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Effect Of Incorporation Of Either Neem Or Aloe Vera Powders On Tear Strength And Hardness Of Acrylic Soft Denture Liner Material

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Abstract

Aim of the study: The heat acrylic soft lining materials are far from ideal due to poor soften and weak tearing strengths. This cause some practical problems when testing the adherence of soft liners to denture bases. The study objective was to assess the effect of either Neem or Aloe Vera extracts on tear strength and hardness of heat acrylic soft denture lining material.

Materials and methods: Sixty acrylic soft liner specimens were prepared and divided into two main groups (30 specimens for tear strength test, 30 specimens for hardness test). These main groups sub-divided into three groups, each one consist of 10 specimens, according to incorporated material. The hardness specimens were fabrication with dimensions of (30 mm diameter × 3 mm thickness). The tear strength specimens were fabricated according to ASTM specification D-624. The scanning electron microscope (SEM) was used to estimate the distribution of either Neem or Aloe Vera particles within the soft liner. Energy dispersive X-ray spectroscopy (EDS) was used to analysis the elements of studied materials. Tear strength specimens were measured by utilizing universal Instron machine. Hardness specimens were measured by utilizing Shore A durometer. Statically all data were analyzed by using SPSS software.

Results: The outcomes showed non-significant differences ($p>0.05$) of all studied groups in tear strength and a highly significant ($p<0.001$) decrease in hardness of all studied groups in comparison with the control group.

Conclusion: Incorporation of Neem or Aloe Vera extracts powders showed slight increases in tear strength and highly significant decreases in hardness of soft liner material.

Keywords: Neem, Aloe Vera, Tear strength, Hardness, Soft denture liner.

Introduction

The soft denture liners are soft polymers that can be applied to the fitting surface of hard dentures. They play a significant role in removable

prosthodontics due to their ability to provide a cushioning influence for maintaining the health of traumatized, swollen, and distorted mucosa via absorption and fair redistribution of stresses over time (1 The relining process used to resurfacing the tissue surface of a removable dental prosthesis with a fresh base material, resulting in an accurate adaptation to the denture foundation area (2). The soft denture lining material could be classified into two types (silicon and acrylic) and both types were provided in heat or auto cured systems (3) The usage of soft denture lining material is accompanied by a lot of complications like poor tear strength, loss of resiliency, color changes, and porosity that lead to microorganisms and fungi colonization (3). Herbal medicines have been shown to be a great alternative therapy option for the management of oral infections, requiring more research into its mechanical properties, biological safety, and antifungal characteristics (4). Between the different available herbal agents also greatest popular are Neem and Aloe vera, both herbal plants were commonly used medically also commercially (5).

The divine tree Neem (Azadirachta indica), a multifunctional medicinal tree of the Meliaceae family, it is one of the most valuable traditional medicinal plants. It is mostly planted in the Indian subcontinent. Seeds, blossoms, bark, and leaves of this divine tree have all been utilized to heal acute and chronic human illnesses. The anti-oxidant, anti-inflammatory, hypolipidemic, antidiabetic, microbicidal, anti-pyretic, insecticidal, nematicidal, anti-fertility, anti-ulcer, anti-leishmaniasis, neuroprotective, and cardioprotective characteristics of the Neem tree made it famous. Phytochemicals like alkaloids, steroids, flavonoids, glycosides, terpenoids, fatty acids, tannins, and carbohydrates were abundant in Neem leaves, and these phytochemicals were responsible for the plant's multiple medical effects (6, 7).

Aloe vera is descending from the Liliaceae family; it is a succulent perennial xerophyte plant that has water storage mechanisms in its leaves, which means it can store water in its tissues, allowing it to exist in areas where water is scarce (8). Aloe vera is extensively used as a root canal anti-inflammatory material against a variety of irritants and used as a mouthwash, and toothpaste with good anti-cariogenic properties, Aloe vera has a periodontal treatment system that aims to decrease inflammation by reducing the number of pathogenic bacteria and eliminating pathogenic pockets. The antimicrobial properties of Aloe vera help to reduce plaque and gingivitis (5).

The objective of this current study was to evaluate the influence of incorporating either Neem or Aloe vera extracted powders with soft lining material powder on tear strength and hardness, and to determine which substance was more ideal for incorporating into heat cure acrylic soft liner material.

Materials and method

Samples grouping

A total of sixty samples of heat acrylic cure soft liner were prepared and divided into two main groups based on tests that evaluated (30 specimens for tear strength and 30 samples for hardness), each main groups sub-divided into three groups based on incorporated material as following:

Control group: 10 samples soft liner without any incorporation. Neem powder group: 10 samples soft liner with 10% by weight of Neem powder. Aloe Vera powder group: 10 samples

soft liner with 10% by weight of Aloe Vera powder.

Incorporation of either Neem or Aloe Vera powders into heat cure acrylic soft liner

The soft liner samples were prepared according to manufacture instructions (Vertex) for mixing of heat acrylic soft lining material (P/L ratio: 1.2g of powder/1ml of liquid monomer). Either Neem powder (Davis finest company, India) or Aloe Vera powder (Mi nature company, India) with 10% by weight were incorporated into heat cure acrylic soft liner (Vertex). The weight of incorporation materials was subtracted from the entire weight of soft liner powder to obtain the exact P/L ratio as follows:

Control group: 24g of powder, 20 ml of liquid. Neem powder 10 % group: Neem powder (21.6g), liquid (20 ml). Aloe vera powder 10 % group: Aloe Vera powder (21.6 g), liquid (20 ml). For fine mixing of studied powders with soft liner powder an amalgamator (Ivoclar Vivadent; Germany) for 40 second was used (9).

Tear strength test

Mold preparation

To evaluate the tear strength of soft liner material, the specimens were fabricated usage plastic plate that cut into suitable shape using a laser machine (CNC) based to American society for testing and material, (ASTM D, 624, 2012) with dimension as illustrated in figure (1).

Samples' preparation

The plastic pattern was invested into additional silicon impression material (Zermack, Italy), then silicon mold with the plastic pattern were invested in dental stone (Zermack, Italy). After proportioning and mixing of either Neem or Aloe Vera powders with acrylic soft liner powder, all samples were packed and cured according to manufacturer's instructions, then finished by using prosthetic hand-piece (Marathon W&H; Korea) and fine grit silicone polishing bur (China), also used fine grit sand-paper (China) with continual water cooling to counteract overheating and warp-age, after that polishing was done as a conventional method. All samples were stored in distilled water (Iraq) at 37°C for 48 hours (9).

Testing procedure

The samples were tested by utilizing a Universal testing machine (Instron 1195; England) at a stretching rate of 500 mm/min of grips separation until the samples were breakdown. The tear strength assess the force per unit thickness and it expressed in N/mm according to (ASTM specification D-624, 2012) formula:

Tear strength (Ts) = F/d

Where:

F = the maximum force, in N.

d = the median thickness of each test piece, in mm.

Hardness test

To prepare mold of hardness sample usage plastic round plate with the dimensions of (30mm diameter , 3mm thickness)(10). As shown in figure (2). The proportioning, mixing, curing, finishing and polishing of the soft liner were done as a tear strength test.

A digital durometer (Shore A hardness tester; China) was used to test the hardness samples. The average of five readings from the durometer scale represented the value of the test, and the contact time was 5 seconds after each penetration.

Scanning electron microscopy (SEM) (Inspect S 50 FEI-CO; England):

SEM analysis at 1000x was used to investigate the particles shape and size of either Neem or Aloe vera and soft liner powder.

Energy dispersive X-ray spectroscopy (EDS):

EDS technique was used in conjunction with scanning electron microscopy (SEM) to determine the elemental analysis of the samples and identified if experimental particles get blended with the soft liner matrix or not.

Statistical Methods

All study data analyzed with Levene test (equal variances), One-way ANOVA, and least significant difference (LSD) test was used to determine pair differences.

Results

Tear strength test

For tear strength test, soft liner with Aloe Vera 10% wt. powder group had the highest mean values, and the lowest mean was for the control group (without any incorporation), and the mean of the soft liner with Neem 10% wt. powder group was in between, figure (3).

Statistically, the outcomes of Levene test and ANOVA test showed non-significant differences at $P>0.05$ among studied groups, Table (1).

Hardness test

The soft liner with Neem 10% wt. powder group had the lowest mean value.Whereas the highest mean value was for the control group. While the soft liner with Aloe Vera 10% wt. powder group was in between. Levene test result showed non-significant differences at $P>0.05$ among all groups, while one-way ANOVA result showed highly significant differences at $P<0.05$, Table (2). LSD test among all groups for hardness test shows that soft liner with Neem 10% wt. powder group and the soft liner with Aloe Vera 10% wt. powder group has recorded a statistically highly significant differences compared with the control group at $P<0.01$, while non-significant differences at $P>0.05$ between soft liner with Neem 10 % and soft liner with Aloe Vera 10 % groups, Table (3). All tested groups were graphically presented in figure (4).

Scanning electron microscopy (SEM)

SEM results for powder particles showed the soft liner particles were round with diameter of (15-43 µm), and the Neem powder particles had irregular borders with size (2-5 µm) while Aloe vera powder particles had irregular borders with size (3-6 µm) as shown in figure (5). In addition, the result of SEM showed irregular porous surface of acrylic soft liner (control group) samples, figure (6). Also, SEM showed regular distribution of Neem particles within the soft liner matrix and regular distribution of Aloe vera particles within the soft liner matrix. The results showed closed all porous of acrylic soft liner surface, figure (7).

Energy Dispersive X-ray Spectroscopy (EDS)

The EDS mapping illustrates the fairly uniform homogeneous blending particles of either Neem or Aloe vera with the matrix of soft liner material, figure (8, 9).

Discussion

Soft denture lining materials are now commonly used for therapeutic purposes to improve patient's comfort and tolerance for denture-induced stress. Soft lining materials provide a number of benefits such as cushioning effect under dentures by distributing and releasing the functional load.

Nevertheless, the continuous use of soft lining material for a prolonged period may have an adverse effect on the oral environment. One of the most serious problems was poor tear strength and loss of softness during a period of time (11).

Tear strength test

The material resistance to tearing force is calculated by this test. Tear strength is affected by many factors like filler content, the strength of filler and matrix interaction, degree of crosslinking, specimen geometry, and deformation rate (12, 13).

Incorporation of either Neem 10% and Aloe Vera 10% powders into heat acrylic soft liner results in a slight increase in tear strength but statistically non-significant as compared with the control group, this is may be due to the physical bonding between particles of either Neem or Aloe Vera and soft liner in addition to the differences in particle size and form of all studied materials.

The EDS mapping indicated silica particles on the outer surface of Neem and Aloe Vera material, these silica particles have the ability to create hydrogen bonds between the surface hydroxyl group of studied materials and the oxygen in the polymer network. The polymer networks resistance to tearing was increased by these hydrogen bonds (14).

In addition, the EDS mapping illustrated the fine distribution of either Neem or Aloe Vera into acrylic soft liner which could explain the increase in tear strength.

As well as the ability of the polymer to remove strain energy around the tips of developing cracks could explain the improvement in tear strength (15).

Hardness test

The hardness was an important property of the soft denture liners to measure the modulus of elasticity or their softness (16, 17).

It is preferable that soft denture liners show low hardness, so the lowest mean is the best, this showed with soft liner with 10 % Neem powder group and the highest mean value was for control group. While the soft liner with Aloe Vera 10% wt. powder group was in between. The groups of soft liner with Neem 10 % powder and soft liner with Aloe Vera powder showed a highly significant difference in comparison with the control group. This could be explained by the incorporation of Neem and Aloe vera into soft liner material might enhance and increased the plasticizer ability for softening gel formation and its ability for polymeric chains penetration, the Neem and Aloe Vera may be acting as fillers that decreases soft liner hardness and resistance when dispersed inside soft liner matrix.

The results showed a non-significant difference when compared between the groups of soft liner with 10 % Neem powder and soft liner with 10% Aloe Vera powder that may be attributed to both the groups have the same compatibility and high degree of similarity in elements composition.

Since, there was no previous study and no published data regarding the effect of Neem or Aloe vera extracts on some properties of the acrylic soft lining materials. The purpose of this current study is to provide baseline data regarding the incorporation of either Neem or Aloe vera herbal extract powders into heat cure acrylic soft lining material regarding tear strength and hardness.

Conclusion

With the limitations of the present study, incorporation 10% of Neem powder and 10% Aloe Vera powder into soft liner has a slight increase in tear strength and highly significant

decreases in hardness values. According to the best results obtained by Neem powder can be probably considered the most best appropriate material incorporated into heat-cured acrylic soft liner material.

Conflicts of Interest

The authors reported that they have no conflicts of interest.

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Table 1. Descriptive analysis statistics and Levene's and one-way ANOVA tests for Tear Strength

Test	Groups	No.	Mean	Std. D.	Min.	Max.	Levene test	ANOVA test
Tear Strength	Control	10	6.62952	1.231	4.587	8.507	p=0.360 (NS)	p=0.302 (NS)
	Soft liner with Neem 10% wt. powder	10	6.70463	0.806	5.884	8.339		
	Soft liner with Aloe Vera 10% wt. powder	10	7.36046	1.305	5.683	9.268		

(NS) Non Sig. at P>0.05

Table 2. Descriptive analysis statistics and Levene's and one-way ANOVA tests for hardness

Test	Groups	No.	Mean	Std. D.	Min.	Max.	Levene test	ANOVA test
Shore A Hardness	Control	10	78.073	2.248	74.33	80.50	p=0.082 (NS)□	p=0.000 (HS)□□
	Soft liner with Neem 10% wt. powder	10	65.099	3.867	57.86	70.16		
	Soft liner with Aloe Vera 10% wt. powder	10	67.396	2.159	62.96	70.60		

□(NS) : Non Sig. at P>0.05 , □□(HS): Highly Sig. at p<0.01

Table 3. (LSD) Least Significant Difference tests for hardness of all studied groups

(I) Group	(J) Group	Mean Diff. (I-J)	Sig.	C.S. (*)

Control group	**Soft liner with Neem 10% wt. powder**	**12.974**	**0.000**	**(HS)**
	Soft liner with Aloe Vera 10% wt. powder	**10.677**	**0.000**	**(HS)**
Soft liner with Neem 10% wt. powder group	**Soft liner with Aloe Vera 10% wt. powder**	**-2.297**	**0.084**	**(NS)**
(HS): Highly Sig. at p<0.01 , (NS) : Non Sig. at P>0.05				

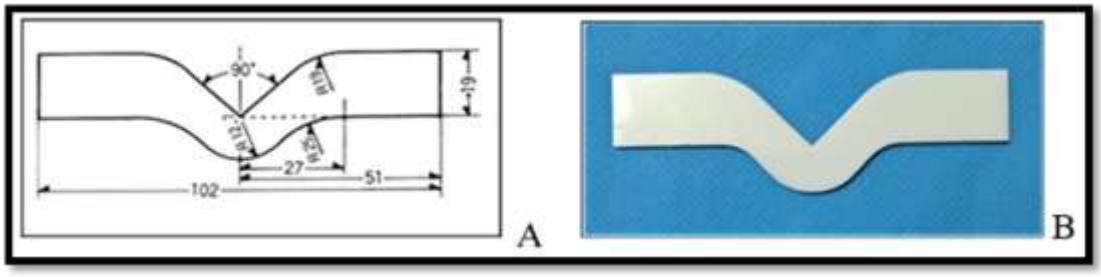

Figure (1): (A) Tear strength pattern dimensions (B) Plastic pattern of tear strength specimen

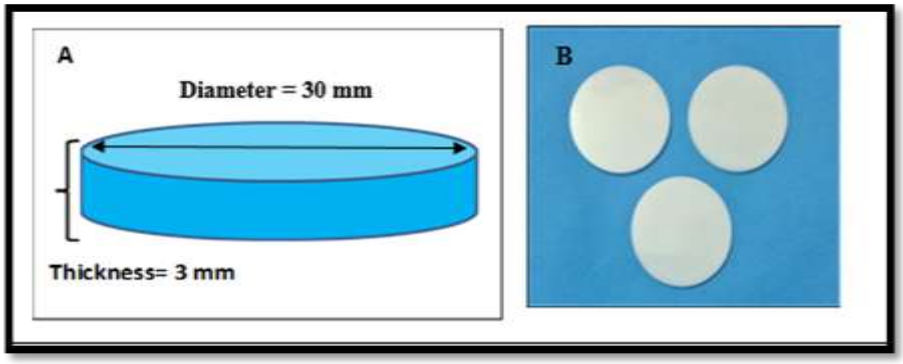

Figure (2): (A) Hardness pattern dimensions (B) Plastic pattern of Hardness specimen

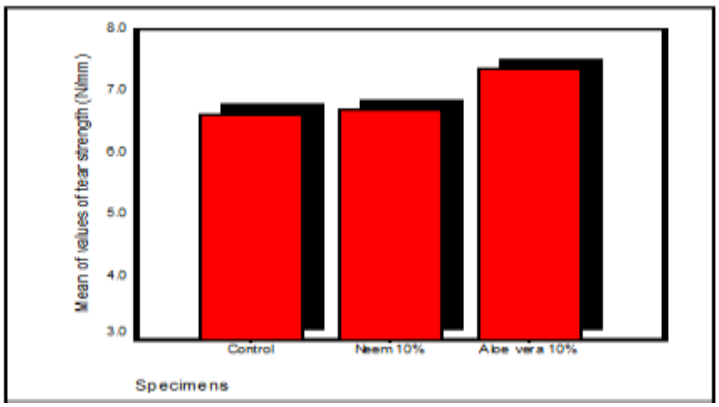

Figure (3): Bar chart of tear strength test

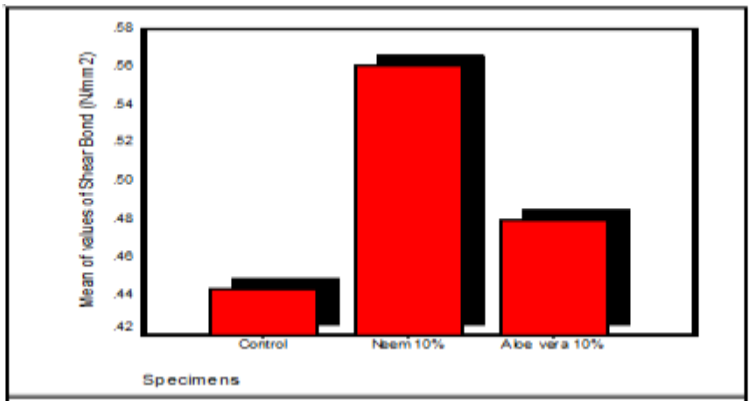

Figure (4): Bar chart of Hardness test

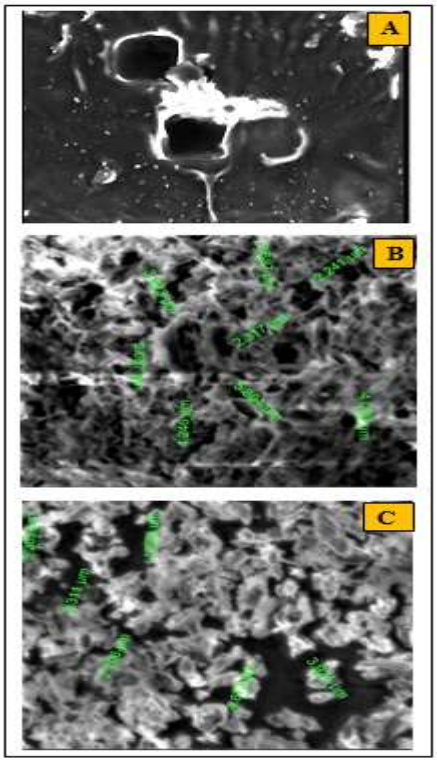

Figure (5): (A) SEM of soft liner powder particles, (B) SEM of Neem powder particles, (C) SEM of Aloe vera powder particles

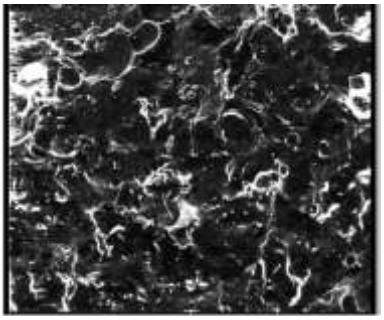

Figure (6): SEM for soft liner (control specimen) at 1000x

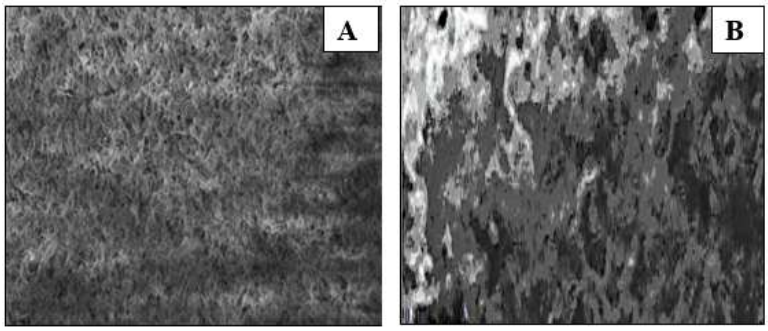

Figure (7): SEM for A) incorporation of Neem 10%, B) incorporation of Aloe vera 10% at 1000x

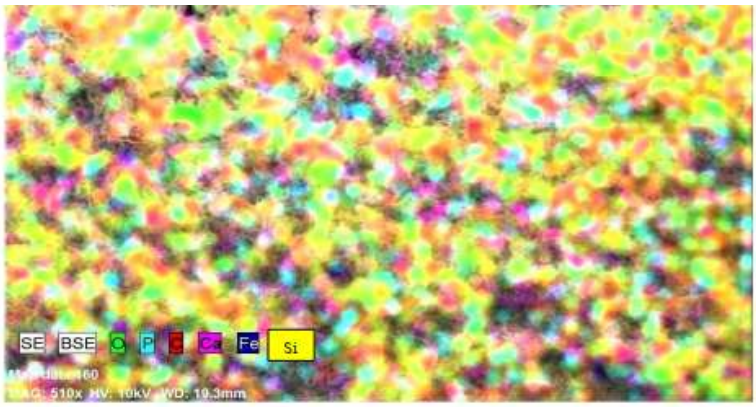

Figure (8): EDS mapping of Neem 10% specimen

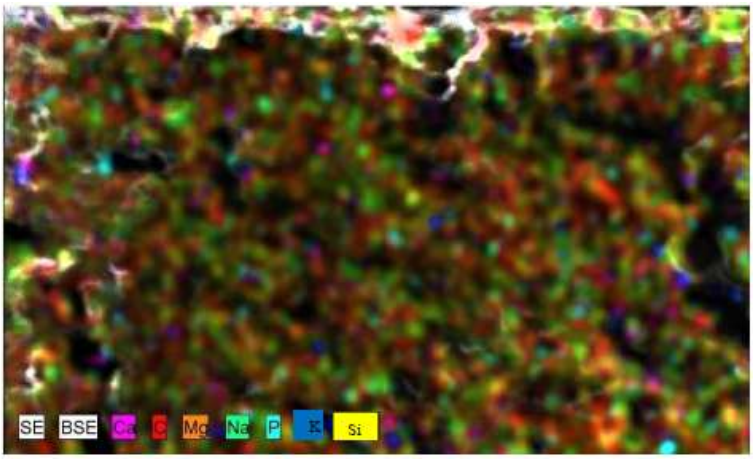

Figure (9): EDS mapping of Aloe vera 10% specimen