mɪk/.

Vowel Formant Values

The formants values in Table 2 confirms the acoustic distinction of the vowels as high and near-high front unrounded vowels /ɪ/ and /i/, with different formant value for the mid vowel /e /. Khowar language also has a low front vowel /a/. The acoustic analysis also distinguished the two rounded vowels /o/, and /u/ in Khowar language. Khowar language has a total six number of monophthongs.

Table 2: Formant Values for Vowels of Khowar Language.

Vowels	F1(Hz)	F2(Hz)
i	288	2210
ɪ	395	1855
e	422	2010
a	626	1523
o	532	933
u	331	808

Diphthongs

Diphthongs are those vowel segments which consist of two segments, it means a glide from one to another segment (Roach, 2009). The first segment of the diphthong is comparatively stronger from the other counterpart; this kind of segments has been observed in Khowar language also:

An Upgliding Diphthong /aɪ/

In the following spectrogram, the last position of the word has two different adjacent vowels like formant structures. The first part of the last segment has an acoustic similarity and formant value of the vowel /a/ which is 626Hz for F1 and 1523Hz for F2 in Khowar language. The second part of the segment has also clear formants, it has also near formant values of vowel /ɪ/ which has an F1 value of 396Hz and F2 of 1855Hz. Hence it is clear then that Khowar language has an upgliding diphthong /aɪ/.

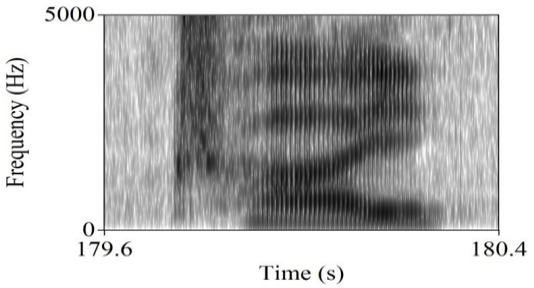

Figure 8: An Upgliding Diphthong /aɪ/ in the Word/ʈʂʰaɪ/.

An Upgliding Diphthong /oɪ/

In the spectrogram below, the first vowel segment has a low F1 with low F2 value, nearly matching with the values of low-mid-back rounded vowel/o/, which has formant values 532Hz and 933Hz for F1 and F2 respectively. The other vowel segment has the same formant structure and near formant values as near high front vowel /ɪ/, hence it is observed that the above spectrogram has an upgliding diphthong /oɪ/ in the last position.

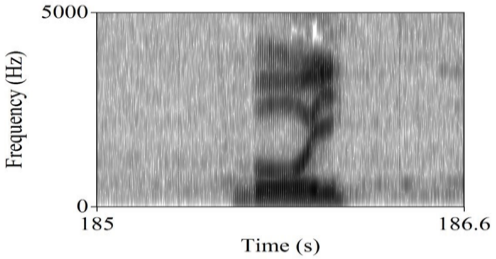

Figure 9: An Upgliding Diphthong /oɪ/ in the Word /boɪ/.

An Upgliding Diphthong /ʊɪ/

The last position of the below spectrogram has also a diphthong acoustic impact, but here the first vowel segment has near matching values of 352Hz and 882Hz for F1 and F2 respectively which are formant values of near high back rounded vowel/ʊ/. The segment adjacent vowel has matching formant patterning and formant values of near high front unrounded vowel /ɪ/. Hence it is defined that the acoustic behavior of the last segments of the above spectrogram is matching with an upgliding diphthong /ʊɪ/.

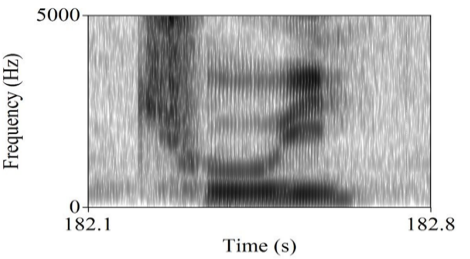

Figure 10: An Upgliding Diphthong /ʊɪ/ in the word /ʈʂʰʊɪ/.

Conclusion

It has been observed and now cleared that Khowar language has sixteen number of oral stops /p/, /pʰ/, /b/, ʈ/, /ʈʰ/, /ɖ/, /t/, /tʰ/ /d/, /ʈ/, /ʈʰ/, /ɖ/, /k/, /kʰ/, /g/, /q/, with their exact acoustic output, results their articulatory behavior, the alveolar plosives are new in the list, these segments are added with their accepted minimal pair setting and acoustic differences from the reset of oral plosive segments. The three nasal stops /m/, /n/, and /ŋ/, ten number of fricatives /f/, /s/, /z/, /he alveolar plosives are new in the list, these segments are added with their accepted mini /ʈʂ/, /ʈʂʰ/, /ɖʐ/ also have exact acoustic images matching with their articulatory behavior. Khowar language also has a trill phoneme /r/, two approximants //, /s/, /z/, /he alveolar plosives are new in the list, these segments are added with their lar to the effect came with their kind of articulation. The total number of consonantal phonemes in Khowar language is forty-three.

This current study also looked into the vowel segments of Khowar language, and redefine vowel segment /i/, /e/, /a/, /o/, u/ with their formant frequencies. This research also confirms one vowel segment unreported in previous inventory, having formants structure and values of near high front unrounded vowel /ɪ/ used by the speakers of Khowar language. Khowar language also have diphthongs which have been observed and analyzed with Praat and it is concluded that Khowar language has three upgliding diphthongs /a Khowar language, and redefine vowel segment /i/, /e/, /a/, /oThe objectives of the current study to acoustically redefine the phonetic inventory of Khowar language and to observed phonemes not mention as part of the Khowar phonetic inventory. The analysis confirmed identical acoustic behavior of documented phonemes and some other phonemic segments, for example, alveolar plosives /t/,/tʰ/ and /d/, acoustic description for the /r/ and new observed monophthong /ɪ/, and diphthongs /aɪ/, /oɪ/, and /ʊɪ/ occur in the speech of natives of Khowar language. The analysis was done by using the Praat software with the corpus data of the researcher and a male and female Khowar speakers. The findings are worth considering for the language researchers, native speakers and the educational institution teaching Khowar language.

The study may contribute to a better understanding of phonemes in Khowar language specifically and Phonetics in general. Acoustic study on supra-segmental level for example syllable, stress and tone will be a big contribution to the Khowar language and understanding the phonemic behavior of sounds in Khowar language more eloquently.

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APPENDIX

Phonemic Inventory of Khowar Language

List of Consonants

Phoneme	Words (Transcriptions)	Meaning
/p/	/pan/	Pigeonhole
/pʰ/	/pʰan/	Palm of hand
/b/	/ban/	Stick
/ʈ/	/ʈan/	Own's/possessive/reflexive pronoun
/ʈʰ/	/ʈʰan/	Figure(Body)
/ɖ/	/ɖan/	Pop corns
/t/	/tim/	Metal Plate for roof
/d/	/dim/	Body
/ʈ/	/ʈak/	Miser
/ɖ/	/ɖak/	Full
/k/	/kan/	Tree
/g/	/gan/	Wind
/kʰ/	/kʰar/	Vegetable bad
/k/	/kar/	Ear
/h/	/hon/	Flood
/q/	/qon/	coal

List of Vowels

Phoneme	Words (Transcriptions)	Meanings
/i/	/bim/	Will go
	/mik/	Urinate
	/gir/	Saw
	/pim/	Will drink
	/fil/	Elephant
/ɪ/	/bɪk/	To go
	/mɪk/	Uncle
	/ɪ/	One
	/ɪʃʈok/	Match
	/pɪʃin/	Noon
/ɛ/	/ɖɛk/	Leg
	/bɛk/	Bag
	/dɛk/	Run
	/xɛʂ/	Good relation(between)
	/krɛm/	Waist
/a/	/kan/	Tree
	/xal/	Taste
	/ʈaʈ/	Father
	/kʰak/	Head
	/qaq/	Thirsty
/o/	/bom/	Can do
	/bop/	Kind of fruit
	/boʈ/	Dinner