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ORIGINAL ARTICLE

The effect of avocado consumption on salivary pH among students with halitosis

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ABSTRACT

Halitosis is an oral health problem frequently associated with salivary condition, particularly its degree of acidity (pH). Acidic salivary pH supports the growth of anaerobic bacteria which produce volatile sulphur compounds, the primary cause of oral malodour. A non-pharmacological approach with the potential to neutralise salivary pH is the use of natural substances, such as avocado fruit (Persea americana), which contains bioactive compounds with antibacterial and acid-buffering effects. This study aimed to determine the effect of avocado consumption on salivary pH in students with halitosis. A quasi-experimental design with a one-group pretest-posttest model was employed. The sample consisted of 38 students meeting the inclusion criteria of having acidic salivary pH and halitosis. Salivary pH was measured before intervention, and at 30 and 60 minutes after subjects chewed 10 grams of avocado 32 times. Data were analysed using the Friedman and Wilcoxon tests with a significance level of 5%. The results demonstrated a significant increase in salivary pH 30 minutes after avocado consumption, from an acidic towards a neutral state ($p < 0.05$). However, at the 60-minute measurement, salivary pH returned to baseline and showed no significant difference compared to pre-intervention values ($p > 0.05$). This indicates that the effect of avocado consumption on increasing salivary pH is transient. In conclusion, consuming avocado fruit can significantly increase salivary pH in the short term and may help reduce halitosis, although regular consumption coupled with diligent oral hygiene practices is necessary to maintain this effect.

Keywords: avocado, halitosis, salivary pH, oral malodour, acid neutralisation

Introduction

Oral health is an integral aspect of overall quality of life, where an imbalance in the oral ecosystem can precipitate various disorders.[1] A key element in oral homeostasis is saliva, a complex fluid crucial for lubrication, digestion, remineralisation, and acid neutralisation.[2] Normal salivary pH ranges from 6.2 to 7.6, with an average of 6.7.[3] Deviation from this range can disrupt the oral microbiological balance. Low (acidic) salivary pH creates an environment conducive to the growth of acidogenic and anaerobic bacteria, such as *Streptococcus mutans*, *Fusobacterium nucleatum*, and *Campylobacter rectus*.[4,5] These bacteria not only contribute to caries and periodontal disease but also metabolise amino acids into volatile sulphur compounds (VSCs) like hydrogen sulphide (H_2S) and methyl mercaptan (CH_3SH), which are primary causes of halitosis or oral malodour.[6,7]

In Indonesia, the prevalence of oral health problems remains high. Data from the 2018 National Basic Health Research (Riskesdas) indicated that dental caries, closely linked to an acidic oral environment,

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reached 39.15% in Medan City.[8] This highlights the need for approaches that can help neutralise the oral environment.

Various efforts to address halitosis and acidic salivary conditions have been undertaken, both pharmacologically and non-pharmacologically. The use of natural substances as supportive therapy is increasingly favoured due to perceived safety, accessibility, and minimal side effects.[9] One promising natural agent is the avocado fruit (*Persea americana*). Avocados are rich in bioactive compounds such as unsaturated fatty acids (e.g., oleic acid), polyphenols, vitamins, and minerals, known for their antibacterial properties and buffering capacity.[10,11] A preliminary study by Aditama & Chairani (2023) indicated that chewing avocado fruit could increase salivary pH.[12] However, further exploration of its temporal effects, particularly in populations with halitosis, remains limited. Based on this background, the present study was conducted to analyse the effect of avocado fruit consumption on changes in salivary pH among students with halitosis at the Faculty of Dentistry and Health Sciences (FKKGIK), Universitas Prima Indonesia, by measuring effects at 30 and 60 minutes post-consumption.

Method

This study employed a quasi-experimental design with a one-group pretest-posttest model. The research was conducted at the Faculty of Dentistry, Universitas Prima Indonesia, Medan, from May to August 2025. The target population comprised all second- and third-year students totalling 107 individuals. The sample was selected via purposive sampling based on inclusion and exclusion criteria. Sample size calculation using Slovin's formula (5% margin of error) yielded 84 subjects. However, following the selection process based on the criteria, 38 eligible and consenting participants were enrolled. Inclusion criteria were: FKKGIK UNPRI students from the 2022-2023 cohorts willing to provide informed consent, aged 20-25 years, diagnosed with halitosis via a breath checker, and possessing acidic salivary pH (pH < 6.2). Exclusion criteria included students not from the specified cohorts, absence of halitosis, current systemic medication affecting saliva, or uncooperative behaviour.

The independent variable was the intervention of avocado consumption, while the dependent variable was the change in salivary pH value. Research instruments included: 1) Advantec test paper (pH range 0-14) for measuring salivary pH, 2) A portable halimeter breath checker for detecting and scoring halitosis, 3) A digital scale for weighing avocado portions, 4) Sterile containers for saliva collection, and 5) A stopwatch. Research materials consisted of ripe butter avocado (*Persea americana*) portions of 10 grams per respondent and mineral water.

The research procedure commenced with participant preparation, requesting fasting (except for water) and refraining from toothbrushing for two hours prior to examination. *Pretest stage*: Initial salivary pH was measured using test paper, and halitosis was assessed with the breath checker. *Intervention stage*: Participants chewed 10 grams of fresh avocado 32 times over approximately 10 minutes. *Posttest stage*: Salivary pH measurement was repeated at 30 and 60 minutes after completing consumption. All measurement procedures were performed by the same researcher. Collected data were analysed using SPSS software version 25.0. The Shapiro-Wilk test was used to determine data distribution. As data were not normally distributed ($p<0.05$), inferential statistical analysis utilised the non-parametric Friedman test to compare pH across the three measurement times, followed by the Wilcoxon signed-rank test for paired analysis. The significance level was set at $\alpha=0.05$.

Results

A total of 38 students (1 male, 37 females) with a mean age of 20-22 years met the criteria and completed the study protocol. Sample characteristics based on academic year and gender are presented in Table 1. The majority of the final sample were from the 2023 cohort and predominantly female (97.4%).

Prior to intervention, all respondents (100%) had acidic salivary pH with the following distribution: pH 3 (n=13, 34.2%), pH 4 (n=9, 23.7%), and pH 5 (n=16, 42.1%). Salivary pH measurements across the three time points are presented in Table 2. A dramatic change was observed at 30 minutes post-consumption, where all respondents exhibited an increase in pH to the neutral range (pH 6-7). However, at the 60-minute measurement, the pH pattern returned perfectly to the initial acidic distribution and values.

Table 1. Frequency distribution and descriptive statistics of salivary ph at three measurement times (n=38)

Measurement Time	pH 3 (n)	pH 4 (n)	pH 5 (n)	pH 6 (n)	pH 7 (n)	Mean	Median	SD
Pre-Intervention	13	9	16	0	0	4.08	4	0.88
30 Minutes Post	0	0	0	16	22	6.58	7	0.5
60 Minutes Post	13	9	16	0	0	4.08	4	0.88

Inferential statistical analysis using the Friedman test revealed a statistically significant difference in salivary pH values across the three measurement times ($\chi^2 = 76.000$; $p = 0.000$). Subsequent Wilcoxon testing (Table 3) elucidated that significant differences occurred between pH before and 30 minutes after consumption (p=0.000), and between 30 minutes and 60 minutes after consumption (p=0.000). No significant difference was found between pH before and 60 minutes after consumption (p=1.000).

Table 2. Results of Wilcoxon test for paired comparison of salivary pH values

Comparison Pair	Median Difference	p-value	Interpretation
Pre- vs. 30 Minutes Post	3	0.000*	Significant difference
Pre- vs. 60 Minutes Post	0	1,000	No significant difference
30 Minutes vs. 60 Minutes Post	3	0.000*	Significant difference

Discussion

The results of this study clearly demonstrate that consuming 10 grams of avocado via chewing significantly increased salivary pH from an acidic to a neutral state within 30 minutes. This finding aligns with the research by Aditama & Chairani (2023), which also reported a pH-elevating effect following avocado chewing.[12] The presumed mechanism involves the buffering capacity of bioactive components within avocado. Avocado is rich in minerals such as potassium, magnesium, and calcium, and contains potential alkaline compounds that can neutralise hydrogen ions (H^+) in the oral cavity.[13] Furthermore, the act of chewing itself stimulates salivary flow rate. Newly secreted saliva has a higher bicarbonate (HCO_3^-) concentration, which is the most important natural buffering system in saliva for acid neutralisation.[14] The combination of the buffering content from avocado and increased salivary secretion due to masticatory stimulation is hypothesised to be the primary cause of the rapid pH improvement.

However, a key additional finding is that this neutralising effect is transient. At 60 minutes post-consumption, the salivary pH of all respondents returned to the initial acidic values and distribution. This indicates that the effect of the avocado's active constituents or the mechanical stimulation of chewing had dissipated, and oral homeostasis reverted to being dominated by the original predisposing factors. These factors may include an oral microbiome composition dominated by acidogenic/aciduric bacteria, dietary habits, or individual physiological conditions affecting basal saliva composition.[15] This result reinforces the concept that a single intervention with a natural substance may be insufficient to permanently alter the oral environment but can serve as an adjuvant or supportive therapy.

Increasing salivary pH towards neutral has relevant clinical implications for halitosis. An acidic oral environment supports the proliferation of gram-negative anaerobic bacteria such as *Fusobacterium nucleatum* and *Porphyromonas gingivalis*, which are major producers of Volatile Sulphur Compounds (VSCs) like hydrogen sulphide and methyl mercaptan.[16,17] By raising the pH, conditions become less favourable for these bacteria, potentially reducing VSC production and malodour intensity. Although this study did not measure VSCs directly, the association between low salivary pH and increased VSC concentration has been reported in several studies.[18] Therefore, avocado consumption, which can temporarily neutralise pH, may represent a simple non-pharmacological strategy to help control halitosis, particularly prior to important social situations.

The predominance of female respondents (97.4%) in the sample with acidic salivary pH and halitosis is noteworthy. Although the FKKGIK student population has a higher proportion of females, this percentage is exceptionally high. Some studies report that hormonal fluctuations during the menstrual cycle can influence saliva composition and flow rate, potentially making females more susceptible to salivary pH changes.[19] Additionally, differences in dietary habits, psychological stress, or oral hygiene maintenance patterns may also contribute.[20] However, this finding must be interpreted cautiously given the very small number of male participants, preventing robust generalisation regarding gender differences.

Regarding limitations, this study used a one-group pretest-posttest design without a control group, making it difficult to conclusively attribute pH changes solely to avocado, although the highly consistent

pattern of change supports this association. The use of test paper, while practical, has lower accuracy compared to digital pH meters. Future research is recommended to employ a randomised controlled trial (RCT) design with a control group (e.g., chewing an inert material or placebo), longer observation periods, objective measurement of VSCs using a halimeter or GC-MS, and analysis of oral microbiome composition to gain a more comprehensive understanding of the mechanisms involved.

Conclusion

Consumption of 10 grams of avocado fruit chewed 32 times significantly increased salivary pH from acidic to neutral within 30 minutes in students with halitosis. However, this pH-normalising effect was transient, as values returned to the initial acidic state after 60 minutes. This finding indicates the potential of avocado as a natural supportive agent for neutralising oral acidity and potentially aiding in the short-term reduction of halitosis. For dental practitioners, this information can be integrated into patient education regarding the benefits of healthy foods for oral health. For the public, avocado can be considered a healthy snack option that helps neutralise the oral environment, although its use should be accompanied by good, routine, and sustained oral hygiene practices. Further research with more rigorous designs and more comprehensive parameter measurement is required to confirm and extend these findings.

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