



The Effectiveness of Starfruit (*Averrhoa bilimbi* L.) As A Hand Sanitizer to Reduce the Bacteria on Hand of Food Handlers

Tahta Aulianti Widiatmo^{1*}, Siti Hani Istiqomah¹, Tri Mulyaningsih¹

¹ Yogyakarta Health Polytechnic, Yogyakarta. Indonesia

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ABSTRACT

The cleanliness of the hands of food handlers is a major factor in preventing the spread of disease. The study aims to analyze the effect of using starfruit juice hand sanitizer on the bacteria in the hands of food handlers. The study used a Pretest Posttest with a Control Group Design, conducted in Yogyakarta from March to May 2024. The study involved 24 food handlers. The study used starfruit juice as the basic ingredient for hand sanitizer in three concentration variations (25%, 30%, and 35%). Sampling of hand bacteria was carried out before and after each treatment using the swab method, then incubated for 24 hours at 37°C. Data were analyzed using the Shapiro-Wilk test, One Way ANOVA, and Tukey HSD with a confidence level of 95%. The study results found that starfruit juice hand sanitizer can reduce the number of hand germs ($P = 0.001$). A concentration of 25% was able to reduce 65.06% (2.29×10^4 to 8.22×10^4 CFU/cm²), a concentration of 30% reduced 69.79% (from 2.09×10^4 to 6.15×10^4 CFU/cm²), and a concentration of 35% reduced up to 85.53% (from 2.72×10^4 to 3.99×10^3 CFU/cm²). The study results also found that more than 85% of respondents liked the color, smell, viscosity, and texture of the hand sanitizer. In addition, the hand sanitizer did not change even though it was stored for up to 28 days (12-14°C). Star fruit has the potential to be used as a basic ingredient for making hand sanitizers. In addition to being easy to obtain and cheap, hand sanitizers made from star fruit juice have been proven to be effective as antiseptic.

Kebersihan tangan penjamah makanan menjadi faktor utama dalam pencegahan penyebaran penyakit. Penelitian bertujuan menganalisis pengaruh penggunaan *hand sanitizer* perasan belimbing wuluh terhadap angka kuman tangan penjamah makanan. Penelitian menggunakan rancangan *Pretest Posttest with Control Group Design*, dilaksanakan di Kota Yogyakarta selama bulan Maret hingga Mei 2024. Penelitian melibatkan 24 orang penjamah makanan. Penelitian menggunakan perasan buah belimbing wuluh sebagai bahan dasar hand sanitizer, pada tiga variasi konsentrasi (25%, 30%, dan 35%). Pengambilan sampel angka kuman tangan dilakukan setiap sebelum dan sesudah percobaan dengan metode swab, selanjutnya diinkubasi selama 24 jam pada suhu 37°C. Data dianalisis dengan uji *Saphiro-Wilk*, *One Way Annova*, dan *Tukey HSD* dengan tingkat kepercayaan 95%. Hasil penelitian mendapatkan bahwa *hand sanitizer* perasan belimbing wuluh dapat menurunkan angka kuman tangan ($P = 0,001$). Konsentrasi 25% mampu menurunkan 65,06% ($2,29 \times 10^4$ menjadi $8,22 \times 10^4$ CFU/cm²), konsentrasi 30% menurunkan 69,79% (dari $2,09 \times 10^4$ menjadi $6,15 \times 10^4$ CFU/cm²), dan konsentrasi 35% menurunkan hingga 85,53% (dari $2,72 \times 10^4$ menjadi $3,99 \times 10^3$ CFU/cm²). Hasil penelitian juga mendapatkan bahwa lebih dari 85% responden menyukai warna, bau, kekentalan, dan tekstur hand sanitizer. Selain itu, hand sanitizer tidak mengalami perubahan walaupun disimpan hingga 28 hari pada suhu (12-14°C). Buah belimbing wuluh potensial digunakan sebagai bahan dasar pembuatan hand sanitizer. Selain mudah diperoleh dan murah, hand sanitizer berbahan dasar perasan buah belimbing wuluh terbukti efektif sebagai antiseptik.

* Corresponding author: Tahta Aulianti Widiatmo
Yogyakarta Health Polytechnic, Yogyakarta. Indonesia
Email: tahtaaaa08@gmail.com

1. Introduction

Food is a basic human need, so food must be free from all contamination, whether physical, chemical, or biological (Lestari, 2020; Nuryani et al., 2017). The quality of hygiene and sanitation in food is influenced by two main factors: food handlers and the processing environment. Of the two factors, the factor that is considered more important is the food handler (Alamri et al., 2021; Ehuwa et al., 2021; Fatimah et al., 2022; Gallo et al., 2020; Yushananta & Putri, 2024).

Food handlers have a role in food contamination, so good personal hygiene is essential (Trigunarso, 2020). According to V. I. Dewi (2021), disease transmission can occur through several media, namely through people, places, objects, or food. The most frequently reported foodborne disease transmission is diarrhea and typhoid (Kemenkes RI, 2021; Qisti et al., 2021; Yushananta & Bakri, 2021; Yushananta & Putri, 2024).

The cleanliness of the hands of food handlers is an important factor in preventing the spread of disease through food, in addition to the processing process that meets standards (Yushananta & Putri, 2024). Washing hands with soap is a behavior that must be implemented to avoid food contamination.

Currently, people tend to use hand sanitizers as an alternative to washing hands with soap. However, the use of alcohol-based hand sanitizers for a long time can cause skin irritation. So, the use of natural ingredients is a solution to overcome this (Permatasari et al., 2023).

One of the natural ingredients that can be used as an alternative as a hand sanitizer is star fruit (*Averrhoa bilimbi* L.) because it contains active compounds in the form of flavonoids, tannins, and saponins which can function as antibacterials (Prastiyanto et al., 2020; Sari et al., 2022; Setyawan et al., 2021). Several types of bacteria whose growth can be inhibited by these active compounds are *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Streptococcus mutans* (Javed et al., 2020; Purwanti, 2023; Raji et al., 2019; Rini et al., 2017). Research by Septiani et al. (2017) found that a 10% concentration of star fruit juice can inhibit the growth of *Staphylococcus aureus* bacteria. According to P. Dewi et al. (2019),

a 10% concentration of starfruit juice can inhibit the growth of *Escherichia coli* bacteria. The study aims to analyze the effect of using starfruit juice hand sanitizer on reducing the bacteria in the hand of food handlers. This study will also assess respondents' preferences for the product, as well as the storage temperature of the hand sanitizer.

2. Material and Methods

The study used a Pretest Posttest with a Control Group Design, conducted in two bakpia industries in Yogyakarta from March to May 2024. The study involved 24 workers as food handlers, then grouped into treatment groups ($n = 3$) and control ($n = 1$).

The manufacture of hand sanitizers follows Amsal et al. (2024). Starfruit (*Averrhoa bilimbi* L.) is washed and peeled with clean water. Then, it is pureed with a blender, squeezed, filtered, and evaporated to obtain a thick solution. Dilution is carried out with distilled water to obtain concentrations of 25%, 30%, and 35%. Hand sanitizer is applied using a spray bottle.

Data collection was carried out by measuring the number of germs on the hands of handlers before and after using hand sanitizer. Sampling was done using the swab method with a swab area ratio of 10 cm². The procedure for using hand sanitizer follows Wynland Laboratories (Pty) Ltd (2015). Next, the samples were incubated for 24 hours at 37°C to grow bacteria. Data were analyzed using the Shapiro-Wilk test, One Way ANOVA, and Tukey HSD with a 95% confidence level.

3. Results

The results of the study (Table 1) showed that a concentration of 25% can reduce from 2.29×10^4 CFU/cm² to 8.22×10^4 CFU/cm² (65.06%), a concentration 30% can reduce 69.79% (from 2.09×10^4 CFU/cm² to 6.15×10^4 CFU/cm²), and a concentration 35% reduce 85.53% (from 2.72×10^4 CFU/cm² to 3.99×10^3 CFU/cm²). The results showed that the higher the concentration, the greater the reduce of the bacteria.

Table 1. Pre and post test result

Concentration	Pre test (CFU/cm ²)	Post test (CFU/cm ²)	Reduction (%)
25%			
Mean	2.29 x 10 ⁴	8.22 x 10 ³	65.06
Minimum	1.10 x 10 ⁴	3.33 x 10 ³	60.44
Maximum	4.12 x 10 ⁴	1.63 x 10 ⁴	69.73
30%			
Mean	2.09 x 10 ⁴	6.15 x 10 ³	69.79
Minimum	1.12 x 10 ⁴	3.24 x 10 ³	61.72
Maximum	3.49 x 10 ⁴	8.17 x 10 ³	78.17
35%			
Mean	2.72 x 10 ⁴	3.99 x 10 ³	85.53
Minimum	5.82 x 10 ³	8.37 x 10 ²	78.26
Maximum	4.05 x 10 ⁴	7.50 x 10 ³	90.72
0%			
Mean	2.15 x 10 ⁴	1.97 x 10 ⁴	8.31
Minimum	1.52 x 10 ⁴	1.38 x 10 ⁴	3.52
Maximum	3.15 x 10 ⁴	2.74 x 10 ⁴	13.02

The Shapiro-Wilk and Levene tests were applied to determine the distribution and differences in variation. The test results (Table 2) showed that all data were normally distributed ($P > 0.05$) and

showed no differences in variance between groups ($P = 0.133$).

Table 2. The Shapiro-Wilk and Levene tests result

Saphiro-Wilk test			
Group	F	P	
25%	0.890	0.317 (Normal)	
30%	0.898	0.364 (Normal)	
35%	0.926	0.553 (Normal)	
0%	0.922	0.518 (Normal)	
Levene test			
Levene Statistic	df1	df2	P
2.095	3	20	0.133

The one-way ANOVA test result (Table 3) showed that the average reduction in the number of bacteria in the four groups was significantly different ($P < 0.01$). Meanwhile, the Tukey test result (Table 4) showed no difference in the reduction in the number of bacteria between the concentrations of 25% and 30%. A significant difference was shown at a concentration of 35%, which was able to reduce up to 85.53%.

Table 4. One way ANOVA test result

	Sum of Squares	df	Mean Square	F	P
Between Groups	20480.242	3	6826.75	298.77	0.0001
Within Groups	456.988	20	22.849		
Total	20937.230	23			

Table 5. Tukey HSD test results

Concentration	Subset for alpha = 0.05		
	1	2	3
0%	8.31		
25%		65.06	
30%		69.79	
35%			85.53
P	1.000	0.344	1.000

In this study, respondents' assessments of color, odor, shape, and texture were also conducted (Figure 1). All respondents liked all of the hand sanitizers in terms of odor, shape, and texture.

However, in terms of color, only the 25% concentration was preferred by all respondents, while the 30% and 35% concentrations were preferred by 88% of respondents.

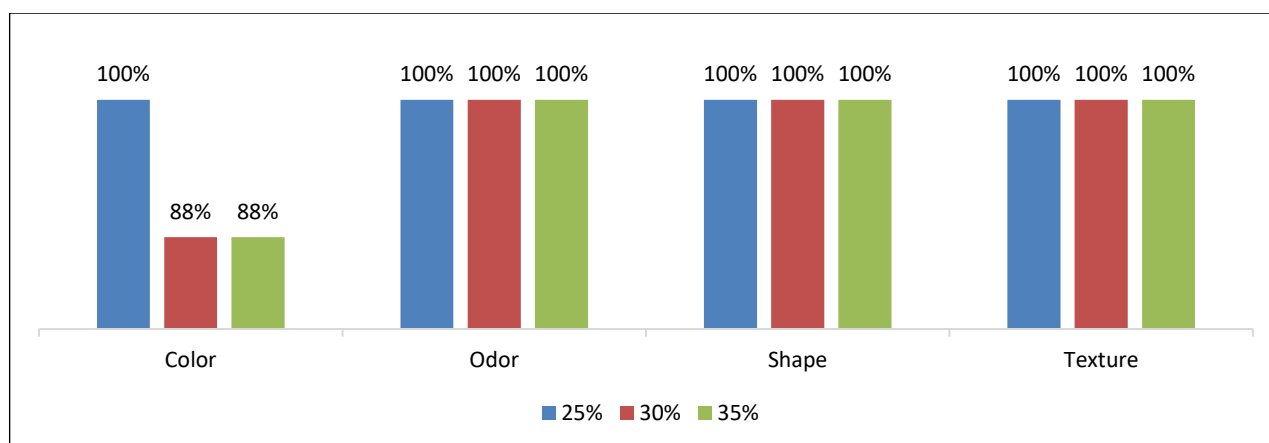


Figure 1. The preference test result

Organoleptic testing was carried out by storing the hand sanitizer preparations for 28 days at room temperature (29-31°C) and cold temperatures (12-14°C). Figure 3 shows that the hand sanitizer (concentrations of 25%, 30%, and 35%) experienced a change in color (from clear yellow to brownish-yellow) and an unpleasant odor. Meanwhile, the shape and texture did not show

any changes, with the remaining liquid having a non-sticky texture.

In cold storage (12-14°C), the three types of hand sanitizer did not change. The three types of hand sanitizer remained clear yellow, had a distinctive smell of star fruit, were liquid, and had a non-sticky texture.

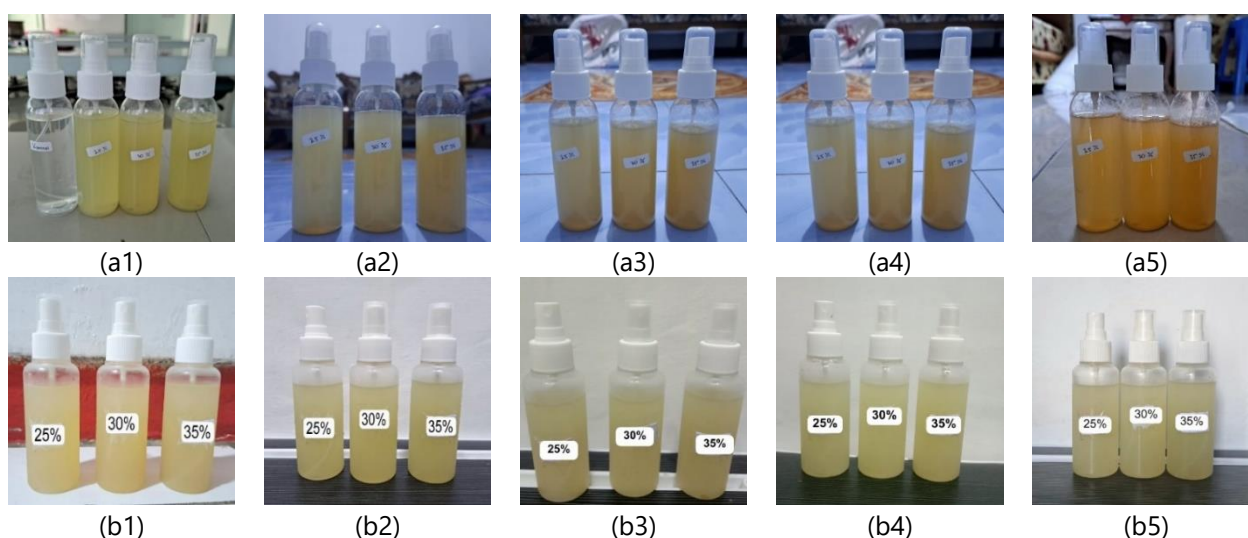


Figure 3. Organoleptic tests result of hand sanitizer during storage at room temperature (a) and cold temperature (b), in fresh conditions (1), 7 days (2), 14 days (3), 21 days (4) and 28 days (5).

4. Discussion

Starfruit is known as vegetable starfruit or sour starfruit because it has a fairly sour taste and is usually used as a cooking spice or herbal medicine (Suryaningsih, 2016). The criteria for starfruit used are ripe, fresh, and yellowish-green starfruit in

order to produce more secondary metabolites (Hasim et al., 2019). Hand sanitizer from starfruit juice is a natural-based hand sanitizer, where natural hand sanitizers are safer to use and can minimize side effects (Permatasari et al., 2023).

The study results (Table 1) show the effect of using hand sanitizer on reducing the bacteria on

the hands. A concentration of 25% can reduce by 65.06% (from 2.29×10^4 CFU/cm² to 8.22×10^4 CFU/cm²), a concentration of 30% reduced it by 69.79% (from 2.09×10^4 CFU/cm² to 6.15×10^4 CFU/cm²), and at a concentration of 35% can be reduced by up to 85.53% (from 2.72×10^4 CFU/cm² to 3.99×10^3 CFU/cm²). The results showed that the higher the concentration, the greater the reduction in the number of bacteria. Statistical analysis proved the effect of the experiment on reducing the number of germs on the hands ($P = 0.001$).

Similar to Susilawaty et al. (2019) and Ilmi et al. (2022), the higher the concentration of the solution, the greater the antibacterial ability. Septiani et al. (2017) found that star fruit juice with a concentration of 20% had a higher inhibitory effect on the growth of *Staphylococcus aureus* compared to a concentration of 10%. In addition, Ilmi et al. (2022) also concluded that a 25% star fruit solution had the highest ability to reduce the number of bacteria compared to concentrations of 15% and 20%.

Hand sanitizer is a product that functions as an alternative antiseptic on the hands. As a product, respondent acceptance is carried out by preference and organoleptic tests (Permatasari et al., 2023; Rini et al., 2017). Figure 2 explains that all respondents liked all of hand sanitizer (odor, shape, and texture parameters). All respondents preferred the color of the 25% concentration, while the 30% and 35% concentration were preferred by 88% of respondents. In addition, based on the trials that have been conducted, it is known that starfruit hand sanitizer does not affect the taste of bakpia.

The organoleptic tests results (Figure 3) showed that the hand sanitizer stored at cold temperatures (12-14°C) did not experience changes (color, viscosity, and texture) for up to 28 days. According to Setyawardani et al. (2017), cold storage can slow down the activity of microorganisms compared to storage at room temperature, thereby extending the shelf life. According to Wiyono et al. (2021), hand sanitizers must be stored at low temperatures so that they do not oxidize quickly and do not experience significant color changes.

Starfruit hand sanitizer has many advantages, namely, the ingredients are easy to obtain and cheap, simple, and effective (Amsal et al., 2024). In this study, the cost required to make starfruit hand sanitizer was only IDR 2,875/100 ml. This cost is

much cheaper than the price of hand sanitizers on the market. This can certainly be a consideration for people to use starfruit as an alternative ingredient for making hand sanitizers.

5. Conclusions

The study results prove that hand sanitizers from starfruit juice can reduce the number of bacteria on the hands of food handlers in all three treatment variations. A concentration of 25% can reduce 65.06%, a concentration of 30% can be reduced by 69.79%, and a concentration of 35% can be reduced up to 85.53%. All respondents liked all of the hand sanitizer (odor, shape, and texture parameters), and more than 88% of respondents liked the color of the product. In addition to not affecting the taste of food, starfruit juice hand sanitizer did not change (color, odor, texture, thickness) even though it was stored for up to 28 days at cold temperatures (12-14°C).

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