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ORIGINAL RESEARCH

Garcinia Mangostana L. Peel Extract Inhibit The C. Albicans without Discoloration on Acrylic Resin

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ABSTRACT

Background: Dentures are retention factors for plaque accumulation and microorganisms such as *Candida albicans*, which can cause denture stomatitis. Therefore, denture hygiene must be maintained using a denture cleanser that is antibacterial, antifungal, convenient to use, and color stable. Mangosteen peel has antimicrobial properties and contains pigments, such as anthocyanins.
Objective: This study aims to determine the antifungal effect of mangosteen peel and its color stability on heat-cured acrylic resin plates.
Method: This research employed laboratory experiments using 75 acrylic resin discs (10 mm diameter and 2 mm thickness), divided into five groups. Concentrations were immersed for 15, 30, and 45 minutes and incubated at 37°C for 48 hours. Samples were divided into five groups with immersion times of 15, 105, and 210 minutes and incubated in synthetic saliva (for 15, 105, and 210 minutes) at 37°C for 24 hours to determine discoloration. Discoloration was measured using a spectrophotometer (UV-Vis 1240).
Outcome: The results of the Kruskal-Wallis and Mann-Whitney tests show significant differences in the effect of Mangosteen (*Garcinia mangostana* L) peel extracts with concentrations of 15%, 30%, and 60% on the growth of *C. albicans*. However, there was no significant difference based on immersion times of 15, 30, and 45 minutes.
Conclusion: This study concludes that a 60% concentration of mangosteen (*Garcinia mangostana* L) peel extract is the most effective in inhibiting *C. albicans* on a heat-cured acrylic resin plate and does not influence the color changes of the heat-cured acrylic resin plate.

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INTRODUCTION

Mangosteen (*Garcinia mangostana* L.) is known as the "Queen of Fruits".[1] It is a tropical plant native to Southeast Asia. Indonesia is a major center for mangosteen production, exporting to various parts of the world, including China, Malaysia, and Singapore.[1,2] The discarded mangosteen peel, typically considered waste, can be utilized and developed as a drug candidate. Mangosteen peel is rich in xanthone compounds.[3] Activity tests have identified alpha-mangosteen, gamma-mangosteen, and garcinol-E as active compounds. Further research indicates that mangosteen peel extract and its active compounds possess various pharmacological activities, including anti-microbial, anti-allergenic, anti-inflammatory, anti-oxidant, anti-cancer, anti-atherosclerotic, and anti-HIV properties.[4] Mangosteen peel (*Garcinia mangostana* L.) also contains anthocyanin, a pigment responsible for red-to-purple coloration.[5] Anthocyanin contributes to the pink, red, blue, and purple hues in flowers and other plant parts, also influencing yellow and colorless (all colors except green) appearances.[6]

Denture stomatitis is an inflammation of the oral mucosa caused by the use of removable dentures. It results from trauma or poor oral hygiene, often exacerbated by *Candida albicans* fungal infection.[7] *Candida albicans* is dimorphic[8] and capable of producing true hyphae. When cultured on agar media at 37°C for 24 hours, it forms smooth, cream-colored colonies with a yeast aroma. This pathogenic species can cause candidiasis, with predisposing factors facilitating its occurrence. Dentures act as a retention factor for plaque accumulation, allowing microbes, calculus, and food residue to adhere and cause various problems, such as denture stomatitis. Consequently, many denture wearers experience denture stomatitis associated with Candida infection. The reported prevalence of denture stomatitis among denture patients ranges from 25% to 67%.[9]

To mitigate the risk of denture stomatitis, every denture patient must maintain good oral hygiene and denture cleanliness.[10] Patients commonly use various materials to clean removable dentures, such as toothpaste, commercial denture cleaners, mild detergents, bleaching agents, and vinegar. However, while effective at cleaning, some denture cleansers can be abrasive, potentially affecting the internal and external surfaces of the denture.[11] This can compromise the function and aesthetics of the denture resin. Ideal denture cleansers should be antibacterial, antifungal, easy to use, and not cause discoloration. However, no single product currently meets all these requirements, highlighting the importance of identifying novel denture cleanser materials. Therefore, this study aims to investigate the effect of mangosteen peel extract concentration and immersion time on *C. albicans* growth and on the color changes in heat-cured acrylic resin plates.

RESEARCH METHODS

This research was an experimental laboratory study conducted in the Research, Microbiology, and Biochemistry Laboratories of the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta.

1. Producing Mangosteen Peel Extract

Fresh mangosteen peel was washed thoroughly, then air-dried in a drying cabinet at 45°C. After complete drying, it was weighed and ground with a machine. The finely ground mangosteen peel was then placed into a glass maceration vessel (jar) and submerged in 70% ethanol. The jar was tightly closed, stored at room temperature for one week, and stirred occasionally. After one week, the mixture was filtered, and the filtrate was collected in a storage vessel. The obtained extract was then evaporated with a vacuum rotary evaporator at 70°C, yielding a thick mangosteen peel extract with a concentration of 100%. This extract was then diluted into various concentrations of 15%, 30%, and 60%.

2. Antimicrobial Inhibitory Power Test of Mangosteen Peel Extract

Seventy-five acrylic resin discs, each 10mm in diameter and 2mm thick, were sterilized with 70% alcohol. The discs were then placed in a glass beaker and soaked in artificial saliva for 24 hours to facilitate the attachment of *Candida albicans*. Subsequently, the discs were immersed in a test tube containing a suspension of *Candida albicans* at 10^8 CFU/ml for 24 hours at 37°C.

The acrylic resin discs were divided into five groups. These groups were soaked in mangosteen peel extract (*Garcinia mangostana* L.) at concentrations of 15%, 30%, and 60%, sterile distilled water (negative control), and 0.2% CHx (positive control). Immersion times were 15, 30, and 45 minutes. Following immersion, serial dilutions were performed, and 0.01 ml from each group was plated on Sabouraud Dextrose Agar. The plates were incubated at 37°C for 48 hours, and the number of *C. albicans* colonies was counted.

Acrylic resin discs that had been immersed in mangosteen peel extract (*Garcinia mangostana* L.) at various concentrations were then removed with sterile tweezers and placed into test tubes numbered 1-75, each containing 10 ml of sterile distilled water. Each tube containing an acrylic disc was shaken with a vortex mixer for 1 minute to release *Candida albicans* from the disc. Serial dilutions were then performed up to 10-3 as follows:

a. Dilution P1 (10-1) from test tube number 1 is obtained by inserting 1 ml of solution from test tube number 1 into another test tube containing 9 ml of sterile aquadest.

b. Dilution P2 (10-2) is obtained by inserting 1 ml of solution P1 into a test tube containing 9 ml of sterile aquadest.
c. Dilution P3 (10-3) is obtained by inserting 1 ml of solution P2 into a test tube containing 9 ml of sterile aquadest.
d. It is obtained by taking 0.1 ml of test solution from diluent P3, then dropping it on 1 Sabouraud agar petri dish and incubating it in an incubator for 48 hours at 37°C.
e. The above procedure was done in test tube number 2 to test tube number 75. After incubation for 48 hours at a temperature of 37°C, the number of *Candida albicans* fungal colonies was then calculated using a magnifying glass and a counting tool.

3. Observing Color Changing

Color changes were observed using rectangular heat-cured acrylic resin denture base plates, each measuring 35 mm long, 11.5 mm wide, and 2 mm thick. The plates were subjected to concentrations of 15%, 30%, and 60% of a solution, with distilled water and a 0.2% chlorhexidine solution serving as controls. Each of the five treatments was soaked for 15 minutes, 105 minutes, and 210 minutes.

The acrylic resin plates were divided into five concentration test groups: distilled water, 15% mangosteen peel extract, 30% mangosteen peel extract, 60% mangosteen peel extract, and 0.2% chlorhexidine. There were also three time-division groups: 15 minutes, 105 minutes, and 210 minutes, with five replicate plates for each group.

Before treatment, each acrylic plate was soaked in artificial saliva and incubated at 37°C. Initial color measurements were then obtained using a UV-Vis 1240 spectrophotometer.

The five treatment test groups were subsequently immersed in distilled water, 15% mangosteen peel extract, 30% mangosteen peel extract, 60% mangosteen peel extract, and 0.2% chlorhexidine for 15 minutes, 105 minutes, and 210 minutes, which were assumed to be equivalent to immersion for 1 day, 7 days, and 14 days, respectively. After immersion, re-measurements were performed using a spectrophotometer to determine the extent of color change.

RESEARCH FINDINGS

The results of the study entitled "*Garcinia Mangostana* L. Peel Extract Inhibits *C. Albicans* Without Discoloration on Acrylic Resin" are as follows:

Table 1. The effect of concentration and time immersion of mangosteen peel extract (*Garcinia mangostana* L) on the growth of *Candida albicans* on heat-cured acrylic resin denture plates

Immersion Time (minutes)	Colony-forming units of *Candida Albicans*				
	Mangosteen Peel Extract (%)				
	CHx 0,2%	Aq	15	30	60
15	0	20	2	1	0
	0	32	2	2	0
	0	28	3	3	0
	0	35	0	0	0
	0	40	1	2	0
Colony Count	0	155	8	8	0
30	0	28	10	9	0
	0	42	10	7	0
	0	30	11	10	0
	0	32	18	6	0
	0	40	20	5	0
Colony Count	0	172	69	37	0
45	0	36	22	17	0
	0	30	19	38	0
	0	47	38	10	0
	0	45	17	45	0
	0	50	20	20	0
Colony Count	0	208	116	130	0
Total Colony Count	0	535	193	175	0
Mean	0	35,67	12,87	11,67	0

Note: CHx 0,2% = Khlorheksidin 0,2%, Aq = Aqua destillata

According to Table 1, mangosteen peel extract (*Garcinia mangostana* L.) and a 0.2% Chlorhexidine solution inhibited *Candida albicans* colonies at 15, 30, and 45 minutes. In the aquadest solution, the number of *Candida albicans* colonies was 155 at 15 minutes, 172 at 30 minutes, and 208 at 45 minutes. Concentrations of 15% and 30% yielded eight *Candida albicans* colonies within 15 minutes. At 30 minutes, there were 69 colonies with a 15% concentration and 37 with a 30% concentration. At 45 minutes, with a 15% concentration, the number of *Candida albicans* colonies was 116, and with a 30% concentration, it was 130. Meanwhile, at a 60% concentration, no *Candida albicans* colonies were found at 15, 30, or 45 minutes.

The effectiveness of mangosteen peel extract at each concentration is shown by statistical data analysis using one-way ANOVA, followed by the LSD test. Based on the one-way ANOVA test, there is a significant difference between each concentration of mangosteen peel extract on the growth of *Candida albicans* ($p<0.05$), indicating an effect on reducing the number of fungi. The significant value of the ANOVA test is attributed to the antifungal power of the xanthone compound in mangosteen peel.

The results of the study on the effect of concentration and immersion duration of mangosteen peel extract (*Garcinia mangostana* L.) on discoloration in heat-cured acrylic resin plates are as follows:

Table 2. Data on the average value of color changes in acrylic plates before and after immersion in distilled water, 15% mangosteen peel extract, 30% mangosteen peel extract, 60% mangosteen peel extract, and 0.2% chlorhexidine for 15 minutes, 105 minutes, and 210 minutes.

Immersion Time (minutes)	Specimens	Before Immersion	After Immersion
15	Aquades	2,75224	2,364272
	Mangosteen Peel Extract 15%	2,170476	2,238436
	Mangosteen Peel Extract 30%	2,408384	2,422308
	Mangosteen Peel Extract 60%	2,166164	2,197804
	CHx 0,2%	2,49618	2,388668
105	Aquades	2,2797	2,263304
	Mangosteen Peel Extract 15%	2,356964	2,453876
	Mangosteen Peel Extract 30%	2,441788	2,488664
	Mangosteen Peel Extract 60%	2,381324	2,383176
	CHx 0,2%	2,52138	2,392188
210	Aquades	2,841236	2,3477
	Mangosteen Peel Extract 15%	2,240228	2,40476
	Mangosteen Peel Extract 30%	2,478712	2,500228
	Mangosteen Peel Extract 60%	2,348008	2,4313
	CHx 0,2%	2,30484	2,15562

Table 2 shows that the discoloration of the acrylic plate increased with immersion in mangosteen peel extract at concentrations of 15%, 30%, and 60%. Meanwhile, the discoloration of the acrylic plate decreased in distilled water and 0.2% chlorhexidine (control group).

The measurement results with the UV-Vis 1240 spectrophotometer showed differences in discoloration occurring before and after immersion, including both color fading and color increase on the acrylic resin plate. This is due to the material's ability to absorb liquids from the surrounding environment, allowing the absorbed substance to react with elements in the acrylic resin.

DISCUSSION

Candida albicans is one of the fungi frequently found in the oral cavity.[12] This fungus causes denture stomatitis or canker sores due to using acrylic resin-based dentures. *Candida albicans* can adhere to the denture base through plaque, as the base surface is rough and susceptible to *Candida albicans* colonies. The attachment of *Candida albicans* to acrylic resin is the beginning of colonization and the development of an infection.[12]

Candida albicans development can be prevented by regularly cleaning dentures. Generally, the patient removes the denture and immerses it in water at night. There are many solutions used to immerse dentures, including immersion in garlic juice.[13] Since water garlic extract has antifungal potential to prevent Candida growth, which leads to denture stomatitis.[14] This study shows that other natural ingredients can be used to clean and immerse dentures susceptible to the growth of *Candida albicans* fungal colonies. One is mangosteen peel extract, which has xanthone content as an antifungal.

The effectiveness of mangosteen peel extract from each concentration is shown by statistical data analysis of one-way ANOVA, then continued with the LSD test. Based on the one-way ANOVA test, it can be proven that there is a significant difference between each concentration of mangosteen peel extract on the growth of *Candida albicans* ($p < 0.05$), indicating an effect on reducing the number of fungi. The significant value of the ANOVA test appears due to the antifungal power of the xanthone compound in mangosteen peel.

Mangosteen peel contains several compounds with pharmacological activity, such as antioxidant, anti-inflammatory, antiacne, anti-aging, anti-hyperpigmentation, antibacterial, antidiabetic, anti-obesity, anti-inflammatory, antimalarial, antiparasitic, and antitumor.[15,16] The mechanism of xanthone antimicrobial activity is assumed to be due to the reaction of the carbonyl group in xanthone with amino acid residues in cell membrane proteins, extracellular enzymes, and cell wall proteins, which causes the protein to lose its function.[17] The carbonyl group of a ketone compound can interact with non-ionized amino groups (such as the terminal α-amino group or the α-amino group of lysine residues) of a protein.[17]

The use of acrylic resin-based dentures reduces the self-cleansing of mucosal and denture surfaces by the tongue and saliva, leading to the accumulation of *Candida albicans* colonies.[18] One property of acrylic resin discs is their easy absorption of water. Therefore, when soaked in mangosteen peel extract, they will absorb flavonoid compounds and essential oils, which will directly contact *Candida albicans* and reduce the number of *Candida albicans* colonies.[18–20] Based on this study, it can be concluded that a 15% concentration of mangosteen peel extract has the lowest inhibitory power against *Candida albicans*, while a 60% concentration has the most significant inhibitory power and can kill the growth of *Candida albicans*.[21]

Measurements with the UV-Vis 1240 spectrophotometer showed differences in color changes occurring before and after immersion using the test material, specifically color fading and color increase on the acrylic resin plate. This is due to the material's ability to absorb liquids from the surrounding environment, allowing the absorbed substance to react with elements in the acrylic resin. Acrylic resin material absorbs water slowly over a specific period, with an

absorption mechanism through the diffusion of water molecules according to the law of diffusion. In immersion using chlorhexidine, a bis-biguanide derivative effective against bacteria and fungi, it works quickly and has low toxicity, causing color changes at 15 minutes, 105 minutes, and 210 minutes. This occurs due to the interaction of cations and anions from chlorine contained in chlorhexidine with acrylic, so the acrylic dye will experience color fading.[17]

The results of this study are slightly different from the hypothesis, which states that the concentration and duration of immersion of mangosteen peel extract (*Garcinia mangostana* L.) affect color changes in heat-cured acrylic resin. In this study, only concentration was affected, while the duration of immersion did not have an effect. This occurs due to a brief contact duration, so the effect of mangosteen peel extract has not shown any color changes (discoloration) due to the thickness of the acrylic plate. The statistical test results showed that the effect of concentration and duration of immersion of mangosteen peel extract does not affect discoloration in heat-cured acrylic resin ($p > 0.05$).

There was an increase in color change before and after immersion using mangosteen peel extract (*Garcinia mangostana* L.) on heat-cured acrylic plates. However, the higher the concentration of mangosteen peel extract, the less it affected the color changes in heat-cured acrylic resin plates. Based on the immersion duration, it turns out that there is no effect of the immersion duration of 15%, 30% and 60% mangosteen peel extract and the control solution (distilled water and 0.2% chlorhexidine) on the discoloration on the acrylic resin plate for 15 minutes, 105 minutes, and 210 minutes ($p > 0.05$). The result of this study is there is no effect of the concentration and the immersion duration of mangosteen peel extract (*Garcinia mangostana* L.) on the color changes in the heat-cured acrylic resin denture plate.

CONCLUSION

Based on this study, it can be concluded that the 60% mangosteen peel extract concentration was the most effective in inhibiting *Candida albicans* growth on heat-cured acrylic resin plates. The immersion concentration of mangosteen peel extract (15%, 30%, and 60%) was proven to affect the color change of acrylic resin denture plates, but there was no significant effect from the immersion duration. The mangosteen peel extract was proven not to affect the discoloration of acrylic resin denture plates ($p > 0.05$).

DECLARATION

Authors Contributions

[SP]: Conceptualization, Methodology; **[VS]:** Writing – Original Draft, Investigation, Formal Analysis; **[RAK]:** Supervision, Writing – Review & Editing; **[DA]:** Writing – Review & Editing **[AS]:** Writing – Review & Editing. All authors have read and approved the published version of the manuscript and agreed to be accountable for all aspects of the work.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Ethics Approval and Consent to Participate

The study protocol was reviewed and approved by the Ethics Committee of Faculty of Dentistry Universitas Muhammadiyah Yogyakarta [Faculty of Medicine and Health Sciences] (Protocol No. [002/EC-KEPK FKIK UMY/I/2022).

Consent for Publication

Not applicable.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Generative AI In Scientific Writing

During the preparation of this manuscript, the authors utilized Grammarly and ChatGPT for language polishing, grammar checking and improving the readability of the text. The authors reviewed and revised the suggested changes and take full responsibility for the integrity and accuracy of the publication.

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