

## Evaluation of Side Effects of Caffeine on Xerostomia

**Hala Zakaria Mahmoud\* and Akram Nabil**

*Department of Oral Radiology and Diagnosis and Oral Medicine, RAK College of Dental Sciences, RAK Medical and Health Sciences University, Ras Al Khaimah, United Arab Emirates*

**\*Corresponding Author:** Hala Zakaria Mahmoud, Associate Professor, Department of Oral Radiology and Diagnosis and Oral Medicine, RAK College of Dental Sciences, RAK Medical and Health Sciences University, Ras Al Khaimah, United Arab Emirates.

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### Abstract

**Background:** Saliva is an exocrine secretions plays a very important role in the oral environment, consists of nearly 99% water. Lubrication, clearance of substances, digestion, buffering and capacity for neutralization of acids or bases are properties of saliva. Various systemic conditions, Medications and psychological factors can effect salivary output. Black tea, green tea, coffee and soft drinks are the most commonly consumed drinks by people.

**Aim:** The aim of this study to evaluate the effects of different types of Caffeine on Xerostomia.

**Methods:** Literature review conducted on Google scholar articles and Pub med search engines that matched the inclusion criteria.

**Results:** The results showed three of the four caffeinated drinks have a direct effect on xerostomia. (Black tea and green tea) can increased the salivary flow rate and pH which can be helpful in the treatment of xerostomia. Soft drinks decrease the salivary pH and flow rates and can be harmful for the patients who are suffering from xerostomia. Only coffee in general has no side effects on xerostomia.

**Conclusion:** Soft drinks decrease the salivary pH, flow rates and can be harmful for the patients who are suffering from xerostomia but the results proved that not the caffeine itself who has the side effects on xerostomia but from its components.

**Keywords:** Caffeine; Salivation; Coffee; Black Tea; Green Tea; Soft Drinks

### Introduction

Xerostomia is a medical condition, characterized by mouth dryness. Most common etiological factors which commonly associated with xerostomia are Old Age, Salivary gland diseases, Chronic inflammatory autoimmune diseases, Endocrine diseases, Neurologic diseases, Psychogenic diseases, Infections, Medications, Chemotherapy or Radiotherapy. It can cause numerous complications as increase dental decay rate, plaque, mouth soreness, fungal infection, wrinkled and cracked lips, difficulty in chewing and swallowing of food, less nutrition intake, coating tongue, gagging sensation, Halitosis, Cheilitis, Dysgeusia or Glossodynia. Different Diagnosis methods can be done to examine salivary secretion as Sialometry, Sialography and Biopsy. It has been found that different types of caffeine have a serious effect on the salivary flow rate. In this study we will focus on the assessments of the side effects of different types of caffeine in xerostomia.

### Review of the Literature

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 [1]. Saliva has properties such as lubrication, clearance of substances, digestion and buffering capacity for neutralization of acids or bases.

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Saliva has an important homeostatic role in the oral cavity. Hypo salivation can lead to diseases such as caries and mucous membrane candidiasis as well as difficulties in speech, mastication and deglutition. Like all exocrine secretions, salivary production is under the control of the autonomic nervous system, but physical factors such as hypovolemia and dehydration can also play a role [27]. Thus, various systemic conditions, medications, and psychological factors can affect salivary output. Caffeine, a natural derivative of coffee beans and tea leaves, is a methylxanthine with proven activity on the central nervous system and the smooth muscle cells of the cardiac, respiratory and digestive organs [6]. Its effects mostly parallel the adrenergic pathway and include increased arterial blood pressure and cardiac output and decreased gastrointestinal muscle tone. Following this teleological path, it would be expected that caffeine had a significant effect on reducing salivary secretion. This effect has been an accepted tenet of the treatment of hypo salivation yet surprisingly it has not been confirmed scientifically. Further, knowing the size of the effect of caffeine on salivation can inform treatment advice to patients [22]. Diet is one of the important factors affecting oral health and drinks play a key role among etiological factors for oral diseases. Black tea, coffee, and soft drinks 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. 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 [13]. 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 chemo preventive effect [3]. Both caffeinated and caffeine-free soft drinks were associated with a slight increase in unstimulated and stimulated salivary flow rates and a slight decrease in the flow rate from labial minor salivary glands, however, these trends were not statistically significant. Any potential diuretic effects of caffeine in the amount found in a single soft drink were not reflected in salivary flow [11]. Barasch, *et al.* on 2016 concluded that caffeine modestly but significantly reduced salivation in the tested population. Since the decrease in saliva production was just over one-tenth cubic centimetre per minute, caffeine's effects may not be clinically important in most routine situations, and widespread advice to refrain from caffeine ingestion to improve salivation may not be warranted [4]. Gary H., *et al.* Hildebrandt in 2013 concluded that Caffeinated soft drink consumption had no significant effect on salivary flow rate after one hour by any of the three measures employed in this study. Caffeine's contribution to the carcinogenicity of soft drinks is likely be centrally-mediated effects on consumption patterns [11].

### **Aim of the Study**

The aim of this study to evaluate the effects of different types of Caffeine on Xerostomia.

### **Materials and Methods**

This study is a Review of Literature study and Ethical approval was obtained from RAK Research Ethics Committee under Reference Number (RAKMHSU-REC-45-2017-UG-D).

Duration: 3 months (February 2018 - May 2018).

Study setting: RAKMHSU.

Study design: Literature Review.

Sampling method: Not Applicable.

Inclusion criteria: Articles.

- 1- From (2000 - 2018)
- 2- Written in English
- 3- Abstracts that contain one or more of the key search identified

**Data collection procedure**

All google scholar articles and PubMed search engines that matched the inclusion criteria and by using the keywords were 32 References, some articles mentioned the effects of caffeine in general on saliva, and some discussed the effects of one caffeinated drink on saliva, and the others compared between the effects of more than one type of caffeinated drink on saliva.

Access issues: NA.

Proposed data analysis: Data analysis by ANOVA.

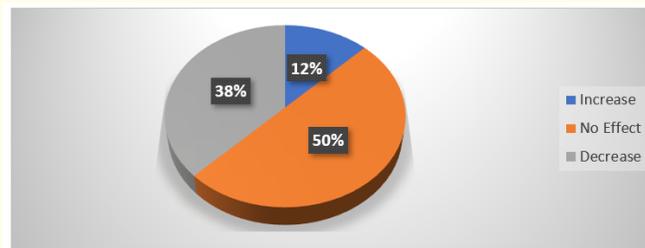
Limitations/expected challenges: NA.

**Results**

All google scholar articles and Pubmed search engines that matched the inclusion criteria and by using the keywords were (32) References, some articles mentioned the effects of caffeine in general on saliva, and some discussed the effects of one caffeinated drink on saliva, and the others compared between the effects of more than one type of caffeinated drink on saliva.

**Results 1**

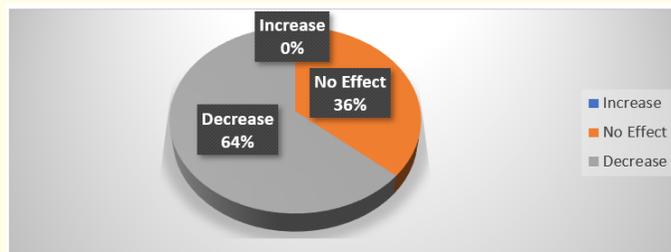
Between eight articles talking about the effects of coffee on salivation, three articles mentioned that there is a slight decrease in salivary secretion, while four articles said that it has no effect on salivation, one article said that it increases the salivary flow rate.



**Figure 1:** Effect of coffee on salivation.

**Results 2**

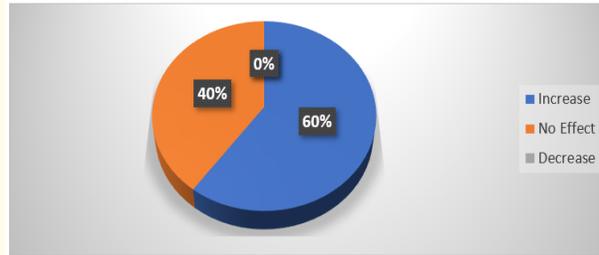
Between eleven articles discussed the effects of Soft drinks on salivary secretion, seven articles confirmed that Soft drinks reduces the salivary flow rate, four articles showed that it has no effect, no articles said that it increases the salivary secretion.



**Figure 2:** Effect of soft drinks on salivation.

**Results 3**

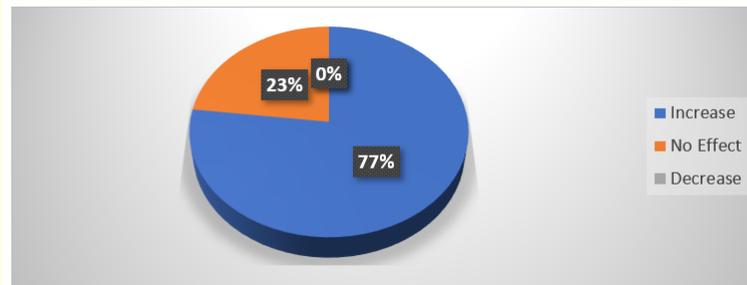
Between ten articles discussed the effects of black tea on salivation, six articles confirmed that black tea increase the salivary secretion, four articles showed that it has no effect, and no articles mentioned that the black tea can increase the salivary secretion.



**Figure 3:** Effect of black tea on salivation.

**Results 4**

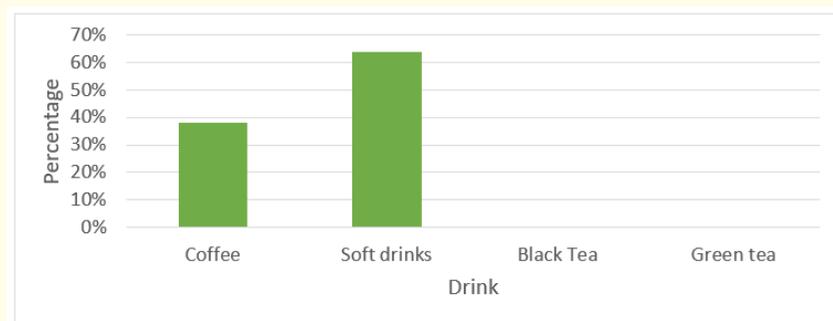
Between thirteen articles discussed the effects of Green tea on salivation, ten articles confirmed that the green tea can increase the salivary secretion, three articles showed that it has no effect, no articles said that it decreases the salivary flow rate.



**Figure 4:** Effect of green tea on salivation.

**Results 5**

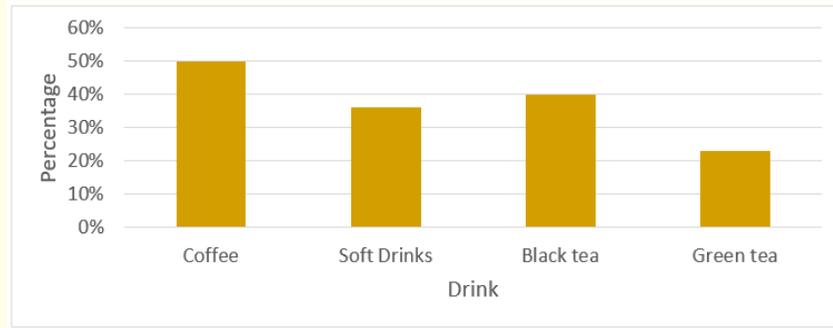
According to our inclusion criteria references, soft drinks is the main drink that reduces the salivary flow rate (64%).



**Figure 5:** Decreasing percentage for each drink.

**Results 6**

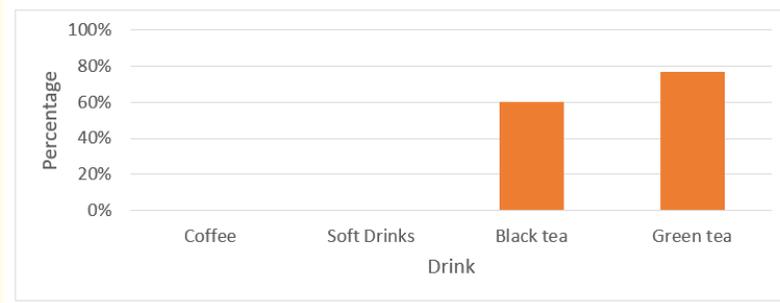
The main caffeinated drink that showed no effect on salivary secretion, is coffee (50%).



**Figure 6:** No effect percentage for each drink.

**Results 7**

According to our inclusion criteria references, The main caffeinated drink that increases salivary secretion is Green tea (77%).



**Figure 7:** Increasing percentage for each drink.

**Discussion**

The aim of this study is to evaluate the side effects of caffeine on xerostomia, while the caffeinated drinks has a different effect on saliva, it shows a very big difference between each type of a caffeinated drink and even between each article.

**Coffee:** Between eight articles discussed the effect of coffee on the saliva, four of them (50%) showed that it has no significantly effect on salivation, as it was mentioned in this article for example: “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” [26]. But this article found an opposition from others, for example: “Coffee overdose may lead to dehydration and dry mouth” [7]. One review mentioned that coffee can increase the salivary flow rate (12%): “caffeine normally causes an increase in salivation. However, for regular coffee drinkers, this increase in salivation is minimal” [12]. By focusing on the instant coffee composition, we can find that it is the most contained of caffeine approximately 27 - 173 mg in a cup (230 mL) [33].

**Soft drinks:** Between eleven articles discussed the effects of Soft drinks on salivary secretion, seven articles confirmed that Soft drinks reduces the salivary flow rate (64%), the soft drinks has a direct effect on saliva and on xerostomia, so many articles showed that for example: "Soft drink Coca Cola® was responsible for significantly lowering of salivary pH; flow rate" [22].

Under the condition of that study, there are many other reviews that agreed with that result: "Present study suggested that there is a decline in the salivary pH after consumption of both types of beverages. There was higher fall in the salivary pH in the case of fruit juice when compared to carbonated drink. Regular consumption of such drinks should be Discouraged" [11]. However, other articles mentioned that it has no significantly effects such like: "Any potential diuretic effects of caffeine in the amount found in a single soft drink were not reflected in salivary flow" [9].

The soft drinks is the least drink that contains caffeine with approximately 23-37 mg in one bottle (230 mL) [33].

**Black tea:** Between ten articles discussed the effects of black tea on salivation, six articles showed that it can increase the salivary flow rate (60%), for example: "According to results obtained from this study, drinking black tea increased both salivary flow rate and pH level" [25] and other articles talking even about increasing the saliva pH like: "There is a tendency of influence between consumption of black coffee and black tea on the pH of saliva. Black coffee consumption tends to lower the pH of saliva, whereas black tea consumption tends to raise the pH of saliva" [8].

The black tea is the second most drink that contains caffeine 25 - 110 mg in a cup (230 mL) [33].

**Green tea:** Between thirteen articles discussed the effects of Green tea on salivation, ten articles confirmed that the green tea can increase the salivary secretion, which shows a good effect on salivary secretion, so many articles showed that result clearly, for example: "The SS patients' symptoms of oral dryness were considerably relieved since the green tea consumption began, particularly during day-time and when eating dry foods" [14].

Also it was mentioned in other articles confirming the increasing salivary results: "The present study demonstrated that after intake of both green and black tea there was an increase in salivary pH both in caries-free and with caries groups. The pH rise was more in green tea intake compared to black tea" [24]. Green tea occupy number three of the most drinks that contains caffeine 30 - 50 mg in a cup (230 mL) [33].

Looking briefly to the amount of caffeine that is contained in every drink we can see that:

- 1- Coffee (27 - 173) mg in a cup (230 mL)
- 2- Black tea (25 - 110) mg in a cup (230 mL)
- 3- Green tea (30 - 50) mg in a cup (230 mL)
- 4- Soft drinks (23 - 37) mg in a bottle [33] (230 mL).

And when we compare that amount of caffeine in a single drink to its effect on saliva, we can understand the caffeine role in affecting the salivary secretion, pH and xerostomia in general.

When the coffee that is the most contained caffeine shows no effect on saliva in general, and the black tea which is the second most caffeinated drink increases the salivation, and the green tea which the third most caffeinated drink not only increasing the salivation flow rates, it is also used to treat the xerostomia as mentioned in many articles [31] and the soft drinks which is the least caffeinated drink decreases salivation. We can understand that not the "caffeine" itself that makes the differences in salivation, but another contents in that caffeinated drinks.

For example in the soft drinks some studies mentioned the reason that they decreased the saliva pH, flow rate: "In the present study, the carbonated beverage used was pepsi which contains carbonated water, sugar, caffeine, colouring agents, and acidity regulator as its

ingredients. The quantity of sugar added is 10.6 grams/100 grams or 11 teaspoonful of sugar in 300mL of pepsi. It caused an instant decrease in salivary pH. This may be probably due to the fact that the carbonated beverage has increased intrinsic acidic content (maintained in the range of 2 - 3) and sugar content (14.9 grams in 100mL) in its composition which are responsible for its high cariogenic and erosive potential" [26]. And in coffee: "Coffee was found to lower the salivary pH but well above the level of critical pH. This might be due to the fact that milk has lactose which has low acidogenicity" [26]. And depending on this review which confirmed that the caffeine doesn't really alter the salivary pH, flow rates: "The most ecologically valid of the published studies offers no support for the suggestion that consumption of caffeine-containing beverages as part of a normal lifestyle leads to fluid loss in excess of the volume ingested or is associated with poor hydration status" [20].

In Gray H Hildbrandt, *et al.* in 2013 [11] concluded that both caffeinated and caffeine-free soft drinks were associated with a slight increase in unstimulated and stimulated salivary flow rates and a slight decrease in the follow rate from labial minor salivary glands, however, these trends were not statistically significant. Any potential diuretic effects of caffeine in the amount found in a single soft drink were not reflected in salivary flow.

However Rinki Hans., *et al.* in 2016 [31] stated that after clinical trials on 120 subjects although it was found out that liquids cleared rapidly from the oral cavity, they had the significant cariogenic and erosive potential. Hence it is always advised to minimize the consumption of beverages, especially amongst children and young adults to maintain a good oral health.

Also this results agreed with in 2015. Vishal Arya and Lavina Taneja (2015) [35] summarized that Tannic acid and beverages containing tannic acid such as green tea, oolong tea, and red wine inhibit salivary fluid secretion. But the results disagreed with the results which had done in 2016 by Andrei Barasch and Sara C who concluded that Caffeine mostly but significantly decreased both stimulated and unstimulated saliva production. The effects of caffeine approximately 6.5% that of stimulation. The effects from caffeine was consistent across both stimulated and unstimulated samples. Additionally, caffeine did not increase the variability of saliva production either within or between individuals, in contrast with the effects of stimulation [4].

Most of studies are intriguing and present more questions than answers with regard to the relationship among caffeine intake, stress. Nonetheless, the findings suggest that studies on the health effects of caffeine and that a multilevel biomarker and psychosocial assessment approach that includes men and women, both in and out of the laboratory, will be needed more investigations.

### Conclusion

- 1- Three of the four caffeinated drinks have a direct effect on xerostomia, (Black tea and green tea) can increase the salivary flow rate and pH which can be helpful in the treatment of xerostomia.
- 2- Soft drinks decrease the salivary pH and flow rates and can be harmful for the patients who are suffering from xerostomia.
- 3- Only coffee in general has no side effects on xerostomia.
- 4- Not the caffeine itself who has the side effects on xerostomia, caffeine is not the main reason that makes that caffeinated drinks alter the salivation pH, flow rates, but their own contents.

### Future Direction

It is recommended to research the effects of soft drinks and caffeine by clinical studies should be conducted on outpatients.

### Conflict of Interest

There are no conflicts of interest.

### Financial Support and Sponsorship

Nil.

### Ethical Approval

Approval was obtained from the research and Ethics Committee of RAK Medical Health Sciences University, Ras Al Khaima, UAE in 15<sup>th</sup> of December 2017.

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