Diyala Journal of Medicine

ORIGINAL RESEARCH
Published: 25 June 2024
Doi: 10.26505/DJM.26028440415

Influence of Some Plant Extracts on Antifungal Properties, Hardness, and Peel Bond Strength of Heat-Cured Denture Soft Liner

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Abstract

Background: Soft liners in dentures play a crucial role in enhancing patient comfort and preventing tissue irritation especially for patients with resorbed ridges. However, microbial colonization presents a challenge to their long-term effectiveness, particularly Candida albicans, leading to conditions like denture-induced stomatitis.

Objective: To evaluate the antimicrobial efficacy and mechanical properties of heat cured soft liners incorporating plant extracts from Olea europaea and Ficus carcia, individually and synergistically.

Patients and Methods: Extracts were obtained through Soxhlet extraction, and their antimicrobial activity against Candida albicans was determined using the broth microdilution method. Soft liner specimens were prepared with varying concentrations of the extracts and subjected to disk diffusion tests, shore A hardness measurements, and peel bond strength tests. Statistical analysis involved the use of one-way ANOVA and Dunnett tests.

Results: Results demonstrated significant antimicrobial activity, with the synergistic mixture exhibiting the highest inhibition zone against Candida albicans. Moreover, the addition of such extracts led to increased shore A hardness, with the highest levels recorded for synergistic groups. The extracts also displayed a significant decrease in peel bond strength, indicating potential challenges in adhesive properties. These findings suggest that while individual extracts show promise in antimicrobial efficacy and mechanical reinforcement of soft liners, their combination may lead to compromised adhesive properties.

Conclusion: The study contributes valuable insights into the development of antimicrobial soft liners reinforced with Olea europaea and Ficus carcia

OPEN ACCESS

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Website: https://djm.uodiyala.edu.iq/index.php/djm

Received: 15 April 2024
Accepted: 23 May 2024
Published: 25 June 2024

ORIGINAL RESEARCH
Published: 25 June 2024
Doi: 10.26505/DJM.26028440415

extracts, advancing dental materials towards improved patient outcomes and enhanced oral health.

Keywords: Soft liner, Olea europaea, Ficus carcia, Disk diffusion, Compressive strength.

Introduction

Natural rubbers have been used in dentistry since 1869, with Twichell creating the earliest denture soft liners. Since then, advancements in dental materials have led to various soft liner types, each with specific advantages and disadvantages [1]. Denture base poor adaptation to the underlining tissues frequently due to bone resorption can lead to problems to patients, such problems can be controlled by the use of relined dentures [2]. In general, soft liners are useful over the hard denture bearing areas to help patients suffering from irritation during wearing of complete and partial dentures to act as a cushion that can absorb the load created by the masticatory forces, reduces the traumatic effects of occlusal forces, and spread these forces in equal manner and makes the patient more comfortable [3].

The colonization of microbes in the soft lining material is one of the serious problems that affects the long-term efficacy of the material, the most common clinical condition associated with this problem is denture-induced stomatitis which mainly caused by C. albicans which is the most common fungi responsible for oral infections [4]. Olea europaea and Ficus carcia are noted for their therapeutic properties, with chemical analysis revealing the presence of various bioactive compounds such as saponins, tannins, silica, resin, trimethylamine, alkaloids, and phenols [5]. Each of these constituents exhibits distinct pharmacological effects attributable to their chemical nature [6].

Olea europaea, frequently recognized as the olive tree and it is native to, Asia and Africa, and Mediterranean Europe displays different amounts of oleuropein OL, hydroxytyrosol HT, verbascoside, apigenin-7-glucoside, and luteolin-7-glucoside in the leaf extracts. OL and HT have been recognized for their antioxidant and antimicrobial characteristics [7]. Both belong to the Oleaceae family, Ficus carcia is one of the oldest cultivated fruits globally. Phytochemical analyses of F. Carcia leaves have unveiled a plethora of bioactive compounds, including phenols, flavonoids, tannins, alkaloids, and saponins [8]. These compounds contribute to the reported antioxidant, anti-inflammatory, antiviral, and antimicrobial activities of Ficus carcia [9].

Phytotherapy which revolves around the beneficial uses of medicinal herbs and synergistic relations of such plant extracts an give several advantages. These include mitigating undesirable effects, enhancing the efficacy and bioavailability of active agents, and potentially enabling therapeutic effects with lower dosages compared to individual synthetic materials [10]. Additionally, research has demonstrated that incorporating extracts from Olea europaea and Ficus carcia into glass ionomer cement can augment antimicrobial effects [8].

Patients and Methods

Preparation of Two-Plant Extract Mixture

Extracts from Ficus carcia and Olea europaea plants were obtained separately. Each plant

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was washed, dried, and ground into powder. These powders were then added to the thimble of a Soxhlet extractor (Carl Roth GmbH +Co. KG, Karlsruhe, Germany). Ethyl alcohol (70%) was used as solvent for extraction over several hours. The resulting extracts from each plant were filtered (JIAO JIE, China) and proportioned to create a mixture. This mixture underwent ethanol removal using a rotary evaporator, resulting in a crude mix stored in a closed flask at 4°C until further use [11].

Isolation and Identification of Candida albicans

Candida albicans specimens were taken from the oral cavity of four male patient aged between 60 to 65 years old, complete denture wearers, who attended the Collage of Dentistry/ University of Baghdad with signs and symptoms of denture stomatitis, the procedure was accomplished by using sterile cotton swab and gentle rubbing of the intra-oral lesion. Plates were then incubated for 48 h at 37 °C in the incubator. Following which, the cultured plates were preserved in a refrigerator at 4°C for further investigations and tests [12].

The method used to identify Candida was through the morphology of their colonies. In sabouraud dextrose agar medium, the Candidal colonies appear as convex, smooth, creamy and pasty [13]

Minimal Inhibitory Concentration (MIC)

The broth microdilution method was utilized to estimate the Minimum Inhibitory Concentration (MIC) against Candida albicans, a fungal pathogen. Sabouraud dextrose broth was employed as the selective medium for Candida growth. Inoculum preparation involved culturing Candida albicans to a specific cell density, standardized visually using the McFarland standard value of 2. A microdilution plate was prepared with 12 rows of wells. Aqueous extract of Olea europaea and Sabouraud dextrose broth were added to wells 2 through 11, followed by Candida albicans inoculum, resulting in two-fold serial dilutions ranging from 0.032 mg/mL to 16.384 mg/mL. Well 12 served as the negative control, while well 1 acted as the positive control. After 24 hours of incubation in an incubator (Memmert, Germany) at 30°C, MIC was determined by the absence of visible fungal growth, observed as a loss of turbidity compared to the positive control wells. This methodology was similarly applied for determining the MIC of Ficus carcia and synergistic mixtures against Candida albicans [14]. 1 MIC Olea europaea and 1 MIC Ficus carcia were selected. Two synergistic mixtures (1 MIC + 1 MIC, 2 MIC + 2 MIC Olea europaea and Ficus carcia respectively) extracts were chosen based on their minimum inhibitory concentration (MIC) values.

Preparation of Test Specimens

One hundred fifty soft liner (Vertex, Italy) specimens were divided into three groups based on the tests to be conducted (Disk diffusion test, shore A hardness, and peel bond strength). Each group was further subdivided into five groups depending on the type of additive material. Plastic disc models were prepared using AutoCAD software and laser cutting machine (JL-1612, Jinan Link Manufacture and Trading Co., Ltd., China). For disk diffusion test 50 plastic discs measuring 10 mm in diameter and 3.0 mm in thickness [15], and for Shore A hardness 50 disc-shaped plastic discs measuring 35 mm in

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diameter and 6 mm thickness [16]. The plastic patterns were invested in addition silicone and after setting of silicone they were coated with separating medium (Shanghai new century dental material Co., Ltd, China), filled with dental stone in the lower flask half. After setting, it was coated again, and the upper flask half was added. Left to set, after an hour, the flask was opened, and the patterns were removed to create mold spaces.

Heat cured acrylic soft liner is available as powder and liquid; according to the manufacturer instructions mixing ratio of volume/parts by weight is 1mL liquid to 1.2 g of powder.

The specimens were divided into five groups (n=10 specimens per group): Control group (Group 1) without any additive, MIC Olea europaea (Group 2) prepared by adding 4.096 mg/mL of Olea europaea aqueous extracts per ml of monomer, 1 MIC Ficus carcia (Group 3) prepared by adding 2.048 mg/ml of Ficus carcia aqueous extracts per ml of monomer, Synergistic group (Group 4) prepared by adding 4.096 mg/ml of Olea europaea aqueous extracts and 2.048 mg/ml of Ficus carcia aqueous extracts per ml of monomer, and Synergistic group (Group 5) prepared by adding 8.192 mg/ml of Olea europaea aqueous extracts and 4.096 mg/ml of Ficus carcia aqueous extracts per ml of monomer. An electronic balance (Worner lab with 0.001 accuracy) was used.

The monomer and extracts (Olea europaea, Ficus carcia, and synergistic mixtures) were added to a glass container and sonicated to disperse particles. This mixture was then combined with soft liner powder to prevent particle accumulation and maintain the proper ratio. Once the soft liner reached the dough stage, it was loaded into silicone molds and pressed to ensure even distribution. The molds were then placed under hydraulic pressure to remove excess material and achieve uniformity. Afterward, excess material was removed, and the molds were left to dry, followed by securing the flask with a hydraulic press and immersion in a water bath for curing. The curing process involved heating the flasks in a digital water bath at 70°C for 90 minutes, then at 100°C for 30 minutes. After curing, the flasks were cooled gradually, and the specimens were removed, finished using sharp blades and silicon polishing bur. The specimens were conditioned in distilled water at 37 C for 48 hrs. according to ADA specification No.12 (1999).

For peel bond test, 50 Specimens (Acrylic part and soft-liner part) were prepared according to ASTM D903-93 specifications. Flasks made from stainless steel plates with holes were fabricated. The flask consists of four plates, two of them 5 mm in thickness were used as a cover, while the others 2 mm in thickness contain holes inside them, one for soft liner and the second for acrylic with the dimension mentioned above for each material. Two stainless steel plates one contains holes measuring 100 x 10 x 2 mm for acrylic resin, and the other contains holes measuring 150 x 10 x 2 mm for soft liner were fabricated. Heat-cured acrylic resin specimens were fabricated according to the manufacturer. Before packing the soft liner, a part of the acrylic specimen surface of all specimens was wrapped with tinfoil (Figure 1) to guarantee that just 70 mm length of the soft liner is bonded, and the remaining length

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is unbonded [5]. Soft liner specimens were prepared by packing soft liner material into the hollow space designed for soft liner. The specimens were then cured and finished as previously mentioned.

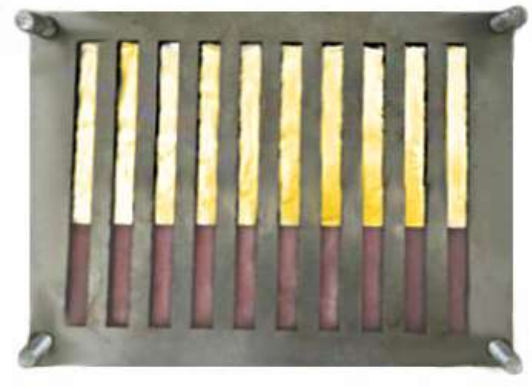

Figure (1): Acrylic specimens covered by tin foil inside the metal flask.

Disc Diffusion test

Sabouraud dextrose agar (Oxoid, England) was prepared according to manufacturer instructions and poured into sterile petri dishes. The disc diffusion method, following WHO recommendations, was utilized to assess the antifungal effects of Olea europaea, Ficus carcia, and their synergistic mixtures incorporated into soft lining material specimens. preparation of fungal suspension was performed after checking the purity of tested yeast; the isolates with 18-24 hrs were transferred to 5ml physiological solution then mixed well to prepare a homogenous yeast suspension with a turbidity equivalent to no. 2 McFarland respectively by using a Densichek instrument (17). Subsequently, a sterile cotton swab was used to inoculate a small portion of the fungal suspension and evenly spread it on the surface of Sabouraud dextrose agar medium by streaking. The inoculated plates were then allowed to dry for 10 minutes. Following this, the specimen discs were carefully inserted onto the agar using sterile forceps and pressed gently to ensure proper contact with the agar surface. Finally, the plates were inverted and incubated for 18-24 hours at 30 ºC. Inhibition zones were then measured using a scale in millimeters [18].

Shore A Hardness Test

Soft denture lining specimens measured using a shore A durometer device (Ezitown, China). Readings were taken from five different points on each sample. The mean of these five readings was calculated as the hardness value for the specimen.

Peel Bond Strength Test Specimens

The peel bond strength test, per ASTM D903-93, used an Instron testing device (LAYREE, China) at a 180º angle and 152 mm/min speed (Figure 2). The non-relined part of acrylic resin was secured on the upper clamp, while the free soft liner was secured in the lower clamp (grip 25mm). Specimen alignment was ensured using an alignment plate.

Peel bond strength (N/mm) was determined by the following equation [19]:

Peel strength = average load / width of the sample ……. 1

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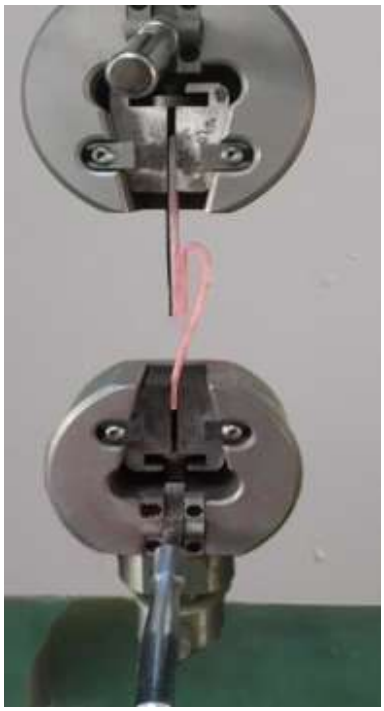

Figure (2): Peel bond strength test.

Statistical Analysis

Statistical Analysis involved the use of SPSS version 26. One way ANOVA and Dunnett post hoc test at significance level of P=0.05 were conducted to determine the difference between groups. P<0.05 was considered significant while P<0.01 was considered highly significant [20].

Results

Candida albicans appearance on sabouraud dextrose agar medium is presented in (Figure 3). MIC determination using a disposable sterile plastic contains 96 well, well 12 served as the negative control, while well 1 acted as the positive control as presented in Figure (4).

Figure (3): Candida albicans on sabouraud dextrose agar medium to be incubated for 48h at 37 °C.

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Figure (4): Minimum inhibitory concentration (MIC) determination using a plastic container that contains 96 wells.

Disk diffusion test

The higher mean value for inhibition zone was recorded for group 5 followed by group 4 while the lowest value was for group 2 Figure (5). Group 1 was not included because no inhibition zone was recorded Table (1).

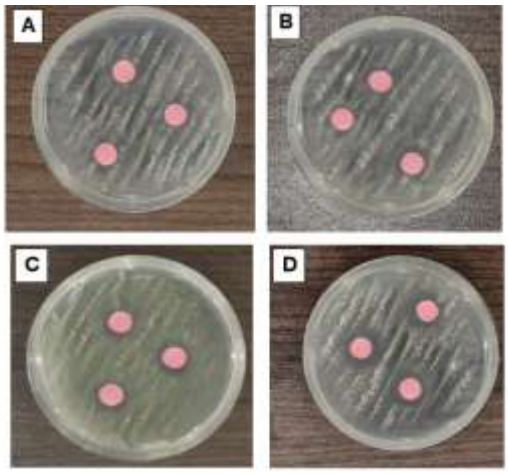

Figure (5): Effect of Ficus carcia and Olea europaea extracts on Candida albicans measured by the diameter of the inhibition zone ± Standard Error (mm) using disk diffusion test; A, Group 2. B, Group 3. C, Group 4. D, Group 5.

Table (1): Effect of Ficus Carcia and Olea europaea extracts on Candida albicans measured by the diameter of the inhibition zone ± Standard Error (mm).

Disk diffusion test (mm)					ANOVA	
Group	Min	Max	Mean	±SD	F	P value
Group 2	4.52	4.79	4.6390	.02838	1940.239	.000
Group 3	6.61	7.60	7.1050	.10532		
Group 4	10.85	11.60	11.2650	.08747		
Group 5	12.61	13.60	13.1050	.10532		
Levene statistics=5.135, p value=0.005 HS						

Dunnett's post hoc was used to determine the differences between the groups. There were highly significant differences (P<0.01) between all the groups Table (2).

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Table (2): Dunnett's post hoc test for disk diffusion test.

(I)	(J)	Std. Error	Sig.
Group 2	Group 3	.10907	.000
	Group 4	.09196	.000
	Group 5	.10907	.000
Group 3	Group 4	.13691	.000
	Group 5	.14894	.000
Group 4	Group 5	.13691	.000

Shore A hardness

The higher mean value for hardness was recorded for group 5 followed by group 4, group3, and group 2, while the lowest value was for group 1 Table (3).

Table (3): Effect of Ficus Carcia and Olea europaea extracts on shore A hardness.

Shore A hardness					ANOVA	
Group	Min	Max	Mean	±SD	F	P value
Group 1	41.61	42.28	41.9440	.22352	644.961	.000
Group 2	42.68	43.61	43.1210	.32354		
Group 3	43.78	44.77	44.2750	.33304		
Group 4	44.71	45.70	45.2050	.33304		
Group 5	47.72	47.75	47.7336	.00892		
Levene statistics=7.374, p value=0.000 HS						

Dunnett's post hoc revealed highly significant differences between all the groups (P<0.01) Table (4).

Table (4): Dunnett's post hoc test for shore A hardness.

(I)	(J)	Std. Error	Sig.
Group 1	Group 2	.12435	.000
	Group 3	.12684	.000
	Group 4	.12684	.000
	Group 5	.07074	.000
Group 2	Group 3	.14683	.000
	Group 4	.14683	.000
	Group 5	.10235	.000
Group 3	Group 4	.14894	.000
	Group 5	.10535	.000
Group 4	Group 5	.10535	.000

Peel bond strength The lowest peel strength value was for group 5 and the highest was for group 1 Table (5).

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Table (5): Effect of Ficus Carcia and Olea europaea extracts on peel bond strength between soft liner and acrylic measured in (N/mm).

Peel bond strength (N/mm)					ANOVA	
Group	Min	Max	Mean	±SD	F	P value
Group 1	3.55	3.75	3.6340	.06653	373.678	.000
Group 2	3.02	3.20	3.1100	.06055		
Group 3	2.65	2.83	2.7400	.06055		
Group 4	2.15	2.76	2.5130	.19945		
Group 5	1.87	2.02	1.9360	.05254		
Levene statistics=7.860, p value=0.000 HS						

There was a highly significant difference between all groups (P<0.01) except between group 4 and group 3 which was significant (P<0.05) Table (6).

Table (6): Dunnett's post hoc test for peel bond strength.

(I)	(J)	Std. Error	Sig.
Group 1	Group 2	.02845	.000
	Group 3	.02845	.000
	Group 4	.06649	.000
	Group 5	.02681	.000
Group 2	Group 3	.02708	.000
	Group 4	.06591	.000
	Group 5	.02535	.000
Group 3	Group 4	.06591	.048
	Group 5	.02535	.000
Group 4	Group 5	.06522	.000

Discussion

Olea europaea contains several phenolic compounds, notably oleuropein, hydroxytyrosol, and tyrosol. These compounds have been extensively studied for their antimicrobial properties, including antifungal activity against Candida albicans such as disruption of cell membranes. Phenolic compounds can disrupt the integrity of fungal cell membranes by interacting with membrane lipids and proteins. This disruption leads to leakage of intracellular components and ultimately cell death [20]. In addition, these phenolic compounds such as oleuropein can inhibit key fungal enzymes involved in metabolic processes, impairing fungal growth and proliferation. Oleuropein belongs to secoiridoids [22]. The precise enzyme that oleuropein can inhibit its activity in fungi is known as β-glucosidase. This enzyme involved in the hydrolysis of β-glucosidic bonds, that are present in various substrates. In fungi, β-glucosidases has critical activities in the metabolism of carbohydrates which includes the breakdown of complex carbohydrates structures into simple sugar that can be used by the fungus to produce energy. By inhibiting β-glucosidase, oleuropein can interfere with the ability of fungus to utilize carbohydrates,

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thus preventing the growth and proliferation [23].

Ficus carcia, similar to olive extract, encompasses compounds such as chlorogenic acid, quercetin, and rutin, these have strong antimicrobial and antioxidant characteristics [24]. Chlorogenic acid can prevent fungal proliferation by interfering with the function and organization of the phospholipid bilayer of the fungal cell membrane. The hydrophobicity of chlorogenic acid enables it to intercalate inside the lipid bilayer, this in turn can lead to changes in the permeability of fungal cell membrane. Also, it prevents vital fungal enzymes involved in metabolic functions, for example glycolysis and the tricarboxylic acid cycle, by adhering to the active sites [25]. In addition, it can generate reactive oxygen species inside the fungal cell, such as superoxide radicals and hydrogen peroxide that can damage cellular elements such as proteins, lipids, and DNA [26].

Another flavonoid abundant in various plant sources is quercetin, which exhibits comprehensive antifungal mechanisms. It inhibits fungal enzyme activity by interrupting key metabolic pathways necessary for growth and survival. Such interference can disrupt processes like glycolysis or nucleic acid synthesis, preventing fungal proliferation. Quercetin also impacts mitochondrial function, preventing energy production and metabolic homeostasis. Such disruption of mitochondrial activity promotes cell dysfunction and ultimate fungal death [27]. Furthermore, quercetin induces oxidative stress by generating reactive oxygen species within the fungal cell [28]. Also, rutin has been reported to modulate virulence factors of Candida albicans, such as adhesion, filamentation, and biofilm formation, thereby attenuating its pathogenicity [26].

The synergistic effects observed with the combination of Olea europaea and Ficus carcia extracts, especially after increasing the MIC of the two extracts, can be attributed to the through complementary mechanisms, with phenolic compounds in olive extract disrupting fungal cell membranes while quercetin and chlorogenic acid in Ficus carcia target different metabolic pathways within the fungal cell, leading to a broader spectrum of antifungal action [26, 29]. Also, the combination of both extracts increases the permeability of the fungal cell wall, facilitating better penetration of antifungal compounds into the fungal cell interior, thus enhancing their efficacy against Candida albicans [30]. Moreover, synergistic interactions between compounds in the two extracts may enhance their bioavailability or cellular uptake, leading to more efficient inhibition of fungal growth [31].

The greater increase in hardness following the addition of Ficus carcia extract compared to Olea europaea extract stems from the distinct chemical composition of these extracts. Ficus carcia extract contains higher concentrations of bioactive compounds, such as chlorogenic acid and quercetin, which exhibit stronger interactions with the polymer matrix of the soft liner. These compounds facilitate enhanced crosslinking or reinforcement effects within the polymer structure, leading to a more substantial increase in hardness [32].

The observed increased hardness levels after the synergistic mixture addition can be related to the fact that bioactive compounds

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in the extracts interact with the polymer matrix, potentially forming additional crosslinks and reinforcing the structure, leading to increased rigidity [33]. Some components act as fillers, reducing polymer chain mobility and increasing density. Furthermore, variations during drying and curing processes could affect the mechanical properties more [34].

The decrease observed in peel bonding after the addition of Olea europaea can be caused by the disruption of the polymer structure which weakens the bonding between soft liner and acrylic part by altering the surface characteristics of the soft-lining material such as surface energy and roughness which affects the ability to adhere to the acrylic [35].

The decrease in peel bonding after the addition of Ficus carcia extract is likely related to the bioactive compounds in the extract, such as chlorogenic acid and quercetin which can disrupt the polymer matrix of the soft-liner. This leads to structural irregularities and weak bonding sites. Also. It can interfere with crosslinking reactions and weaken intermolecular forces between polymer chains that reduces cohesive strength. Furthermore, alterations in the surface properties of the soft-liner material induced by the extract may hinder proper adhesion to the acrylic part [36].

The difference between the effects of the two synergistic mixtures likely stems from the higher concentrations of bioactive compounds. At 2 MIC concentrations, there are more of these compounds present, intensifying their effects on the soft liner. This leads to increased disruption of the polymer structure, cohesion, and adhesive properties, resulting in a more significant decrease in peel bond strength compared to the 1 MIC concentrations [37].

Conclusions

The synergistic mixture exhibited promising antimicrobial efficacy but posed challenges in adhesive properties. These findings highlight the importance of carefully balancing antimicrobial efficacy with mechanical integrity in the formulation of soft liners.

Recommendations

The study highlights the benefits of some plant extracts on soft liners used in conjunction with acrylic dentures. Farther research is recommended after using different plants or in conjunction with different materials.

Source of funding: The current study was funded by our charges with no any other funding sources elsewhere.

Ethical clearance: This study was conducted according to the approval of College of Medicine/ University of Diyala and in accordance with the ethical guidelines of the Declaration of ethical committee of the College (Document no. 2024ASA844).

Conflict of interest: Nil

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Diyala Journal of Medicine

ORIGINAL RESEARCH
Published: 25 June 2024
Doi: 10.26505/DJM.26028440415

تأثير بعض المستخلصات العشبية على الخصائص المضادة للفطريات والصلابة وقوة رابطة القشرة للبطانة الناعمة لأطقم الأسنان المعالجة بالحرارة

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الملخص

خلفية الدراسة: تلعب البطانات الناعمة في أطقم الأسنان دورا حاسما في تعزيز راحة المريض ومنع تهيج الأنسجة وخاصة للمرضى الذين يعانون من نتوءات تمت إعادة الامتصاص. ومع ذلك، فإن الاستعمار الميكروبي يمثل تحديًا لفعاليتها على المدى الطويل، وخاصة المبيضات البيضاء، مما يؤدي إلى حالات مثل التهاب الفم الناجم عن أطقم الأسنان.

اهداف الدراسة: لتقييم الفعالية المضادة للميكروبات والخصائص الميكانيكية للبطانات الناعمة المعالجة بالحرارة والتي تتضمن مستخلصات من أوليا أوروبا و التين الكاريكي ، بشكل فردي وتآزري.

المرضى والطرائق: تم الحصول على المستخلصات من خلال استخلاص سوكسلت وتم تحديد نشاطها المضاد للميكروبات ضد المبيضات البيضاء باستخدام طريقة التخفيف الدقيق للمرق. تم تحضير عينات البطانة الناعمة بتركيزات مختلفة من المستخلصات وإخضاعها لاختبارات انتشار القرص وقياسات صلابة الشاطئ A واختبارات قوة رابطة القشرة. وشمل التحليل الإحصائي استخدام اختبارات ANOVA وDunnett أحادية الاتجاه.

النتائج: أظهرت النتائج نشاطًا كبيرًا مضادًا للميكروبات، حيث أظهر الخليط التآزري أعلى منطقة تثبيط ضد المبيضات البيضاء. علاوة على ذلك، أدت إضافة هذه المستخلصات إلى زيادة صلابة الشاطئ A، مع تسجيل أعلى المستويات للمجموعات التآزرية. أظهرت المستخلصات أيضًا انخفاضًا كبيرًا في قوة رابطة القشرة، مما يشير إلى التحديات المحتملة في خصائص الالتصاق. تشير هذه النتائج إلى أنه على الرغم من أن المستخلصات الفردية تظهر نتائج واعدة في الفعالية المضادة للميكروبات والتعزيز الميكانيكي للبطانات الناعمة، إلا أن مزيجها قد يؤدي إلى ضعف خصائص الالتصاق.

الاستنتاجات: تساهم الدراسة برؤى قيمة في تطوير البطانات الناعمة المضادة للميكروبات المعززة بمستخلصات أوليا أوروبا و التين الكاريكي ، مما يؤدي إلى تطوير مواد طب الأسنان نحو تحسين نتائج المرضى وتعزيز صحة الفم.

الكلمات المفتاحية: بطانة ناعمة؛ أوليا أوروبا, التين الكاريكي ,انتشار القرص قوة الضغط

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