EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
Vol. 70, 2975:2984, July, 2024
Print ISSN 0070-9484 • Online ISSN 2090-2360
Conservative Dentistry and Endodontics
Submit Date : 21-05-2024 • Accept Date : 12-06-2024 • Available online: 10-0702024 • DOI : 10.21608/EDJ.2024.291375.3047

SURFACE ROUGHNESS AND STAIN REMOVER ABILITY OF PROPHYLAXIS PASTE AND BIOCHAR GEL FOR STAINED TEETH BASED ON CUCURBITA MOSCHATA – IN VITRO STUDY

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ABSTRACT

Introduction: While the term "polishing" has been employed to refer to the expert elimination of soft deposits and stains from the surfaces of teeth, this encompasses both cleaning and polishing.

Objective: To compare invitro the surface roughness and stain Remover Ability of Prophylaxis Paste and Biochar gel for Stained Teeth Based on Cucurbita Moschata.

Materials and methods: study was carried out on 10 sound non-carious periodontally involved human premolars teeth after getting the patients' approval (age of 20-40 years). Teeth were then immersed in black tea for 24 hrs. After staining, all specimens were stored in artificial saliva for 7 days. Then randomization by software divided in to 2 groups: Group 1: Prophylaxis paste, Group 2: Biochar Gel. Specimens were embedded in self-cure acrylic resin and allowed to set to create blocks. Specimen was divided horizontally into three thirds by permanent colour marks. Each sample were subjected to Mitutoyo Surface Roughness Tester pre and post polishing in both groups. Shade Assessment of the three thirds of each sample were assessed before and after polishing per group by VITA Easyshade® V.

Results: In surface roughness, Comparison between prophylaxis paste and Biochar Gel revealed insignificant difference as P was 0.46 and 0.27 regarding pre-and post-polishing respectively. Regarding stain remover ability, comparison between Biochar gel and prophylaxis paste groups regarding post-polishing VITA SYSTEM 3D- MASTER shade guide and VITA classical shade guide showed no significant difference as P>0.05.

Conclusion: Biochar Gel Based on Cucurbita Moschata is considered a promising alternative to prophylactic pastes.

KEYWORDS: Teeth polishing, prophylaxis paste, Biochar Gel, Stained teeth, surface roughness

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INTRODUCTION

In most dental offices, polishing teeth is a process that is done as part of oral prophylaxis. It smoothes the tooth surfaces to give them a glossy, lustrous appearance. While the term "polishing" has been employed to refer to the expert elimination of soft deposits and stains from the surfaces of teeth, this encompasses both cleaning and polishing. [1] Plaque, biofilm, stains, and acquired pellicle are all eliminated during polishing. The fact that patients enjoy the clean, smooth feeling that polishing gives them is a significant contributing factor. In addition, it is easier for the patient to comprehend and tolerate, and it causes less pain and stress than scaling. Patients can see and feel the noticeable advantages of polishing. [2] It was first used by Pierre Fauchard, the Father of Modern Dentistry, to remove tooth stains using finely powdered coral, eggshells, salt, or ginger. [3,4] The techniques for polishing teeth have changed over time. Dr. Fones, the founder of dental hygiene, began teaching his assistants how to do coronal tooth polishing at the turn of the 20th century. The conventional way of cleaning teeth (rubber-cup with prophylaxis paste) reduces the outer layer of enamel and over time modifies the morphology of the tooth structure. [5]

Numerous applications exist for Cucurbita moschata. Examined the sensory perception and physical properties of noodles that had Cucurbita moschata powder added during food processing. Cucurbita moschata flour, both peeled and unpeeled, was compared to wheat flour in terms of its physical and chemical properties. A medical study extracted pectin polysaccharides from the peel of Cucurbita moschata and found that pectin can promote the growth of beneficial bacteria in the intestines. Changes in the amount of beta-carotene during Cucurbita moschata storage were found in another investigation. The benefits of plant extracts, such as those derived from Cucurbita moschata, include their capacity to promote angiogenesis, cell proliferation, and differentiation, as well as their antioxidant and anti-inflammatory properties and role in the process of bone regeneration. [6]

A growing number of plant-related industries, including horticulture, forestry, and agriculture, are striving for "sustainable intensification," which is characterized as increasing food or biomass production while preserving or improving environmental outcomes. Our focus is on biochar derived from pyrolysis, which is produced at temperatures between 300 and 900 degrees Celsius. Biochar is a solid material resembling charcoal that is produced by the thermochemical conversion of organic biomass under oxygen-limited or -absent conditions using gasification, torrefaction, or pyrolysis techniques. Because of its natural characteristics, which include its high to extremely high surface area, high cation exchange capacity, and porous structure, biochar has been shown to optimize system components and increase system efficiency. [7,8] The purpose of this study to evaluate and compare in vitro the surface roughness and stain Remover Ability of Prophylaxis Paste and Biochar gel for Stained Teeth Based On Cucurbita Moschata plant.

MATERIALS AND METHODS

Ethics approval

This study was reviewed and approved by the Ethics Committee of Faculty of Dentistry- The British University in Egypt with Research Approval Number:23-018.

Sample Size Calculation

Sample size calculated depending on a previous study [9] as reference. According to this study, the minimally accepted sample size was 5 per group, when the response within each subject group was normally distributed with standard deviation 0.006, the estimated mean difference was 0.012, when the power was 80 % & type I error probability was 0.05.

P.S. power 3.1.6. software was used to calculate sample size.

Two stain remover ability materials were used in this study: first, was the Qartz prophylaxis paste (professional use product, available in dental market) and second, was the biochar gel based on Cucurbita moschata plant (laboratory synthesis & fabricated) as in Table 1.

Teeth collection and storage

With the consent of the patients (aged 20–40), this in vitro investigation was performed on 10 healthy, non-carious human premolar teeth that were involved in the periodontal system.[11]

Teeth will be completely cleaned under running water to eliminate mucus and blood right after extraction, and they will be scaled to remove calculus and any remaining periodontal ligament. The teeth will next be checked with a magnification tool to check for the absence of cracks. Any teeth with microcracks or other structural flaws will be extracted and thrown away. After that, the teeth will be kept at room temperature in distilled water containing a 0.5% chloramine-T antiseptic solution until they are needed.[12]

Staining of teeth and Groups Randomization

After that, teeth were submerged in black tea for twenty-four hours (Lipton tea, which Unilever Mashreq Co. imported and packaged in Egypt). Following staining, each specimen was kept for seven days in artificial saliva.[12] The artificial saliva utilized included the following ingredients: distilled water with a pH adjustment of 7.2, Na3 PO4 (3.90mM), NaCl (4.29mM), KCL (17.98mM), CaCl2 (1.10mM), MgCl2 (0.08 Mm), H2SO4 (0.50mM), and NaHCO3 (3.27mM).[13] Two groups of the ten teeth were randomly assigned by computer software: Group 2: Biochar Gel; Group 1: Prophylaxix paste.

Specimen preparation

Radicular portion of each tooth was removed, and the coronal portion was then longitudinally sectioned in the mesio-distal direction resulting into two sections (buccal and Lingual sections) using a high-speed diamond tipped disc under water coolant (Buehler IsoMet 4000, USA). Specimens were embedded in self-cure acrylic resin and allowed to set to create disc blocks. The surface was flattened and polished using 400, 800, 1000, 1200 grit abrasive. Each specimen was divided horizontally into three thirds by permanent colour marks (apical, middle, and coronal) as in figure 1.

TABLE (1) Materials used in teeth polishing, their ingredients and composition.

Materials	Ingredients and Composition
Qartz prophylaxis paste, non-spatter formula, Fine grit (Dharma, USA)	1.23% fluoride ion, glycerine, sodium silicate, titanium dioxide, methyl salicylate, water, sodium carboxymethylcellulose, sodium saccharin, flavour (Bubble gum), Xylitol, gluten free
Biochar Gel (Laboratory synthesized)	In order to prevent the production of air bubbles, 3% w/w of carboxymethyl cellulose (CMC) was dissolved in demineralized water at 80 °C while being gently stirred for two hours. For two hours, papermint (0.001%, w/w) was added to CMC while stirring. After the biochar (pyrolyzed Cucurbita Moschata biochar) was ground, it was cleaned for five hours with 0.1 M HCl, rinsed with demineralized water to get rid of any remaining contaminants, and dried for twenty-four hours at 70 °C in an oven. To create a uniformly distributed solution, pre-treated charcoal (BC, 0.6%, w/w) was added to the CMC and sonicated for 20 minutes. Under stirring, glycerol (0.2 % w/w, based on the polymer's final dry weight) was added. Lastly, a glass petri dish was filled with 20 mL of the mixture.[10]

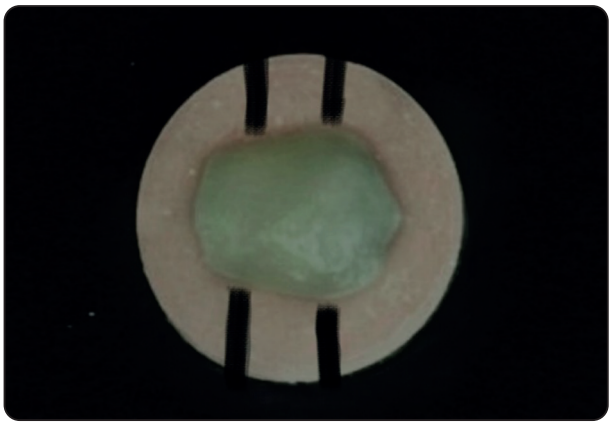

Fig. (1): Specimen embedded in acrylic resin disc block

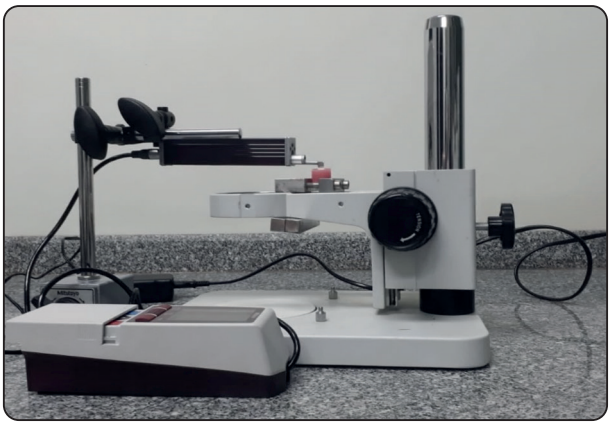

Fig. (2): Mitutoyo Surface Roughness Tester

Surface roughness Measurement

Each sample were subjected to Mitutoyo Surface Roughness Tester (SJ-210, Japan) [14] pre and post polishing in both groups. For evaluation of surface roughness in to three readings (one reading for each third) then mean was calculated as in Figure 2.

Shade Assessment

Shades of the three thirds were identified before and after polishing per each group by VITA Easyshade® V [15] (VITA Zahnfabrik H. Rauter GmbH & Co. KG, Germany). It utilized two shades sytemes either VITA SYSTEM 3D-MASTER shades or VITA classical A1–D4 shades.

Polishing Procedure

Each sample per group was polished for 5 s with bristle brush (group 1: Prophylaxis paste, group 2: Biochar Gel) attached to the low-speed contra-angle handpiece in a circular motion. The rpm value applied for speed was a steady slow pace of 2500 rpm. The polishing procedure of the samples was performed by one operator. [16,17]

Statistical Analysis

Ststistical analysis was performed using IBM SPSS statistics for windows. Data were presented as mean and standard deviation. Data analyzed for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. Significance level was set at ≤0.05. Inter groups comparisons was conducted using paired – sample T- test if data were normally distributed or Wilcoxon test in case of data non normality.

RESULTS

Shade Assessment

Comparison between Biochar gel and prophylaxis paste groups regarding pre-polishing VITA SYSTEM 3D- MASTER shade guide and VITA classical shade guide: as seen in table 2

VITA SYSTEM 3D -MASTER shade guide

There was insignificant difference between both groups in all sections regarding buccal and lingual surfaces as P>0.05, except buccal surface of coronal section as Bio char gel was significantly lower than prophylaxis paste, while in lingual surface of coronal section Bio char gel was significantly higher than prophylaxis paste.

VITA classical shade guide:

There was significant difference between both groups in all sections regarding buccal and lingual surfaces as Biochar Gel group was significantly lower than Prophylaxis Paste with P<0.05.

TABLE (2) Comparison between Biochar gel and prophylaxis paste groups regarding pre polishing VITA SYSTEM 3D- MASTER shade guide and VITA classical shade guide in buccal and lingual surfaces of all section:

Pre-polishing	Section	surface	Biochar Gel		Prophylaxis Paste		Difference				P value
							MD	SD	95% CI		
			M	SD	M	SD			L	U	
VITA SYSTEM 3D -MASTER shade guide	Coronal	Buccal	12.6	0.55	13.00	0.00	0.4	0.17	0.034	0.76	0.03*
		Lingual	13.8	1.1	13.00	0.00	0.8	0.34	-1.53	-0.06	0.03*
	Middle	Buccal	12.4	0.89	12.6	3.05	0.2	1.01	-1.91	2.31	0.84
		Lingual	13.6	1.34	14.2	1.64	0.6	0.66	-0.81	2.01	0.38
	Apical	Buccal	12	1	12.2	1.92	0.2	0.68	-1.23	1.63	0.77
		Lingual	13.6	0.89	10.2	6.57	3.4	2.09	-7.81	1.01	0.12
VITA classical shade guide	Coronal	Buccal	12.40	1.52	13.4	1.52	1	0.67	-0.42	2.42	0.15
		Lingual	14.40	1.34	14.2	2.05	0.2	0.77	-1.82	1.42	0.79
	Middle	Buccal	11.40	0.55	13.2	1.64	1.8	0.54	0.65	2.94	0.004*
		Lingual	14.40	1.95	14.4	1.82	0.0001	0.84	-1.77	1.77	0.999
	Apical	Buccal	11.00	1.22	13.6	1.95	2.6	0.72	1.07	4.12	0.002*
		Lingual	13.80	2.17	14.4	2.51	0.6	1.04	-1.61	2.8	0.57

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at P ≤ 0.05

TABLE (3) Comparison between charcoal and prophylaxis groups regarding post polishing VITA SYSTEM 3D- MASTER shade guide and VITA classical shade guide in buccal and lingual surfaces of all section:

Post-polishing	Section	surface	Biochar Gel		Prophylaxis Paste		Difference				P value
							MD	SD	95% CI		
			M	SD	M	SD			L	U	
VITA SYSTEM 3D -MASTER shade guide	Coronal	Buccal	10.6	4.34	12.40	3.29	1.8	1.72	-1.81	5.4	0.31
		Lingual	13.2	1.79	14.60	1.52	1.4	0.74	-0.165	2.96	0.07
	Middle	Buccal	6.2	5.36	9	5.48	2.8	2.42	-2.29	7.89	0.26
		Lingual	11.6	4.98	11	4.47	0.6	2.11	-5.04	3.84	0.78
	Apical	Buccal	9	4.06	5.6	4.67	3.4	1.95	-7.51	0.71	0.09
		Lingual	11.2	4.92	8.75	4.19	2.45	2.04	-6.71	1.84	0.24
VITA classical shade guide	Coronal	Buccal	11.80	0.45	12.6	0.8	0.44	-0.13	1.73	1.54	0.09
		Lingual	11.80	0.45	12.6	1.34	0.8	0.44	-0.13	1.73	0.09
	Middle	Buccal	11.60	0.55	11.8	0.45	0.2	0.22	-0.27	0.67	0.38
		Lingual	11.60	0.55	13	1.87	1.4	0.61	0.105	2.69	0.03*
	Apical	Buccal	9.20	3.83	11.6	2.19	2.4	1.39	-0.53	5.33	0.11
		Lingual	11.20	1.30	12.8	2.05	1.6	0.76	-0.012	3.21	0.06

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at P ≤ 0.05

VITA SYSTEM 3D -MASTER shade guide and VITA classical shade guide:

There was insignificant difference between both groups in all sections regarding buccal and lingual surfaces as P>0.05.

Surface roughness: as seen in table 4 and figure 3

Effect of treatment (Comparison between pre-polishing and post-polishing):

In prophylaxis paste group, there was a significant increase in surface roughness from (0.48 ± 0.03) to (1.6 ± 0.85) as P<0.0001.

In Biochar Gel group, there was a significant increase in surface roughness from (0.47 ± 0.03) to (1.25 ± 0.49) as P<0.0001.

Effect of material (Comparison between prophylaxis paste group and Biochar Gel):

Comparison between them revealed insignificant difference as P was 0.46 and 0.27 regarding pre-polishing and post-polishing respectively.

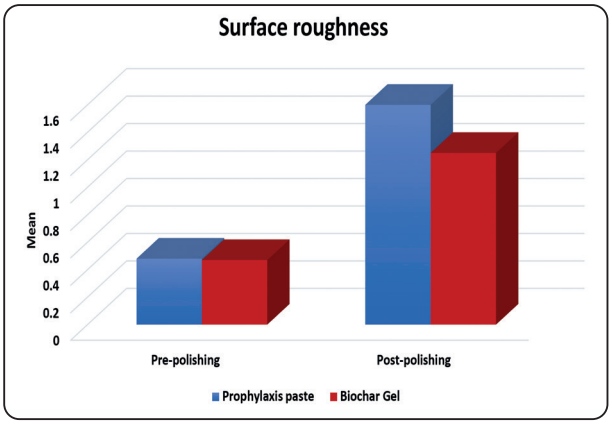

Fig. (3) Bar chart showing Surface roughness in Biochar Gel group and prophylaxis paste group.

TABLE (4) Mean and standard deviation of pre and post Surface roughness Biochar Gel group and prophylaxis paste group and comparison between them:

	Pre-polishing		Post-polishing		Paired Differences					P value
					MD	SD	SEM	95% CI		
	M	SD	M	SD				Lower	Upper	
Prophylaxis paste	0.48	0.03	1.60	0.85	-1.13	0.85	0.27	-1.73	-0.52	<0.0001*
Biochar Gel	0.47	0.03	1.25	0.49	-0.78	0.49	0.16	-1.13	-0.42	<0.0001*
P value	0.46		0.27							

M: mean SD: standard deviation MD: mean difference P: probability level which is significant at P ≤ 0.05

TABLE (5) Arrangement of Vita Classic Shade Guide

Arrangement of Vita Classic Shade Guide (Adapted From Browning and Others)															
Vita Shade Guide															
B1	A1	B2	02	A2	C1	C2	04	A3	03	B3	A3.5	B4	C3	A4	C4
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Brigh1es1 shade												Darkest shade			

DISCUSSION

Tooth polishing is usually part of an appointment with the dentist. Dental professionals used to smooth teeth to lessen plaque and bacteria that could cause cavities, gingivitis, and periodontitis. Dentists currently have a wide range of alternatives when it comes to the polishing materials and types of polishers they can use. They can now use a variety of polishers, depending on the patient's condition and acceptance level, to give excellent care by carefully organizing the treatment to match the patient's demands and reduce loss of tooth structure. [2]

The three perfect conditions for a polishing material are minimum abrasion, good cleaning ability, and simultaneous polishing. [18]

Regularly used grit is fine; medium or coarse pastes are only required for heavily stained areas. Scratches smaller than 0.5 mm are created during the polishing process as coarse to fine abrasion moves forward. Because these scratches are tiny than visible light's wavelength, they seem smooth and glossy. [19]

The proper hand piece with contra-angled shanks, was attached to bristle brush. The handpiece was always handled steadily, between 2500 and 3000 rpm. The pressure applied approximately 20 psi. [2] With a light, steady speed and a patting action, the surface was polished in two to five seconds according to Christensen and Bangerter's findings. [20]

In this study, the bristles brushes were only used for many reasons. first to simulate clinical scenario, since it is limited to crown thus prevent damage to the gingiva and cementum. Second less heat generated by friction. Finaly, the patient compliance and acceptance are high to bristle brushes. [2]

The stained solution used in this study was tea since it is the most popular beverage consumed worldwide. [13] Artificial dental staining was created to imitate the extrinsic stains that naturally arise over the tooth's surface. [12]

The polishing paste and dentifrices both include the same abrasive agents. The abrasive's particle size, which is higher in professional prophylactic pastes, makes a difference. Preservative, pigment, flavoring, humectants, and binder are all included in prophylactic polishing pastes. [21] In addition to aluminum oxide (alumina), other abrasive particles included in commercial prophylactic polishing pastes include silicon carbide, aluminum silicate, garnet, feldspar, zirconium oxide, zirconium silicate, boron, and calcium carbonate. [21]

The regulated process known as **(pyrolysis)** is used to burn organic material from forestry and agricultural wastes to create biochar, a substance with a high carbon content that resembles charcoal. Good biochar cannot be produced using the conventional way of manufacturing charcoal. High porosity, a wide microstructure, and adsorption capacity are characteristics of good biochar that promote positive interactions between soil microbes, nutrients, and water. [22]

Cucurbita moschata, a significant horticultural crop in the Cucurbitaceae family, is also known as "MistiKumra" in Bangla and "Pumpkin" in English. Numerous researchers are interested in this plant because of its nutritional worth, potential health benefits, and abundance of different phytochemicals. Cucurbita moschata has been the subject of numerous studies over the past few decades, and the results have shown that the plant has a wide range of medical uses, including the ability to operate as an antioxidant, analgesic, anthelmintic, antibacterial, anticancer, and obesity-fighting agent. [23]

Hippocrates is credited with originating the use of charcoal for dental health in ancient Greece. Many cultures and regions of the world have utilized charcoal as a cleaning agent. [24]

It has been suggested that dentists use newer tools for shade matching, like VITA Easyshade® V, for better and more accurate shade matching

because shade selection depends on many factors, including lighting conditions, the color of the environment, the observer's eyes, and mental and psychological factors.[25] It showed up shades either VITA SYSTEM 3D-MASTER shades or VITA classical A1–D4 shades. The results of this study suggest that it might be able to use the 3D guide to identify tooth colors, and then use conversion tables to translate those colors into VC values without introducing a clinically significant inaccuracy. [26]

A value-oriented shade guide was utilized to visually identify the color changes over the course of the study after conversion tables were applied. This method was chosen because it is a simple, quick, and effective approach that has been applied to multiple investigations. Numerous research have validated the validity and reliability of this color rating method. According to a report, the Vitapan Classical shade guide can be a valid and reliable tool for visually assessing tooth color, even with its subjectivity. It can distinguish between light and dark colors as seen in table 6. [27]

Negahdari et al., 2015 [25] agreed with the results of the current study in both groups to evaluate the repeatability of color selection with the use of Vitapan Classical and 3DMaster shade guides. And reported no significant differences in the repeatability between these two systems. Zenthöfer et al., 2014 concluded that use of the conversion tables gave equal or better matches than direct matching with VC.

Franco et al., 2020 [24] agreed with results of the present study regarding biochar (charcoal) had a certain degree of whitening effect, but it was not as effective as dental bleaching.

Retzius grooves, pits, and other small flaws, along with possible mineral buildup in the oral environment, give the enamel surface its inherent roughness. Using high-abrasive pastes or cycle tools at the incorrect torque, speed, or time can exacerbate surface roughness and lead to more discolorations. [28, 29] **Burcu et al., 2021**, have been proposed that the best way to get smooth surfaces is to use a bristle brush for polishing. The surface of the samples treated with an air-polishing device has been reported to be more uneven than the surface of the samples treated with rubber and brush based on the study results. [28]

Although regarding surface roughness and comparison between prophylaxis paste group and Biochar Gel group revealed insignificant difference as P was 0.46 and 0.27 regarding pre-polishing and post-polishing respectively. The Biochar gel recored less surface roughness than prophlaxis paste this due to Gel is more accepted than paste since gel formula is less abrasive ingredients than paste that owe more abrasive ingredients. [30]

Also gel coat the teeth into thin layer and works smoothly against teeth. While paste coats the teeth into a thick layer that require additional scrubbing to clean off. Additionaly, gel has more subtle flavoring, less minty aftertaste rather than stronger flavor of paste thus more patient satisfaction.[30]

CONCLUSION:

1- The current study is considered the first in vivo study investigating the polishing effects and consequences of **Biochar Gel Based on Cucurbita Moschata** on stained human teeth.

2- According to the results of the current study, **Biochar Gel Based on Cucurbita Moschata** is considered a promising alternative to prophylactic pastes products in the management of stained enamel.

RECOMMENDATIONS

More in-vitro trials are strongly recommended to isolate and characterize bio actives from pumpkin parts to check their medicinal uses in dentistry field.

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