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Spectral analysis of the Vedic mantra Omkara

Heisnam Jina Devi, N V C Swamy* and H R Nagendra

Hindu University of America, Orlando, Florida, USA
Extension Center, Vivekananda Yoga Anusandhana Samsthana, Bangalore

E-mail: swamynvc@yahoo.com

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It has been recognised for quite some time that Mantras or sacred words have beneficial effects on human beings and even plants. In a previous study, the authors have demonstrated the effect of Agnihotra mantra chanting at sunrise and sunset on the germination of rice seeds. Scriptures also mention that mantras like Om, Gayatri and Mrityunjaya have benefited humanity quite a lot.

This paper is an attempt to identify quantitatively the signal characteristics of mantra sound patterns. It is a pilot study and appears to be one of the first of its kind in the world. The study has confined itself to the identification of the predominant frequencies and their subharmonics of A-kara, U-kara, Ma-kara and Om-kara.

Keywords: Spectral analysis, Vedic mantra, Omkara.
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Since time immemorial, there has been a belief that sacred words and their combinations called Mantras have beneficial effects on human beings, animals and even the plant kingdom. This belief has been so widespread that practically every scripture refers to it in some way or other. Extensive details regarding the meaning and significance of Mantras and their use in daily life are available in Jina Devi[1].

Recently, some investigations have been carried out on the effect of chanting of Agnihotra mantra at sunrise and sunset, accompanied by sacrificial fire, on the germination of rice seeds[2]. It has been demonstrated with the help of controlled experiments that the Agnihotra ritual performed according to scriptural injunctions has a remarkable effect on the rate of rice seed germination. This naturally leads to the question—what is that aspect of the mantra which influences the germination so noticeably?

While a qualitative analysis of the effect of mantras is easily done, a quantitative analysis is more complicated. It is known from scriptures that mantras like Om, Agnihotra mantra, Gayatri mantra and Mahamrityunjaya mantra have benefited humanity to a large extent. However, it is very difficult to pinpoint what precisely there is in these mantras which makes them so effective. This

*Correspondent author

requires a detailed study of the sound patterns of the mantras and their characteristics, based upon the latest advances in speech synthesis, analysis and recognition. It is against this background that the study reported in this paper was undertaken. To the best of the authors knowledge, this appears to be the first study of its kind.

Literature

Since the time of Lord Rayleigh, i.e., the beginning of the 19th century, there has been a lot of interest in studying the effect of music on the human system. It is only recently that interest has developed in extending this work to Mantras also.

In 1981, Stigsby *et al*[3] conducted a study on the effect of mantra meditation on the electroencephalograms of experienced meditators. The results were inconclusive. Seer & Raeburn[4] conducted a similar study on the effect of meditation training on hypertension. Here also, the study showed modest reductions in blood pressure, but the results were again inconclusive.

In 1994, Telles *et al*[5] conducted experiments on the effect of Om meditation on Middle Latency Auditory Evoked Potentials of 18 male subjects between the ages of 25 and 45 years, 9 of whom had more than 10 years of experience in Om meditation and the other 9 had no experience at all. The results indicated that the experimental group showed an increase in the peak amplitude of Na-wave, whereas there was a significant decrease in the control group.

They extended this work in 1998[6], with the experimental group meditating on Om and the control group meditating on a neutral word One. Mental repetition of Om showed a significant decrease in skin resistance level of the experimental group as against the control group. There was also a reduction in the heart rate and the rate of breathing.

Takahashi *et al*[7] conducted a pilot study in 1999 on the effect of low frequency noise on human body vibration. They showed that the low frequency noise affects the health of individuals depending on the structure of the body. The frequency range used by them was from 20 to 50 Hz, which is quite below the frequency of a normal human voice.

Perhaps the most interesting study, and the most relevant for our current work, is that of Uchida & Yamamoto[80] the effect of sound forms on the germination of seeds, which showed that sinusoidal vibrations in the range of 40 to 120 Hz had a significant effect on seed germination. The increase in the rate of seed germination depended upon the frequency and was noticeable in the range of 70 to 100 Hz. This behaviour, however, was not uniformly noticed for seeds of different varieties. This work compares favourably with our own studies on the effect of Agnihotra Mantra on the germination of rice seeds as reported in Jina Devi[2].

It is thus seen that attention has so far been focused on the effect of sound forms, hardly anything having been done on the structure of the sound forms or mantras. Unless one knows the sound characteristics of mantras in detail, one will not be in a position to identify the factors, which have been found to influence seed germination in the two studies referred to in the previous paragraph. It is this fact which has motivated the current study.

Materials and Methods

The experiment consisted of the following steps: recording of the mantra with the help of a sensitive microphone, digitizing the analog waveforms with the help of a computer with a sampling rate of 44100 per second, analysing the digitized data to extract information about the frequency and the energy spectra from the waveform, and to identify the predominant frequencies.

It was decided as a first step to concentrate on the study of the mantra Om, with its components A, U and Ma. The system configuration used consisted of a microphone, a computer fitted with the Sound Blaster software and the necessary software for spectral analysis.

In the first trial, an ordinary microphone was used, fitted to a computer with vocal response. It was seen that the noise level was rather high, affecting the signal-to-noise ratio, even though the recording had been done in a room with a quiet ambience. Subsequent trials showed that the noise in the signal was due to the poor quality of the microphone.

A more sophisticated microphone was then fitted to the system. Trials showed that the noise level was considerably reduced. The quality of the signal was then vetted by two experts in the field of Acoustics, one from the Indian Institute of Science and the other from Datalogic Pvt. Ltd., both from Bangalore.

Four recordings were then made, two with male voices and the other two with female voices. The recordings were restricted to A-kara, U-kara, Ma-kara and Om-kara. After a few repeated recordings, the ones with the best quality of reproduction were chosen for analysis. The results of the analysis are presented in the next section.

Results

The waveforms of A-kara, U-kara, Ma-kara and Om-kara were used as raw data to extract the following information:

(a) Short-time window patterns of the four voices displaying the periodicity of the signals.
(b) Energy-frequency spectra, with prominent frequencies and subharmonics.
(c) Frequency-time spectra or spectrograms.
(d) Hundred millisecond records of the waveforms as energy-frequency spectra.

Only a small sample of the above results is presented here to illustrate the conclusions drawn. A full record of the above, running to 126 figures is available in Jina Devi[1].

Figures la and Ib show the waveforms for a female and a male voice, respectively for all the four letters—A, U, Ma and Om. This represents the direct recording on the computer, which is subjected to digital analysis. One can clearly recognise that A has a flat signal,

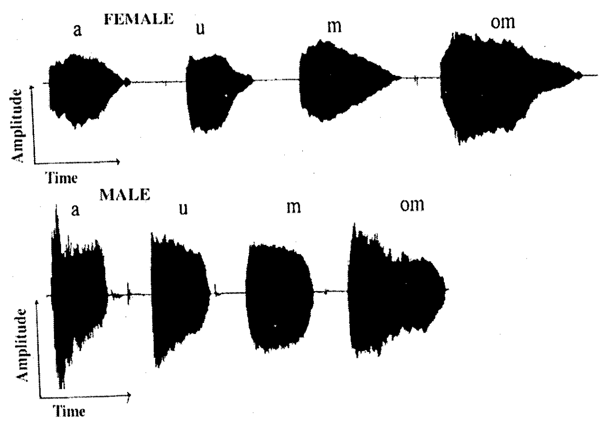


Fig. 1

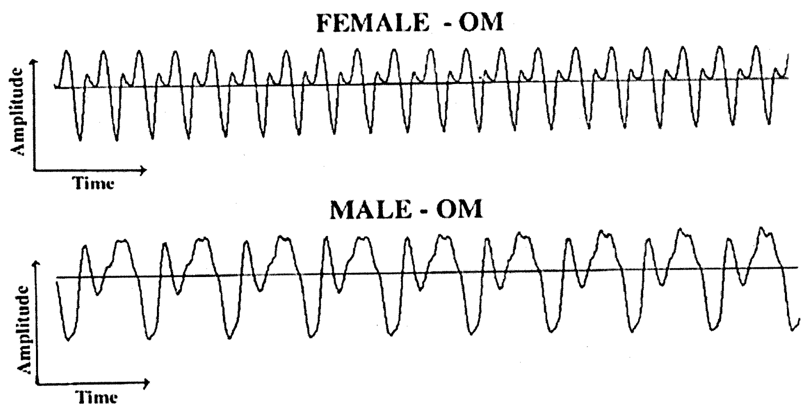


Fig. 2

U is initially flat but tapers off, Ma also tapers off like U, but Om displays two segments, one for O and the other for M. This is in general true for all waveforms.

Figures 2a and 2b show expanded waveforms, clearly indicating the periodic nature of the signals and the low noise level. This again is generally true of all signals recorded. This implies that the signals can be analysed as periodic functions and not as random signals.

Figures 3 and 4 show respectively the energy-frequency spectra for the waveforms shown in figures I and 2. It is seen that the fundamental frequency for the female voice is approximately double that for the male voice. It is also seen that the energy content goes down to 1% of its peak value around the 4th subharmonic for the female voice and the 6th for the male voice. This is again the general trend for all cases studied.

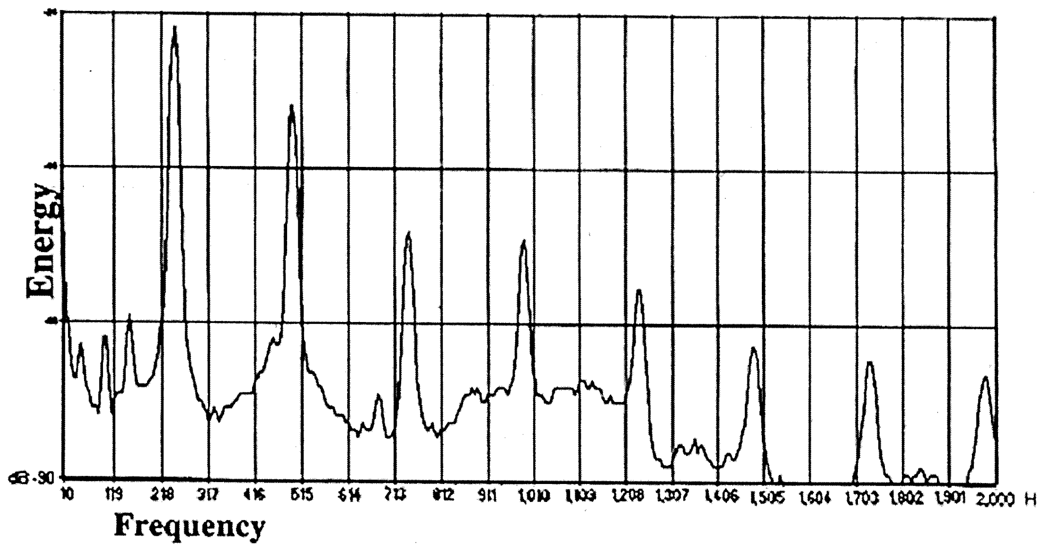
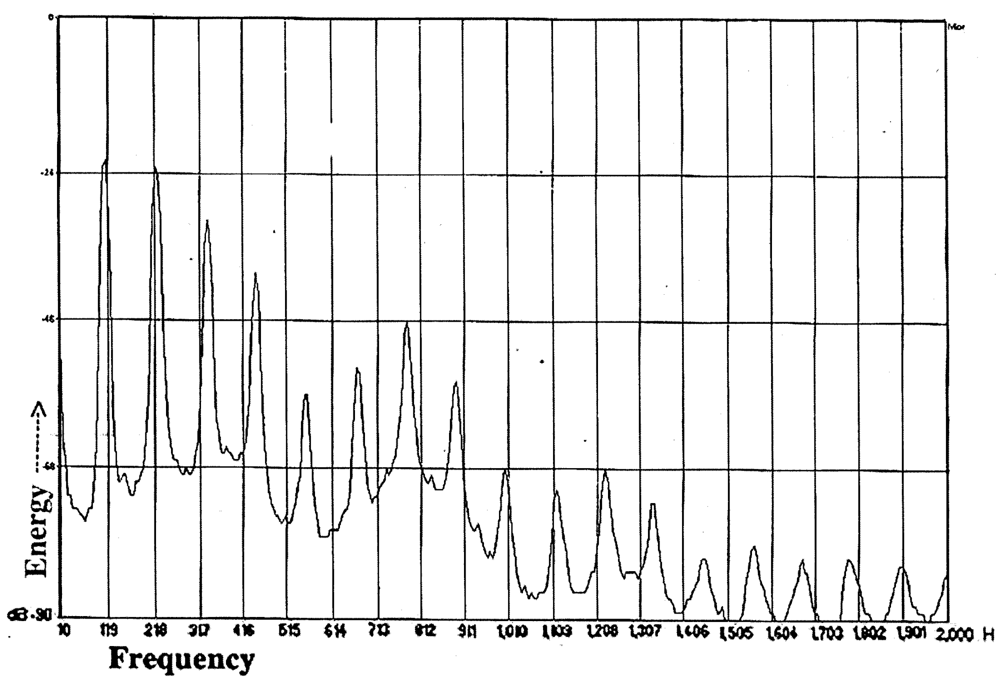

Energy
dB -90
10
119
218
317
416
515
614
713
812
911
1,010
1,109
1,208
1,307
1,406
1,505
1,604
1,703
1,802
1,901
2,000 H
Frequency

Fig. 3


Energy ------>
dB -90
10
119
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1,010
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1,604
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1,901
2,000 H
Frequency

Fig. 4

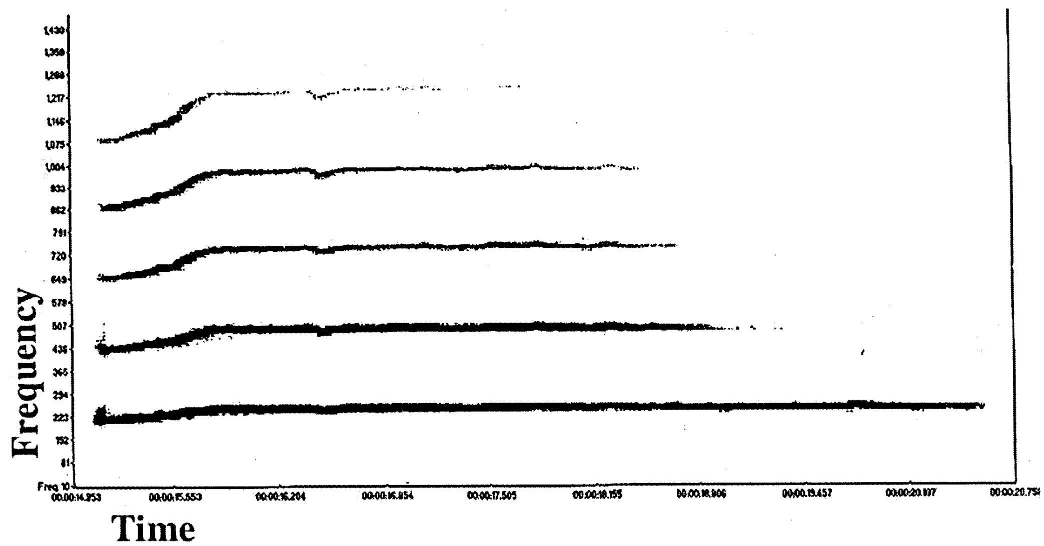

Fig. 5

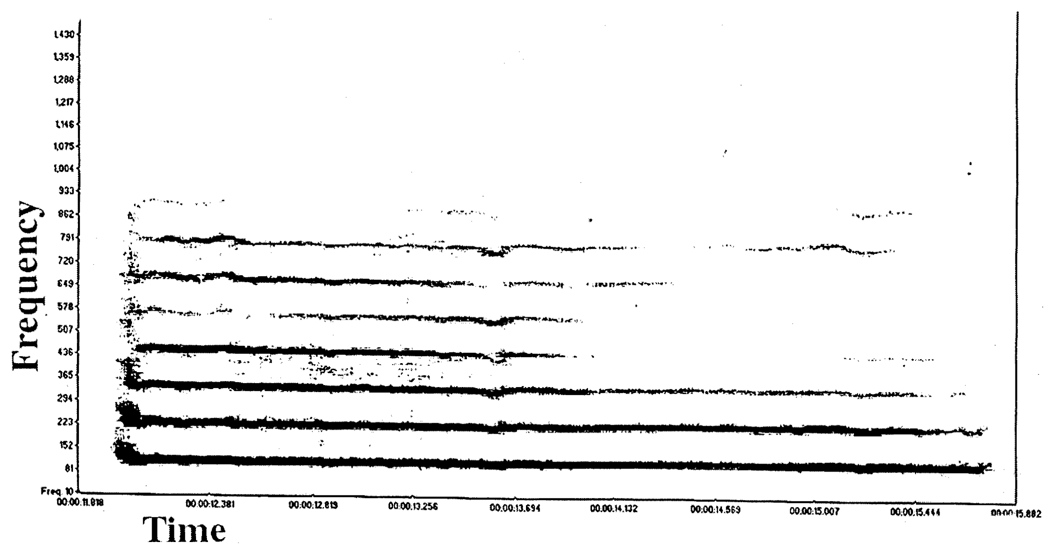

Fig. 6

Figures 5 and 6 show spectrograms for the sample cases. Figure 5 is the energy-time spectrogram for the female voice for Om and figure 6 that for the male voice. The corresponding cases for A, U and Ma have not been shown here, but the general trends will be discussed in the next section.

Discussion

The most important figures from which useful results can be extracted are the figures 5 and 6. These are frequency-time spectra, called spectrograms, representing the peaks of the energy-frequency spectra as a function of time. In these figures, no energy levels are indicated. However, dark bands represent predominantly high energy regions and white patches represent almost zero energy. The level of grey colour is an indicator of the relative levels of energy.

Spectrograms are used to separate the characteristics of the voice from those of words. The lowest frequency, which is the bottom-most line in these figures, indicates the pitch, which is a characteristic of the voice. Since the male voice has a lower pitch compared to the female voice, it also has a lower fundamental frequency. In the present case, the ratio of the fundamental frequencies of the male and female voices is about 1:2, which is the usual case.

The male voices in the present cases have also a larger number of subharmonics than the female voices, before the energy drops off to negligible values. This is a typical feature of the human voice, which is due to the difference in structure of the voice-producing mechanism.

A detailed study of all the spectrograms showed that the two male voices had the fundamental frequencies of 108 Hz and 118 Hz. The corresponding values for the female voices were 237 Hz and 242 Hz. In the case of A, both the male voices show 11 subharmonics, whereas both the female voices show 6 subharmonics. In the case of U, the two male voices show 7 subharmonics, but the female voices have only 1 subharmonic. For Ma, the number of subharmonics for the male and the female voices was respectively 3 and 1.

A more interesting result is that for Om. This signal has two segments, starting with O and gradually tapering off to M. From the point of view of intonation and the shape and the cavity of the mouth, the sound O is in between the sounds A and U. This was clearly seen in all the four figures for Om, of which only two are presented in figures 5 and 6. The male voices show 9 subharmonics in the region of O and 2 in the region of M. In the case of the female voices, these are 4 for O and 1 for M. Thus, it is clearly seen that the sound pattern for O in all cases lies between those for A and U. In the second segment, all sound patterns agree with those recorded earlier for M.

There is an internal consistency in the data, which testifies to its authenticity and reliability.

Conclusions

It has thus been possible to identify the. fundamental and subharmonics for the sound patterns A, U, Ma and Om, according to the Sanskrit pronunciation.

Where is a work of this type useful? Consider the two investigations referred to earlier in Jina Devi[2] and Uchida & Yamamoto[8]. These two were done almost at the same time, but independently of each other. But a comparison between them is almost impossible, because the sound patterns used by the two groups cannot be compared. It is only when the spectrograms are properly analysed and the sound characteristics properly identified, does a comparison become meaningful. By recording the sound patterns and extracting their frequency characteristics, one can identify that frequency which has the most noticeable effect on seed germination and only then does a comparison become possible.

It is proposed to analyse in a future study the Agnihotra mantra spectrally and to use this information in germination studies.

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References

1 Jina Devi Heisnam, Concept of Mantra and its corresponding qualities, MS Dissertation, Hindu University of America, Florida, USA, January 2003.

2 Jina Devi Heisnam, Effect of Agnihotra on the germination of rice seeds, MBYR Dissertation, Vivekananda Yoga Anusandhana Samsthana, Bangalore, 2002.

3 Stigsby B, Rodenberg J C & Moth H B, Electroencephalographic findings during Mantra Meditation (Transcendental Meditation), *Clinical Neurophysiology,* 51 (1980) 434-442.

4 Seer P & Raeburn J M, Meditation training and essential hypertension, *J Behavioral Medicine,* 3 (1980) 59-71.

5 Telles S, Nagarathna R, Nagendra H R & Desiraju T, Alterations in auditory middle latency evoked potentials during meditation on a meaningful symbol Om, *International J Neuroscience,* 76 (1994) 83-93.

6 Telles S, Nagarathna R & Nagendra H R, Autonomic changes while mentally repeating two syllables—one meaningful and the other neutral, *Indian J Physiol Pharmacol,* 42 (1998) 57-63.

7 Takahashi Y, Yonekawa Y, Kanada K & Maeda S, A pilot study on the human body vibration induced by low frequency noise, *Industrial Health,* 37 (1999) 28-35.

8 Uchida A & Yamamoto K T, Effects of mechanical vibrations on seed germination of *Arabidopsis thaliana* (L.) Heynh, *Plant Cell Physiology,* 43 (2002) 647-651.