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ORIGINAL ARTICLE

A Prefatory Assessment of Erosive Potential of Commonly used Indian Spices

[1]Jayeeta Surinder Verma, [2]Leena Padhye, [3]Lalitagauri Mandke, [4]MV Sumanthini, [5]Vanitha Shenoy

ABSTRACT

Objective: Spices are an integral part of Indian cuisine and their consumption is increasing in popularity. These mouth-watering spices can lower the pH of the mouth; dissolving the protective outer layer of the teeth. Thus, it is essential to protect our teeth from the various chemical insults which may lead to erosion. The purpose of the study was to assess the erosive, potential of these spices.

Materials and methods: The pH and the titrable acidity of commonly used Indian spices, like turmeric, red chillies, cumin and coriander powder were determined. The same test was carried out for spice mixes (masalas), like garam masala, pav-bhaji, sambhar, panipuri and goda masalas. The single powder spices were home-made while the spice mixes were ready to use available in the market. The initial pH was measured using digital pH meter and titration was carried out against 0.1M NaOH.

Results: All the spices showed an endogenous pH lower than critical pH. Among these, panipuri masala, a spice mix used in a widely relished snack in the western part of India showed the lowest pH and also required the highest quantity of 0.1M NaOH to neutralize its acidity.

Conclusion: People may be placing themselves unintentionally at risk of dental erosion due to their diet and clinicians may find this study to be helpful while counseling patients regarding their dietary habits.

Keywords: Dental erosion, Indian spices, pH, Titrable acidity.

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INTRODUCTION

From connoisseurs to novices, Indian cuisine has captivated taste buds and received great praise through the centuries. India has been known for its spices and spice trade was carried between India and the world well before beginning of Christian era.[1] Apart from their culinary use as taste and flavor enhancers, spices are also consumed for their beneficial medicinal properties, such as tonic, carminative, stomachic, diuretic and antispasmodic. Spices have been generally believed to increase the salivary flow and gastric juice secretion, thus aiding in digestion.[2] However, these mouth-watering spices may be an etiological factor in dental erosion due to their acidic content.

Dental erosion occurs as a result of acidic attacks during simultaneous unsaturation of both hydroxyl-and fluorapatite in saliva, causing loss of dental hard tissue, layer by layer. Dental erosion is defined as 'loss of dental hard tissue by a chemical process that does not involve the influence of bacteria'.[3] Research has suggested that erosion is the most common cause of noncarious tooth substance loss (TSL). Dissolution of mineralized tooth structure may have a multifactorial etiology attributable to either intrinsic or extrinsic sources as shown in Table 1.[4] Dental erosion is also seen in systemic conditions (diseases and syndromes), like cerebral palsy, salivary gland agenesis, Down's syndrome and Sjögren's syndrome.

Spices that form an important part of authentic Indian cuisine may also be an important extrinsic etiological

Table 1: Extrinsic and intrinsic etiological factors of dental erosion[5]

Extrinsic erosion causes (Caused by acidic products originating from outside the body)	*Intrinsic erosion causes* (Due to acids from stomach reaching the teeth)
1. Occupational related	1. Gastric reflux
• Wine tasters	• Increased gastric pressure e.g: pregnancy
• Swimmers	• Increased gastric volume e.g: after meals
• Acid fumes in industries	• Sphincter incompetence
2. Dietary habits	2. Vomiting
• Acidic foods	• Gastrointestinal disorders
• Soft drinks	• Psychosomatic
• Fruit juices	• Drug-induced
3. Medications	3. Regurgitation
• Mouthwashes	
• Vitamin C	
4. Life style	4. Rumination

[1]Lecturer, [2,4]Professor, [3,5]Professor and Head

[1,4,5]Department of Conservative Dentistry and Endodontics MGM Dental College and Hospital, Kamothe, Maharashtra, India

[2,3]Department of Conservative Dentistry and Endodontics Dr DY Patil Dental College and Hospital, Pune, Maharashtra, India

Corresponding Author: Jayeeta Surinder Verma, Lecturer Department of Conservative Dentistry and Endodontics, MGM Dental College and Hospital, Kamothe, Maharashtra, India Phone: 9819246333, e-mail: jayeetaverma@gmail.com

factor for erosion. There is also some evidence to suggest that vegetarians are more at risk of developing TSL and although with some variations, Indians are predominantly vegetarians.[6] Many of the food products, drinks and spices are known to be slightly acidic in nature. Furthermore, people also prefer more acidic foods and drinks. An acidic environment ensures the safety of any product by providing conditions which do not allow the pathogenic organisms to survive. A pH of 5.5 is considered to be the 'critical pH' for enamel dissolution.[7] The 'critical pH' is the pH at which a solution is just saturated with respect to a particular mineral, such as tooth enamel. If pH is above the critical pH; then solution is supersaturated and the mineral will precipitate out. Conversely, if the pH is less; the solution is unsaturated and mineral will tend to dissolve until the solution becomes saturated; in this case the solution being saliva.[8]

The erosive potential of foods can be assessed by testing the inherent pH and measuring the titrable acidity of a solution. Associations between diet and dental erosion have received considerable attention, especially in relation to acidic foods and drinks, and clinical studies have identified some particular food and drinks as etiological factors in erosion.[9] Hence, the purpose of the present *in vitro* study was to determine the erosive potential of commonly used Indian spices.

MATERIALS AND METHODS

Nine commonly used Indian spices were used in this study. Of these, four were single ingredient powders namely cumin (Cuminum cyminum L), coriander (Coriandrum sativum L), turmeric (Curcuma longa L), red chillies (Capsicum annuum L) and five were spice mixes (masalas) which is a mixture of various individual spices. Preparation of powders (single component) and spice mix (masala) was done as follows:

- *Single ingredient spice powder:* Each of the four core ingredients was procured from the local market. All the samples were air dried and grounded to a fine powder in a mechanized domestic grinder.
- *Spice mix:* five spice mixes were tested. The masalas were of common brand available in the local market and used on a regular daily basis. Table 2 shows the investigated spices with their composition and manufacturers.

Specimen preparation was done by measuring 3 gm of each individual spice powder and the ready-to-use masalas on a digital scale (Contech CA223, India). Further, aqueous solutions of these spices were prepared by mixing 3 gm of powder in 30 ml of distilled water. The obtained mix was stirred rigorously with magnetic stirrer to obtain a homogenous solution.

- *Measurement of pH:* The pH was measured using a pH meter (equiptronics EQ-614A, India). The pH meter was calibrated to '7' to avoid any discrepancies in the reading. pH meter comprises of a beaker to contain the testing solution, magnetic stirrer to ensure a homogenous solution and digital reading panel. The solution was measured in the beaker (30 ml) and the probe was inserted. Reading was obtained on the digital panel and noted.
- *Measurement of titrable acidity:* After the initial pH was measured, 30 ml of the test solution was titrated against 0.1M sodium hydroxide (NaOH). The volume of the base required to raise the pH of the solution to pH of 5.5 (critical pH) and 7 (neutral) were recorded.

RESULTS

Assessment of the spices showed that panipuri masala had the lowest initial pH of 3.13 while turmeric powder had the highest initial pH of 5.47 (Table 3). The individual spice powders on an average showed higher pH when compared to the spice mixes (masalas). Results showed that the volume of sodium hydroxide base needed to raise the pH of the specimens to 5.5 ranged from 0.1 to

Table 2: Composition of the specimens

Specimen name	*Ingredients*	*Manufacturer*
Cumin powder	Cumin seeds (Jeera)	Home made
Coriander powder	Coriander seeds (Dhaniya)	Home made
Turmeric powder	Turmeric (Haldi)	Home made
Red chilly powder	Red chillies (Lal Mirchi)	Home made
Garam masala	Cumin, coriander, black pepper, cardamom, cinnamon, bay leaves, whole clove	Everest
Pavbhaji masala	Coriander, chillies, cumin, black pepper, turmeric, fennel seed, salt	Everest
Sambhar masala	Cumin, coriander, curry leaves, asafetida, fenugreek, turmeric, mustard, red chillies	Everest
Panipuri masala	Dry mango, salt, black salt, cumin, red chillies, asafetida, citric acid, black pepper, coriander	Everest
Goda masala	Cardamom, cinnamon, cloves, coconut powder, mustard, cumin, bay leaves, black pepper	Bedekar

6.2 ml while to increase to 7 ranged from 3.1 to 14 ml. Panipuri masala showed the highest titration values to raise the pH to 5.5, i.e. 6.2 ml and 7, i.e. 14 ml. Turmeric powder showed the lowest titration value of 0.1 ml to reach pH of 5.5 whereas coriander powder showed lowest titration value of 3.1 ml to reach pH of 7 (Table 4).

DISCUSSION

The pH of soft drinks has been tested by many researchers.[10-13] However, the effect of the spices used to cook authentic Indian food has not yet been studied extensively. pH is defined as decimal logarithm of reciprocal of hydrogen activity in a solution. The level of acidity of a substance is measured by pH scale from 0 to 14. A substance measuring 7 is neutral. A substance measuring <7 is acidic. A substance measuring >7 is alkaline. The erosive potential of a material can be assessed by determining the inherent pH and measuring the titrable acidity or buffering capacity. The buffering capacity is the ability of the drink to resist a change of pH (to maintain its pH).[14-16] The higher the buffering capacity of a drink, the higher is its erosive potential.

The normal pH of saliva is around 7 until other factors are introduced. pH is a factor in demineralization and remineralization of dental tissues. Acidic substances have the potential to dissolve the minerals in the enamel (calcium and phosphorous) causing demineralization. Enamel demineralization takes place below pH of 5.5, known as the critical pH; while dentin demineralization occurs below pH of 6.5. Generally, a pH value of 5.5 or lower is capable of softening the surface of enamel in only a few minutes. It takes the saliva between 30 and 45 minutes to neutralize an acid attack.[17] Theoretically, the erosive potential of any foodstuff is dependent upon the tooth anatomy, fluoride content present, immediate effect of the food on the tooth surface, the time it takes to clear the food from the mouth, the eating method, the protective effect of saliva,[18] the amount of residual food after swallowing, the actual amount of spice consumed and the frequency of consumption.

Table 3: Initial pH of spices

Sl. no.	*Specimen name*	*Initial pH*
1	Cumin powder	5.17
2	Coriander powder	5.02
3	Turmeric powder	5.47
4	Red chilly powder	4.62
5	Garam masala	4.53
6	Pavbhaji masala	3.99
7	Sambhar masala	4.59
8	Panipuri masala	3.13
9	Goda masala	4.81

Table 4: Quantity of base NaOH required to raise pH

		Volume (ml) of base NaOH needed to increase the pH to	
	Specimen name	*pH 5.5*	*pH 7*
1	Cumin powder	0.3	3.2
2	Coriander powder	0.6	3.1
3	Turmeric powder	0.1	4.8
4	Red chilly powder	5.8	9.0
5	Garam masala	2.5	4.0
6	Pavbhaji masala	5.0	7.5
7	Sambhar masala	2.8	4.5
8	Panipuri masala	6.2	14
9	Goda masala	4.5	6.0

The spices used in this study are commonly used in Indian food preparations. All the spices had an initial pH lower than critical pH of 5.5 (Table 3), and thus can be inferred as potential etiological factors for dental erosion. However, most of these spices are not consumed directly; they are generally consumed as additives with vegetables, cereals, millet, pulses or meat. This may reduce the overall harmful effect which the spices may have on the teeth. Also, the quantity of spices used might also vary depending on an individual's taste and style of preparation. In general, a single acidic attack is of minor importance, but if repeated, the ability of the saliva to buffer the acidity decreases.

An important consideration is, however, the panipuri masala, which is generally consumed by mixing with water, without adding any other additives as mentioned previously to reduce its acidity levels. According to our study, panipuri masala showed the lowest pH and also required the maximum base to neutralize it. This could be attributed to the fact that it contains citric acid as one of its core ingredients. Citric acid sequesters calcium ions from saliva, preventing remineralization, etches dentin and causes dental erosion; similarly for carbonated drinks. The citric acid also acts as an effective buffer giving the drinks higher titrable acidity and making their pH reducing effects in the mouth greater than the protective buffering actions of saliva.[19]

Indian cuisine often has a high fat content and is also heavily spiced. Thus, it has greater potential for provoking gastroesophageal reflux disease (GERD). In a study on the Indian population,[20] 90% of the participants felt relief after decreasing the consumption of spicy foods. In this aspect, GERD is commonly associated with dental erosion. Therefore, the effect that the spices have on the GI tract may indirectly cause dental erosion, in addition to its inherent acidic property.

The results of this study indicate the potential of certain Indian spices to be erosive in nature and, therefore, can be considered to contribute to TSL among the people who consume spicy food. However, to further confirm

our results, more observational long-term tests need to be carried out *in vivo* in order to ascertain the effect of the Indian spices consumed on a daily basis by the general population on the dental structures. Also, other readily available spices need to be evaluated.

CONCLUSION

Within the limitations of the study, the results indicate that the spices used in Indian cooking have an endogenous pH below the critical pH and, thus, may have an erosive potential on teeth. Among these, panipuri masala showed the least pH and highest titrable acidity and, thus, must be consumed cautiously. This information could be considered useful while treating erosive tooth lesions and advising patients regarding their dietary habits.

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