Effectiveness Comparison of *Aloe vera* and 70% Alcohol Hand Sanitizers in Reducing Hand Microorganism Colonies

Laurenz Diffa Yunanda[1], Masfiyah Masfiyah[2]*, Rahayu Rahayu[2]
[1]Medical Student, Faculty of Medicine, Sultan Agung Islamic University, Semarang, Indonesia
[2]Department of Microbiology, Faculty of Medicine, Sultan Agung Islamic University, Semarang, Indonesia
*Corresponding author: Masfiyah@unissula@.ac.id

Abstract

Microbe-based infection transmission commonly occurs through hands, as they harbor both normal microbiota and pathogenic microorganisms. Hand sanitizer is preferred by the public due to its practicality compared to handwashing. However, alcohol-based hand sanitizers can cause skin irritation and dryness. The availability of natural ingredient-based hand sanitizers remains limited. This study aimed to analyze the difference in effectiveness between *Aloe vera*-based hand sanitizer and 70% alcohol hand sanitizer in reducing the number of microorganism colonies on hands. This experimental study employed a pre-post test group design. Samples were consecutively taken from medical students at Sultan Agung Islamic University, Semarang, using the glove juice method, with 20 samples per group. The percentage reduction in microorganism colony counts between the *Aloe vera*-based hand sanitizer group and the 70% alcohol group was analyzed using the Mann–Whitney test. The results showed that the mean reduction in colony count was 59.2% for the alcohol-based hand sanitizer and 37.97% for the *Aloe vera*-based hand sanitizer. The Mann–Whitney test yielded a p-value of 0.001 ($p < 0.05$). There is a significant difference in effectiveness between *Aloe vera*-based and 70% alcohol-based hand sanitizers in reducing microorganism colony counts on hands. The 70% alcohol-based hand sanitizer was found to be more effective.

Keywords: hand sanitizer, *Aloe vera*, 70% alcohol, microorganism colony count, glove juice method

1. INTRODUCTION

Hands serve as a medium for microbe-based infection transmission because they harbor both normal microbiota and pathogenic microorganisms (Tulsawani et al., 2024). Various pathogenic organisms capable of causing serious diseases such as respiratory tract infections and gastrointestinal infections can be transmitted via hands. The lack of proper handwashing models, inadequate handwashing facilities such as clean water, soap, tissue, and the limited accessibility of handwashing sinks are some reasons for the failure of hand hygiene practices (Vishwanath et al., 2019). According to the Centers for Disease Control and Prevention (CDC), hand hygiene includes cleaning hands with soap and water, antiseptic hand rubs, and alcohol- based hand sanitizers. During the Coronavirus Disease 2019 (COVID-19) pandemic, the use of hand sanitizer was more widely adopted by the public due to its practicality compared to handwashing (Gold et al., 2024). Hand sanitizers contain chemical compounds such as triclosan and alcohol,

which can kill germs on the hands but may cause irritation and dryness (Kusdiyah et al., 2022). Research on natural ingredient-based hand sanitizers remains limited. Natural ingredients can be used to reduce environmental waste and decrease the chemical content in hand sanitizers, moreover, the side effects of chemical compounds have driven innovation in the development of natural ingredient-based hand sanitizers (Asngad & Subiakto, 2020).

Handwashing is the primary step to prevent various types of infectious disease-causing germs present on the hands (Seran et al., 2022). According to the United Nations Children's Fund (UNICEF), although washing hands with soap is critical in combating infectious diseases, including Coronavirus Disease 2019 (COVID-19), millions of people worldwide lack easy access to handwashing facilities. This simple action of cleaning hands can save lives and reduce disease by helping to prevent the spread of infectious diseases. These diseases may be caused by pathogens transmitted through the air or via surfaces, food, or human feces. Because people frequently touch their faces, food, and surfaces, hands play a crucial role in disease transmission. It is estimated that 1.4 million people, including nearly 400,000 children under five years old, die annually due to poor hand hygiene, resulting in diseases such as diarrhea, acute respiratory infections (ARI), soil-transmitted helminths, and malnutrition. Unsafe hand hygiene is responsible for 394,000 deaths from diarrhea and 356,000 deaths from ARI. The use of hand sanitizer or antiseptic agents is more effective and efficient compared to using soap and water, thus attracting widespread public interest (Asngad et al., 2018).

Hand sanitizer is an antiseptic gel commonly used as a practical hand cleansing medium. For some people, hand sanitizer is considered more effective and efficient than washing hands with soap and water (Fatricia et al., 2021). Alcohol-based hand sanitizers typically contain active ingredients such as ethanol, isopropanol, and n-propanol (Valentino et al., 2023). As an antiseptic, alcohol-based hand sanitizers have disadvantages, including a burning sensation and, with repeated use, causing skin dryness and irritation (Asngad et al., 2018). Other side effects include bacterial resistance (Minarni et al., 2022). One natural antiseptic that can be safely used repeatedly on the palms is *Aloe vera* (Harahap & Yanti, 2023). *Aloe vera* also has emollient properties that function as a moisturizer (Padakang, 2020). *Aloe vera* extract contains anthraquinones and saponins, which have been shown to possess antimicrobial activity. Research by Seran et al. (2022) also indicates that the active compounds in *Aloe vera* with strong antibacterial activity derive from anthraquinones. The highest anthraquinone content is found in the

latex layer, which is yellowish-brown and located between the *Aloe vera* skin and pulp (Seran et al., 2022). The moisturizing components of *Aloe vera* are essential in hand sanitizer formulation to prevent dryness and irritation caused by the high alcohol content in these products (Padakang, 2020).

Although alcohol-based hand sanitizers are well studied, research on *Aloe vera* as a natural alternative remains limited—especially in direct comparison using standardized in vivo methods. This study aims to address this gap by comparing the effectiveness of *Aloe vera*- and 70% alcohol-based hand sanitizers in reducing hand microorganism colonies.

2. METHOD

This study was an experimental research utilizing a Pretest – Postest Control Group Design. The research was conducted on January 11—12, 2025 at the Microbiology Laboratory of the Faculty of Medicine, Sultan Agung Islamic University, Semarang, Indonesia. The study population consisted of medical students from the Faculty of Medicine, Sultan Agung Islamic University, Class of 2021.

The total sample size was 20 participants, with two groups: the intervention group, which used an *Aloe vera*-based hand sanitizer, and the control group, which used an alcohol-based hand sanitizer.

The calculation of the number of microorganism colonies was performed before and after the intervention using the glove juice method. This study was approved by the Bioethics Committee for Medical/Health Research of the Faculty of Medicine, Sultan Agung Islamic University, Semarang, Indonesia with approval number 117/III/2025/Komisi Bioetik.

The data on the percentage reduction of microorganism colonies between the *Aloe vera*-based hand sanitizer group and the 70% alcohol group were analyzed using normality and homogeneity tests, specifically the Shapiro-Wilk test and the Levene test. The statistical analysis was conducted using Mann-Whitney test. Data analysis was performed using a computer with the SPSS (Statistical Package for the Social Sciences) software program.

3. RESULTS AND DISCUSSION

To provide context for the study population, Table 1 presents the demographic characteristics of the respondents involved in the experiment.

Table 1. Characteristics of Research Respondents

Characteristics of Respondents	N
Sex	
Female	20 (100%)
Age	
20-22 years old	20 (100%)
Occupation	
Students	20 (100%)

Data on Percentage Reduction in Microorganism Colony Counts Pre- and Post-Intervention

The number of microorganism colonies was counted before and after using alcohol-based and *Aloe vera*-based hand sanitizers. Measurement was conducted using the glove juice method. The data on the reduction in microorganism colony counts pre- and post-intervention, as well as microorganism identification, are shown in Tables 2 and 3.

Table 2. Percentage Reduction in Microorganism Colony Counts in the 70% Alcohol Group

Number	pH	Number of Microorganism (CFU/ml)		Microorganism		Percentage Reduction in Microorganism Colony Counts
		PRE	POST	PRE	POST	
1	6.0	217	64	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	70.5
2	6.0	80	40	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	50.0
3	6.0	185	90	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	51.4
4	6.0	63	27	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	57.1
5	6.0	172	82	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	52.3
6	6.0	216	87	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	59.7
7	6.0	109	48	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	56.0
8	6.0	142	57	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	59.9

9	6.0	188	69	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	63.3
10	6.0	127	39	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	69.3
11	6.0	70	32	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	54.3
12	6.0	99	43	*Bacillus sp* *Coagulase Negative Staphylococcus*	*Coagulase negative Staphylococcus*	56.6
13	6.0	134	64	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	52.2
14	6.0	160	69	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	56.9
15	6.0	108	50	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	53.7
16	6.0	98	36	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	63.3
17	6.0	105	40	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	61.9
18	6.0	190	68	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	64.2
19	6.0	218	54	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	75.2
20	6.0	127	56	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	55.9
				Mean		59.2

In the 70% alcohol group, the mean effectiveness in reducing microorganism colony counts was 59.2%. The types of bacteria grown on agar media were *Bacillus sp*. and coagulase- negative *Staphylococcus* (CoNS).

Table 3. Percentage Reduction in Microorganism Colony Counts in the *Aloe vera*-Based Hand Sanitizer Group

Number	pH	Number of Microorganism (CFU/ml)		Microorganism		Percentage Reduction in Microorganism Colony Counts
		PRE	POST	PRE	POST	
1	5.5	34	17	*Coagulasenegative Staphylococcus*	*Coagulase negative Staphylococcus*	50
2	5.5	53	29	*Bacillus sp Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	45.3
3	5.5	63	31	*Bacillus sp Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	50.8
4	5.5	66	33	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	50
5	5.5	101	52	*Bacillus sp Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	48.5
6	5.5	86	57	*Bacillus sp Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	33.7
7	5.5	67	40	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	40.3
8	5.5	72	57	*Bacillus sp Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	20.8
9	5.5	102	51	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	50
10	5.5	59	39	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	33.9
11	5.5	61	30	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	50.9
12	5.5	73	41	*Bacillus sp Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	43.8
13	5.5	41	35	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	14.6
14	5.5	76	37	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	51.3

15	5.5	47	30	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	36.1
16	5.5	86	64	*Coagulase negative Staphylococcus*	*Coagulasenegative Staphylococcus*	25.6
17	5.5	97	62	*Bacillus sp* *Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	30.1
18	5.5	200	98	*Coagulase negative Staphylococcus*	*Coagulase negative Staphylococcus*	51
19	5.5	98	48	*Bacillus sp* *Coagulase Negative*	*Coagulase Negative Staphylococcus*	51
20	5.5	67	51	*Coagulase Negative Staphylococcus*	*Coagulase Negative Staphylococcus*	23.9
Mean Effectiveness						37.97

The *Aloe vera*-based hand sanitizer group achieved a mean effectiveness percentage of 37.97% in reducing microorganism colony counts. The types of bacteria grown on agar media were *Bacillus sp.* and coagulase-negative *Staphylococcus* (CoNS).

Normality and Homogeneity Tests

To determine the appropriate statistical analysis, the data were first tested for normality and homogeneity. The outcomes of these tests are shown in Table 4.

Table 4. Results of Normality and Homogeneity Tests for Percentage Reduction of Microorganism Colonies

Type of Hand sanitizer	***P-value***	
	Shapiro-Wilk	*Levene Test*
Aloe vera-based hand sanitizer	0.182	0.004
70% alcohol hand sanitizer	0.009	

Based on Table 4, the normality test using Shapiro-Wilk for the *Aloe vera*-based hand sanitizer group showed a p-value of 0.182 ($p > 0.05$), indicating that the data were normally distributed. Meanwhile, the 70% alcohol hand sanitizer group had a p-value of 0.009 ($p < 0.05$), indicating that the data were not normally distributed. The homogeneity test using Levene's Test showed a p-value of 0.004, indicating that the variance of the data was not homogeneous.

Mann-Whitney Test

The Mann-Whitney test was performed to compare the effectiveness between the two groups. The results are shown in Table 5.

Table 5. Mann-Whitney Test Results

	Mann-whitney
Assymp. Sig. (2-tailed)	0.001

Based on Table 5, a p-value of 0.001 ($p < 0.05$) was obtained, indicating a significant difference in effectiveness between the *Aloe vera*-based hand sanitizer and 70% alcohol hand sanitizer in reducing microorganism colony counts on hands. Based on the mean effectiveness of microorganism colony reduction on hands, the 70% alcohol hand sanitizer was more effective than the *Aloe vera*-based hand sanitizer.

This study showed a p-value of 0.001 ($p < 0.05$), indicating a significant difference in the effectiveness between the *Aloe vera*-based hand sanitizer and 70% alcohol hand sanitizer in reducing the number of microorganism colonies on the hands. The mean percentage reduction of microorganism colonies in the 70% alcohol group was 59.2%, whereas in the *Aloe vera*-based hand sanitizer group, it was only 37.97%. This indicates that 70% alcohol has a higher effectiveness in reducing microorganisms on the surface of the skin compared to *Aloe vera*. This finding is in line with the study by Ratmaja et al. (2023) which demonstrated that hand washing with 70% alcohol resulted in a 99% reduction of bacterial colonies, or that 70% alcohol-based hand sanitizer had the highest effectiveness in reducing bacterial colonies among other hand cleansing agents.

Alcohol possesses bactericidal properties with rapid action against various types of microorganisms, including Gram-positive bacteria and vegetative Gram-negative bacteria (including multidrug-resistant pathogens such as Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Vancomycin-Resistant *Enterococcus* (VRE) as well as viruses (Subhan, 2022). The mechanism of alcohol involves protein denaturation and disruption of the bacterial cytoplasmic membrane (Ratmaja et al., 2023).

The *Aloe vera*-based hand sanitizer group only showed a 37.97% effectiveness in reducing microorganism colonies. This is in line with the research conducted by Akuba & Hasan (2022) which showed that *Aloe vera* hand sanitizer is effective in killing microorganisms. *Aloe vera* is rich in bioactive compounds such as glucomannan, aloin, and various vitamins, which have anti-inflammatory and antibacterial properties.

Studies have shown that polysaccharides in *Aloe vera* can help maintain skin moisture and accelerate the healing process, making it an ideal ingredient for hand sanitizer formulations (Hadi & Stefanus Lukas, 2024).

Aloe vera contains active components such as saponins, which have the ability to kill microorganisms. Saponins are soluble in water and ethanol but insoluble in ether. When mixed with water, saponins in *Aloe vera* produce foam, acts as an antiseptic (Akuba & Hasan, 2022). The pH of the *Aloe vera* active ingredient used in this study was 5.5. Research by Indriati et al., (2019) showed that a good formulation has a pH close to the skin's natural pH, which ranges from 4.5 to 6.5, thus preventing irritation when applied to the hands. *Aloe vera* extract in hand sanitizer formulation shows several advantages, such as a skin-safe pH, appropriate viscosity, and antibacterial properties. Besides being effective in killing microorganisms, *Aloe vera* also helps maintain skin moisture and reduces the risk of irritation. The main advantage of this natural-based hand sanitizer innovation is providing comfort and safety for users. The use of natural ingredients such as *Aloe vera* is also more environmentally friendly compared to chemical-based products (Hadi & Stefanus Lukas, 2024).

The evaluation in this study found that the *Aloe vera*-based hand sanitizer was non-sticky, felt soft on the hands, and did not cause irritation or side effects among the respondents. However, there are some limitations. The study did not quantify the levels of key active compounds such as anthraquinones, polyphenols, tannins, flavonoids, and saponins, which may influence the antimicrobial effect.

4. CONCLUSION

Based on the results of this study it can be conclude that there is a difference in the effectiveness between *Aloe vera*-based hand sanitizer and 70% alcohol hand sanitizer in reducing the number of microorganism colonies on the hands. The mean percentage reduction of microorganism colonies after using the alcohol-based hand sanitizer was 59.2% and after using the *Aloe vera*-based hand sanitizer was 37.97%. The effectiveness of 70% alcohol hand sanitizer in reducing microbal colonies was higher compared to *Aloe vera*-based hand sanitizer.

REFERENCE

Akuba, J., & Hasan, H. (2022). Pemanfaatan Lidah Buaya (*Aloe vera*) dalam pembuatan Hand Sanitaizer pada Masyarakat Desa Ulapato A. *Jurnal Pengabdian Masyarakat*

Farmasi : Pharmacare Society, *1*(1), 16–20. https://doi.org/10.37905/phar.soc.v1i1.13996

Asngad, A., R, A. B., & Nopitasari, N. (2018). Kualitas Gel Pembersih Tangan (Handsanitizer) dari Ekstrak Batang Pisang dengan Penambahan Alkohol, Triklosan dan Gliserin yang Berbeda Dosisnya. *Bioeksperimen: Jurnal Penelitian Biologi*, *4*(2), 61–70. https://doi.org/10.23917/bioeksperimen.v4i2.6888

Asngad, A., & Subiakto, D. W. (2020). Potensi Ekstrak Biji Alpukat Sebagai Hand Sanitizer Alami: Literatur Review. *Bioeksperimen: Jurnal Penelitian Biologi*, *6*(2), 106–115. https://doi.org/10.23917/bioeksperimen.v6i2.11765

Ekasanti, D., Seran, M., Deviani Pakan, P., Pieter, H., Wungouw, L., & Lidia, K. (2022). Uji Perbandingan Efektivitas Antibakteri Sabun Cuci Tangan Komersial. In *Cendana Medical Journal. Edisi* (Vol. 24, Issue 2).

Fatricia, J. F., Sari, Apri Dodi Elfiadi Putra Sima, P. D., & Hardiansyah, Apriliany Amanda Putri, F. H. (2021). Laporan Penelitian Pembuatan Hand Sanitizer Dengan Penambahan *Aloe vera Gel* Serta Pengujian Efektivitasnya. *Universitas Jambi*.
Gold, N. A., Mirza, T. M., & Avva, U. (2024). *Alcohol Sanitizer.*

Hadi, W. A., & Stefanus Lukas. (2024). Inovasi Hand Sanitizer Alami Berbahan Lidah Buaya (*Aloe vera* L.) dan Daun Sirih (*Piper Betle* L.) untuk Pembersih Tangan dan Mencegah Kulit Kering. *Seroja Husada Jurnal Kesehatan Masyarakat*, *1*(5), 372–383.

Harahap, C. L. F., & Yanti, S. (2023). Evaluasi Fisik Sediaan Hand Sanitizer Dari Lidah Buaya Segar (*Aloe vera* L.). *Jurnal Kesehatan Ilmiah Indonesia (Indonesian Health Scientific Journal)*, *8*(1), 197–203. https://doi.org/10.51933/health.v8i1.1048

Indriati, I. L., Cahyani, A., & Harismah, K. (2019). Formulasi Gel Lidah Buaya Dengan Bahan Tambahan Minyak Cengkeh Sebagai Hand Sanitizer. *Seminar Nasional Edusainstek*, 359–364.

Kusdiyah, E., Darmawan, A., Indah Dewi Aurora, W., Irbah, A., & Ilmu Kesehatan dan Kedokteran Keluarga Fakultas Kedokteran dan Ilmu Kesehatan Universitas Jambi, D. (2022). Efektifitas Antimikroba Hand Sanitizer Berbahan Dasar Alami *Piper betle* L. dan *Aloe vera*. *Jurnal Kesehatan Masyarakat Indonesia*, *17*(September), 48.

Minarni, M., Yusnidar, Y., Ernawati, M. D. W., Wardiah, R., & Epinur, E. (2022). Edukasi Bahaya Kandungan Zat Pada Hand Sanitizer Sebagai Upaya Menekan Risiko Resistensi Dan Iritasi Kulit Di Smp N 16 Kota Jambi. *Jurnal Pengabdian Masyarakat Pinang Masak*, *3*(2), 88–94. https://doi.org/10.22437/jpm.v3i2.21207

Padakang, S. R. (2020). *Buku Panduan Pelatihan Hand Sanitizer Berbahan Herbal Untuk Pencegahan COVID-19*. 6.

Ratmaja, I. G. A. N. D., Darwinata, A. E., Pinatih, K. J. P., & Fatmawati, N. N. D. (2023). Perbandingan efektivitas mencuci tangan dengan air, sabun antiseptik, hand sanitizer gel, dan alkohol 70% terhadap jumlah bakteri pada tangan. *Jurnal Medika Udayana*, *12*(8), 56–61.

Seran, D. E. M., Pakan, P. D., Wungouw, H. P. L., & Lidia, K. (2022). Uji Perbandingan Efektivitas Antibakteri Sabun Cuci Tangan Komersial Berbahan Sirih Hijau, Jeruk Nipis Dan Lidah Buaya Terhadap Bakteri *Staphylococcus aureus*. *Cendana Medical Journal (CMJ)*, *10*(2), 328–340. https://doi.org/10.35508/cmj.v10i2.9172

Subhan, A. (2022). Studi Evaluasi Mekanisme Hand Rub (Hand Sanitizer) Berbasis Alkohol Terhadap Methicillin-Resistant *Staphylococcus aureus* (MRSA) Dengan Metode Pengamatan Scanning Electron Microscope (SEM). *Jurnal Farmasi Klinik Base Practice*, *1*(1), 61–71. https://doi.org/10.58815/jfklin.v1i1.20

Tulsawani, R., Verma, K., Kohli, E., Sharma, P., Meena, Y. S., Amitabh, Ponmariappan, S., Kumar, P., & Maithani, R. (2024). Anti-microbial efficacy of a scientifically developed and standardized herbal-alcohol sanitizer. *Archives of Microbiology*, *206*(2), 77. https://doi.org/10.1007/s00203-023-03805-4

Valentino, M., Cahyadi, S. N., Andini, P., Ferdian, M., Widjaja, T., Razan Fachrudin, B., Nabila, A. H., Wandira, S. P., Marliah Saputri, S., Azzahra, K. S., Kusumaningrum, A. A., Shabrina, C. L. N., & Nurjannah, R. P. (2023). Comparative Test of Effectiveness of Alcohol Mixture Base Hand Sanitizer With Chlorhexidine Mixture Base on *Escherichia coli* and *Shigella sonnei* Bacteria. *Journal of Research in Pharmacy and Pharmaceutical Sciences*, *2*(1), 17–28. https://doi.org/10.33533/jrpps.v2i1.7013

Vishwanath, R., Selvabai, A. P., & Shanmugam, P. (2019). Detection of bacterial

pathogens in the hands of rural school children across different age groups and emphasizing the importance of hand wash. *Journal of Preventive Medicine and Hygiene*, *60*(2), E103– E108. https://doi.org/10.15167/2421-4248/jpmh2019.60.2.1186