RESEARCH ARTICLE

Alcoholic and Non-Alcoholic Mouthwash: The Effect on Salivary Flow Rate and pH

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ABSTRACT

Objective: This research aimed to investigate the impact of alcoholic and non-alcoholic mouthwash on salivary flow rate and pH.

Methods: This research utilized a quasi-experimental, pre-test and post-test were conducted on 30 subjects belonging to non-equivalent group. The subjects were carefully selected according to inclusion criteria, ensuring they did not have systemic disease, did not take drugs that cause an effect on salivary flow rate and pH, had a good oral hygiene index score (OHIS), did not use an orthodontic device or denture, and did not eat or drink for 90 minutes before saliva collection. The subjects were subsequently asked to gargle using either alcoholic or non-alcoholic mouthwash. The alcoholic mouthwash used was Listerine® Cool Mint, while the non-alcoholic mouthwash was Enzim® Mouthwash. Saliva was then collected through the draining method. The data was then analyzed to assess the salivary flow rate and pH.

Results: The results revealed a slight increase in salivary flow rate (p=0.083) and a minor decrease in salivary pH (p=0.059) when using alcoholic mouthwash, with no significant difference in salivary flow rate or pH before and after gargling. Similarly, the results also revealed a slight increase in salivary flow rate (p=0.317) and a minor decrease in salivary pH (p=0.120) when using non-alcoholic mouthwash, with no significant difference in salivary flow rate or pH before and after gargling.

Conclusion: This study indicates that alcoholic and non-alcoholic mouthwashes do not significantly affect salivary flow rate and pH during short-term use.

Keywords: Mouthwash, Saliva, Salivary flow rate, Salivary pH

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INTRODUCTION

Mouthwashes, also referred to as mouth rinses, oral rinses, are composed of liquid with the primary goal of preventing, treating, and easing oral health issues, including caries, dental erosion, bad breath, gingivitis, periodontitis, mucositis, and reducing the oral microbial population.[1] Mouthwash is an additional method that can reach out to the surfaces of the oral cavity quickly.[2,3] Mouthwashes are suggested to complement standard oral care routines like brushing and flossing. Based on its composition, mouthwash consists of various types. Alcohol is frequently utilized in mouthwashes due to its antiseptic properties and as a medium for certain active components like menthol or thymol, aiding their penetration into the plaque.[4] Literature shows that using mouth rinses containing alcohol can induce moderate-to-severe adverse effects. Meanwhile, several studies have found that when compared to non-alcoholic mouthwash, alcoholic mouthwash does not have significant cytological side effects.[5]

Saliva has an important role as a fluid that maintains the integrity of oral structure and, in turn, affects all bodily functions.[6] Salivary gland dysfunction is defined by a reduction or increase in salivary flow rate as well as alterations in the composition of saliva.[7] Oral homeostasis is significantly influenced by saliva.[8] Patients who have impaired salivary function are more likely than those with normal salivary flow rates to experience dental caries, denture discomfort, and infections like candidiasis.[8] Moreover, a transition to an aciduric and acidophilic oral microbiota happens when the flow rate of unstimulated whole saliva drops below 0.2 ml/min.[7] Oral candidiasis and caries are more likely as a result.

Mouthwash influences the salivary flow rate and pH through mechanical and chemical stimulation.[9] Mechanical stimulation from the gargling movement affects the salivary flow rate through the muscle contraction mechanism. These muscle contractions are innervated by the facial nerve, which is linked to the salivary glands, leading to saliva secretion.[10] The chemical stimulation comes from the taste sensation of mouthwash, which is transmitted by the facial nerve that innervates 2/3 of the anterior tongue.[9,10] An increase in salivary flow rate is related to the saliva's buffering system, so the salivary pH will increase as the salivary flow rate increases.[11] This study observed the effects of alcoholic and non-alcoholic mouthwash on salivary flow rate and pH before and after gargling during short-term use.

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Table 1: Distribution and frequency based on age and gender

Age	Frequency	Percentage (%)
17-25	29	96.67
26-35	1	3.33
Total	30	100
Gender		
Male	12	40
Female	18	60
Total	30	100

MATERIALS AND METHODS

This research was quasi-experimental, using a pre-test and post-test design with a non-equivalent group design. This research involved thirty subjects who were divided into 15 subjects in each group who gargled with alcoholic or non-alcoholic mouthwash. The subject was assigned randomly into alcoholic and non-alcoholic mouthwash groups using a single-blind method. Subjects were selected by purposive sampling based on inclusion criteria, which included not having systemic disease, not taking medications that affect salivary flow rate and pH, such as fever medication, having a good oral hygiene index score (OHIS), not using an orthodontic device or denture, and not eating or drinking for 90 minutes before saliva collection.

The subject was given instructions to sit comfortably throughout the salivary collection process in order to assess the salivary flow rate. Saliva was collected using the draining method for 5 minutes. The result was divided by five to get the ml/min results. The salivary pH was determined by dipping the colored part of the universal pH paper (Onemed®) into the saliva sample. After that, the pH paper was removed from the saliva and left for 10 seconds. The salivary pH was determined by looking at the color changes on the paper and matching them with the color in the pH indicator.

After that, the subject was given 10 ml of alcoholic or non-alcoholic mouthwash to gargle for 1 minute. The alcoholic mouthwash used in this research was Listerine® Cool Mint, while the non-alcoholic mouthwash was Enzim® Mouthwash. Listerine® Cool Mint is an antiseptic mouthwash containing four active components, namely eucalyptol, thymol, methyl salicylate, and menthol. Other formulations include water, 21.6% alcohol, sorbitol solution, FD&C Green No. 3, sodium benzoate, benzoic acid, flavoring, sodium saccharin, and poloxamer 407. Meanwhile, Enzim® Mouthwash contains natural active enzymes without alcohol or antiseptics. Enzim® Mouthwash contains the enzymes amyloglucosidase, glucose oxidase, and lactoperoxidase, as well as other ingredients such as potassium nitrate, silica, allantoin, and zinc gluconate. Both types of mouthwash used in this study are available in various marketplaces.

The saliva collection procedure was then repeated, and the salivary flow rate was measured again. The salivary pH was then determined again by dipping the universal pH paper into the saliva. The collected data was processed manually and statistical analysis was carried out using computer software. The Wilcoxon Signed Rank Test was employed for data analysis.

Table 2: Analysis of salivary flow rate before and after gargling with alcoholic mouthwash.

Alcoholic Mouthwash	Average Salivary Flow Rate (Mean ± SD) (ml/min)	p-Value
Before gargling	0.307 ± 0.029	0.083*
After gargling	0.309 ± 0.029	

*= Not significant

The ethical approval was granted by the Haji Adam Malik General Hospital and the Faculty of Medicine at Universitas Sumatera Utara ethics committee with No. 352/TGL/KEPK FK USU-RSUP HAM/2019. All subjects was given written informed consent.

RESULTS

This research included 30 subjects. The research subjects ranged in age from 18 to 26. Twenty-nine (96.67%) subjects were aged 17-25, and one (3.33%) subject was found to be aged 26-35 (Table 1). Furthermore, the subjects participating in this study were 12 (40%) males and 18 (60%) females (Table 1).

The average salivary flow rate prior to gargling in the alcoholic mouthwash group was 0.307, with a standard deviation of 0.029. Meanwhile, the average salivary flow rate following gargling was 0.309, with a standard deviation of 0.029 (Table 2). According to the Wilcoxon Signed Rank Test analysis showed no significant difference in salivary flow rate before and after gargling with alcoholic mouthwash, with a p-value of 0.083 ($p > 0.05$).

The average salivary flow rate prior to gargling in the non-alcoholic mouthwash group was 0.300, with a standard deviation of 0.000. Meanwhile, the average salivary flow rate following gargling was 0.301, with a standard deviation of 0.026 (Table 3). According to the Wilcoxon Signed Rank Test analysis showed no significant difference in salivary flow rate before and after gargling with non-alcoholic mouthwash, with a p-value of 0.317 ($p > 0.05$).

The average salivary pH prior to gargling in the alcoholic mouthwash group was 6.873, with a standard deviation of 0.080. Meanwhile, the average salivary pH following gargling was 6.733, with a standard deviation of 0.123 (Table 4). According to the Wilcoxon Signed Rank Test analysis showed no significant difference in salivary pH before and after gargling with alcoholic mouthwash, with a p-value of 0.059 ($p > 0.05$).

The average salivary pH prior to gargling in the non-alcoholic mouthwash group was 6.900, with a standard deviation of 0.085. Meanwhile, the average salivary pH following gargling was 6.873, with a standard deviation of 0.096 (Table 5). According to the Wilcoxon Signed Rank Test analysis showed no significant difference in salivary pH before and after gargling with non-alcoholic mouthwash, with a p-value of 0.120 ($p > 0.05$).

DISCUSSION

Using mouthwash is an additional method to maintain oral health.[4] Many mouthwashes contain alcoholic concentrations between 5-27%.[12] Alcohol serves as a

Table 3: Analysis of salivary flow rate before and after gargling with non-alcoholic mouthwash.

Non-alcoholic Mouthwash	Average Salivary Flow Rate (Mean ± SD) (ml/min)	p-Value
Before gargling	0.300 ± 0.00	0.317*
After gargling	0.301 ± 0.026	

*= Not significant

Table 4: Analysis of salivary pH before and after gargling with alcoholic mouthwash.

Alcoholic Mouthwash	Average Salivary pH (Mean ± SD) (ml/min)	p-Value
Before gargling	6.873 ± 0.080	0.059*
After gargling	6.733 ± 0.123	

*= Not significant

solvent for various active ingredients, stabilizers, preservatives, and antiseptics to obtain a distinctive flavor.[12,13] In this study, the effects of alcoholic and non-alcoholic mouthwash on salivary flow rate and pH were observed in 30 subjects. The participating subjects comprised 12 (40%) males and 18 (60%) females. The study by Mitha et al. in 2016 about mouthwash use and perceived advantages among Malaysian adults showed that only 157 (39.3%) males used mouthwash, whereas 243 (60.8%) females did.[14] The study by Rajeh in 2022 about gender disparities in oral health information and behaviors among Jeddah's adults showed that in terms of oral health habits, female subjects reported using mouthwash more frequently than males.[15] This could be due to the fact that females are generally more concerned with their health and overall appearances compared to males.[14]

The subjects of this research were 29 (96.6%) subjects aged 17-25 years, which is late teens, and 1 (3.33%) subject aged 26-35 years, which is early adulthood. The study by Mitha et al. in 2016 about mouthwash use among Malaysian adults also showed the majority of subjects who used mouthwash were aged 18-25 years, with 178 (44.5%) subjects.[14] The study by Kaur et al. in 2020 about mouthwash usage among the general public of Mississauga showed the majority of subjects who used mouthwash were aged 14-23 years, with 178 (47.3%) subjects.[16] This might be the case because young people are more likely to be concerned with their health and appearance, so they are better informed about the benefits of mouthwash and how to use it consistently.[17]

The group that gargled with alcoholic mouthwash showed an increase in salivary flow rate from 0.307 ± 0.029 ml/min (before gargling) to 0.309 ± 0.029 ml/min (after gargling). With a p-value of 0.083, the Wilcoxon Signed Rank Test result revealed no significant difference in salivary flow rate before and after gargling. The study by Kerr et al. in 2015 about the comparison of alcoholic and non-alcoholic mouthwash on salivary flow and perceived dryness

Table 5: Analysis of salivary pH before and after gargling with non-alcoholic mouthwash.

Non-alcoholic Mouthwash	Average Salivary pH (Mean ± SD) (ml/min)	p-Value
Before gargling	6.900 ± 0.085	0.120*
After gargling	6.873 ± 0.096	

*= Not significant

revealed an increase in salivary flow rate after 4 weeks of using alcoholic mouthwash, but there was no discernible difference before and after gargling.[18]

The group that gargled with non-alcoholic mouthwash showed an increase in salivary flow rate from 0.300 ± 0.000 ml/min (before gargling) to 0.301 ± 0.026 ml/min (after gargling). With a p-value of 0.317, the Wilcoxon Signed Rank Test result revealed no significant difference in salivary flow rate before and after gargling. The research conducted by Kerr et al. in 2015 about comparing the effects of alcoholic and non-alcoholic mouthwash on salivary flow revealed no discernible difference in salivary flow rate before and after using non-alcoholic mouthwash.[18] The study by Susanto in 2015 about the severity of xerostomia in elderly people who used alcohol versus non-alcohol-containing mouthwash revealed no significant difference in the visual analog score (VAS) of xerostomia before and after gargling with alcohol-free mouthwash.[19]

Regardless of the mouthwash's alcohol or non-alcohol content, stimulation was the reason for the increase in salivary flow rate in both alcoholic and non-alcoholic mouthwash groups.[9,18] The stimulations are mechanical stimulation, such as gargling movements, and chemical stimulation, such as alcohol content in mouthwash.[9] The alcohol content in alcoholic mouthwash is metabolized into acetaldehyde by microbes in the oral cavity.[20] Acetaldehyde is an irritant that can cause mucosal irritation, causing a burning sensation.[12] The burning sensation is a factor that can trigger pain, potentially leading to an increase in the rate of saliva production. Furthermore, alcohol's bitter flavor and mouthwash's sorbitol sweetener affect the taste perception of chemoreceptors in the tongue's taste buds, generating nerve impulses that can boost the salivary flow rate.[10,21] In both alcoholic and non-alcoholic mouthwash groups, the action of gargling enhances the salivary flow rate. Gargling involves rinsing the mouth by moving mouthwash around using the muscles of mastication, temporomandibular joint, and oral mucosa.[10] Chemoreceptors and pressure receptors in the oral cavity will react to muscle contraction by initiating impulses through afferent nerve fibers, which transmit information to the center of saliva found in the brainstem's medulla.[21] The center of saliva transmits signals through the parasympathetic nerve to the salivary glands, leading to an elevation in salivary production.[10]

The group that gargled with alcoholic mouthwash showed a decrease in salivary pH from 6.873 ± 0.080 (before gargling) to 6.733 ± 0.123 (after gargling). With a p-value of 0.059, the Wilcoxon Signed Rank Test result revealed no significant difference in salivary pH before and after gargling. The research conducted by Shaik et al. in 2017 about the measurement of pH, total acid, and ethanol levels in alcoholic mouthwash showed that gargling with alcoholic mouthwash led to a reduction in salivary pH.[22] Alcoholic mouthwash has a low pH, so it can affect the salivary pH after gargling. The alcoholic mouthwash used in this study has a mean pH of 4.3, which is low and acidic.[23] In this study, salivary pH was measured immediately after gargling. Therefore, the presence of remaining mouthwash in the mouth led to a reduction in salivary pH. A reduction in salivary pH indicates that the alcoholic mouthwash has a low pH level, is highly acidic, and contains a significant amount of alcohol.[22] Although there is a reduction in salivary pH, it is not considered significant, as saliva's buffering capacity remains effective and the salivary pH after gargling is still neutral.[23] The study by Belardinelli et al. in 2014 about the effect of alcoholic and non-alcoholic mouthwash on salivary pH showed that salivary pH returned to normal within 15 minutes after gargling in 59% of subjects who gargled with alcoholic mouthwash.[24]

The group that gargled with non-alcoholic mouthwash showed a decrease in salivary pH from 6.900 ± 0.085 (before gargling) to 6.873 ± 0.096 (after gargling). With a p-value of 0.120, the Wilcoxon Signed Rank Test result revealed no significant difference in salivary pH before and after gargling. The research conducted by Lindawati et al. in 2020 about the impacts of alcoholic and non-alcoholic mouthwash on salivary pH showed no significant decrease in salivary pH following the use of non-alcoholic mouthwash.[25] When compared to alcoholic mouthwash, non-alcoholic mouthwash typically has a higher mean pH.[26] The study by Shaik et al. in 2017 about the estimation pH of different commercially available mouthwashes showed mouthwash that contains a lot of alcohol has a more acidic pH, for example, ranging from 3.84 to 4.92, while mouthwash with less alcohol or alcohol-free mouthwash has a higher pH.[22,26] The decrease in salivary pH occurred because the non-alcoholic mouthwash used in this study has a mean pH of 5.9, but it is close to the normal salivary pH (6.2-7.6).[27] Despite a reduction in salivary pH, it was not significant, and the pH can normalize within a few minutes.

CONCLUSION

This research concludes that alcoholic and non-alcoholic mouthwashes do not significantly affect salivary flow rate and pH during short-term use.

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REFERENCES

1. Radzki D, Wilhelm-Weglarz M, Pruska K, Kusiak A, Ordyniec-Kwasnica I. A fresh look at mouthwashes- What is inside and what is it for? Int. J. Environ. Res. Public Health 2022;19(3926):1-2. DOI: 10.3390/ijerph19073926
2. Ren X, Zhang Y, Xiang Y, Hu T, Cheng R, Cai H. The efficacy of mouthwashes on oral microorganisms and gingivitis in patients undergoing orthodontic treatment: A systematic review and meta-analysis. BMC Oral Health 2023;23(204):1-2. DOI: 10.1186/s12903-023-02920-4
3. Soham B, Srilatha KT, Seema D. Effects of fluoridated toothpaste and mouth rinse on salivary pH in children- An in vivo study. J of Oral Hygiene & Health 2015;3(06):192. DOI: 10.4172/2332-0702.1000192
4. Hostiuc S, Ionescu IV, Drima E. Mouthwash use and the risk of oral, pharyngeal, and laryngeal cancer. A meta-analysis. Int. J. Environ. Res. Public Health 2021;18(8215):1. DOI: 10.3390/ijerph18158215
5. Gupta V, Pant VA, Pandey S, Pant AB. Efficacy and safety evaluation of alcohol-containing and alcohol-free mouth rinses: A clinicocytological study. J Indian Soc Periodontol. 2021;25(2):128-32. DOI: 10.4103/jisp.jisp_196_20
6. Dawood IM, El-Samarrai SK. Saliva and oral health. Int. J. Adv. Res. Biol. Sci. 2018;5(7):1-45. DOI: 10.22192/ijarbs
7. Farah CS, Balasubramaniam R, McCullough MJ, editors. Contemporary oral medicine a comprehensive approach to clinical practice. Switzerland: Springer Publisher; 2019. DOI: 10.1007/978-3-319-72303-7
8. Nadig SD, Ashwathappa DT, Manjunath M, Krishna S, Annaji AG, Shivaprakash PK. A relationship between salivary flow rates and candida counts in patients with xerostomia. J Oral Maxillofac. Pathol. 2017;21:316. DOI: 10.4103/jomfp.JOMFP_231_16
9. Prihastari L, Setianingtyas P, Surachin A, Azkiya NM. Effectiveness of 2% black tea (*Camellia sinensis*) infusion in increasing salivary pH and fluoride in children. J Dent Indones. 2019;26(2):99-102. DOI: 10.14693/jdi.v26i2.1263
10. Tampubolon KE, Lubis WH, Saragih A. The improvement of saliva flow rate by gargling green tea stepping in menopause women with xerostomia. Int. J. Adv. Res. 2020;8(10):460-4. DOI: 10.21474/IJAR01/11873
11. Pindobilowo, Ariani D, Herawati M, Dwiyono S, Byungchan A. Effects of sodium bicarbonate mouthwash on saliva pH and oral microflora. Formosa J of Applied Sciences 2023;2(9):2135. DOI: 10.55927/fjas.v2i9.6095
12. Ustrell-Borras M, Traboulsi-Garet B, Gay-Escoda C. Alcohol-based mouthwash as a risk factor of oral cancer: A systematic review. Med Oral Patol Oral Cir Bucal. 2020;25(2):e2. DOI: 10.4317/medoral.23085
13. Argemi RA, Navarro BG, Garcia-Seisdedos PO, Devesa AE, Lopez-Lopez J. Mouthwash with alcohol and oral carcinogenesis: Systematic review and meta-analysis. J Evid Based Dent Pract. 2020;20(2):2. DOI: 10.1016/j.jebdp.2020.101407
14. Mitha S, Elnaem MH, Koh M, En C, Babar MG, Siddiqui J, et al. Use and perceived benefits of mouthwash among Malaysian adults: An explanatory insight. J of Advanced

Oral Research 2016;7(3):7-14. DOI: 10.1177/2229411220160302

15. Rajeh MT. Gender differences in oral health knowledge and practices among adults in Jeddah, Saudi Arabia. Clinical, Cosmetic and Investigational Dentistry 2022;14:235-42. DOI: 10.2147/CCIDE.S379171
16. Kaur H, Sharma P. Mouthwash use in general population of Mississauga, Ontario, Canada. J of Advanced Medical and Dental Sciences Research 2020;8(7):6-8. DOI: 10.21276/jamdsr
17. Shabr SFSB, Alqudairy MSM, Alkhamis TAM, AlSalamah SIH, Alkathiri AS, Almousa AAA, et al. Awareness and prevalence of mouthwash use among the general public: A survey based study in Riyadh, Saudi Arabia. Medical Sciences 2020;24(106):4648.
18. Kerr AR, Corby PM, Kalliontzi K, McGuire JA, Charles CA. Comparison of two mouthrinses in relation to salivary flow and perceived dryness. Oral Surg Oral Med Oral Pathol Oral Radiol 2015;119(1):59-63. DOI: 10.1016/j.oooo.2014.09.027
19. Susanto H. Xerostomia severity difference between elderly using alcohol and non alcohol-containing mouthwash. Dent. J. 2015;48(3):109-12. DOI: 10.20473/j.djmkg.v48.i3.p109-112
20. Stornetta A, Guidolin V, Balbo S. Alcohol-derived acetaldehyde exposure in the oral cavity. Cancers 2018;10(20):10. DOI: 10.3390/cancers10010020
21. Andayani R, Noviyandri PR, Husna A. The effect of gargling old coconut water (*Cocos Nucifera L.*) on the salivary flow rate and pH in students of SMAN 10 Fajar Harapan Banda Aceh. Advances in Health Sciences Research 2021;32:76-9. DOI: 10.2991/ahsr.k.210201.017
22. Shaik R, Reddy SP, Shaik S, Nemalladinne SES, Reddy DSP, Praveen KNS. Estimation of pH, total acid and ethanol content of commercially available alcohol-containing mouthwashes and its effect on salivary pH. J. Evid. Based Med. Healthc. 2017;4(54):3302-6. DOI: 10.18410/jebmh/2017/656
23. van Swaaij BWM, Slot DE, Van der Weijden GA, Timmerman MF, Ruben J. Flouride, pH value, and titratable acidity of commercially available mouthwashes. International Dental J 2024;74:260-5. DOI: 10.1016/j.identj.2023.09.002
24. Belardinelli PA, Morelatto RA, Benavidez TE, Baruzzi AM, Lopez de Blanc SA. Effect of two mouthwashes on salivary pH. Acta Odontol. Latinoam. 2014;27(2):66-70. DOI: 10.1590/S1852-48342014000200004
25. Lindawati Y, Nazriyanti G, Ritonga PWU, Sari IP. The effects of alcohol and non-alcohol mouthwash on oral cavity environmental alterations (salivary pH and plaque index). J of Biomimetics, Biomaterials and Biomedical Engineering 2020;48:77-84. DOI: 10.4028/www.scientific.net/JBBBE.48.77
26. Garib BT, Tofiq SA, Fakhruldeen ZE. pH of commercially available brands of toothpaste and mouthwashes in Sulaimani/Iraq Markets: An in-vitro study. Sulaimani Dent J. 2019;6(2):45-50. DOI: 10.17656/sdj.10096
27. Bechir F, Pacurar M, Tohati A, Bataga SM. Comparative study of salivary pH, buffer capacity, and flow in patients with and without gastroesophageal reflux disease. Int. J Environ. Res. Public Health 2022;19(201):2. DOI: 10.3390/ijerph19010201