Evaluating the antimicrobial properties of natural and combined disinfectants (based on vinegar and rose water) against surface bacteria

Arian Jafarian1,2; Mohammad Hoseini3; Mansooreh Dehghani4; Abooalfazl Azhdarpoor2*

1Environmental Health Engineering, Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran.
2Department of Environmental Health Engineering, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran.

Abstract

Background: This study evaluated the effectiveness of disinfecting surfaces using natural products (vinegar, Peganum harmala, and rose water) and common chemical disinfectants (ethanol and hydrogen peroxide) against Escherichia coli, Pseudomonas sp, Bacillus sp, and Staphylococcus sp.

Methods: Initially, 122 samples were collected from different surfaces before disinfection, and another 122 samples were taken after disinfection, followed by colony counting. In the subsequent approach, the surfaces were pre-infected with the four bacterial genera and then disinfected with various disinfectants. In the final approach, blank antibiogram discs and Muller Hinton solid culture media were employed. The data were analyzed using SPSS software with appropriate statistical tests.

Results: Results showed that \( H_2O_2 \) 3% (mean=97.96%) and vinegar (mean=83.19%) exhibited the highest efficiency on the surfaces. In the method involving surfaces contaminated with the four bacterial genera, \( H_2O_2 \) (η=100%), ethanol (η=90%), vinegar (η=88.8%), and a mixture of vinegar/ethanol/rose water (η=94%) demonstrated the greatest effect on Escherichia coli. Additionally, the results of the antibiogram test indicated that vinegar had the largest growth inhibition zone for Pseudomonas sp., Bacillus sp. and Escherichia coli, while the vinegar/ethanol/rose water mixture showed the highest inhibition for Staphylococcus sp. Among the chemical compounds, \( H_2O_2 \) significantly influenced all bacterial strains.

Conclusion: This study provides valuable insights into the potential use of natural and combined disinfectants for surface disinfection, highlighting their effectiveness in controlling bacterial contamination.

Keywords: Disinfection; Natural disinfectants; Bacteria; Surface.
person to the surrounding environment [1,5]. Disinfection is the process of removing pathogenic microorganisms using several types of agents. Modern disinfectants comprise intricate formulations that penetrate and kill pathogens [6]. Conventional antimicrobial methods are generally limited to chemical disinfectants such as hydrogen peroxide (H\textsubscript{2}O\textsubscript{2}) and ethanol. Previous studies [7,8] show that a small amount of H\textsubscript{2}O\textsubscript{2} can harm human health, especially in children. In addition, skin absorption of ethanol can lead to a wide range of skin damage, from dry skin to cancer. Additionally, these compounds have adverse effects on the environment. Using chemical disinfectants has always been challenging due to adverse health effects, short-term effects, leaving residues in the environment, and the formation of disinfection by-products (DBPs) [7,9]. In addition to chemicals, identifying the properties of natural compounds and using them to disinfect surfaces are useful in eliminating microbial agents. Besides, they may not have the limitations and disadvantages of chemical disinfectants. Vinegar, rose water, and peganum harmala extract were the natural agents investigated for their disinfection effects in this study. Vinegar induces a low pH-dependent conformational change in hemagglutinin glycoproteins (found on the surface of influenza viruses), inactivates and dissociates these compounds, destroys the viral envelope, and inhibits virus transmission [10,13]. Also, Rosa damascena has been the subject of intense research in agriculture, biochemistry, and pharmaceutical industries regarding its essential oil and high content of bioactive substances. The methanolic extract of this plant has significant potential to kill different genera of bacteria, such as Pseudomonas aeruginosa, Klebsiella Pseudomonas, Escherichia coli, and Proteus mirabilis [14,17].

Identifying the properties of natural compounds and their use as disinfectants requires further scientific studies. To the best of our knowledge, this study is the first to compare the effectiveness of chemical disinfectants with that of natural compounds. Overall, the objectives of this study are as follows:

- Comparing the effectiveness of natural products and chemical agents on surface bacterial colonies.
- Measuring the non-growth diameter of halobacteria using an antibiogram blank approach; and
- Identifying the best disinfectant and proposing an efficient mixture.

**Materials & methods**

**Disinfectants:** In this study, different disinfection methods were applied using the following materials: 1) ethanol 70% and H\textsubscript{2}O\textsubscript{2} (0.5%, 1%, 2%, and 3%) as chemical disinfectants, 2) vinegar (30%, 50%, 70%, and 100%), rose water and peganum harmala extract (from boiling and filtering seeds) as natural disinfectants, and 3) combinations of vinegar/rose water (1:4), vinegar/rose water (3:4), vinegar/ethanol/rose water (1:1:3), and vinegar/ethanol/rose water (1:1:3). Next, their effects on the surface bacteria were examined after the exposure times of 5, 10, 15, and 30 min.

**Bacteria genus:** In this study, different disinfectant efficacies were investigated for domestic surfaces in terms of Staphylococcus, Bacillus, Pseudomonas, and Escherichia coli genus. The streaking sample cultured on a nutrient agar medium was used for these genera and incubated for 48 hours at 35°C. After the incubation, the colonies were dissolved in 5 mL of normal saline to reach a turbidity of 0.5 McFarland, and the suitable bacteria solution was prepared.

**Sampling methods:** Three sampling approaches were adopted to analyze the effects of different disinfectants. First, samples (n=122) were taken before disinfection. Next, the disinfectants were spread on the whole surface with a spray, and 122 samples were obtained. Sampling was done using sterilized normal saline with swabs dipped in normal saline and stretched on the surface. Then, the swabs were returned to the test tube that contained 3 mL of normal saline and put in a shaker for the 30s to make the concentration of the solution uniform. Afterward, 0.5 mL of the solution test tube was poured using a sampler on the surface of the nutrient agar culture (28 g/L) and cultured by surface method, and incubation was performed for 48 hours at 30°C. Samples were taken from different surfaces of residential and official areas, especially from a working desk with a 100 cm\textsuperscript{2} area. Before and after disinfection, the samples were taken from the same place at a distance of a few centimeters from each other in one day and with a short time interval. Sampling conditions were observed for each sample. In the second method, two fixed smooth plastic surfaces with an area of 100 cm\textsuperscript{2} were selected, and their primary disinfection was done with ethanol for bias prevention in the final results. Next, 0.5 mL of the stock bacterial solution was distributed on the disinfected surfaces. Finally, the selected disinfectants were sprayed on one of the contaminated surfaces. After 30 min, sampling was done from both areas. After sampling, the swab was placed in 3 mL of normal saline and set in a shaker for a few seconds, and 0.1 mL of this solution was poured onto nutrient agar. Next, the samples were incubated at 35-37°C for 48 hours. In this method, 96 samples were taken to check the effect of each disinfectant on the bacterial genera. This approach was performed using blank antibiogram disks, the disc fusion method, and Muller Hinton solid culture (Muller Hinton Agar, 38 g/L). A sterile swab was soaked in a normal saline (5 mL) containing bacterial genus and then cultured on Mueller Hinton’s media with the lawn culture method. Then, the antibiogram blank disks were removed using sterile tweezers, immersed in the disinfectant solution for a few moments, and soaked in disinfectant. The smeared discs were placed on the plates cultured by the grass method (2 cm from the edge of the plate and 2.5 cm from the other discs). Finally, the plates were put in the incubator at 35°C for 18 hours, and the bacteria colonies were counted in terms of CFU/cm\textsuperscript{2} [18].

**Statistical analysis:** The data were analyzed using SPSS software (IBM-V 16). All tests were performed at a significance level of 5% (p<0.05) and a confidence interval of 95% (CI=0.95). Descriptive statistics were used to describe the data. In addition, one-way analysis of variance (ANOVA) and post hoc test (Post Hoc - Tukey HSD) were used to compare the mean of efficiency on the type of disinfectant. Furthermore, the paired sample test was used to measure the group’s mean efficiency before and after disinfection [19,21].

**Results and discussion**

The efficiency of chemical and natural disinfectants in reducing bacterial colonies on different surfaces of residential-office areas was investigated and compared. Chart 1 shows the disinfection efficiency of various compounds based on the expo-
sure times of [5,10,15,30] min. According to this chart, vinegar with a concentration of 100% at a retention time of 15 min ($\eta=85.69\%$), ethanol 70%, rose water and vinegar/rose water (1:4) with a retention time of 30 min ($\eta=94.73\%, 77.73\%, and 81.6\%$, respectively) had the highest efficiency. Meanwhile, $H_2O_2$ showed the best disinfection efficiency after 10 min of exposure ($\eta=98.37\%$). Also, at all times, vinegar 100% among natural disinfectants and $H_2O_2$ among chemicals showed the best performance. $H_2O_2$ can be considered a defense mechanism against invading intracellular pathogenic bacteria. The use of Reactive Oxygen Species (ROS), including $H_2O_2$, is well known as an effective and direct tool for killing microbial pathogens.

The mean performance of different disinfectants to reduce surface contamination was compared using an ANOVA test. The results showed a significant difference ($p=0.000$) in the mean efficiency of chemical and natural compounds in disinfection procedures between and within the groups. The Tukey HSD is a significance test of the difference between means and a multi-step comparison method. In this test, the average of the quantitative variables is calculated for all independent groups, prioritized, and sorted. Then, the mean of all possible pairs is differentiated in the form of a conservative method. As shown in Table 1, this post hoc test divided the groups (treatments) into seven categories. According to this table, the pairs of disinfectants that had a significant effect on bacterial colony reduction before and after the disinfection mechanism became statistically significant ($p=0.000$). Examining the performance of different concentrations of vinegar in surface disinfection revealed that the efficiency of reducing contamination from surfaces increased with increasing in vinegar concentration. Based on Figure 2: The best disinfection performance ($\eta=84.60\%$) belongs to vinegar 100%.

In a study conducted to deal with Mycobacterium tuberculosis, Cortesia et al. [12,22] proved that vinegar reduces at least seven logarithms (Log10) of living bacteria. Besides, this acid showed significant mycobactericidal activity due to the pH reduction, leading to an antibacterial effect.

Vinegar contains organic acids (e.g., acetic acid) whose antimicrobial effect is related to its inseparable forms. This compound passively diffuses into the bacterial cell wall, turns to a neutral pH, and breaks the wall down into anions and protons. The release of protons lowers internal pH and inhibits bacterial growth. Therefore, vinegar can kill Gram-negative bacteria by lowering internal pH and preventing bacteria growth. Also, vinegar barricades the growth of Gram-positive bacteria such as Staphylococcus aureus and Listeria monocytogenes. This organic acid destroys cell integrity and inhibits the growth of

Table 1: Tukey HSD results to compare the average efficiency of disinfectants in 15 min.

<table>
<thead>
<tr>
<th>Disinfectants</th>
<th>Ethanol 70%</th>
<th>Vinegar 100%</th>
<th>Vinegar 70%</th>
<th>Vinegar 50%</th>
<th>Vinegar 30%</th>
<th>Rose water</th>
<th>$H_2O_2$ 3%</th>
<th>Vinegar/RW (1/4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinegar 100%</td>
<td>.267</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vinegar 70%</td>
<td>.003</td>
<td>.104</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vinegar 50%</td>
<td>.000</td>
<td>.004</td>
<td>.992</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vinegar 30%</td>
<td>.000</td>
<td>.000</td>
<td>.014</td>
<td>.135</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rose water</td>
<td>.000</td>
<td>.000</td>
<td>.027</td>
<td>.312</td>
<td>.962</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$H_2O_2$ 3%</td>
<td>.001</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>Vinegar/RW (1/4)</td>
<td>.000</td>
<td>.022</td>
<td>.999</td>
<td>.761</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1: The efficiency of chemical and natural disinfectants at different retention times.

Figure 2: The efficiency of different concentrations of vinegar in 15 min for all genera.

Figure 3: The efficiency of different concentrations of $H_2O_2$ in 15 min for all genera.

Figure 4: Mean efficiency of different disinfectants on the bacterial genera (30 min).
these bacteria. Hence, vinegar has antibacterial properties against both Gram-positive and Gram-negative bacteria [23]. Data published by various research groups highlight the antimicrobial and sporidical activities of \( \text{H}_2\text{O}_2 \). Also, laboratory experiments show that concentrations of 0.3 to 35% hydrogen peroxide may reduce the microbial load of various opportunistic pathogens (in suspension and on several types of contaminated surfaces) [24,25]. In the current study, \( \text{H}_2\text{O}_2 \) was used as a disinfectant in four different concentrations. The results (Figure 3) showed that the disinfection efficiency increased by increasing the hydrogen peroxide concentration. The highest disinfection power was related to hydrogen peroxide concentration of 3% with an efficiency of 97.64%. This performance difference was checked by t-test. Based on the obtained results, the mean reduction in the number of colonies before and after disinfection was 0.937 ± 3.814 CFU/cm\(^2\), respectively, which was in the confidence interval range of 3.36-4.36. Therefore, it is confirmed that the difference between the number of colonies on the surfaces before and after disinfection was significant (\( p=0.000 \)).

The antibacterial properties of Rosa damascena petal extract were evaluated in the study of Randam et al. [26] using Minimum Inhibitory Concentration (MIC), Minimum Bactericidal Concentration (MBC), and IC\text{50}. The results showed that the Ethyl Acetate (EToAc) part had the highest antibacterial activity, followed by the Methanolic (MeOH) part. The most sensitive bacterial strains were Staphylococcus aureus and Bacillus cereus, and the most resistant strains were Pseudomonas aeruginosa and Escherichia coli. Overall, this study shows that Rosa damascena petal extract has promising antibacterial properties. On the other hand, investigating aqueous and hydroalcoholic extracts of rose water by Saghafi et al. [27] showed that rose extract has no antibacterial activity. This study also showed that the heating process used to prepare the sap may have caused the loss of phenols, leading to its lack of antibacterial activity. The effectiveness of different disinfectants on the bacterial colonies demonstrated that among the natural and chemical disinfectants, hydrogen peroxide 3%, ethanol 70%, and vinegar 100% had the highest mean effect on bacterial colonies, in the order of their appearance. On the other hand, rose water and vinegar 30% in a 15-min exposure time were less effective than other disinfectants, with a mean efficiency of 63.03 and 61.74%, respectively. Paired t-test was used to compare the mean disinfection performance of different compounds, and the average of the pairs was 4.23 CFU/cm\(^2\) (mean ± SD = 4.32±1.79) in the 95% confidence interval. In general, it can be stated that the average efficiency of chemical and natural compounds before and after the disinfection process was significantly different (\( p=0.000 \)). In a similar study, Straus et al. [28] prepared a solution of vinegar, hydrogen peroxide, and water as a green disinfectant and an antimicrobial agent suitable for disinfecting surfaces against pathogens such as Ichthyophthirius multifilis and Saprolegnia spp.

The results concerning the average effect efficiency of different disinfectants on contaminated surfaces and Escherichia coli, Bacillus, Pseudomonas, and Staphylococcus are shown in Chart 4. \( \text{H}_2\text{O}_2 \), vinegar/ethanol/rose water (1:1:3), ethanol 70%, vinegar 100%, and vinegar/Peganum harmala/rose water (1:1:3) had a significant effect on Escherichia coli. In the case of Pseudomonas, the efficiency of disinfectants from the highest to the lowest was related to hydrogen peroxide, ethanol 70%, vinegar/rose water (3:4), and vinegar/ethanol/rose water (1:1:3). Bacillus genus was more sensitive to \( \text{H}_2\text{O}_2 \), ethanol 70%, vinegar 100%, and vinegar/ethanol/rose water (1:1:3), in the order of their appearance. Also, Staphylococcus was less resistant to \( \text{H}_2\text{O}_2 \), ethanol 70%, vinegar 100%, and vinegar/ethanol/rose water (1:1:3). Moreover, some disinfectants (e.g., rose water) had a moderate effect on surfaces but did not show good efficacy using the second approach due to the higher density of bacteria.

The average efficiency of natural and chemical disinfectants on surfaces contaminated with four genera of Escherichia coli, Pseudomonas, Bacillus, and Staphylococcus showed the best performance of disinfectants in killing surface bacteria belonging to alcohol 70% (\( n=96.2\% \)) and grape vinegar 100% (\( n=91\% \)) for Bacillus, hydrogen peroxide for all genus (\( n=97.9-100\% \)), the vinegar/rose water (3:4) mixture for Bacillus (\( n=69.1\% \)), the combination of vinegar/ethanol/rose water (1:1:3) for Escherichia coli (\( n=94\% \)), and vinegar/Peganum harmala/rose water (1:1:3) for Escherichia coli (\( n=79.1\% \)). The compared efficiency of different compounds to destroy bacterial colonies on contaminated surfaces was different and statistically significant (\( p=0.000 \)). The present results are consistent with those of William [29] to compare the effects of natural and chemical disinfectants in residential areas. Based on the results, chemical compounds such as phenolic disinfectants, ethanol, and Lysol reduced bacteria between 4 and 6 logarithms (log\(_\text{10}\)), and compounds such as vinegar led to a reduction of Staphylococcus aureus and Escherichia coli up to about three logarithms (log\(_\text{10}\)) [29].

Moreover, Soto et al. [30] investigated the antimicrobial effect and cytotoxic activity of vinegar-hydrogen peroxide mixture against Candida albicans and Staphylococcus aureus. The results showed that the vinegar-hydrogen peroxide mixture effectively removed Candida albicans and Staphylococcus aureus bacteria from acrylic resin, and dilutions equal to or less than 10-2 of this mixture showed potent cytotoxic effects. Based on the mentioned study and the findings of our study, it is possible to prepare an effective disinfectant from these two substances that have powerful cytotoxic effects with cell death and significant morphological changes. Sakis DDS et al. [31] investigated three types of disinfectants (i.e., bleach, white vinegar, and \( \text{H}_2\text{O}_2 \)) for household surfaces against two types of bacteria: Staphylococcus aureus and Escherichia coli. The compounds used on ceramic surfaces caused a further reduction of Escherichia coli, while on steel surfaces, they were more effective for Staphylococcus. Therefore, these compounds can be a good choice for disinfecting surfaces, provided that their solution is prepared daily. In the antiangiobacterium disks approach, the sensitivity of bacteria to the performance of disinfectant compounds is divided into three spectrums: weak effect (d<6 mm), medium effect (7<d<10 mm), and strong effect (d>11 mm) [32,33]. Based on the results, the effectiveness of disinfectants in the method of surfaces contaminated with the four genera of bacteria under study is consistent with the results of the antiangiobacterium disk method. According to Table 2 and based on the previous classification, among chemical disinfectants, hydrogen peroxide for all genera and ethanol 70% for Escherichia coli, Pseudomonas, and Bacillus were strong disinfectants. In addition, among the natural disinfectants, vinegar 100% and vinegar/Peganum harmala/rose water (1:1:3) were recognized as strong disinfectants for all types except Staphylococcus. Also, the vinegar/ethanol/rose water (1:1:3) mixture had a significant efficacy on all bacteria, and the vinegar/rose water (3:4) was efficient for Escherichia coli, Pseudomonas, and Bacillus. Other disinfectants, i.e., Peganum harmala and rose water extracts, were in the range of medium and weak disinfectants.
Also, comparing the disinfection efficiency of the compounds with each other proved that the highest growth inhibition diameter (in natural compounds) belongs to vinegar 100% (d=40 mm) and (among chemical compounds) hydrogen peroxide 3% (d=68 mm) against Pseudomonas. Calvo-Guirado et al. [34] studied the effect of chemical disinfectants with the antibiogram method. These authors showed that using dentine (sodium hydroxide plus ethanol) or EDTA 10% is effective against E. coli, P. gingivalis, and E. faecalis, but citric acid did not show such an effect. Ali Asghari et al. [35] analyzed the disinfection effect of vinegar, rose water, and ethanol extracted from green tea on Streptococcus mutants, Streptococcus subrings, Streptococcus sanguis, and Streptococcus salivarius. The results showed that the highest inhibition diameter was 24.2 mm for Streptococcus salivarius and 22 mm for Streptococcus subrings about vinegar. Although chemical disinfectants such as ethanol and hydrogen peroxide are highly effective in removing bacteria, the present study recommends using vinegar as a natural combination. In addition, it is recommended to use a vinegar/rose water (3:4) and vinegar/ethanol/rose water (1:1:3) mixture to improve the smell of the disinfectant, increase its efficiency, and reduce the use of chemical disinfectants. Natural compounds prepared from herbal compounds are suitable substitutes for chemical products as bio-innovations in the health scope. One of the significant reasons for this substitution is the fewer side effects of herbal products compared to chemical compounds. The present study showed that natural products have a high ability to compete with chemical compounds in eliminating bacterial contamination of the surfaces of domestic and office places. Besides, the present study showed the potential capacity of vinegar, peganum harmala, rose water, and other natural disinfectant compounds for preventing or controlling the growth and reproduction of different genera of bacteria. Nevertheless, herbal products need more advanced scientific research for wide use and on a large scale.

### Conclusion

In the current study, the antibacterial potency of chemical compounds was compared with natural products to combat pollution in residential and office areas at different levels. Among the chemical compounds, hydrogen peroxide exhibited the highest disinfection efficiency due to its strong oxidation power (η=97.96%) across all investigated exposure durations. As natural disinfectants, 100% concentration vinegar and the combination of vinegar/rose water (1:4) demonstrated effective removal of bacteria from surfaces at all times, with mean removal efficiencies of 83.19% and 78.73%, respectively. Therefore, vinegar can be considered a suitable alternative to chemical disinfectants for cleaning residential and office surfaces. Moreover, 100% concentration vinegar exhibited a satisfactory efficiency (η=88.8%) and was comparable to ethanol (η=90%) in removing Escherichia coli. Overall, the highest removal efficiency of this natural disinfectant was observed against the Bacillus sp. (η=91%). Studying the disinfection efficiency of the combination of different disinfectants showed that the combination of vinegar/rose water (1:1.3) with an efficiency of 94% reduced the amount of chemical disinfectant application and had a good effect on Escherichia coli. Although some natural compounds have good disinfection ability to reduce surface pollution, other disinfectants like rose water and peganum harmala extract need further investigation to improve their performance. According to the study results, it can be stated that the use of chemical disinfectants can be reduced, and their health complications and environmental damage can be prevented by knowing and carefully examining natural disinfectants.

### Declarations

**Acknowledgments:** The authors would like to gratefully acknowledge the research assistant of Shiraz University of Medical Sciences for the financial support (Grant No. 44962), and the ethics code was IR.SUMS.SCHEANUT.REC.1401.1220 in the ethics committee.

**Ethical approval:** Not applicable.

**Authors contributions:** All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [Abooalfazl Azhdarpoo] and [Arian Jafarian Lari]. The first draft of the manuscript was written by [Arian Jafarian Lari] and [Mohammad Hoseini]. The data curation and analysis [Arian Jafarian Lari] and [Mansoorrereh Dehghani], and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

**Funding:** This work was supported by Shiraz University of Medical Sciences (Grant numbers Grant No. 44962). Author A.J.L. has received research support from this university.

**Competing interests:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Availability of data and materials:** All required data is provided in the text.

### References

3. Barker J, D Stevens and S. Bloomfield. Spread and prevention of some common viral infections in community facilities and

---

**Table 2:** The efficiency of different disinfectants in the antibiogram discs approach.

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Vinegar/Ph RW (3/1/1)</th>
<th>Vinegar/Ethanol/ RW (3/1/1)</th>
<th>Vinegar/RW (4/3)</th>
<th>H₂O₂ 3%</th>
<th>Rose water</th>
<th>Peganum harmala</th>
<th>Vinegar 100%</th>
<th>Ethanol 70%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escherichia-coli</td>
<td>14</td>
<td>16</td>
<td>22</td>
<td>46</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>Pseudomonas</td>
<td>16</td>
<td>18</td>
<td>27</td>
<td>68</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>Bacillus</td>
<td>14</td>
<td>17</td>
<td>20</td>
<td>54</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>Staphylococcus</td>
<td>1</td>
<td>14</td>
<td>1</td>
<td>56</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

**The diameter of the aura of non-growth of bacteria (mm)**


