

## Comparison of pH and Flow Rate of Saliva After Using Black Tea, Green Tea and Coffee in Periodontal Patients and Normal Group

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### Abstract

**Objectives:** Periodontal pathogens need acidic environments to proliferate in periodontium, and their growth is affected by the salivary flow rate and pH of the mouth. Alterations in flow and acidity of saliva have an important effect on oral diseases such as periodontitis. This study was designed to compare salivary pH and flow rate before and after using green tea, black tea and coffee in patients with periodontitis and healthy subjects.

**Methods:** The present case control study was conducted on 60 subjects that were allocated into two groups: 30 subjects without periodontitis and 30 subjects with chronic periodontitis. Gingival index (GI), plaque index (PI), probing depth (PD) and clinical attachment loss (CAL) were recorded. Next, 5mL of saliva from both groups was collected for analysis before and after green tea, black tea and coffee rinsing and salivary pH and flow rate were recorded.

**Results:** The result showed significant increase in salivary flow rate and pH after rinsing of green tea in periodontitis group but there was no significant change in pH and flow rate after rinsing of black tea and coffee in both groups.

**Conclusion:** The results suggest that green tea causes a significant increase in salivary flow rate and pH and seems to be a safe and applicable adjunct treatment for periodontitis.

**Key Words:** Periodontitis; Saliva; Coffee; Tea

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## Introduction

Periodontitis is a chronic inflammatory disorder that results in tissue destruction and is usually diagnosed by clinical and radiographic examinations (1). As a multifactorial disease, periodontitis is related to both genetics and environment (2). Microorganisms related to periodontitis include Gram-negative anaerobic bacteria such as *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis* (*P. gingivalis*), *Tannerella forsythia*, *Campylobacter rectus*,

*Eubacterium nodatum* and *Prevotella intermedia* (3). These pathogens grow in a mildly acidic pH: 6.5-7 for *P. gingivalis*, 5-7 for *P. intermedia* and 5.5-7 for *F. nucleatum* (4,5).

Saliva is an exocrine secretion that plays a very important role in oral environment and consists of nearly 99% water and the remaining 1% is a combination of molecules such as calcium, magnesium, potassium, chloride, bicarbonate and phosphate (6). Saliva contains a variety of host defense factors. It influences calculus formation and periodontal disease (7). Saliva has properties

such as lubrication, clearance of substances, digestion and buffering capacity for neutralization of acids or bases (8). Amount and characteristics of saliva have been associated with oral health. It has been demonstrated that individuals who have higher salivary level of inorganic calcium and phosphate, pH and flow rate and have poor oral hygiene would be at higher risk for developing periodontitis (9).

Diet is one of the important factors affecting oral health and drinks play a key role among etiological factors for oral diseases. Green tea, black tea, and coffee are the most commonly consumed drinks by people. Poly-phenols in coffee and tea play a significant role in prevention of inflammation and bacterial activities (10,11). Polyphenols, especially theanine amino acid and catechins with their antioxidant properties are present in composition of these drinks and are ideal for medicinal and dental applications. Hattarki *et al.* (10) assessed the effect of green tea catechins on the red complex organisms. They showed that green tea catechin can cause a significant reduction in red complex organisms and suggested that it can be used as an effective local drug in patients with chronic periodontitis. Studies have shown that catechins also have an inhibitory effect on collagenase activity and suggest that they may be useful for prevention of periodontal diseases. Sakanaka *et al.* (12) studied the effects of polyphenolic compounds extracted from green tea on the growth and adherence of *P. gingivalis* to buccal epithelial cells. They reported that polyphenols greatly reduced the ability of *P. gingivalis* to adhere to oral

epithelial cells and suggested that green tea polyphenols had the potential to be applicable as a remedy for periodontal disease. Hirasawa *et al.* (13) studied the usefulness of green tea catechin for improvement of periodontal disease. They concluded that catechin in green tea has an anti-bacterial effect and the combined use of mechanical treatment and the application of green tea as a slow release local delivery system is beneficial in improving periodontal health status. Hrishi *et al.* (14) assessed the impact of a locally prepared green tea dentifrice on gingival inflammation and severity of periodontal disease. They compared the effects of green tea with fluoride-triclosan dentifrice and concluded that green tea caused greater reduction in gingival inflammation and improved periodontal parameters. Awadalla *et al.* (15) studied the role of green tea use in oral health. They showed that local application of green tea had effective antibacterial properties and it decreased the acidity of saliva.

Coffee also contains polyphenols including chlorogenic acid, which have been evaluated in studies and are believed to have a potent chemopreventive effect. Machida *et al.* (11) evaluated the association between coffee consumption and periodontitis in patients during the maintenance phase of periodontal treatment. They found an inverse relationship between coffee consumption and prevalence of severe periodontitis in the maintenance phase of periodontal treatment.

Using saliva as a diagnostic fluid is non-invasive and easy for a wide range of diseases and clinical situations. Because of

the decisive role of saliva in prevention of periodontal disease, and the possible positive effects of tea and coffee on periodontal treatment, the aim of the present study was to compare the effects of green tea, black tea and coffee on pH and salivary flow rate in patients with periodontitis as well as healthy subjects.

## Methods

In this case control study, 60 subjects with an age range of 20-50 years were randomly chosen in the Department of Periodontology, International Branch of Shiraz University of Medical Sciences and allocated into two groups. Thirty subjects suffering from chronic periodontitis were randomly allocated to the study group, and 30 subjects without any type of periodontal disease were allocated to the control group. In each group, subjects were randomly divided into three subgroups with 10 subjects in each of them. Written informed consent was obtained from each subject and the aim of the study was verbally explained to them. Subjects with history of systemic disease or conditions that may adversely affect periodontal health or the composition of saliva were excluded from the study. The exclusion criteria for the study were:

- Patients with the history of diabetes mellitus, kidney disease, cancer, fungal or respiratory infections.
- Current or previous tobacco use.
- Patients with the history of taking medications or hospitalization in the past six months.

- Mouth breathing and local pathological factors inducing periodontal disease.

Periodontal findings were recorded for each subject. Clinical parameters (GI, PI, PD and CAL) were measured and recorded. The control group included 30 subjects with clinically healthy gingiva with a PD of up to 3mm and without any CAL or bleeding on probing. The test group included 30 patients with chronic periodontitis. The criteria for periodontitis were based on CAL with PD of  $\geq 5$ mm in at least 30% of the sites. The PD was measured around all teeth using Williams graduated periodontal probe. More than 5mm of PD was considered as periodontitis. The CAL was recorded according to the criteria by Armitage (16). The CAL of more than 1.5 mm was recorded as periodontitis.

### *Collection of salivary sample:*

The saliva samples were collected from subjects in an upright position between 11-12 a.m. with no oral intake of food or drinks or tooth brushing for two hours before saliva collection. Next, 5 mL of saliva was collected in sterilized and refrigerated tubes before and after rising 250 mL of green tea (Golestan Co., Tehran, Iran), black tea (Golestan Co., Tehran, Iran) and coffee (Instant coffee, Nestle Co., Bern, Switzerland). The green tea and black tea were prepared by immersing one tea bag in 250 mL of hot water (80-90°C) for two to three minutes. Coffee was made by mixing 2 tea spoons of coffee powder in hot water. The saliva was allowed to accumulate for one minute and spit into the collecting tubes. Then, the time for collection of 5mL of saliva was recorded and flow rate was

defined as volume of saliva (5mL) per minute (mL/min).

The pH of saliva was immediately measured before and 1, 5 and 10 minutes after rinsing green tea, black tea and coffee using a calibrated digital pH meter (AZ-8686, AZ Co., Taiwan).

The pH meter used in this study had accuracy of  $\pm 0.05$  pH, range of 0-14, resolution of 0.01 pH and calibration of 10, 7, 4.

#### Statistical analysis:

Mann-Whitney test, student's t-test and paired t-test were used and data were analyzed via SPSS software (version 20). A P-value of  $< 0.05$  was considered significant.

## Results

Comparison of pH and flow rate of saliva before rinsing black tea, green tea and coffee between periodontitis and healthy groups

showed that the pH was not significantly different ( $P=0.057$ ) but the flow rate of saliva in the subjects with periodontitis was higher than that in healthy group ( $P= 0.006$ ). Comparison of flow rate and pH of saliva after rinsing between healthy and periodontitis groups showed that there was no significant difference, and green tea, black tea and coffee had the same effect on both groups. (Table 1).

In the periodontitis group, black tea and coffee did not induce significant changes in pH and flow rate of saliva after rinsing ( $P>0.05$ ), but there was a rise in the pH value and flow rate after rinsing green tea in this group and the increase in these values was statically significant ( $P=0.019$  for pH and  $P= 0.001$  for flow rate).

In the healthy group, black tea, green tea or coffee did not cause a significant change in pH or flow rate after rinsing (Table 2).

**Table 1- Comparison of pH and flow rate after rinsing beverages between the two groups**

Drink	Change of flow rate			Change of pH		
	Periodontitis	Healthy group	P value	Periodontitis	Healthy group	P value
Green tea	4.5(4.8 $\pm$ 2.69)	2(1.9 $\pm$ 5.27)	0.143	1(0.7 $\pm$ 0.77)	0.02(0.02 $\pm$ 0.05)	0.165
Black tea	0(0.7 $\pm$ 4.73)	0(0 $\pm$ 1.76)	0.912	0(0.02 $\pm$ 0.13)	0(0.01 $\pm$ 0.028)	0.632
Coffee	1(0.5 $\pm$ 1.84)	1(0.6 $\pm$ 1.07)	0.917	0.005(0.009 $\pm$ 0.03)	0.005(0.003 $\pm$ 0.01)	0.353

**Table 2- Comparison of pH and flow rate before and after rinsing beverages in each group**

Group	Drink	pH			Flow rate		
		Before	After	P	Before	After	P
Periodontitis	Green tea	6.84 $\pm$ 0.77	6.91 $\pm$ 0.08	0.019	64.20 $\pm$ 14.33	69 $\pm$ 13.8	<0.001
	Black tea	6.94 $\pm$ 0.13	6.97 $\pm$ 0.12	0.515	87.90 $\pm$ 27.13	87.20 $\pm$ 25.59	0.652
	Coffee	6.87 $\pm$ 0.079	6.86 $\pm$ 0.087	0.417	85 $\pm$ 15.92	85.5 $\pm$ 16.44	0.413
Healthy	Green tea	6.84 $\pm$ 0.088	6.86 $\pm$ 0.126	0.209	82.6 $\pm$ 14.33	84.5 $\pm$ 13.176	0.285
	Black tea	6.81 $\pm$ 0.068	6.82 $\pm$ 0.067	0.211	95.6 $\pm$ 4.92	95.6 $\pm$ 4.16	1.00
	Coffee	6.86 $\pm$ 0.053	6.86 $\pm$ 0.052	0.616	96.7 $\pm$ 3.65	97.3 $\pm$ 3.71	0.111

## Discussion

The concept of periodontal disease has changed considerably over the years. The putative pathogens associated with periodontal diseases are susceptible to a variety of antiseptics and antibiotics (13). Non-surgical periodontal therapy has long been documented to preserve the natural dentition by achieving and maintaining a healthy periodontium (17). According to the current state of knowledge, species such as the red complex organisms play a major role in pathogenesis of periodontal disease (18). Scaling and root planing remains the gold standard of periodontal therapy; however, various adjuncts such as local drug delivery systems have been used to improve the therapeutic results. Several *in vitro* studies have suggested that green tea catechins such as epigallocatechin gallate inhibit periodontal pathogens (12) and prevent the destruction of periodontal tissue (10,11).

Saliva is a watery substance secreted by the salivary glands. The average normal pH of saliva is 6.7, and in the oral cavity the pH is maintained near 6.7-7.3 by the buffering capacity of the saliva, which neutralizes acids produced by microorganisms and the acidity of foods and drinks (19). The volume of saliva depends on many factors, such as its stimulation, circadian rhythm, diet, age, drugs and hydrogen (H<sup>+</sup>) concentration. Meanwhile, these factors can also change due to pathological conditions such as periodontal disease (20).

In our study, we compared the level of salivary pH and flow rate in patients with periodontitis and healthy controls before and after rinsing of green tea, black tea and

coffee. Changes in the composition of saliva have been previously evaluated. Koss *et al.* (1) studied salivary parameters that could identify different stages of periodontal disease. They showed significant quantitative changes in chemical composition of saliva like calcium level between periodontitis and control groups. However, they did not report any difference in pH between the two groups (1). Shaila *et al.* (21) studied the salivary protein concentration in gingivitis and periodontitis patients and also compared parameters like salivary flow rate and pH in patients. They showed that there were no significant changes in flow rate or pH between disease and control groups. Gazy *et al.* (22) evaluated some salivary biochemical parameters in patients with chronic periodontitis and normal subjects. They found no difference in salivary acidity level between the groups. Nevertheless, other studies showed that saliva pH in patients with periodontitis was higher than that in the control group (9,23) while another study showed that it was lower than that in healthy group (7). In our study, we found no significant difference in the mean salivary pH between periodontitis and healthy groups before rinsing ( $P=0.057$ ).

Salivary flow rate seems to have a relationship with periodontitis. As shown in our study, initially, salivary flow rate was significantly higher in patients with periodontitis compared to healthy subjects. Findings concerning the flow rate of saliva are somewhat controversial in periodontal patients. While the study carried out by Fiyaz *et al.* (9) showed a significant increase in flow rate, Junior *et al.* (23) did not find

any difference in flow rate between periodontitis and healthy groups. On the other hand, Koss *et al.* (1) found lower flow rate of saliva in patients with periodontitis compared to control group. Our findings were similar to those of Fiyaz *et al.* (9) who reported an increase in salivary flow rate in periodontal patients.

Green tea has been shown to possess antioxidant, antibacterial and anti-inflammatory effects on various cell types in the oral cavity (14). A couple of studies evaluated the effect of green tea on periodontal patients. Kudva *et al.* (24) studied the adjunct use of locally delivered green tea catechin with periodontal treatment in management of chronic periodontitis. They found that although the plaque and gingival indices did not considerably change, the PD decreased significantly. Awadalla *et al.* (15) evaluated the effectiveness of local application of green tea in the oral cavity. They concluded that green tea induces an increase in pH of the saliva and dental plaque in the oral cavity. However, other studies were not able to support the effectiveness of green tea in the oral cavity. Jenabian *et al.* (25) investigated the efficacy of green tea mouthwash for plaque-induced gingivitis. They came into conclusion that although improvement was achieved in mouthwash group, the differences were not statistically significant. In our study, we found that periodontitis group had a significantly higher mean salivary pH and flow rate after green tea consumption. However, no significant difference was seen in the mean salivary pH values of healthy group or between test and control groups after consuming green tea. The rise of pH

after rinsing green tea in periodontitis group was in accordance with the results of studies that showed beneficial effects of green tea on periodontal disease and oral health.

Some studies have assessed the possible positive effects of black tea on the oral cavity. All of the previous works focused on the anti-cariogenic potential of black tea in the mouth and showed that black tea was significantly more effective than green tea in reducing intraoral *Streptococcus mutans* (26), initial bacterial adherence to enamel (27) or reducing intraoral hydrolysis of starch (28). We tried to find any possible effects of black tea on pH and salivary flow rate in the test and control groups; however, we did not find any difference in periodontitis group or healthy subjects after consuming black tea. Taking into account the effects of unfermented (green) and fermented (black) tea on the acidity of saliva or flow rate, green tea seems to be more advantageous to be used especially in patients with periodontitis.

Coffee is a major dietary source of antioxidants as well as other anti-inflammatory substances. Given the favorable role of such factors, researchers tried to explore the effectiveness of drinking coffee for periodontal health of patients. Ng *et al.* (29) reported that higher coffee consumption was related to a significant reduction in number of teeth with periodontal bone loss and concluded that coffee consumption may be periodontally supportive in adults. Machida *et al.* (11) studied the relationship between coffee and periodontitis during maintenance phase of periodontal treatment. They showed that there seemed to be an inverse association

between coffee consumption and prevalence of severe periodontitis in patients. In our study, we found that coffee did not induce any significant change in flow rate and pH in subjects in the control group or patients with periodontitis.

## Conclusion

The results suggest that green tea causes a significant increase in salivary flow rate and pH and seems to be a safe and applicable adjunct treatment for periodontitis. Since no substantial impact was observed for black tea or coffee, further studies on possible effects of specific substances in these beverages, and more specific studies on

salivary samples are needed to draw definite conclusions.

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**Conflict of interest:** "None Declared"

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