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Research Article

Efficiency of Benzyltrimethylammonium Bromide in Biological Ways and their Applications

BV Deepthi[1]* C Isac Sobana Raj[2], Jeeffin Blessikha R[3] and Suba Jelin Goldy S[3]

[1]Research Scholar, (Reg.No.21113112032008), Department of Chemistry and Research, Nesamony Memorial Ch Christian College (Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli) Marthandam, Tamilnadu, India

[2]Associate Professor, Department of Chemistry and Research, Nesamony Memorial Christian College, Marthandam, Tamilnadu, India

[3]Research Scholar, Department of Chemistry, NMCC Marthandam, Tamilnadu, India

***Corresponding Author:** BV Deepthi, Research Scholar, (Reg.No.21113112032008), Department of Chemistry and Research, Nesamony Memorial Ch Christian College (Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli) Marthandam, Tamilnadu, India.

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Abstract

The purpose of this study is to prepare the Benzyltrimethylammonium bromide compound and determine its bacterial, fungal, and viral activity, which infections it works best against, and how to use this compound against all those diseases. Benzyltrimethylammonium bromide is a quaternary ammonium compound. In general, quaternary ammonium compound is an excellent disinfectant, something that the World Health Organization has agreed upon during the COVID-19 virus outbreak. Therefore, in this research, Benzyltrimethylammonium bromide was prepared and their pH variation, protein solubility test, antibacterial, antifungal studies, and termite resistance test were conducted. Also, through Benzyltrimethylammonium bromide hand sanitizer and soap have been prepared and it has been known whether humans can use them. Copper nanoparticles in general have various medicinal properties. In this study, copper nanoparticles were also mixed with hand sanitizer prepared with benzyltrimethylammonium bromide and their antibacterial and antifungal studies showed excellent activity. Therefore, the results of these studies suggest that the compound benzyltrimethylammonium bromide is effective against various types of infections. Also, sanitizer and soap made with Benzyltrimethylammonium bromide can be used against skin diseases caused by many bacteria and fungi.

Keywords: Benzyltrimethylammonium Bromide; Covid-19; Bacteria; Fungi; Virus

Introduction

Quaternary ammonium compound has been used by humans for many years in various ways. But it is during the period of virus infection called COVID-19 that we have heard the name quaternary ammonium compound more and more [1-3]. That's why quaternary ammonium compound worked as a good disinfectant to control coronavirus [4-8]. In general, if quaternary ammonium compounds can kill viruses alone, no. This compound is widely used in pharmaceuticals, detergent manufacturing industries, and manufacturing factories [9,10]. So, Benzyltrimethylammonium bromide was prepared in this study and its antibacterial activity, antifungal activity, protein solubility test, termite resistance test, etc were investigated. The important reason for taking antibacterial and antifungal activity is that it has been stated in various articles that a compound that kills bacteria can kill 100% of viruses [11-14]. Therefore, it was found that the antibacterial and antifungal activity of the synthesized benzyltrimethylammonium bromide solution works very well. In the protein solubility test, the membrane protein around the virus called COVID-19 was mixed with a solution synthesized to find the percentage of solubility and based on those results, this study was conducted to show that if the virus protein is dissolved, it can prevent the virus from spreading. The termite test has proved that this solution is useful for farmers [15-19].

Materials and Methods

Materials

Trimethylamine and Benzyl bromide were collected from a laboratory namely Isochem Laboratory Chemicals, Pvt. Ltd Kochi (India). Isopropyl alcohol and glycerine were purchased from High Purity Laboratory Chemicals, Pvt. Ltd Maharashtra (India). Double distilled water is used throughout the experiment and this water is

collected from the M.sc chemistry laboratory at Nesamony Memorial Christian College, Marthandam (India). The chemicals used in the study were of analytical purity.

Sample preparation

In a separate container, place benzyl bromide this will be the alkylating agent. Add an organic solvent, such as dichloromethane or chloroform, to the reaction vessel. The solvent should be dry and free from impurities. Place the container with the reaction mixture in an ice bath to keep the temperature low. This is important to control the reaction. Slowly add benzyl bromide to the trimethylamine solution while stirring continuously. The reaction between the amine and the alkylating agent will form benzyltrimethylammonium bromide.

Results and Discussions

pH variation

pH variation was taken to find out the behavior of the prepared quaternary ammonium compound. The pH value of the Benzyltrimethylammonium bromide solution and sanitizer prepared by benzyltrimethylammonium bromide was determined separately. Generally quaternary ammonium compound is an acidic compound. So, the pH value of the quaternary ammonium compound will be below 7. If a hand sanitizer is to be used by human beings, the pH value of the sanitizer prepared by this Benzyltrimethylammonium bromide is below range 7. Also, the sanitizer prepared in 0.4M concentration has a pH range of 1.4 so it can be believed that the sanitizer in 0.4M concentration will not cause any skin problems. And if humans use a sanitizer made of benzyltrimethylammonium bromide, there is no chance of any problem coming to the skin [15-17]. The pH variation results are given in the table below.

Concentrations	pH variations
0.1M	2.7
0.2M	3.8
0.3M	3.9
0.4M	4.2
0..5M	4.6
0.6M	5.2
0.7M	5.7
0.8M	5.8

Table 1: pH variations for prepared quaternary ammonium compound.

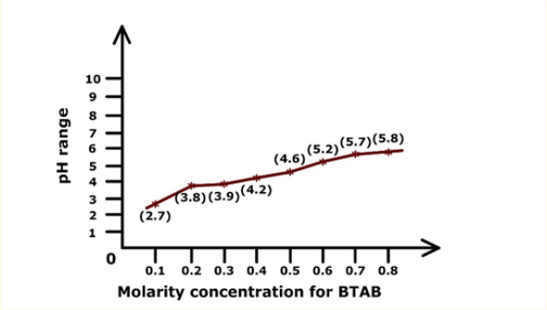

Figure 1: pH variations of prepared quaternary ammonium compound.

Antibacterial activity

Benzyltrimethylammonium bromide was sent to a bacterial testing lab to find out if it is active against five types of bacteria. All prepared quaternary ammonium compounds are solutions of 0.1M to 0.8M concentration. Separate standard values are given for all five bacteria. At the end of the studies, it is known that benzyltrimethylammonium bromide solution works very well against *E. coli* and *P. aeruginosa* bacteria [16,27,29]. Also, the standard value

Concentrations	pH variations
0.1M	5.7
0.2M	2.9
0.3M	6.6
0.4M	1.4
0.5M	3.6
0.6M	4.2
0.7M	6.2
0.8M	5.4

Table 2: pH variations for sanitizer prepared from quaternary ammonium compound.

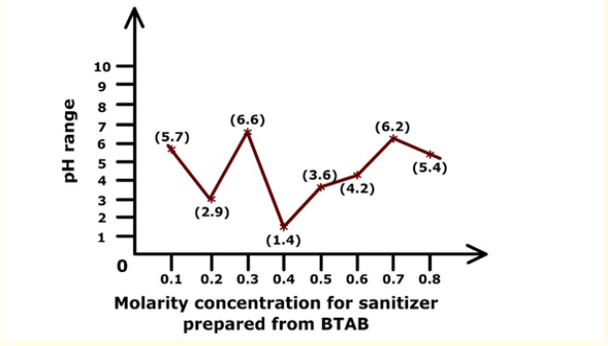

Figure 2: pH variations of sanitizer prepared from quaternary ammonium compound.

given for bacteria *E. coli* is 25. Similarly, the bacterial activity of Benzyltrimethylammonium bromide prepared at 0.8N concentration is 25. Therefore, the result of this study is that if the concentration range is increased, the activity will be more. This quaternary ammonium compound is moderately effective against the other three bacteria, so benzyltrimethylammonium bromide solution can be said to be an excellent antibacterial agent. The antibacterial activity results are shown in Table 3 and figure 3.

Bacteria	Zone of inhibition(mm)								
	Concentration level								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	Std
Staphylococcus aureus	7	7	9	9	11	12	12	14	30
Staphylococcus epidermidis	7	7	9	9	10	11	11	13	14
Klebsiella pneumonia	11	12	13	14	15	16	18	20	30
Escherichia coli	10	11	15	15	17	21	22	22	25
Pseudomonas aeruginosa	7	9	11	13	14	14	15	15	16

Table 3: The Antibacterial activity results for BTAB.

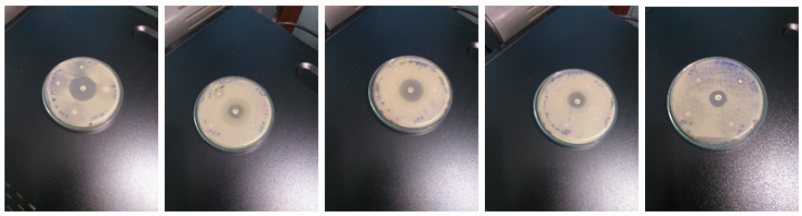

Figure 3: Antibacterial activity results for BTAB.

Antifungal activity

When examining how benzyltrimethylammonium bromide works against two types of fungi infections namely *A. flavus* and *C. albicans,* the results of the studies have shown that more than 75% of 100% can work against fungi infections through this quaternary ammonium compound [16,27,29]. In this study, only 0.1M to 0.8M concentration has been prepared. It can be understood from this result that if a work is prepared in a higher concentration and applied against these fungal infections, there is a 100% chance of giving 100% activity.

Protein solubility test

The protein around the virus has been taken to find out if the compound benzyltrimethylammonium bromide works against the virus. Membrane protein, one of the proteins surrounding the virus COVID-19, has been taken for a protein solubility test. Membrane protein was powdered and each molarity concentration was taken separately by putting a particular amount of protein powder in a magnetic stirrer for 1 hour. After one hour, the solution with a concentration of 0.1M to 0.8M was filtered and weighed to see how much percentage of the membrane protein was dissolved. Also, because the protein around the virus can be dissolved through this quaternary ammonium compound, this benzyltrimethylammonium bromide solution will have the ability to work against the virus as well.

Fungal	Zone of inhibition(mm)								
	Concentration level								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	std
Aspergillus flavus	7	7	7	11	13	15	16	18	30
Candida albicans	10	11	12	12	14	16	17	19	30

Table 4: The Antifungal activity results for BTAB.

Figure 4: Antifungal activity results for BTAB.

Concentration range	Time
0.2M	3 minutes
0.4M	2 minutes
0.6M	1 minute
0.8M	40 seconds

Table 5: The termite resistance test results for BTAB.

Termite resistance test

The termite was collected from a mound near a pond at Thickanamcode in Kanyakumari district. The area surrounding the pond is agricultural land. Coconut trees, cassava tubers, bananas, etc are cultivated there. These termites eat the cassava tubers and coconut trees planted there, reducing their yield. Therefore, studies were carried out to see if prepared Benzyltrimethylammonium bromide can kill termites. Benzyltrimethylammonium chloride solution prepared in concentrations of 0.2M, 0.4M, 0.6M, and 0.8M was taken for this study. It was found that the benzyltrimethylammonium bromide solution kills termites by putting eight to 10 termites at each molarity concentration. The results of the studies found are given in the table.5 below. Benzyltrimethylammonium bromide has been shown to have very high termite-killing potential. Therefore, it is said through this study that benzyltrimethylammonium bromide will be very useful for farmers and agriculture. The termite resistance test results are shown in the table below. Here, the results clearly show the level of concentration is increased as the period is decreased.

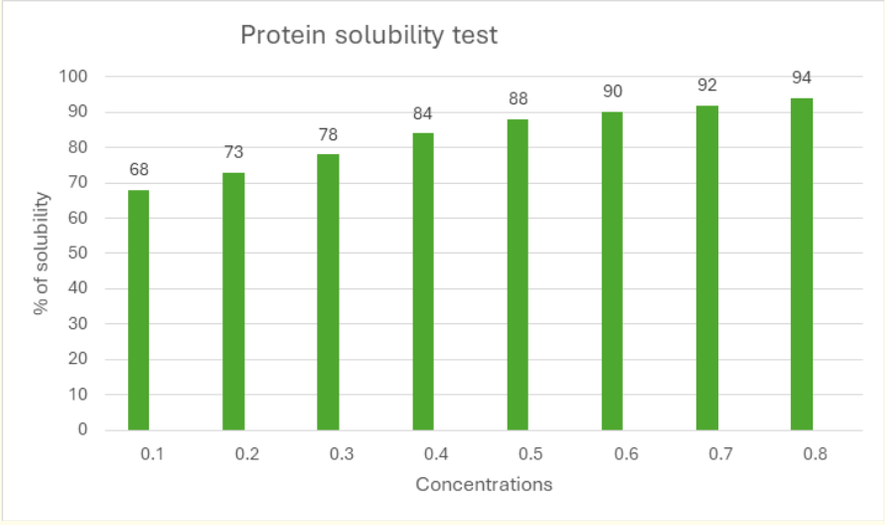

Figure 5: Solubility of BTAB mixed with protein powder.

Utilization studies

In this study, the benzyltrimethylammonium bromide solutions are used to prepare hand sanitizer and soap. Then this sanitizer and soap are studied against five types of gram-positive and gram-negative bacteria, and two types of fungi.

Sanitizer

Mix 75% isopropyl alcohol and glycerol mixed with double distilled water and pour 10mL benzyltrimethylammonium bromide solution and kept in a magnetic stirrer for one hour. If the same is done for each molarity concentration, the sanitizer prepared by benzyltrimethylammonium bromide is ready. In antibacterial results, this sanitizer is highly effective against bacteria like *E. coli, S. epidermidis,* and *P. aeruginosa*. If you look at fungal activity, both *C. albicans* and *A. flavus* have almost the same activity in other words, there is more active against *C. albicans.*

Bacteria	Zone of inhibition(mm)								
	Concentration level								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	Std
Staphylococcus aureus	10	10	12	15	17	18	19	21	30
Staphylococcus epidermidis	9	9	11	14	15	15	16	17	16
Klebsiella pneumonia	11	13	13	14	16	17	17	18	16
Escherichia coli	10	13	13	15	16	19	21	23	30
Pseudomonas aeruginosa	11	15	16	17	18	19	20	23	25

Table 6: The Antibacterial activity results for sanitizer prepared from BTAB.

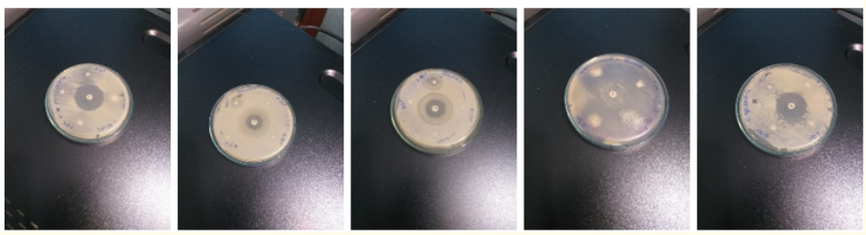

Figure 6: Antibacterial activity results for sanitizer prepared from BTAB.

Fungal	Zone of inhibition(mm)								
	Concentration level								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	std
Aspergillus flavus	9	9	11	13	16	17	19	20	30
Candida albicans	12	13	14	15	18	20	21	23	30

Table 7: The Antifungal activity results for sanitizer prepared from BTAB.

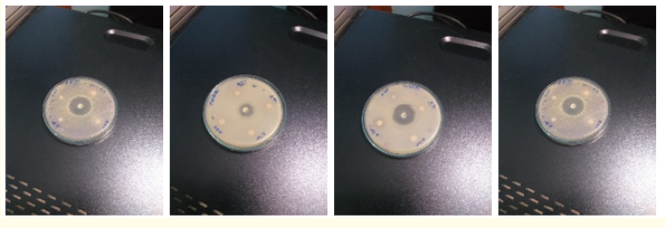

Figure 7: Antifungal activity results for sanitizer prepared from BTAB.

SOAP

Soap was prepared by using a solution of 0.4M concentration prepared with benzyltrimethylammonium bromide and also using soap base, vitamin E capsules, and aloe vera gel. When the soap was tested against five types of bacteria and two types of fungi, it showed good activity against *S. aureus* and *K. pneumoniae* bacteria, and *A. flavus* fungi had almost the same activity in other words there is more activity against *C. albicans*.

Bacteria	Benzyltrimethylammonium bromide for 0.4M	Std
Staphylococcus aureus	15	35
Staphylococcus epidermidis	13	23
Klebsiella pneumonia	14	15
Escherichia coli	18	30
Pseudomonas aeruginosa	14	20

Table 8: The Antibacterial activity results for soap prepared from BTAB.

Figure 8: Antibacterial activity results for soap prepared from BTAB.

Fungi	Benzyltrimethylammonium bromide for 0.4M	Std
Aspergillus flavus	14	35
Candida albicans	16	35

Table 9: The Antifungal activity results for soap prepared from BTAB.

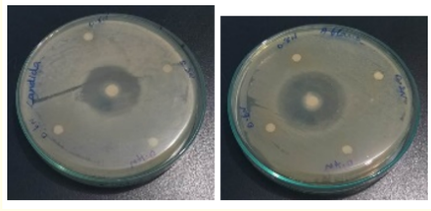

Figure 9: Antifungal activity results for soap prepared from BTAB.

Copper nanoparticles blended sanitizer

The incipiently composed sanitizer was mixed with four different sizes of copper nanoparticles and its bacterial and fungal activities were assessed. On sizes 33,30, 27, and 26, the sanitizer was taken in 0.8M, 0.6M, 0.4M, and 0.2M respectively. These solutions are kept in a magnetic stirrer for 1 hour. Then it was proven that the copper nanoparticles and sanitizer have the faculty to act as disinfectants.

Bacteria	Concentrations				
	0.2M	0.4M	0.6M	0.8M	std
Staphylococcus aureus	15	15	15	16	30
Staphylococcus epidermidis	7	7	9	10	14
Klebsiella pneumonia	9	9	9	9	20
Escherichia coli	7	7	7	14	20
Pseudomonas aeruginosa	7	9	11	13	30

Table 10: The Antibacterial activity results for sanitizer mixed with copper nanoparticles.

Figure 10: The antibacterial activity results for sanitizer mixed with copper nanoparticles.

Fungi	Concentrations				
	0.2	0.4	0.6	0.8	Std
Aspergillus flavus	7	7	9	9	35
Candida albicans	7	9	9	13	30

Table 11: The Antifungal activity results for sanitizer mixed with copper nanoparticles.

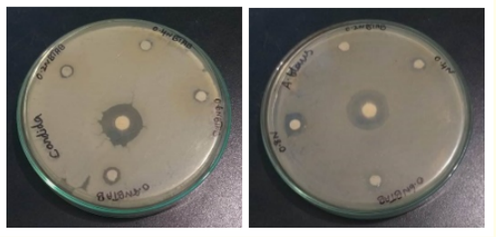

Figure 11: The antifungal activity results for sanitizer mixed with copper nanoparticles.

Conclusion

The present study has demonstrated that the quaternary ammonium compound, Benzyltrimethylammonium bromide is highly effective in protecting against infections caused by a variety of bacteria and fungi. Also, it can destroy virus proteins through protein solubility tests. In the termite resistance test, Benzyltrimethylammonium bromide prepared in 0.1M to 0.8M concentration is a solution that destroys all the termites taken in the test for 5 minutes and helps agriculture and farmers. Further antibacterial and antifungal studies have concluded that benzyltrimethylammonium bromide is an excellent antimicrobial. Apart from that, the sanitizer and soap produced by benzyltrimethylammonium bromide are found to be beneficial for humans. Since the pH value is within the range of 7 to 8, hand sanitizer can also be used without fear.

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