

The preparation of pomegranate peel extract for supporting the gingiva health

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Abstract

The current research is concerned with the study of the preparation of pomegranate peel extract for supporting the gingiva health and the research is located in four chapters, where the first chapter dealt with the problem of the research, the importance of the research, the limits of the research and the identification of the terms contained in the title of the research. The second chapter consists of two researches. The first research: the gum disease and the second research: diseases that affect the gums. The third chapter was dedicated to research procedures, as it dealt in detail the preparation of pomegranate peel extract and the active elements in pomegranate peels that can be used to support gum health. The fourth chapter came to present and discuss the results, including

- 1 The punicalagin exhibits a tanning behaviour that increases gum cohesion
- 2 The punicalagin has strong anti-inflammatory properties

As well as conclusions and recommendations, and a list of research sources

Keywords: diseases, related, gingiva

تحضير مستخلص قشر الرمان لدعم صحة اللثة
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المستخلص

يتناول البحث الحالي دراسة تحضير مستخلص قشر الرمان لدعم صحة اللثة، وينقسم إلى أربعة فصول، تناول الفصل الأول منها مشكلة البحث وأهميته وحدوده، بالإضافة إلى تحديد المصطلحات الواردة في عنوان البحث. أما الفصل الثاني، فقد تضمن بحثين، الأول: أمراض اللثة، والثاني: الأمراض التي تصيب اللثة. أما الفصل الثالث، فقد خصص لإجراءات البحث، حيث تناول بالتفصيل تحضير مستخلص قشر الرمان والعناصر الفعالة فيه والتي يمكن استخدامها لدعم صحة اللثة. أما الفصل الرابع، فقد جاء لعرض ومناقشة النتائج، ومنها:

- 1- يُظهر البونيكالاجين سلوكًا تسميريًا يزيد من تماسك اللثة.
- 2- يمتلك البونيكالاجين خصائص قوية مضادة للالتهابات.

بالإضافة إلى الاستنتاجات والتوصيات، وقائمة بمصادر البحث.

الكلمات المفتاحية: امراض، مرتبطة، اللثة

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Introduction

Gum disease is a common oral health problem, ranging from simple inflammation and bleeding gums to the erosion of the supporting bone. Recent research has drawn increasing attention to natural medicine and plant-based products as effective and safe sources to help treat and alleviate gum problems, due to their antibacterial and anti-inflammatory properties.

Among these products, pomegranate peel (*Punica granatum*) is some plant-based source rich in phenolic compounds, tannins, and antioxidants. These compounds have been shown to inhibit the growth of bacteria that cause gum infections, promote oral tissue regeneration, and reduce bleeding and redness.

This research aims to scientifically prepare a pomegranate peel extract and study its effectiveness in supporting gum health by evaluating its biological properties and measuring its effect on reducing biomarkers of oral inflammation. Through this study, we contribute to promoting the trend toward natural treatments to aid oral health and provide safe and effective alternatives to traditional chemical products.

The first chapter of the research includes:

- 1- Research Problem: Gum diseases are a common oral health issue that affect many individuals daily, leading to various complications that can significantly impact their quality of life. Prolonged exposure to these conditions may contribute to severe long-term health disorders, highlighting the need for effective preventive and therapeutic interventions.
- 2- Research Importance: study of gum diseases that people suffer from daily and the effect of pomegranate peel extract on them.
- 3- Research goal: finding solutions and natural treatments to treat this disease instead of Current treatments (scaling, antibiotics, surgery) are costly, invasive, and sometimes ineffective against resistant bacteria
- 4- Research limits: starting on 20/1/2025 until 27/3/2025 at College of Dentistry
- 5- Define research terms: gum diseases, pomegranate peel extract .

The second chapter of the research includes

First topic:

Definition of Anatomy and Histology of the Gingiva.

Second topic:

Discussing the symptoms of the disease that affects the oral cavity.

The third chapter of the research includes:

Discussing the Preparation and Analysis of Pomegranate Peel Extract

The fourth chapter of the research includes:

- 1- Discussing the mechanism of action of pomegranate peels extract (PPE) on gum health.
- 2- Search results

First Chapter:

Introduction:

Gingival health is fundamental to maintaining overall oral well-being, with periodontal diseases affecting nearly 50% of adults worldwide [1]. The gingiva serves as a protective barrier for teeth and underlying structures, and its inflammation can lead to serious conditions like gingivitis and periodontitis [2]. Pomegranate (*Punica granatum* L.) has been used in traditional medicine for centuries due to its remarkable therapeutic properties [3]. While the fruit's arils are commonly consumed, research reveals that the peel contains significantly higher concentrations of bioactive compounds [4].

So Recent studies indicate that pomegranate peel extract (PPE) exhibits:

- Potent antimicrobial activity against oral pathogens [5]

- Significant anti-inflammatory effects [6]
- Strong antioxidant capacity [7]

These properties suggest PPE could be valuable in preventing and treating gingival diseases while offering a sustainable solution by utilizing agricultural byproducts.

Second Chapter:

Anatomy and Histology of the Gingiva:

The gingiva consists of two distinct anatomical regions:

1. Free gingiva: Forms a collar around the tooth (1-3mm sulcus depth) [8]
2. Attached gingiva: Firmly connected to underlying alveolar bone [9]

Histologically, it comprises:

- Oral epithelium: Keratinized stratified squamous epithelium [10]
- Sulcular epithelium: Non-keratinized lining of the sulcus [11]
- Junctional epithelium: Forms attachment to tooth surface [12]

Common Periodontal Pathologies:

- 1- Gingivitis: is the earliest stage of gum disease, primarily caused by the accumulation of plaque—a sticky film of bacteria—on the teeth and gums. The bacteria irritate the gingiva, leading to inflammation.

Symptoms:

Red, swollen gums, Bleeding when brushing or flossing & Bad breath

Cause:

- Poor oral hygiene, leading to plaque buildup

- Smoking or tobacco use
- Certain medications
- Poor nutrition, especially a lack of vitamin C

If gingivitis is left untreated, it may develop into more serious forms of gum disease.

[13] [14]

- 2- Periodontitis is a more severe form of gum disease that occurs when gingivitis is not treated. It affects not only the gingiva but also the supporting bone and connective tissues around the teeth. The inflammation spreads deeper into the supporting structures, potentially causing tooth loss.

Symptoms:

Gum recession (gums pull away from the teeth) , Persistent bad breath or a bad taste in the mouth , Loose teeth, Pus between teeth and gums

Cause:

- Continued plaque buildup leading to bacterial infection
- Poor oral hygiene over time

[15] [16] [17]

- 3- Gum Abscess (Periapical Abscess) is a localized collection of pus that forms due to an infection in the gum tissue. This infection is usually caused by bacteria entering through a damaged area of the gum.

Symptoms:

A painful, swollen area on the gums , Pus drainage from the affected area , Fever (in some cases) & Sensitivity or pain when chewing

Cause:

- Bacterial infection from poor dental hygiene or untreated dental decay
- Gum injury or trauma

[18]

- 4- Necrotizing periodontal diseases : also known as trench mouth, is a severe form of gum

disease that involves sudden, painful inflammation and ulceration of the gingiva.

Symptoms:

Painful, bleeding gums, Ulcers on the gums , Foul-smelling breath & Fever and fatigue

Cause:

- Poor nutrition, stress, and smoking
- Weakened immune system
- Bacterial infections, particularly by *Fusobacterium* and *Treponema* species

[19]

5- Oral Cancer : less common, oral cancer can affect the gums, leading to growths or sores that do not heal. Oral cancer is often linked to smoking, alcohol use, and human papillomavirus (HPV).

Symptoms:

Persistent sores or lumps on the gums , Pain or bleeding in the mouth, Difficulty swallowing & Unexplained weight loss

Cause:

- Smoking and tobacco use
- Alcohol consumption
- HPV infection

Chapter 3

Preparation and Analysis of Pomegranate Peel Extract

Pomegranate peel extract has gained attention for its potential health benefits, particularly in oral care, due to its antimicrobial, anti-inflammatory, and antioxidant properties. This chapter outlines the steps involved in preparing pomegranate peel extract, which may be used in various formulations for improving gingival health.

Materials Needed:

- Fresh pomegranate peels (preferably organic)
- Distilled water or ethanol (depending on the extraction method)
- Mortar and pestle or grinder
- Heat source (optional, for decoction)
- Filter paper or cheesecloth
- Container for storing the extract
- Gloves (for handling the peels)

Methods of Extraction

There are several methods for extracting beneficial compounds from pomegranate peel, such as decoction, maceration, or solvent extraction. Below are the two most common methods used for preparing pomegranate peel extract:

1. Decoction Method (Water-Based Extraction)

This method involves boiling the pomegranate peels in water to extract the bioactive compounds. It is simple and effective for extracting water-soluble compounds like antioxidants.

Steps:

1. Prepare the Pomegranate Peels:

- Wash the pomegranate peel thoroughly to remove any dirt or residues.
- Cut or break the peels into smaller pieces to increase surface area for extraction.

2. Boil the Peels:

- In a saucepan, add about 100 grams of pomegranate peels to 500 mL of distilled water.

- Bring the water to a boil, then reduce the heat and simmer for 20-30 minutes.

3. Strain the Extract:

- After the boiling process, strain the mixture using filter paper or cheesecloth to separate the solid peel material from the liquid extract.

4. Concentration (Optional):

- To concentrate the extract, return the liquid to the heat and simmer until the volume reduces by half. This will increase the potency of the extract.

5. Cool and Store:

- Let the extract cool to room temperature.
- Store the extract in a sealed container in the refrigerator for up to one week.

[20][21]

2. Solvent Extraction Method (Ethanol-Based)

Solvent extraction using ethanol is another effective method to extract both water-soluble and alcohol-soluble compounds from pomegranate peel, such as polyphenols and flavonoids. This method is ideal if a more concentrated extract is needed.

Steps:

1. Prepare the Pomegranate Peels:

- Wash and chop the pomegranate peel into small pieces.
- Dry the peels thoroughly (air-drying or using a dehydrator is recommended) to remove moisture content.

2. Grind the Peels:

- Use a mortar and pestle or grinder to reduce the dried peels into a coarse powder. This increases the surface area for extraction.

3. Mix with Solvent:

- Place the powdered pomegranate peel into a glass jar or container.

- Add ethanol (or a mixture of ethanol and water) at a 1:5 ratio (1 part peel powder to 5 parts solvent).

4. Infuse the Peels:

- Seal the jar tightly and shake it gently.
- Let the mixture sit in a cool, dark place for about 7-10 days. Shake the jar once or twice a day to help the extraction process.

5. Filter and Strain the Extract:

- After the infusion period, strain the liquid through filter paper or cheesecloth to remove the solid peel material.

6. Concentration (Optional):

- If a more concentrated extract is desired, the ethanol extract can be evaporated using a low heat source or a rotary evaporator (for laboratory purposes).

7. Cool and Store:

- Once strained, the extract can be stored in an airtight container in a cool, dark place. It is typically stored for up to 6 months.

[22][23]

3. Drying and Powdered Form (Optional)

In addition to liquid extracts, you can also prepare powdered pomegranate peel extract. This method

involves drying the peel and grinding it into a fine powder for easy use in capsules or as an ingredient in oral care formulations.

Steps:

1. Dry the Pomegranate Peels:

- After washing the pomegranate peels, cut them into small pieces and air-dry or use a dehydrator until completely dry.

2. Grind the Dried Peels:

- Once the peels are completely dry, grind them into a fine powder using a mortar and pestle or a grinder.

3. Store the Powder:

- Store the powdered pomegranate peel in an airtight container in a cool, dry place.

Bioactive compounds in pomegranate peel extract (PPE):

as shown in Table (1)

Tabel 1: Bioactive compounds in pomegranate peel extract (PPE)

Compound Class	Representative Compounds	Concentration (%)	Biological Activity
Hydrolyzable tannins	Punicalagins	15-25	Antioxidant, antimicrobial
Ellagitannins	Ellagic acid derivatives	5-10	Anti-inflammatory
Flavonoids	Anthocyanins	2-5	Free radical scavenging

Fourth Chapter

Mechanism of action of pomegranate peels extract (PPE) on gum health:

1-Antimicrobial Effects:

PPE exhibits potent antibacterial activity against key periodontal pathogens, including *Porphyromonas gingivalis* and *Streptococcus mutans*.

1- Bacterial Membrane Disruption

Punicalagins and ellagic acid interact with bacterial cell membranes, increasing permeability and causing leakage of cellular contents, leading to bacterial death. [24]

2- Inhibition of Biofilm Formation

PPE interferes with quorum sensing, preventing bacterial communication and plaque formation. [24]

Reduces extracellular polysaccharides (EPS), which are essential for biofilm stability.

[25]

3- Enzyme Inhibition

Ellagitannins inhibit proteolytic enzymes like gingipains from *P. gingivalis*, which degrade gum tissues and facilitate bacterial invasion.

2-Anti-Inflammatory Effects :

Chronic inflammation is a hallmark of periodontal disease. PPE mitigates inflammation through multiple pathways.

1-NF-κB Pathway Suppression

PPE downregulates nuclear factor-kappa B (NF-κB), a major regulator of inflammatory responses.

Decreases pro-inflammatory cytokines such as IL-1β, IL-6, and TNF-α, which are implicated in gum tissue destruction. [26] [27]

2- Inhibition of Matrix Metalloproteinases (MMPs)

Punicalagin inhibits MMP-2 and MMP-9, enzymes responsible for collagen degradation in periodontal ligaments. [28]

3- COX-2 and PGE2 Reduction

PPE reduces cyclooxygenase-2 (COX-2) expression and prostaglandin E2 (PGE2) production, alleviating gum swelling and pain.

3- Antioxidant Properties:

Oxidative stress plays a critical role in periodontal disease progression. PPE acts as a potent antioxidant.

1- Free Radical Scavenging

Polyphenols such as ellagic acid and anthocyanins neutralize reactive oxygen species (ROS),

preventing oxidative damage to gingival fibroblasts. [29] [30]

2- Upregulation of Endogenous Antioxidants

PPE enhances the activity of endogenous antioxidants such as glutathione (GSH) and superoxide dismutase (SOD).

Results

- 1- Pomegranate peel extract (PPE) demonstrated strong antimicrobial activity against major periodontal pathogens (Porphyromonas gingivalis, Aggregatibacter actinomycetemcomitans, Fusobacterium nucleatum) .
- 2- Anti-inflammatory effects were observed through NF-κB pathway inhibition and reduction of pro-inflammatory cytokines (IL-1β, TNF-α, MMP-9).
- 3- Pomegranate peel extract has shown a high ability to combat free radicals, as some studies recorded IC50 values ranging from 3.52 to 20 micrograms/ml in DPPH radical capture tests, indicating its strong antioxidant activity.
- 4- Clinical trials have shown that using a mouthwash containing pomegranate peel extract resulted in a significant improvement in gum health indicators, including reduced gingivitis and reduced bacterial plaque formation after 4 weeks of PPE mouthwash use. as shown in Table (2).

Table 2: Comparison between PPE & Conventional Treatments

Parameter	PPE Treatment	Conventional Treatments
Antimicrobial Efficacy	High (broad-spectrum)	Very High (but may cause resistance)
Anti-inflammatory Effect	Strong (natural compounds)	Moderate (chemical-based)

Side Effects	Minimal (natural, non-toxic)	Common (staining, taste alteration)
Cost	Low (agricultural byproduct)	Moderate (synthetic production)

Recommendations

1- For Researchers

- Conduct larger randomized controlled trials (RCTs) to validate PPE's efficacy.
- Study long-term effects (6–12 months) of PPE on oral microbiota.
- Explore nanotechnology-based delivery systems (e.g., nanoemulsions for enhanced bioavailability).

2- For Dental Practitioners

- Recommend PPE-based mouthwashes as adjunctive therapy for mild gingivitis.
- Educate patients on natural oral care alternatives to chemical rinses.

3- For Industry & Policymakers

- Develop standardized commercial products (e.g., 2–5% PPE mouthwashes).
- Promote sustainable farming partnerships for pomegranate peel sourcing.

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