SONIC ACTIVATION OF WATERDERIVED FROM AQUACULTURE AND MICROBIOLOGICAL EFFECT

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Abstract:The paper presents the problem ofdeveloping anew and effective method for water derived from aquacultureby applying sonic technologies. Researches have shown encouraging resultson the use of ultrasoundin water derived from aquaculture.Themicrobiologicaleffect at sonic activation of water is to reduce TNG, TNF and Salmonella. Ahigh interest shows the influence of the samples storage time on the pH value that confirms water sonic activation phenomenon.
Key words:sonic, activation, generator, microbiology, pH index, water,aquaculture

Introduction

Sonic technology [1,5] is a process that allows water treatment and cleaning aquatic basins. At water sonic treatment performed by using the air-jet ultrasound generators there are two simultaneously processes: degassing due to ultrasonic cavitation that occurs because of generators sonic waves and aeration as a bubbling result which occurs with sonic generators eliminated air in the process of waves generating. One of the main parameters that characterize the aquatic environment and water activation is pH, which in aquatic basins depends on the content of carbon dioxide in water (CO2). To the action of ultrasound, due to cavitation, degassing occurs and the concentration of carbon dioxide in water decreases. If aeration process supports the growth of certain microorganisms, degassing leads to their inhibition.Water pH variation after the sonic treatment and its influence on the development of colonies of microorganisms such as TNG, TNF and Salmonella are of particular interest.

1. Installation for water sonic treatment and experiments methodology

Researches were conducted atInstitute of Research and Development for Aquatic Ecology, Fisheries and Aquaculture,Galati.The basinfromwhichthesamplesweretaken for experimentsis called „Brates".The installation for water treatment from aquaculture contains (Fig.1)compressed air source (compressor or cylinder),pneumatic reducer, air filter,manometer, air-jet ultrasound generator, precision manometer, reactor (glass bottle) with working fluid.

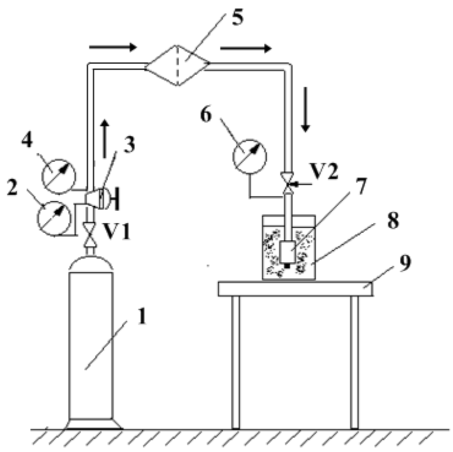

Fig.1. The experimental installation for water sonic treatment:1-compressed air source (compressor or cylinder); V1-admission valve; 2-control manometer before reducer; 3-pneumatic reducer;4-control manometer after reducer; 5-air filter;6-working gas control manometer;V2-admisionopening valve; 7- air-jet ultrasound generator; 8-sample, 9-table

Figure 2 presents the reactor image (glass bottle) with experimental air-jet ultrasound generator during water sonic treatment [2].

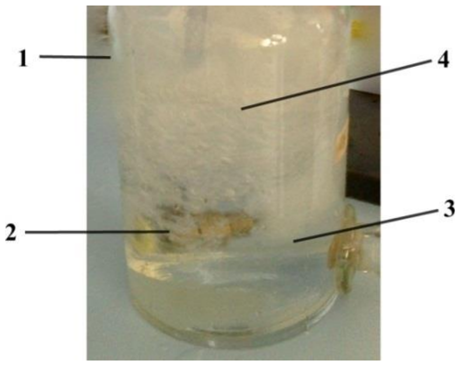

Fig.2. Theexperimental air-jet ultrasound generator during sonic treatment:1-glass bowl;2-experimental air-jet ultrasound generator; 3-cavitation bubbles;4-bubblingbubbles

Water samples (1 liter) were treated by air-jet ultrasound generator immersed in a glass bowl (Fig.2). The ultrasound air-jet generator at supply pressure of 0.35 MPa provide the production of ultrasonic field with frequency of 24-27 kHz and sound intensity level of 112-124 dB. The working time (t) of the air-jet ultrasound generator for water treatment is of 5, 10, 20 seconds. Were monitored the following microbiological indicators: total number of germs (TNG), total number of fungal (TNF) and Salmonella. Microbiological analysis requires three steps: I-samples collection, II-analysis of samples in the laboratory (Fig. 2), III-processing the results of the analyzes (Fig. 3).The total number of germs (TNG), from a sample, basically represents its microbiological chargingin bacteriaand total number of fungal (TNF), from a sample, basically represents its microbiological charging in fungal.Of the amount of the two parameters (TNG and TNF)is obtainedthe sample various laden in microorganisms.For water microbiologicalcharacterization, quantitative microbiological analysis was performed.Quantitative analysis aimed to determine the total number of germs (TNG) total number of fungal (TNF) and Salmonellacontained within a given volume [3].

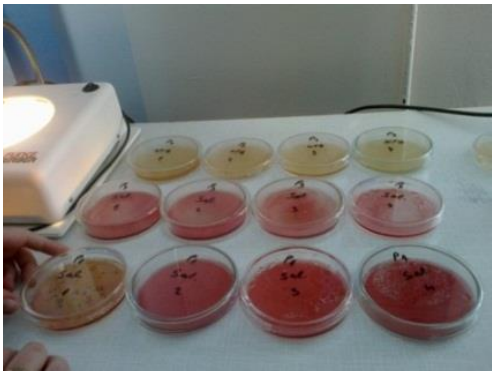

Fig.3. Sowing samples in Petri dishes

The total number of germs, total number of fungal and Salmonella were determined according to ISO 6340 [2]by counting coloniesreared on specific surfaces of culture medium from Petri dishes.TNG and TNF colony counting was madewith ColonyStarcolony counterthat has helped to simplify the counting process (Fig. 4).

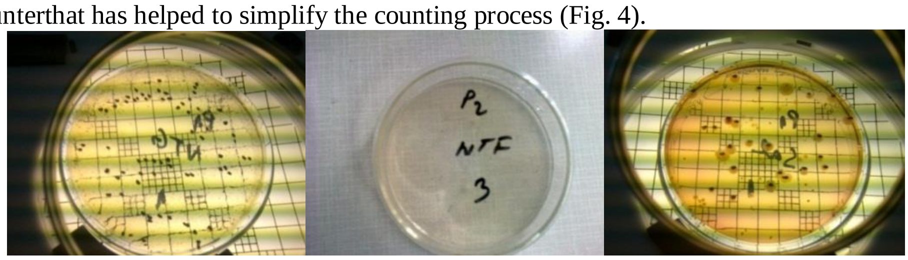

Fig 4. Counting the colonies ofTNG, TNF and Samonella

2. Water sonic activation and microbiological effect

2.1. Evolution of pH index.

The sonic treatment allows the modification of water microbiological indicators by cavitation actionwhich increases the value of physical-chemical parameters, especially pH value [2].The degree of increaseor decreaseof bacteria in aquatic environmentdepends on the content of substances that is contained in it and influences the activity of bacteria.

Figure 5 shows the variation in pH ofwater samples treated with air-jet ultrasound generator according to storage time at sonic treatment for 5 seconds, 10 seconds and 20 seconds.

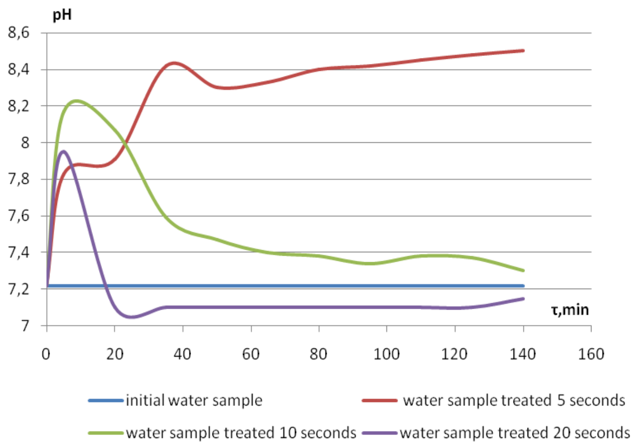

Fig. 5. Untreated water samples pH and sonic treated water samples pH depending on storage time (air-jet ultrasound generator frequency is 24-27 kHz and sound intensity level is 112-124 dB)

The pH line of untreated sonic water shows that pH does not vary depending on the time thatthe analysis were made, which we will call storage timeτ,and remains constant at pH=7.22.Can be noticed that at water sonic treatment,t = 5 seconds, with air-jet ultrasound generator,pH increase from 7.22 up to 8.5 pH units. The increase takes place in two phases: in the first phase pH rises up to 7.91 pH units in 20 minutes of storage, and in the second phase pH increases up to its maximum valuethat is reached after 35 minutes of storage. At the sample treated for 10 seconds we have a rapid increasewithin a period of 5 minutes of storageuntil pH = 8.2, after whichoccursslow decrease in pH until its initial value, in a storage time higher than 140 minutes.At the sample treated for 20 seconds we have a rapid increasewithin a period of 5 minutes of storageuntil pH =7.95 after which occurs slow decrease in pH until its initial value of 7.22 pH units in a storage time of 20 minutes.The pH increasing up to 7.91-8.2 pH units at sonic treatmentregardless of the treatment time, confirm that there is water sonic chemical activation [4]because of cavitation process, leading to liquiddegassing.pHreturningclose to the initial value, that confirms the watersonic activatedrelaxation process, depends on the treatment time.At sonic treatment of only 5 seconds, the relaxation is slow, which corresponds to theactivation energyreceived by liquidin this short time.The change in redox potential (pH) and active acidity value (1/pH) are known as indicators of chemical activation [5].Their relaxation during storage indicates metastable state of water, which causes a number of changes in the studied environment, inducing quantitative and qualitative changes.

Through polynomial numerical approximation were obtained the equations that describe variation on pH during the storage time:

-for watersonic treatmentof 5 seconds:

$$y = -0.4x^2 + 0.0193x + 7.5455 \quad , R^2 = 0.8209 \qquad (1)$$

-for water sonic treatment of 10 seconds:

$$y = -0.5x^2 - 0.0056x + 7.7923 \quad , R^2 = 0.3226 \qquad (2)$$

-for water sonic treatment of 20 seconds:

$$y = -0.5x^2 - 0.0101x + 7.4899 \;, R^2 = 0.3824 \quad (3)$$

where y = pH; x = τ, minutes, storage time; R^2 -the error of approximation (mean squared error).

2.2. Microorganisms evolution.

Microbiological researches of the sonic treatmentshows thatwith increasing sonic treatment time, meaning with sonic energy chemical activation increase, colonies of bacteriadecrease (Fig.6).

In Figure 6 we note that at TNG, after 5 seconds of treatment there is a decrease and this remains constant until 20 seconds of sonic treatment.

Through polynomial numerical approximation was obtained the equation that describe variation on TNG during the storage time:

$$y = 0.1343x^2 - 3.8657x + 92.514 \;, R^2 = 0.9034 \quad (4)$$

Where y = TNG; x = t, minutes, treatment time; R^2 -error of approximation (mean squared error).

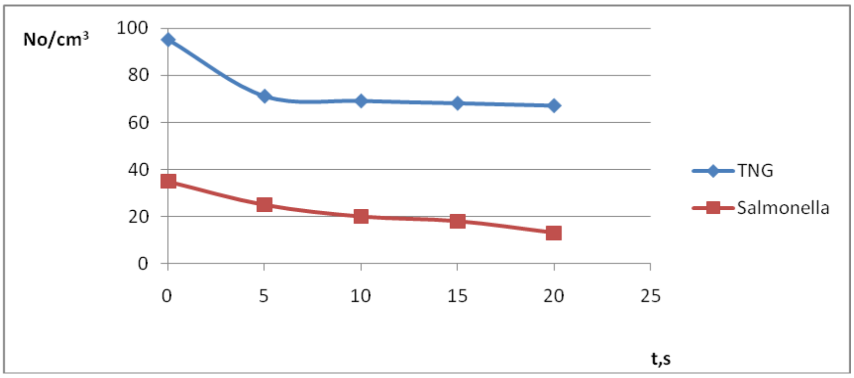

Fig.6. Evolution of TNGand Salmonella depending on air-jet ultrasound generator treatment time for 1 liter of water sample

For Salmonella, starting with the first 5 seconds of treatmentit decreases and the largest decrease occurs at a treatment of 20 seconds.

Through polynomial numerical approximation was obtained the equation that describe variation on Salmonella during the storage time:

$$y = 0.0371x^2 - 1.7629 + 34.257 \;, R^2 = 0.9762 \quad (5)$$

Where y = Salmonella; x = t, minutes, treatment time; R^2 - error of approximation (mean squared error).

To compare the efficacy of sonic treatment actionon different types of bacteriawas insertedthenotion of destruction degreeDe,which is the ratio:

N N , (6)

where N_{net} – untreated bacteria and N_{trat} – sonic treated bacteria.

With increasing treatment time decreases the destruction degree (Fig. 7).

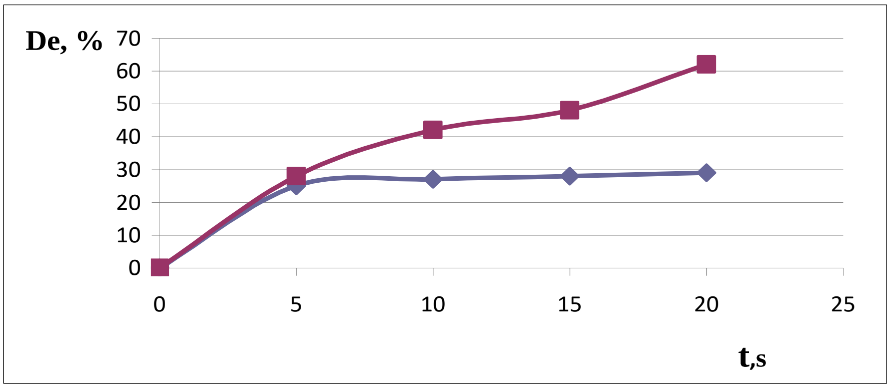

Fig. 7. The destruction degree of microorganisms bysonic treatment time for 1 liter of water sample (air-jet ultrasound generator frequency is 24-27 kHz and sound intensity level is 112-124 dB)

As shown in the graph, we can say that the influence of sonic treatment on different types of microorganisms is different.So the destruction degreeby sonic treatment at Salmonellais double that of TNG and the influence of the treatment time is different depending on the type of bacteria.At TNG after 5 seconds of treatment the inhibition degree does not changeand no longer depends on the treatmenttime.At the same time, at Salmonella, with increasing treatment timethedestruction degree constantly increase.From the equations analysis results that at treatment time = 4.2 seconds, destruction degree (22.3%)does not depend on the kind of studied bacteria.

Analysis of pH variation depending on sonic treatment timeshowed a decreasing of pH in the first 5 seconds of treatment,after which there was practically no change in it [2].If the character degree of destruction up to 5 seconds of treatment is one and the same for both organisms,after 5 seconds it becomes different even if pH variation does not occur.This result shows that even if the environment in which microorganisms grow is no longer changing, their destruction still occurs, probably purely mechanical, due to cavitation bubble implosions.

Conclusions

There was studied the variation of pH sonic treated and untreated water depending on storage time.Analysis of pH variation at sonic treatment, regardless of the time of sonic treatment,confirms that there is water sonic chemical activationdue to cavitation processleading to environment degassing.It can be noticed the return of pH value close to the initial one confirming the sonic activated water relaxationand that depends on the treatment time.Atthe sonic treatment for only 5 secondsrelaxation is slowcorresponding to fluid activation energy received in this short time.After microbiological determinationsis noted thatinfluence of sonic treatment on the different types of microorganisms is different.

Acknowledgements

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