March 2020

Effects of Mouthrinses on Salivary pH After Acidic Drink Consumption

Megan S. Fisher  
*West Virginia University*

Matthew Duggan  
*West Virginia University*

Yilin Cai  
*West Virginia University*

Follow this and additional works at: https://researchrepository.wvu.edu/murr

**Recommended Citation**  
Available at: https://researchrepository.wvu.edu/murr/vol5/iss1/8

This Article is brought to you for free and open access by The Research Repository @ WVU. It has been accepted for inclusion in Mountaineer Undergraduate Research Review by an authorized editor of The Research Repository @ WVU. For more information, please contact ian.harmon@mail.wvu.edu.
Effects of Mouthrinses on Salivary pH After Acidic Drink Consumption

Cover Page Footnote
Sincere gratitude and appreciation to our mentors Alcinda K. Trickett Shockey, DHScMA BSDH RDH, and Amy Funk, MSDH. Special thanks to Dr. Sijin Wen, PhD, MS, MA, BS at WVCTSI for statistical analysis assistance. Research reported in this publication was supported by the National Institute of General Medical Sciences of the National Institutes of Health under Award Number 5U54GM104942-04. The content is solely the responsibility of the authors and does not represent the official views of the National Institutes of Health.
Effects of Mouthrinses on Salivary pH After Acidic Drink Consumption

Megan S. Fisher, Matthew Duggan, Yilin Cai
West Virginia University School of Dentistry

Consumption of acidic beverages is a frequent occurrence for many dental patients causing an increase in the acidity of the oral environment and potentially contributing to dental erosion. Currently, no recommendations are available for a protocol to prevent such an acidic environment if one chooses to consume acidic beverages. The purpose this study was to examine five common mouthrinses for their efficacy in buffering salivary pH after acidic exposure, as measured from a group of subjects at various time intervals after Coca-Cola® consumption. All mouthrinses increased salivary pH to more basic levels than without a rinse. Mean salivary pH testing indicates that Cool Mint Listerine® elevated salivary pH the fastest. At 20 minutes post-rinse, only distilled water and ACT® Anticavity mouthrinses resulted in more basic salivary pH values than baseline. However, the only mouthrinse which produced statistically significant salivary pH buffering was ACT® Anticavity. The results of this study increase dental professionals’ awareness of buffering efficacies of the tested mouthrinses. Further evaluation of ACT® Anticavity mouthrinse in future studies would arrive at a definitive solution for patient recommendation.

Introduction

Many dental patients report frequent acidic beverage consumption; increasing prevalence has made such consumption an oral health concern to both dental professionals and patients. Healthy pH of the oral cavity ranges between 6.7 and 7.4, yet many popular beverages have a much lower pH. Concern arises when the acidity of the oral environment reaches the critical threshold of enamel erosion at pH 5.5. Importantly, recent studies have found that the consumption of acidic beverages can lower oral pH below this critical threshold. Substantial research on oral pH reduction after drinking acidic beverages suggests that pH drop is most significant immediately after consumption, and that pH returns to pre-exposure levels within a half-hour.

The use of medicaments pre and/or post-exposure for a more efficient neutralization of salivary pH and enamel protection have been reviewed in previous research studies. Literature from Turissi et al. noted that a combination of calcium lactate pre-rinse followed by a sodium fluoride rinse protected enamel surfaces from citric acid erosion as opposed to sodium fluoride alone. Other analyses by Lindquist et al. incorporated the use of post-drink mouthrinses and other products to investigate their effectiveness in accelerating the return of salivary pH to acceptable levels. Researchers have noted the pH-buffering abilities of neutralizing agents including antacid tablets, chewing gum, mineral water, milk, and water. More specifically, research evaluating post-exposure rinsing with Listerine® Antiseptic and Periobacter® chlorhexidine mouthrinses showed that it requires 15 minutes for pH to return to pre-exposure levels following acidic challenge. Research evaluating CariFree CTx4® rinse—a product marketed for pH neutralization—concluded that chlorhexidine is still the preferred antibacterial rinse for inhibiting the bacteria Streptococcus mutans and Lactobacillus acidophilus.

To date, there have been no studies comparing the efficacy of multiple salivary pH-altering mouthrinses against one another and against a rinse of distilled water. The purpose
of this research study is to evaluate accessible options for returning salivary pH to a healthy level after acidic exposure. Results from this study may be beneficial in providing dental professionals with information regarding acidic beverage consumption.

Overall, this research supports the hypothesis that post-exposure mouthrinses can buffer salivary pH quicker than distilled water or lack of post-exposure rinse. In addition, this study provides dental professionals with insight about the effects which the tested mouthrinses can have on a patient’s salivary pH post-acidic exposure. This study also provides necessary statistics and details for advancing this area of research to build a basis for future patient education on this topic.

**Methods**

Experiments were conducted on twenty participants at West Virginia University (WVU). For each participant, salivary pH was measured initially, immediately following consumption of Coca-Cola, and at several timepoints after rinsing with commonly recommended dental mouthrinses. This study specifically focused on Coca-Cola as the acidic beverage, as it is the most accessible brand of beverages available on-campus at WVU. According to a recent study, Coca-Cola has a pH of 2.37, an acidity considered “extremely erosive”.

Study participants were all students in the 2019/2020 West Virginia University junior dental hygiene class and consisted of 19 females and 1 male. Participants’ WVU Axium dental records were screened to ensure that participants were free from tooth decay and possessed no systemic diseases which would inhibit their participation. Participants were asked about their current consumption of acidic beverages to be sure that exposure to acidic erosion during the study was not outside of each participant’s normal consumption. Researchers selected participants using a non-probability sampling.

This group had a narrow range of ages (20–29 years) and came from various backgrounds; however, all participants had the same level of dental education. The participants played an active role in recording their own salivary pH levels, but recordings were verified and monitored by research investigators to resolve recording-based questions. Each participant, during the course of his/her studies as a dental hygiene student, was educated in the proper reading of pH test strips. No participants reported issues with color blindness.

All research procedures on human subjects were evaluated and approved by the Institutional Review Board (IRB) of West Virginia University (protocol# 1903485364). At the time of enrollment, all study participants were presented with informed consent forms which documented the study, purpose, procedures, risks, and possible research outcomes regarding participation in the study.

During the course of the study, the participants gathered on six separate occasions with at least 8 hours in between testing (to allow for a washout period). Participants were directed to abstain from food or drink for 20-minutes prior to testing. At time of testing, participants first recorded their baseline salivary pH, consumed 50mL of Coca-Cola within 30 seconds, and subsequently recorded salivary pH at 1-minute, 10-minutes, and 20-minutes post consumption. The research instructions informed participants to drink without a straw and without swishing. The study had a crossover design such that all participants used each of the mouthrinses on separate days (Table 1).

Mouthrinses included in this study were Cool Mint Listerine®, CariFree CTx4®, chlorhexidine, ACT® Anticavity, and distilled water. Wilcoxon rank sum analysis was used to

<table>
<thead>
<tr>
<th>Day</th>
<th>Test salivary pH on each participant</th>
<th>Drink 50mL Coca-Cola®</th>
<th>Test salivary pH at 1-minute, 10-minutes, and 20-minutes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 2</td>
<td>Test salivary pH on each participant</td>
<td>Drink 50mL Coca-Cola®</td>
<td>Test salivary pH at 1-minute post consumption</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rinse with Rinse A (Distilled Water) for 30 seconds</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test salivary pH at 1-minute, 10-minutes, and 20-minutes.</td>
<td></td>
</tr>
<tr>
<td>Day 3</td>
<td>Repeat Day 2 protocol with Rinse B (ACT® Anticavity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 4</td>
<td>Repeat Day 2 protocol with Rinse C (Cool Mint Listerine®)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 5</td>
<td>Repeat Day 2 protocol with Rinse D (Chlorhexidine)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 6</td>
<td>Repeat Day 2 protocol with Rinse E (CariFree CTx4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Summary of testing procedures.
compare mean salivary pH levels at each time increment for each mouthrinse against all independent variables (i.e., each rinse in Table 1). A p-value of less than 0.05 was considered statistically significant.

Results

Our results show that salivary pH generally increased faster and to a more basic reading with a mouthrinse than without (Figures 1 and 2), consistent with previous results and claims by mouthrinse providers.

Figure 1 depicts temporal change in pH adjusted to baseline following acidic exposure and post-exposure rinse with each of six treatments. Figure 2 depicts these results with the addition of error bars to visualize standard deviation (SD). It is important to note that Cool Mint Listerine demonstrated the most dramatic initial pH elevation following acidic consumption. Interestingly, CariFree CTx4, the mouthrinse with the most basic documented pH (10.5), did not elevate pH to the level that Cool Mint Listerine did at 1-minute post rinsing, nor did it perform as well as other mouthrinses at later measurement times. At 20-minutes post rinse, the only rinses with salivary pH significantly more basic than without a mouthrinse were ACT Anticavity and distilled water (Figure 2).

The heat map in Figure 3 shows significance levels of pairwise pH differences among the 6 rinse treatments at the indicated timepoints. Significant results (p<0.05) are colored dark red. At the 1- and 10-minute post rinse testing marks, both Cool Mint Listerine and ACT Anticavity showed significant differences from the majority of rinse treatments. Importantly, the only intervention with a significant p-value at 20-minutes post rinse was ACT Anticavity.

Discussion

Dental patients often disclose their acidic beverage consumption to dental professionals; however, besides total avoidance of acidic beverages, few recommendations on decreasing erosion risk are available to patients. Overall, this study was designed to examine five different mouthrinses for their efficacy in returning salivary pH to a healthy level after acidic exposure. To begin examining this question, a clinical study was performed with consenting participants at the West Virginia University Department of Dental Hygiene. The current study stands in contrast to previous studies of salivary pH and acidic

![Figure 1. Temporal salivary pH changes after acidic beverage consumption among 6 post-exposure rinse treatments. Each point represents average value across study participants (n = 20)](image-url)
beverage consumption, which involved pH measurements using a removable appliance. Such appliances are not expected to accurately reflect changes in salivary flow in an effort to return pH to baseline levels and decrease enamel erosion.

Overall, our results show that there are post-exposure mouthrinses available to patients for significantly elevating their salivary pH after acidic beverage exposure. Based on the results of this study, using any of the tested rinses after an acidic beverage should increase salivary pH more than without a post-exposure mouthrinse.

At 20 minutes post-rinse, only two rinses (distilled water and ACT Anticavity) returned salivary pH readings to baseline levels. Additionally, results showed that a Cool Mint Listerine rinse resulted in the most basic salivary pH initially after acidic exposure. Overall, the only rinse which showed a significant intervention effect was ACT Anticavity.

Interestingly, participants consistently experienced an increase in salivary pH in the minute after drinking Coca-Cola. These results are contrary to previous studies, which find that pH levels generally decrease within the first minute after acidic exposure. The pH increase in this study is thought to reflect an increase in saliva production activated by the beverage. Indeed, salivary flow following acidic beverage consumption was measured in previous studies, and was often found to increase initially.

The findings from this study have limitations in application to other acidic beverages and participant age groups. Other studies have examined multiple acidic beverages, but none have covered as many protective mouthrinses for pH elevation as this study. Additional recommendations for further studies include the use of an electronic pH-meter to remove the need for calibration between different subjects and investigators. Broadening the number and age demographic of participants to analyze correlation between salivary pH levels and specific age groups would also give additional useful information. Finally, future studies could test other acidic beverages with the same mouthrinses to compare their relative efficacies after different acidic exposures.

This research provides evidence for dental professionals that post acidic exposure mouthrinses, especially ACT Anticavity, can...
return salivary pH to baseline or a more neutral pH quicker than distilled water or no mouthrinse at all.

Conclusion

Many dental patients report frequent acidic beverage consumption, which is a recognized and major health risk for exposed enamel and dentin tooth surfaces. From this study, dental professionals can find that a post-exposure mouthrinse of ACT Anticavity can return salivary pH to a healthier level after acidic beverage exposure, compared to using no post-exposure mouthrinse. Such a mouthrinse may aid in protection against enamel and dentin erosion and lead to an overall healthier oral cavity. In general, providing dental professionals with information regarding acidic beverages could help them more effectively educate their patients on how to prevent further erosion and create a less hospitable oral cavity for bacterial growth.

Acknowledgments

Sincere gratitude and appreciation to our mentors Alcinda K. Trickett Shockey, DHScMA BSDH RDH, and Amy Funk, MSDH.

Special thanks to Dr. Sijin Wen, PhD, MS, MA, BS at WVCTSI for statistical analysis assistance. Research reported in this publication was supported by the National Institute of General Medical Sciences of the National Institutes of Health under Award Number 5U54GM104942-04. The content is solely the responsibility of the authors and does not represent the official views of the National Institutes of Health.

Competing Interests

The authors declare no competing interests.
References


About the Author:

Megan Fisher is from Ohio but has spent the last 10 years living in West Virginia. She has been a dental hygienist for 6 years, earning her Associate's degree from Bridge Valley Community and Technical College. She came to West Virginia University to finish her Bachelor's degree in dental hygiene. While taking courses, she has continued to work at multiple dental practices to remain active in the field of dental hygiene. She plans to further her education in the future in hopes of becoming an educator one day. Megan will soon be moving back to Ohio with her husband, Dustin, and their two daughters, Sierra, 5, and Leona, 1.

How to Cite This Article: