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Using Ultrasound on Water to Terminate *Escherichia coli* Bacteria

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Abstract
The basic principal of ultrasound disinfection is based on the destruction of bacterial cells. In this study it found to be that ultrasonic treatment is very effective in water purification in case of ***Escherichia coli*** bacteria. The bacterial populations in contaminated water decreased according to frequency (800 kHz and 830 kHz) and sonication time period (5, 10, 20, 15 and 25 minutes). As the time period increase the bacterial population was decreased due to destruction on cell wall.

Keywords: Ultrasound, *Escherchia coli* bacteria, disinfectant of water.

Introduction
To give the necessary background for the topic covered in this study, basic definitions and other aspects and concepts have relations to the physics of acoustic and bacteria were presented.
There are different techniques used in water disinfection such as chlorination and UV but ultrasound waves considered as unique technique due to its characteristics, for instance non ionizing wave and acoustic cavitation phenomena.
This study aims to test the survival ability of *Escherichia coli* at two frequencies of ultrasound 800 kHz and 830 kHz.

Materials and method
The equipments are: ultrasound generator and probe, pi pump fast release pipette controller, and six plates each plate contain a number of 1000 colonies of *Escherichia coli*. In this method the effect of sonication on bacteria is estimated using viable plate counts, this is a standard plate counting technique which approximately reflects the number of *Escherichia coli* colonies and remaining after Sonication and culture, this colony known as colony forming units (CFU).
Depending on the principle of bubble cavitation accured by ultrasound waves, a sample of E.coli bacteria population had been studded under several frequencies (800 and 830 kHz).

Discussion
Ultrasound waves create large cavitation bubbles which collapsed upon and initiate powerful jet streams exerting strong shear forces in the liquid, so that the bacterial populations in contaminated water decreased, using frequencies (800 kHz and 830 kHz) with time period (5, 10, 20 and 15, 25 minute).

Fig A: represents the control plate which contains 1000 colonies of bacteria.

At frequency of 800 kHz shown in figure (B) after sonication time of 5 minutes the number of colonies had been decreased to 875 colonies at a temperature of $31^{\circ}C$, also by extending the sonication time to 10 and 20 minutes at the same frequency the number of colonies decreased to 825, and 200 colonies respectively as in figures (C) and (D).

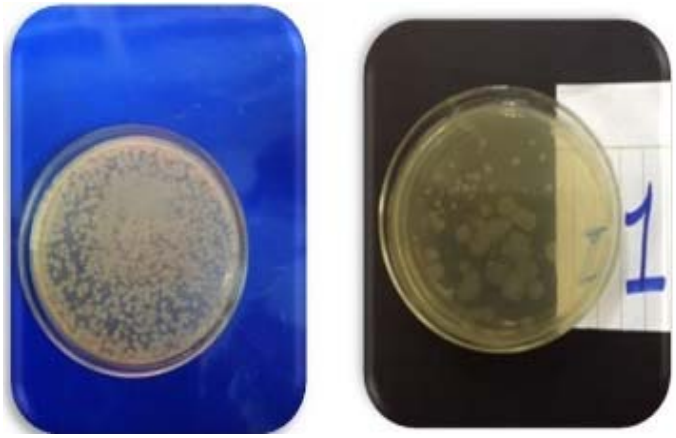

Fig B: comparing between control plate and Escherichia coli Bacteria colonies in polluted water sample after ultrasonic treatment at 800 kHz for 5 minutes

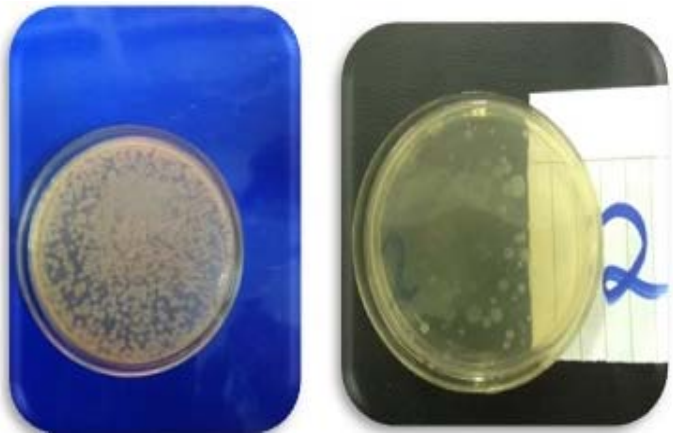

Fig C: comparing between control plate and Escherichia coli Bacteria colonies in polluted water sample after ultrasonic treatment at 800 kHz for 10 minutes.

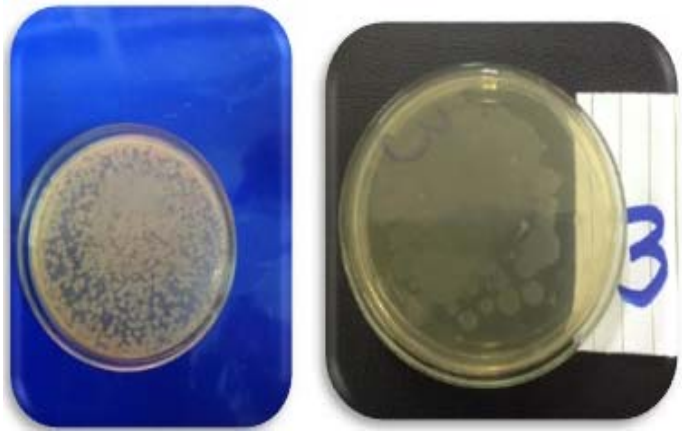

Fig D: comparing between control plate and Escherichia coli Bacteria colonies in polluted water sample after ultrasonic treatment at 800 kHz for 20 minutes

By Applying a deferent frequency of 830 kHz for a same colonies shown in figures (E) and (F) also the number of bacteria population had decreased to 975 and 125 colonies at time period of 15 and 25 minutes.

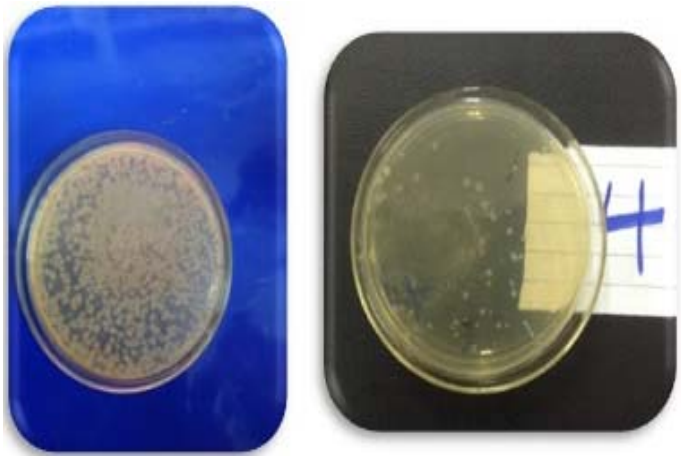

Fig E: comparing between control plate and Escherichia coli Bacteria colonies in polluted water sample after ultrasonic treatment at 830 kHz for 15 minutes.

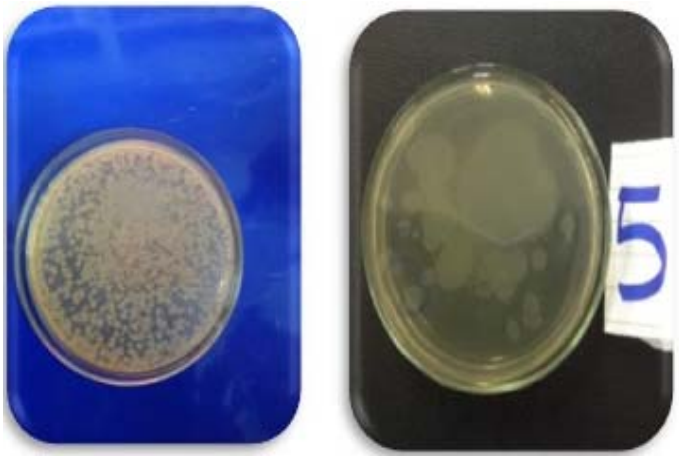

Fig B: comparing between control plate and Escherichia coli Bacteria colonies in polluted water sample after ultrasonic treatment at 830 kHz for 25 minutes.

The experimental results show that the number of *Escherichia coli* colonies decreased with increasing time of sonication process. As the time period increased the bacterial population (i.e. CFU) was decreased. To interpret these results: ultrasonic shock waves hits the microbial cell walls, the larger bubbles implosion gives high mechanical effect, which leads to bacteria destruction. Temperature slightly rose in each sample with the increment of treatment time; comparing the destruction is it due to ultrasonic or thermal effect? It refer to the ultrasonic destruction, because the temperature is almost the optimum for the bacteria yet it is clear observe the decreasing of the numbers of colonies.

High frequency waves create smaller cavitation bubbles and produce strong shear forces, which means more effect in the cell wall. Longer sonication duration times have more effect on decreasing bacterial population comparing to shorter sonication duration times.

Conclusions

At the frequencies of 800 kHz and 830 kHz it found a observable decreasing ratio on the number of colonies due to cell wall destruction as a result of ultrasonic waves, and the great decreasing ratio was at frequency of 800 kHz, therefore ultrasonic treatment is very effective in purification of contaminated water.

This technique would play a major role in development of a large scale water purification procedure.

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