



NATURAL ALTERNATIVES FOR TOOTH WHITENING: AN IN VITRO COMPARISON OF POMELO, LEMON AND SALT SOLUTION, AND TAMARIND EXTRACT

Dental Science

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ABSTRACT

Introduction: Beauty in things exists in the mind which contemplates them” by David Hume, every mind experiences beauty differently, as do civilisations and ethnicities. Due to the image-oriented nature of our society, feelings about our physical appearance and self-esteem are more linked. One of the most likely psychological benefits of teeth whitening is to boost an individual's self-esteem and confidence. A brighter grin frequently leads to a more positive self-image, making people feel more at ease and confident in social circumstances. **Objective:** The objective of the study is to compare the efficacy of pomelo, lemon and salt solution, tamarind extract as natural bleaching agent as an in vitro study. **Methods:** Twenty-four extracted permanent teeth were gathered and subjected to ultrasonic scaling. The teeth were then stained in a coffee decoction for 48 hours. Color measurements were taken using an Android mobile app with a 64 MP camera and an RGB color detector. The 24 teeth were divided into three groups, each containing 8 samples. Group 1 teeth were immersed in pomelo extract, Group 2 in lemon salt solution, and Group 3 in tamarind extract for three days. Afterward, the color of the teeth was reassessed, and the differences were analyzed using a one-way ANOVA statistical test. **Results:** Lemon-salt was the most effective treatment, showing: The highest lightness (L) increase. The greatest reduction in yellowness (b). Pomelo also showed significant improvements but was slightly less effective than Lemon and Salt. Tamarind showed no significant improvement in lightness or yellowness and actually increased in redness (a), making it the least effective treatment. **Conclusion:** The study proves the effectiveness in bleaching property of pomelo and lemon salt solution by showing significant difference in colour before and after immersion to the extracts for three days. Whereas, tamarind shows no significant difference. This study reveals the bleaching property of pomelo and effectiveness in tooth whitening.

KEYWORDS

tooth whitening, pomelo extract, lemon salt solution, tamarind extract, natural bleaching property.

INTRODUCTION

“Beauty in things exists in the mind which contemplates them” by David Hume, every mind experiences beauty differently, as do civilisations and ethnicities[1]. Due to the image-oriented nature of our society, feelings about our physical appearance and self-esteem are more linked[2]. One of the most likely psychological benefits of teeth whitening is to boost an individual's self-esteem and confidence. A brighter grin frequently leads to a more positive self-image, making people feel more at ease and confident in social circumstances. Thereby, professional teeth whitening is favoured for those who desiring whiter teeth since it provides proven and pleasing aesthetic outcomes using conservative approaches. The success of bleaching treatments depends mostly on identifying the etiology of colour alteration, which is often classified as either extrinsic or intrinsic[3].

Intrinsic staining, also known as internal staining, can be caused by heredity, age (due to enamel erosion), antibiotics (tetracycline), more fluoride levels, and developmental abnormalities. After tooth eruption, some dental restorations can cause tooth staining and pulp bleeding, allowing blood to enter the dentinal tubules and degrade, resulting in the deposition of chromogenic blood products such as hemosiderin and haemin and pulp necrosis. Extrinsic tooth discolouration occurs when you consume certain foods and beverages, such as coffee, red wine, or smoke. Coloured substances from these sources are absorbed into dental pellicle or directly onto the tooth's surface, causing a stain to form. Poor oral hygiene can also lead to extrinsic stains[4].

Once the reason of the discolouration has been identified, dentists can create a personalised treatment plan for each patient, taking into account their oral health, dental condition, and expectations. Gels with hydrogen or carbamide peroxides are the most popular option in these therapy regimens[5]. Tooth bleaching usually happens in the dentist's office using stronger gels in short period (in-office technique), at home under the supervision of the dentist using softer gels and longer application times (at-home technique), or occasionally a mix of both methods.

Both the patient and the dentist may find it challenging to control the amount of whitening throughout the procedure, which could lead to

either too much or too little whitening. Furthermore, because of its corrosive properties, the extremely concentrated peroxide utilised in the treatment has the potential to harm delicate tissues. Postoperative tooth sensitivity is also a common and significant side effect, along with other potential complications such as cervical root resorption, crown fractures, mucosal reactions, and changes to the enamel surface[6].

Whereas, natural tooth whitening ingredients promote oral health and minimize enamel erosion and soft tissue irritation while providing a bleaching effect and cost effective. This study aims on bleaching effect of tooth using pomelo, lemon salt solution and tamarind extract as natural bleaching agent.

Objective

The aim of the study is to compare of efficiency of pomelo extract, lemon salt solution and tamarind extract as natural bleaching agent for teeth as an in vitro study.

MATERIALS AND METHODS

In this in vitro study, 24 permanent teeth were cleaned using an ultrasonic scaler to eliminate calculus and debris. And the extract of pomelo, lemon -salt solution and tamarind extract is prepared. And colour assessment by RGB colour detector application.

Inclusion Criteria

To remove confounding variables, teeth with fluorosis, dental caries, fractures, enamel hypoplasia, or those with intrinsic or extrinsic stains from drugs were not included.

Exclusion Criteria

In order to prevent bias, the color assessment was carried out using an RGB camera color detector application on an Android mobile device with a 64 MP camera from a distance of 12 cm. RGB values were recorded on the face surface, and the color detector app converted the readings to CIE lab values.

Twenty-four extracted permanent teeth are collected, and they are split into three groups of eight samples each. Pre-immersion tooth colour

measurements were evaluated and noted. The teeth of Group 1 were submerged in pomelo extract. Group 2 spent three days in a lemon salt solution, whereas Group 3 spent three days in tamarind extract. Readings of tooth colour taken before and after the immersion were assessed and contrasted.

The natural teeth that were gathered were preserved using distilled water. A coffee decoction was used to artificially stain the teeth. To make the decoction, 100 millilitres of deionised boiling water at 100 degrees Celsius was mixed with 250 milligrammes of robusta coffee powder. The liquid was filtered and moved to a 100 mL glass beaker once it had cooled to room temperature. For 48 hours, each of the 24 teeth selected for the study was submerged in the staining solution. After that, they were thoroughly cleaned with water and kept for later usage at room temperature with 100% humidity.

The first test solution of pomelo extract is prepared by peeling the pomelo and was sliced into little cubes. 250 grams of the pomelo, devoid of any extra water, were then put in a blender and mixed until a homogenous liquid combination was achieved. After carefully filtering the resultant mixture, 30 ml are removed and stored in an airtight container.

And the second test solution is prepared by halving two fresh lemons, 30 ml of their juice were squeezed into a container, and one teaspoon of sea salt was added. The mixture was thoroughly mixed until the salt was entirely dissolved. A sieve was used to remove any remaining salt particles after a little amount of distilled water was added to dilute the solution. The finished solution was kept at room temperature in an airtight container.

The third solution, tamarind extract is prepared by taking 50 grams of the tamarind with 30 ml of distilled water. This resulting mixture is filtered and collected in an air-tight container.

Teeth were soaked in pomelo extract, lemon-salt solution and tamarind extract for three days, with the solution changed every 24 hours. The color assessment was expressed as E values. The difference between initial (E1) and final (E2) color assessments indicated the ΔE value, defined in terms of lab values (L for brightness, a for redness to greenness, b for yellowness to blueness). ΔE was calculated through the formulation: $\Delta E = ((\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2)^{1/2}$ [7].

RESULT

Lemon and Salt was the most effective treatment, showing the highest lightness (L) increase. The greatest reduction in yellowness (b). Pomelo (figure 1) also showed significant improvements but was slightly less effective than Lemon and Salt (figure 2). Tamarind (figure 3) showed no significant improvement in lightness or yellowness and actually increased in redness (a), making it the least effective treatment.



Day 1

Day 2

Day 3

Figure 1, Tooth Whitening In Pomelo Extract For 3 Days



Day 1

Day 2

Day 3

Figure 2, Tooth Whitening In Lemon Salt Solution For 3 Days



Day 1

Day 2

Day 3

Figure 3, Tooth Whitening In Tamarind Extract For 3 Days

Table 1 Represent The Intergroup Comparison Between The Study Parameters By Using Repeated Measures Anova Test

PARAMETER	GROUP	FOLLOW UP	MEAN	S.D	95% CONFIDENCE INTERVAL		SIG
					LOWER	UPPER	
RED	POMELO	PRE	212.50	7.856	205.93	219.07	.000
		DAY1	222.38	7.190	216.36	228.39	
		DAY2	230.25	6.018	225.22	235.28	
		DAY3	247.88	4.121	244.43	251.32	
	LEMON AND SALT	PRE	193.63	19.835	177.04	210.21	.000
		DAY1	238.75	7.906	232.14	245.36	
		DAY2	249.13	6.198	243.94	254.31	
		DAY3	254.50	1.414	253.32	255.68	
	TAMARIND	PRE	210.88	18.349	195.53	226.22	.119
		DAY1	219.75	11.411	210.21	229.29	
		DAY2	228.75	13.134	217.77	239.73	
		DAY3	218.25	13.047	207.34	229.16	
BLUE	POMELO	PRE	159.50	25.901	137.85	181.15	.000
		DAY1	206.00	16.708	192.03	219.97	
		DAY2	232.25	8.615	225.05	239.45	
		DAY3	240.25	7.206	234.23	246.27	
	LEMON AND SALT	PRE	133.25	29.543	108.55	157.95	.000
		DAY1	245.13	10.134	236.65	253.60	
		DAY2	254.13	1.808	252.61	255.64	
		DAY3	254.25	1.389	253.09	255.41	
	TAMARIND	PRE	170.75	23.426	151.17	190.33	.149
		DAY1	184.38	9.797	176.18	192.57	
		DAY2	187.38	18.988	171.50	203.25	
		DAY3	171.00	16.423	157.27	184.73	
GREEN	POMELO	PRE	193.25	15.332	180.43	206.07	.000
		DAY1	221.25	9.114	213.63	228.87	
		DAY2	234.75	5.751	229.94	239.56	
		DAY3	249.63	3.335	246.84	252.41	
	LEMON AND SALT	PRE	177.25	24.382	156.87	197.63	.000
		DAY1	246.13	7.827	239.58	252.67	
		DAY2	254.25	2.121	252.48	256.02	
		DAY3	254.88	.354	254.58	255.17	
	TAMARIND	PRE	200.38	18.228	185.14	215.61	.176
		DAY1	208.25	8.746	200.94	215.56	
		DAY2	211.00	8.635	203.78	218.22	
		DAY3	198.38	13.596	187.01	209.74	

*P value less than or equal to 0.05 is considered statistically significant different

The table presents an intergroup comparison of study parameters using the Repeated Measures ANOVA Test for three different groups (Pomelo, Lemon and Salt, Tamarind) across three color-coded parameters (Red, Blue, Green).

Statistical Significance (P-values): A statistically significant difference ($p \leq 0.05$) was observed in the Pomelo and Lemon and Salt groups across all three color-coded parameters (Red, Blue, Green). The Tamarind group did not show statistical significance in any of the parameters ($p > 0.05$), indicating no significant changes over time.

1. Red Parameter: Pomelo group: A gradual increase in the mean

values from 212.50 (Pre) to 247.88 (Day 3).Lemon and Salt group: A marked increase from 193.63 (Pre) to 254.50 (Day 3).Tamarind group: Although there were fluctuations, the changes were not statistically significant ($p = 0.119$).

2. **Blue Parameter: Pomelo group:** A significant increase from 159.50 (Pre) to 240.25 (Day 3).Lemon and Salt group: The most pronounced increase, from 133.25 (Pre) to 254.25 (Day 3).Tamarind group: A lack of consistent increase, with values fluctuating and a non-significant p-value ($p = 0.149$).
3. **Green Parameter: Pomelo group:** A steady rise from 193.25 (Pre) to 249.63 (Day 3).Lemon and Salt group: A sharp increase from 177.25 (Pre) to 254.88 (Day 3), with the smallest variation ($SD = 0.354$ at Day 3).Tamarind group: The values fluctuated, with no consistent upward trend, and no statistical significance ($p = 0.176$).

Pomelo and Lemon and Salt groups showed significant improvements across all color parameters, with Lemon and Salt displaying the most pronounced effect.Tamarind did not show statistically significant changes, indicating that it may be less effective compared to the other two groups.Lemon and Salt consistently had the highest final mean values across all parameters, suggesting its superior effect in this study.

Table 2 Represent The Intergroup Comparison Between The Study Groups With Colorimetric Study Parameters By Using Repeated Measures Anova

PARAMETER	GROUPS	FOLLOW UP	MEAN	S.D	95% CONFIDENCE INTERVAL		SIG
					LOWER	UPPER	
L	POMELO	PRE	78.962	4.9664	74.810	83.115	.000
		DAY1	87.925	3.0513	85.374	90.476	
		DAY2	92.613	1.9599	90.974	94.251	
		DAY3	97.813	1.1606	96.842	98.783	
	LEMON AND SALT	PRE	72.512	8.3379	65.542	79.483	.000
		DAY1	96.387	2.7409	94.096	98.679	
		DAY2	99.375	.8697	98.648	100.102	
		DAY3	99.925	.2121	99.748	100.102	
	TAMARIND	PRE	80.863	6.6078	75.338	86.387	.132
		DAY1	83.887	3.2331	81.185	86.590	
		DAY2	86.338	5.7079	81.566	91.109	
		DAY3	80.975	4.6015	77.128	84.822	
a	POMELO	PRE	1.738	2.8978	-685	4.160	.001
		DAY1	-2.175	1.2892	-3.253	-1.097	
		DAY2	-1.713	1.4525	-2.927	-.498	
		DAY3	-2.188	1.4506	-3.400	-.975	
	LEMON AND SALT	PRE	-.612	3.5950	-3.618	2.393	.106
		DAY1	-2.600	1.0000	-3.436	-1.764	
		DAY2	-1.700	1.4976	-2.952	-.448	
		DAY3	-.238	.5181	-.671	.196	
	TAMARIND	PRE	-1.075	1.4665	-2.301	.151	.019
		DAY1	.113	1.0176	-.738	.963	
		DAY2	.650	2.7749	-1.670	2.970	
		DAY3	2.775	3.2381	.068	5.482	
b	POMELO	PRE	19.563	7.4077	13.370	25.755	.000
		DAY1	7.650	5.8202	2.784	12.516	
		DAY2	.763	2.1494	-1.034	2.559	
		DAY3	4.275	2.2160	2.422	6.128	
	LEMON AND SALT	PRE	24.863	6.2388	19.647	30.078	.000
		DAY1	-.363	1.9309	-1.977	1.252	
		DAY2	-.525	1.7782	-2.012	.962	
		DAY3	.263	.4069	-.078	.603	
	TAMARIND	PRE	16.188	7.0503	10.293	22.082	.598
		DAY1	13.275	4.0503	9.889	16.661	
		DAY2	15.288	4.4803	11.542	19.033	
		DAY3	16.550	4.6889	12.630	20.470	

P value less than or equal to 0.05 is considered statistically significant different

This table presents an intergroup comparison of study groups using Repeated Measures ANOVA for colorimetric parameters (L, a, b) over different time points (Pre, Day 1, Day 2, Day 3).

L Parameter (Lightness)Pomelo and Lemon and Salt showed

statistically significant improvement ($p = 0.000$) with increasing lightness over time.Lemon and Salt reached the highest mean value (99.925 on Day 3).Pomelo showed a steady increase but remained lower than Lemon and Salt.Tamarind did not show statistically significant changes ($p = 0.132$), with fluctuations in lightness and a drop on Day 3.Lemon and Salt resulted in the highest lightness improvement, followed by Pomelo, while Tamarind showed no significant improvement.

a Parameter (Red-Green Spectrum):Pomelo had a statistically significant reduction in a values ($p = 0.001$), indicating a shift towards greenish tones over time.Lemon and Salt did not show a significant change ($p = 0.106$).Tamarind had a statistically significant change ($p = 0.019$) but showed an increase in a value, suggesting a shift toward redder tones rather than green. Pomelo had the most significant greenish shift, while Tamarind resulted in increased redness.

b Parameter (Yellow-Blue Spectrum):Pomelo and Lemon and Salt had statistically significant reductions in b values ($p = 0.000$), indicating a shift away from yellow over time.Lemon and Salt had the most significant drop, almost reaching neutral.Pomelo had an initial drop but slightly increased again on Day 3.Tamarind showed no significant change ($p = 0.598$), maintaining relatively stable yellow values.Lemon and Salt produced the most significant reduction in yellowness, followed by Pomelo, while Tamarind showed no significant change.

DISCUSSION

As public awareness of dental aesthetics grows, there may be a rise in demand for cosmetic procedures, along with higher expectations for treatment results. Tooth bleaching refers to a chemically induced whitening process, primarily driven by carbamide peroxide, which releases about one-third of its concentration as hydrogen peroxide.[8].

Even while professional teeth-whitening treatments shows more success over time, there is still have side effects of damaging soft tissue and tooth sensitivity. Herbal teeth-whitening treatments have become more popular recently as a solution to the safety issues. These herbal substitutes are economical, less harmful, biologically safe, and effective[9]

The staining in this study is done by immersing all 24 tooth in coffee decoction for 48 hours which contains tannic acid. This has potent denaturing capability and affect pellicle protein and causes staining of tooth. These chromogens are integrated into the pellicle, and the colour that results is determined by the chromogen's intrinsic hue[10].

In this study we compare the efficacy of pomelo, lemon salt and tamarind extract as natural bleaching agent.

Citrus grandis L. (syn. Citrus maxima L.) is commonly known as pomelo. This popular fruit belongs to the order Sapindales under the family Rutaceae and genus Citrus[11]but different from grapefruit[12]Pomelo pulp juice has higher levels of β -carotene and lycopene are found to have hypolipidemic, antioxidant, and anticancer properties[13].

The pomelo juice contain oxalic acid, tartaric acid, acetic acid, malic acid, citric acid and succinic acid. The malic acid, ascorbic acid, acetic acid, and citric acid were presented in all pomelo juices[14]which posses excellent tooth whitening property.

Lemon contains various minerals , vitamin and acids. The acidic ph of lemon is 2-3 whereas the ph of enamel is 5.5 hence,the malic acid and di carboxylic acid in lemon oxidise the tooth surface and brightens the teeth[15]. And:the sea salt contain calcium carbonate which act as mechanical abrasive and remove the extrinsic stains[16]. Studies have shown that sea salt and toothpaste with a lemon show teeth-whitening effects when used regularly during brushing sessions[17].

Tamarind extract contains tartaric acid and oxalic acid [18]which has high demineralisation property of teeth and may help in teeth whitening.

Our experimental study involved collection of 24 immersing stained tooth samples and divide them into three groups each group containing 8 teeth and immersed into pomelo extract, lemon-salt solution and tamarind extract They are immersed for three days, with daily change of the solution to maintain the freshness and effectiveness of treatment

Then the significant result where observe in all three solution using camera RGB colour detector application.

Although the results of our study are encouraging, it is important to recognise certain limitations. The outcomes of this study might not be immediately applicable in vivo because it was carried out in vitro. To confirm these results and evaluate their safety and effectiveness in practical contexts, more clinical trial research is needed. Future studies should also assess the tooth sensitivity and any long-term effects of these natural bleaching agents.

CONCLUSION

The study proves the effectiveness in bleaching property of pomelo and lemon salt solution by showing significant difference in colour before and after immersion to the extracts for three days .Whereas, tamarind shows no significant difference. This study reveals the effectiveness of natural alternatives in tooth whitening .

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