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Inactivation of Nematodes by Ultrasonic

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Application of ultrasonic irradiation for inactivation of nematodes was investigated. Experiments show that it is possible to decrease the number of organisms present in the water and that the process depends on exposure time, frequency and intensity of the ultrasound irradiation, as well as on the type of organisms. As it is considered by 2, 4, 6, 8, 10 and 12 min of sonication about 23.75, 42.50, 53.5, 82.25, 89.25 and 100% of the adult present are destroyed, respectively. But by 2, 4, 6 and 8 min of sonication about 38.0, 50.5, 58.75 and 100% of the larva present are destroyed, respectively. The results using Bransonic bath at 42 kHz (155 W input power) show that using this frequency it would appear that 100% of the nematodes adult and larva are destroyed in 12 and 8 min, respectively.

Key words: Nematode, wastewater treatment plant, secondary sewage, rapid sand filter, ultrasonic, acoustic cavitation

INTRODUCTION

There are thousands of nematodes. Not only are there more than 15,000 known species of roundworms, but there are many thousands of individual nematodes in even a single handful of garden soil. Some species of roundworm may contain more than 27 million eggs at one time and lay more than 200,000 of them in a single day. Some scientists have estimated that there may be as many as half a million more unknown species of roundworm yet to be discovered, an estimate based on the fact that many new species are still being discovered, that relatively few people are looking for more species and that most roundworms look pretty much alike. If the estimated number of species is anywhere close to correct, it would mean that roundworms are the second most diverse group of animals, trailing behind only the arthropods^[1,2].

The greatest number of nematodes is the free living forms that are commonly associated with soils and aquatic environments. The free living nematodes found in fresh water are generally microscopic in size, ranging from 5-50 μm in width and 100-1000 μm in length. Conventional water treatment processes are not highly effective in removing nematodes from the supply. Nematodes are very resistant to inactivation by free chlorine and, unless inactivated, nematodes can pass through rapid sand filters^[3,4].

The one way to inactivate nematodes is with ultrasonic. Ultrasonic, part of the sonic spectrum that ranges from 20 to 10 MHz, is generated by a transducer that converts mechanical or electrical energy into acoustical energy. The sound energy is then fed to a horn that transmits the energy as high frequency vibrations to the liquid being processed. When liquids are exposed to these vibrations, both physical and chemical changes occur as a result of a physical phenomenon, known as cavitations. Cavitations is the formation, expansion and implosion of microscopic gas bubbles in liquid as the molecules in the liquid absorb ultrasonic energy. Compression and rarefaction waves rapidly move through the liquid media. If the waves are sufficiently intense they will break the attractive forces in the existing molecules and create gas bubbles. As additional ultrasound energy enters the liquid, the gas bubbles grow until they reach a critical size. On reaching a critical size, the gas bubbles implode or collapse^[5,6].

The energy that exists within the cavity and in the immediate vicinity of the gas bubbles just before collapse causes both physical and chemical effects in the liquid. Physical effects result when cavitations is intense enough to rupture cell membranes, free particulates from solid surfaces and destroy particles and organisms through particulate collisions or by forcing them apart^[7].

Experiments show that it is possible to decrease the number of organisms present in the water and that the process depends on exposure time, frequency and intensity of the ultrasound irradiation, as well as on the type of organisms^[8].

MATERIALS AND METHODS

Controlled laboratory experiments have established the ability of these system to destroy nematodes. Experiments were conducted using of Bransonic ultrasonic cleaner. Histories of the contaminant concentration reductions and inactivation of nematodes were obtained from periodic sampling. The results using Bransonic bath at 42 kHz for the biological decontamination of water show that destruction nematodes dose occur about 12 min. In this study, the major objective was determining ultrasonic effectiveness in control of nematodes of water.

A series of experiments involved sonicating of nematodes and observing the effects of ultrasonic upon its control. Before sonication, the concentration of nematodes in water determined. This test involves collecting the sample, concentrating it and examining the sample under the microscope in order to count the number of nematodes per mL. After cell counts using a microscope, samples were added to the batch reactor in which sonication could be performed. For nematodes destruction investigation in ultrasonic bath, small volumes (200 and 500 mL) of water have been used. The effect of sonicating different volumes of water was measured for the same time intervals. The samples were sonicated in periods of 2, 4, 6, 8, 10 and 12 min. For each trial namely, each sample was exposed to all of the durations. The number of trials per the mentioned exposure levels was variable. Finally, required samples for analyses were taken after 2, 4, 6, 8, 10 and 12 min and determination was performed according to the standard method technique (10550B-1998)^[9].

This research will provide basic information on the fundamental of ultrasonic irradiation as a novel means for nematodes inactivation (Tehran University of Medical Sciences, 1 September 2004).

RESULTS AND DISCUSSION

The application of ultrasonic irradiation to control nematodes was evaluated in the laboratory conditions. This study showed that exposure to ultrasonic irradiation resulting in destruction of nematodes. As it is considered by 12 min of sonication 100% of the nematodes present are destroyed. Besides, the results show that increasing the sonication time has a significant effect on nematodes

Table 1: The effect of sonication time on killing percentage of nematodes larvae in the different volumes

Sonication (min)	Sample volume (mL)		Percent kill mean
	200	500	
2	43.0	33.0	38.00
4	51.0	50.0	50.50
6	62.0	55.5	58.75
8	100.0	100.0	100.00

Table 2: The effect of sonication time on killing percentage of nematodes adult in the different volumes

Sonication (min)	Sample volume (mL)		Percent kill mean
	200	500	
2	24.0	23.5	23.75
4	44.5	40.5	42.50
6	56.0	51.0	53.50
8	85.5	79.0	82.25
10	92.0	86.5	89.25
12	100.0	100.0	100.00

removal. The results also indicate that there is no significant kill of nematodes in less than 8 min contact time to 42 kHz but considerable levels in control can be expected at higher periods. As it is considered by 2, 4, 6, 8, 10 and 12 min of sonication about 23.75, 42.50, 53.5, 82.25, 89.25 and 100% of the adult present are destroyed, respectively. But by 2, 4, 6 and 8 min of sonication about 38.0, 50.5, 58.75 and 100% of the larva present are destroyed, respectively (Table 1 and 2).

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