Response of Yeast to Low Frequency Sound Exposure

Yasuhiro Suzuki
Graduate School of Informatics, Nagoya University, Furocho Chikusa
Nagoya City, Aichi Prefecture 464/0814, Japan[*]

E-mail: ysuzuki@nagoya-u.jp.com
www.ysuzuki.info

Abstract

The response of cells and organisms to exposure to ultrasound and low frequencies has been investigated. The present study investigates the increased number of colonies when physically vibrated by a 40 Hz sine wave and exposed as sound. The number of colonies decreased when exposed to vibration compared to silence. When exposed to the sound, the number of colonies increased.

Keywords: Yeast, Infrasonic, Vibration, very-low frequency

1. Introduction

Infrasound is a sound generated by vibrations of 20 times or less per second. In general, the sound loses energy due to vibration as it passes through the medium. Therefore, high frequencies quickly lose power and are attenuated, while low frequencies are less attenuated. Consequently, it can travel up to thousands of kilometres. Low frequencies are less directional than high frequencies; it proceeds in concentric circles from the source and even if there are obstacles, go around 1).

There is low-frequency sound in nature. Low-frequency sound in nature is produced by a variety of natural phenomena, including tectonic movements such as volcanoes [5)], celestial movements such as asteroids, meteorites, meteors and fireballs entering the atmosphere [6)], meteorological phenomena such as typhoons and lightning [7)], and water flows such as waterfalls and rivers [8)]. Low-frequency sound in nature can be so powerful that it can break windows and damage buildings.

It has reported that sound can influence organisms, that do not possess auditory pathways to detect 2). And vibrations below 20Hz (infrasound) and above 20,000Hz (ultrasound), significantly affect the growth and development of microorganisms [2)-5)].

In the brewer's yeast, *Saccharomyces cerevisiae*, it has reported that sound alter growth and fermentation, significantly [6]. In this study, "*pure tone of low-frequency (100 Hz), and one of high-frequency (10 kHz), both at the same intensity (90 dB at 20 µPa), measured at the location of the fermentation tubes.* [6]"

As is well known in laboratory work, as far as we know, it has not investigated precisely, shaking speed affects the culture rate when shaking E. coli or yeast. The faster the shaking rate, the quicker the culture rate.

2. *Result*

We have investigated the vibrational and acoustic effects of 40 Hz pure tones. A pure tone is a sinusoidal wave containing no overtones other than 40Hz.

We measured the number of colonies after 24 hours of preincubation and after 24 and 48 hours of incubation.

2.1. *Responses to Vibrations*

A sinusoidal wave of 40 Hz vibrated the culture petri dish; amplitudes were around 0.2 mm (strong) and approximately 0.1 mm (weak). In each amplitude, the number of colonies decreased compared to silence. The number of colonies decreased as the amplitude increased.

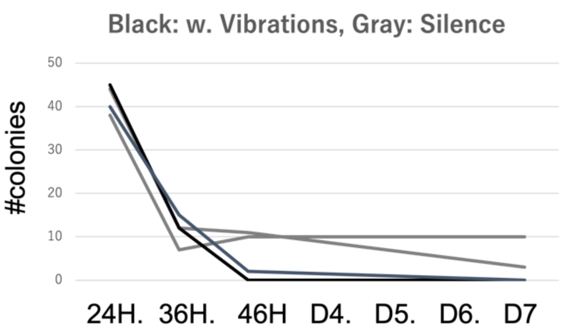


Fig. 1. Comparison of increment of colony numbers: vibrations with 40hz solid sine wave and silence. The horizontal axis is the time in units of 12 hours, and the unit after 48 hours is a day. The vertical axis is the number of colonies increased (increment from the previous time point). The black and grey lines represent the oscillatory and silence stimuli, respectively

Visually, the colony size was more significant when the vibration was more substantial, and the colony number decreased (Fig.1).

This trend was also confirmed when the culture medium was diluted (Fig.2). As the solution was diluted, the decrease in the rate of increase became slower. After 24 h, the number of colonies was higher than that of Silence. 48 h later, Silence continued to increase, while the increase was zero with the addition of vibration.

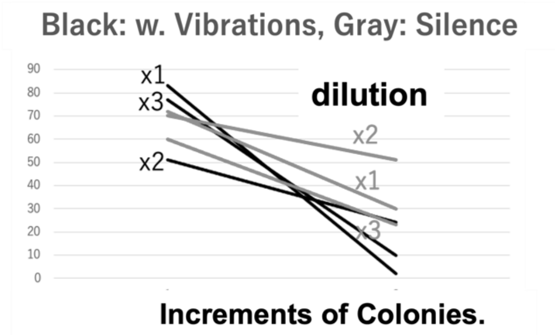


Fig. 2. Comparison of the incremental colony number between 40Hz sine wave intense vibration stimulation and silence in diluted culture medium: The horizontal axis represents 24h and 48h, the vertical axis the number of colonies increased. The black and grey lines represent the oscillatory and silence stimuli, respectively.

2.2. *Responses to Sound*

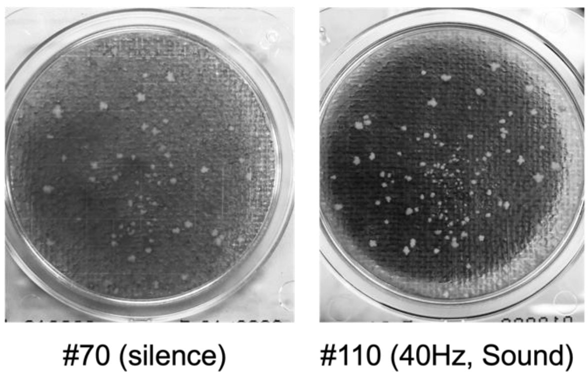
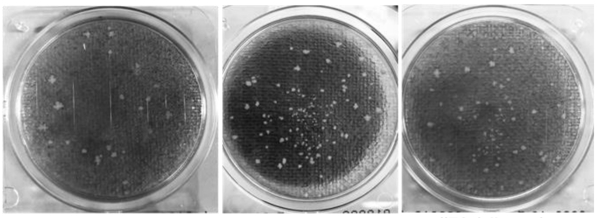


Fig. 3. Left) Silence, right) A typical example of a 50 dB sine wave at 40 Hz exposed for 48 Hours. The number of colonies is high, but the size of the colonies is small.

We exposed 40Hz sinewave in 50 dB to the yeast. And found that the increment number of colonies are more significant than silence and vibrations. We could observe that the size of each colony is smaller (Fig.3).

3. Discussion



#28 (40Hz Vibration) #110 (40Hz, Sound) #70 (silence)

Fig. 4. Typical example of Yest responses: From right to left: Silence, Acoustic stimulus, 40Hz Sinewave with -24 dB FS (weak) and Vibration 40Hz oscillation with acceleration 0.04 m/s^2 , velocity 0.4 m/s, displacement 1mm. The number of colonies in Silence was 70, in 40Hz acoustic stimulation 110, in vibration stimulation 28.

The same 40 Hz sine wave behaved differently when the yeast was exposed to vibration and when it was exposed to sound (Fig.4).

In the case of vibration, the aggregation may be caused by physical vibration. Therefore, it is difficult to discuss the difference only by the number of colonies. Consequently, we cannot conclude an intrinsic difference between sound and vibration.

In this study, commercial baker's yeast was used. Many studies have used yeast with a distinct strain. It is common to pre-culture with shaking for as low as 24 hours in other studies. The yeast was pre-cultured in a thermostatic bath for 24 hours without shaking in this study.

In agar experiments, the number of yeasts is estimated from the number of colonies per square centimetre. In this study we counted the number of colonies.

4. Method and Material

Mix 0.4g of "*Shirakami Kodama*" yeast and 100g of pure water. Drop 0.1ml into the medium and pre-culture for 24 hours in a thermostatic bath at 30°C. YM medium is used (*Nissui* Pharmaceutical, Compact dry, YMR).

We prepare the 40Hz sine wave with Audacity version 3.0.2. Vibrations were generated in a thermostatic chamber at 30°C using a vibration vibrator. The vibrometer was adjusted to an acceleration of 0.04 m/s2, a velocity of 0.3 m/s and a displacement of 1 mm.

The control sample is placed in a thermostatic bath at 30°C. A vibrometer was used to check that the 40 Hz vibration for the vibration stimulus was not transmitted.

The exposure sound stimulus was provided by a subwoofer placed in the 30°C chambers, and the sound level was adjusted to 50 dB using a sound level meter.

Control samples were placed in a 30°C chamber. We confirmed that the 40 Hz tone for the sound stimulus was not transmitted.

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Authors Introduction

Dr. Yasuhiro Suzuki

He is an Associate Professor of Graduate School of Informatics, Nagoya University Japan. graduated from Japan Advanced Institute of Science and Technology in 1995, received D. Informatics from Kyoto University in 2001.