

# Analysis of pH levels Mouthwash Manalagi Apple Peel Extract and Potential Benefits for Dental Health



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**Abstract**— Manalagi apple peel (*Malus Sylvestris Mill*) needs to be developed in the form of health products to provide wider and longer-lasting beneficial effects, such as in the form of mouthwash. The purpose of this study was to determine the difference in pH of the manalagi apple peel extract mouthwash formulations in formulations A (25%), B (30%), and C (35%), and their potential benefits for dental health. The research design is a laboratory experiment with a completely randomized design. The intervention in the study was the addition of apple peel extract, including a concentration of 25% (formulation-A), 30% (formulation-B), and 35% (formulation-C). Each concentration was carried out 3 times. The results showed differences in pH in the mouthwash formulation of manalagi apple peel extract in formulations A, B and C, with a statistical test value of  $p$ -value  $0.004 < (0.05)$ . The pH of the manalagi apple peel extract mouthwash formulation was in the range of values of 4.1–4.4. Formulation C is the highest pH formulation and is stable in storage. The study concludes that there are significant differences in pH in the mouthwash formulation of manalagi apple peel extract in formulations A, B and C, and that the mouthwash formulation has the potential to be developed to improve cosmetic function, namely whitening teeth, and therapeutic functions, namely inhibiting the growth of bacteria and cleaning plaque and debris from the tooth surface.

**Keywords**— Mouthwash, Manalagi apple, pH

## 1. Introduction

Fruits are one type of healthy food that is highly recommended for dental health. Fruits contain nutrients that will be absorbed into the body and are beneficial for health in general, including for the health of the teeth and oral health. In addition, fruits that contain lots of fiber mechanically clean the tooth surface during the chewing process.

Apples have been shown in numerous studies to be beneficial to dental health. One type of apple that has great potential for developing its benefits for dental health is the Manalagi apple. In the process of chewing hard apple flesh, it will stimulate the production of more oral saliva so that it can clean the surface of the teeth from food residue, which is meant to provide a massage stimulus to the gums. The content of apples also contains tannin, which is also useful for preventing gum disease and periodontal health (Sagar, 2015).

Manalagi apple (*Malus Sylvestris Mill*) is one of the local varieties of apples that are widely cultivated in Malang Regency, East Java Province, and is one of the leading local apple varieties so that it is widely distributed to many provinces throughout Indonesia. Manalagi apples are reddish-green with white flesh and a sweeter taste compared to other types of apples (Kusumiyati *et al.*, 2021)

Apples, besides being sold in the form of fresh fruit, have been produced by the industry in various

forms such as apple juice, apple cider, gel, and confectionery products (Touyz, 2016). The use of apples needs to be developed in the form of health products to provide a wider and longer-lasting beneficial effect, such as in the form of mouthwash. According to Suryani et al (2019), brushing, mouth washing, using dental floss, and scaling are some of the ways to control dental and oral problems.

People's habits when consuming apples are those who peel the skin of the apple and only eat the flesh of the apple, even though the skin of the apple also has good nutritional content. The apple processing industry also only takes the flesh of the fruit for further processing and removes the skin. According to Raphael (2019), apple skin has benefits including antibacterial, antifungal, antioxidant, and anti-proliferative properties similar to those of the polyphenols in the skin of the apple, which is also higher than the flesh. Therefore, in order not to waste what is wasted, the researchers are interested in researching apple peels in their benefits for dental health. In this study, the focus is on analyzing the pH value of the mouthwash formulation of manalagi apple peel extract for its potential benefits for dental health. The purpose of this study was to determine the difference in pH of the manalagi apple peel extract mouthwash formulations in formulation A (25%), formulation B (30%), and formulation C (35%), and their potential benefits for dental health.

## **2. Method**

The type of research used is a laboratory experiment. The sample in this study was the skin of the manalagi apple, which was taken using a purposive sampling technique with a sample size of 1.8 kg. The ingredients for manalagi apples were obtained from a fruit market in the East Jakarta area. The fruit was in good condition; nothing was damaged or rotted, and it was packaged tightly with transparent plastic. The apples were washed and peeled to obtain a fruit skin weighing 1.8 kg. The samples were dried by heating using an oven at 40°C for 72 hours and continued with refining to obtain a simplicia of dried fruit skin. Furthermore, the sample is withdrawn from the active substance by the maceration method. Maceration was carried out by soaking dry simplicia with a 70% ethanol solution and storing it in a room protected from sunlight. The initial immersion was carried out for 3 days, then the solution was filtered to only take the filtered sediment for further processing. The filtered dregs are then soaked again (remaceration) for the next 3 days so that all remaining active substances can still be filtered to the maximum. The next process in the study was extraction using a rotavapor for solvent evaporation to obtain a thick extract of the Manalagi apple peel. After the rotavapor process, a thick extract of the active ingredient of Manalagi apple peel was obtained with a weight of 565.2 grams. After obtaining the extract, a mouthwash formulation was then carried out by adding the active ingredient of manalagi apple peel with 3 interventions, namely mouthwash-A formulation (25% active substance extract), mouthwash-B formulation (30% active substance extract), and mouthwash-A formulation (extract active substance of 35%). Each formulation was replicated 3 times. The composition of the mouthwash formulation was as follows:

Table 1.  
Mouthwash formulation composition

Ingredients	Formulation composition		
	Formulation A	Formulation B	Formulation C
Apple Peel Extract	25 g	30 g	35 g
Oleum Mentha	0,4 mL	0,4 mL	0,4 mL
Na Benzoat	0,4 g	0,4 g	0,4 g
Gliserin	1 mL	1 mL	1 mL
Tween 80	1 mL	1 mL	1 mL
Sakarin	0,1 g	0,1 g	0,1 g
Aquadest	Ad to 100 mL	Ad to 100 mL	Ad to 100 mL

Mouthwash apple peel extract that has been made is then examined for mouthwash pH using a pH meter that has been calibrated using pH 4 and pH 7 buffers. Evaluation of the examination is carried out on day-1, day-7, day-14, and day-21.

Analysis of research data was carried out by using the *Shapiro-Wilk* normality test, then the Kruskal-Wallis test analysis was carried out, followed by the Mann Whitney post hoc test, and then to determine the effect of storage time, the Friedman statistical test was used. The confidence level was set at 95% ( $\alpha = 0.05$ ).

### 3. Result

The results of the study are presented as follows :

Table 2.  
Formulation pH Test Results  
Manalagi Apple Peel Extract Mouthwash

Formulation	Days			
	1	7	14	21
A1	4.2	4.3	4.2	4.4
A2	4.2	4.3	4.2	4.3
A3	4.1	4.2	4.2	4.3
B1	4.2	4.3	4.3	4.4
B2	4.2	4.3	4.3	4.3
B3	4.2	4.3	4.3	4.3
C1	4.3	4.3	4.3	4.4
C2	4.3	4.3	4.4	4.4
C3	4.3	4.3	4.4	4.4

Statistical analysis was carried out to determine the difference in pH of the mouthwash formulation of apple peel extract at concentrations of 25%, 30%, and 35%. The results of the normality test were as follows:

Tabel 3  
Data normality test results of *Shapiro Wilk*

pH Score	$\rho$ -value
Formulation A	0,077
Formulation B	0,003
Formulation C	0,000

Based on the results of the analysis of the normality test of the data by Shapiro-Wilk, only 1 group of data was normally distributed, namely the mouthwash-A formulation with  $\rho$ -value of  $0.077 > 0.05$ , while the data for the mouthwash-B formulation group ( $\rho$ -value = 0.003) and mouthwash formulation C ( $\rho$ -value = 0.000) were not normally distributed, so the data analysis used the Kruskal-Wallis statistical test.

### Differences between mouthwash formulations

Table 4  
Kruskal-Wallis statistic results

Interventioan	Mean $\pm$ SD	$\rho$ -value
Formulation A	4,242 $\pm$ 0,0793	
Formulation B	4,283 $\pm$ 0,0577	0,004
Formulation C	4,343 $\pm$ 0,0515	

Based on table 4, the lowest average pH value for mouthwash formulation A is 4.242, while the highest average pH value for mouthwash formulation C is 4.343. Based on the results of the Kruskal Wallis test, the  $\rho$ -value is  $0.004 < 0.05$  so it can be concluded that there are significant differences in pH in the 3 groups of formulations. A post-hoc follow-up test with Mann Whitney was performed, and the following results were obtained:

Table 5  
Test result of post hoc *Mann Whitney*

<i>Mouthwash</i> Formulation	With <i>Mouthwash</i> Formulation	$\rho$ -value
Formulation A	Formulation B	0,135
	Formulation C	0,004
Formulation B	Formulation A	0,135
	Formulation C	0,045
Formulation C	Formulation A	0,004
	Formulation B	0,045

Based on table 5, some groups have significant differences, namely the mouthwash formulation group A with C with  $\rho$ -value of  $0.004 < 0.05$  and the mouthwash formulation B with C with  $\rho$ -value of  $0.045 < 0.05$ .

**Differences in storage time of formulation A**
 Table 6  
 Friedman statistical test results

Storage time	Rata-rata $\pm$ SD	$\rho$ -value
Day-1	4,166 $\pm$ 0,0577	0,047
Day-7	4,266 $\pm$ 0,0577	
Day-14	4,200 $\pm$ 0,000	
Day-21	4,333 $\pm$ 0,0577	

Based on table 6, the lowest average pH value on storage day-1 is 4.166 while the highest average pH value on storage day-21 is 4.333. Based on the Friedman test results, the  $\rho$ -value is  $0.047 < 0.05$ , so it can be concluded that there is a significant difference in pH at 4 storage times for mouthwash formulation A (25%).

**Differences in storage time of formulation B**
 Table 7  
 Friedman statistical test results

Storage time	Rata-rata $\pm$ SD	$\rho$ -value
Day-1	4,200 $\pm$ 0,000	0,043
Day-7	4,300 $\pm$ 0,000	
Day-14	4300 $\pm$ 0,000	
Day-21	4,333 $\pm$ 0,0577	

Based on table 7, the lowest average pH value on storage day-1 is 4,200 while the highest average pH value on storage day-21 is 4,333. Based on the results of Friedman's test, the  $\rho$ -value is  $0.043 < 0.05$ , so it can be concluded that there is a significant difference in pH at 4 storage times of mouthwash formulation B (30%).

**Differences in storage time of formulation C**
 Table 8  
 Friedman statistical test results

Storage time	Rata-rata $\pm$ SD	$\rho$ -value
Day-1	4,300 $\pm$ 0,000	0,061
Day-7	4,300 $\pm$ 0,000	
Day-14	4,366 $\pm$ 0,0577	
Day-21	4,400 $\pm$ 0,000	

Based on table 8, shows the lowest average pH value on storage day-1 and day-7 which is 4,300 respectively, while the highest average pH value on storage day-21 is 4,433. Based on the Friedman test results, the  $\rho$ -value is  $0.061 > 0.05$ , so it can be concluded that there is no significant difference in pH at 4 storage times in the mouthwash formulation C (35%).

#### 4. Discussion

The results showed that there was a significant difference in pH between mouthwash formulation A (25%), mouthwash formulation B (30%), and mouthwash formulation C (35%), which was reinforced by the Mann Whitney post hoc test results showing a significant difference in pH between the mouthwash formulations A and C and between mouthwash formulations B and C. The lowest average pH value for mouthwash formulation A (25%) was 4.242, while the highest average pH value for mouthwash formulation C (35%) was 4.36. These conditions indicate that the addition of active substances affects the pH level of mouthwash; the higher the concentration of the active substance, the higher the pH level. The pH score range shows the mouthwash formulation in the category of low acid content and close to normal (7). These results are similar to the research of Rosidah, et al, (2017) which stated that Manalagi apples have a low acidic pH of 4.27, and also the research of Agustine (1997) which stated that the pH of the Manalagi apple variety was around 4.14, which was similar to the research of Dewi, D. F., et al (2019) which obtained the pH value of apple extract gel with a value of 3.0.

The pH level of the apple skin is influenced by the content of malic acid. According to Virk B (2004), which states that the composition of the malic acid content in the apple skin, in general, is 0.28%, According to the main acid content, malic acid is the main acid content in apples. Malic acid has a sour taste effect on the fruit, but when you eat apples, the sour taste is not dominant because it is covered by a stronger sweet taste.

Malic acid compounds provide good benefits for dental health, namely by providing the effect of cleaning extrinsic staining deposits from the tooth surface while maximizing the cleaning of debris and plaque. According to Wardono (2013), malic acid can remove stains on teeth, while according to Diansari (2012), apples can be beneficial for dental health in 2 ways to help whiten teeth: the mechanical process of chewing apples and the organic acid content in apples.

The results of this study indicate that the pH of mouthwash apple peel extracts, where the concentration of 25%-35% is in the range of 4.1-4.4, shows good potential to improve the function of cosmetic products, namely by providing a cleaning effect of extrinsic staining on the tooth surface. A low pH will be able to release color deposits that stick to tooth enamel, such as the function of whitening agents used in clinical treatment. According to Hendari (2009), bleaching treatment materials have pH levels between 4-7.5. One of the active compounds used is hydrogen peroxide. If the peroxide concentration is higher, the bleaching material will have an increasingly acidic pH. The mechanism of teeth whitening with peroxide occurs by changing the state of the material, one of which is changing the pH. The results of this study reinforce the research by Schenk (2007), which states that apples can be used as a teeth whitening agent, which is almost comparable to several other teeth whitening products such as whitening toothpaste, as well as the research by Stephanie (2012), which showed that there was a significant difference in the effect of whitening on teeth that were soaked. in apple juice for 3 times a day for a week compared to the control

group, then research by Puspasari et.al (2012) states that apple juice is effectively able to provide a whitening effect on the surface of tooth enamel that changes color due to immersion in coffee solution.

However, it is necessary to be careful when using materials with a very low pH to be applied to teeth because low pH can cause side effects on teeth. According to Prasetyo (2005), the problem of tooth enamel demineralization can occur in environmental conditions with a pH value below 5.5. A low pH will increase hydrogen ions, which will cause damage to hydroxyapatite in tooth enamel. While according to Hendari (2009), there is a side effect of using whitening agents on teeth, namely the risk of irritation of the mucosa and sensitive teeth, and according to Miranda, et al, (2005), there are several studies showing side effects of erosion on teeth due to teeth whitening agents (bleaching).

The mouthwash formulation with a pH value of 4.1-4.4 is believed to be able to prevent the growth of microorganisms in the product. According to Pradewa (2008), the pH of mouthwash is a requirement that must be met to prevent bacterial growth in the preparation. Therefore, the range of pH values of mouthwash must be outside the range of pH values for bacterial growth. According to Fardiaz (in Fitri Fitri handayani, 2016), the pH range for bacterial growth is 6.5-7.5. Thus, the mouthwash of Manalagi apple peel extract has potential benefits for good therapeutic function, namely preventing bacterial growth and helping clean debris and plaque, which is a medium for bacterial growth on teeth. According to research by Raphael et al, (2019), gargling with manalagi apple peel extract is effective in reducing dental plaque index, and supports the research by Jannata, et al, (2014), which states that manalagi apple peel extract has an effective ability to inhibit the growth of *Streptococcus mutans* bacteria.

The results of this study indicate that during the storage period from day-1 to day-21, there was a change in the pH value of the mouthwash formulations A (25%) and B (30%). The difference was thin, with an average value of the difference between days in the range of 0,1-0.2 (tables 6 & 7), while in the mouthwash formulation C (35%) there was no significant difference. According to research by Ardana, et al, (2015), there will be ups and downs in the pH of the preparation during the storage period, even though the value is not significant.

## **5. Conclusion**

- a. There is a significant difference in pH between the mouthwash formulation of manalagi apple peel extract in formulation A (25%), formulation B (30%), and formulation C (35%). Formulation C is the highest pH formulation and is stable in storage.
- b. The pH of the mouthwash formulation of manalagi apple peel extract is 25%-35% in the value range from 4.1 to 4.4, so it has the potential to be developed to improve cosmetic functions, namely whitening teeth, and therapeutic functions, namely inhibiting bacterial growth and cleaning plaque. and debris from the tooth surface.

## 6. Suggestion

- a. The mouthwash formulation is recommended to have a higher concentration because it is expected that the pH will be stable in storage and approach the normal pH value to minimize the risk of side effects when used for dental health.
- b. Further applied research and development is recommended to maximize the useful functions of apple peel extract mouthwash manalagi in cosmetic functions, namely whitening teeth, and therapeutic functions, namely inhibiting bacterial growth and cleaning plaque and debris from the tooth surface.

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