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Cempedak leaf extract (*Artocarpus champeden*) as a novel ingredient in antibacterial peel-off gel face masks

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ABSTRACT

Background: Phenolic compounds in plants act as natural antioxidants, with cempedak (*Artocarpus champeden*) leaf extract showing promise due to its high phenolic content and potential antibacterial properties against *Propionibacterium acnes*.

Objective: This study explores the effectiveness of cempedak leaf extract as an active ingredient in peel-off gel face masks for antibacterial purposes

Method: Cempedak leaf extract was analyzed for phenolic content and Fourier transform infrared (FTIR). Its antibacterial activity was tested against *P. acnes* using agar diffusion, comparing inhibition zones with positive control. A peel-off gel face mask was formulated with cempedak leaf extract, undergoing physical and an irritation test.

Results: Cempedak leaf extract contained a total phenolic content of 342.35 mg EAG/g and exhibited significant antibacterial activity. The face mask formulation with cempedak leaf extract showed promising physical properties and did not irritate, meeting the peel-off gel face mask standards.

Conclusion: Cempedak leaf extract has potent antibacterial properties, making it an effective ingredient in peel-off gel face masks for treating acne. Further research could explore its commercial potential in skincare products.

Keywords: *Artocarpus champeden* leaf, antibacterial, peel-off gel, premature aging

Introduction

Facial masks are widely used by women for facial skin care. Among the popular options today is the peel-off gel mask, notable for its ease of removal, functioning akin to an elastic membrane. It offers several benefits, including mitigating wrinkles, aging signs, and acne. Additionally, these masks hydrate, cleanse, and moisturize the skin while relaxing facial muscles [1]. Exposure to sunlight or UV rays is a known catalyst for the development of wrinkles. This is attributed to the diminished capacity of the stratum corneum to retain water, leading to shiny, wrinkled,

and hardened skin [2]. Regular use of facial masks is a preventative measure against premature aging.

Antioxidants derived from natural sources can shield the body against free radicals generated by ultraviolet radiation from sunlight. Such free radicals are responsible for various forms of facial skin damage, including wrinkles, dryness, scaliness, premature aging, and the appearance of black spots [3]. Notably, flavonoid compounds, which are potent antioxidants, have been identified in plant materials such as the leaves of the cempedak (*A. champeden*) [2].

Cempedak, a tropical plant commonly found in Bangka Belitung, Indonesia, is rich in secondary metabolites, including alkaloids, phenolic compounds, flavonoids, and tannins. The antioxidant properties of cempedak leaves are primarily attributed to phenolic compounds, which neutralize free radicals by donating electrons from the hydrogen atoms of their hydroxyl

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Table 1. Formulation of cempedak leaf extract peel off gel mask

Materials	Formula I	Formula II	Formula III	Function
Cempedak leaf extract	0.25	0.5	1	Active substance
polyvinyl alcohol	2.25	2	1.5	Gelling agent
Hydroxypropyl methyl cellulose (HPMC)	1.25	1.25	1.25	Viscosity enhancers
Glycerine	3.75	3.75	3.75	Moisturizer
Nipagin	0.5	0.5	0.5	Preservative
Ethanol 96%	3.75	3.75	3.75	Solvent
Aquadest	25	25	25	Solvent

groups [2]. The inclusion of these antioxidant-rich leaves as active ingredients in a peel-off gel face mask could leverage their benefits. Consequently, this study aims to validate the antibacterial efficacy of cempedak leaf ethanol extract against *P. acnes* and to develop an anti-aging peel-off gel mask formulation utilizing the extract.

Method

Sample preparation

Cempedak leaves were sourced from Teluklimau Village, Parittiga District, West Bangka Regency, in the Bangka Belitung Islands, Indonesia. These leaves were air-dried, ground into fine powder, and then sieved. A total of 250 g of the powdered leaves were dissolved in 96% ethanol at a 1:10 ratio. The mixture was then stored in a dark place for three days, followed by filtration and evaporation to remove the solvent [4]. The ethanol extract of cempedak leaves exhibited a high total phenolic content of 342.35 mg EAG/g [5]. Subsequent analysis of the extract's functional groups was performed using Fourier Transform Infra-Red (FT-IR).

Antibacterial test

The antibacterial efficacy of the cempedak leaf extract against *P. acnes* was assessed. A diffusion method utilizing 6 mm diameter paper discs impregnated with the extract at concentrations of 20, 40, 60, and 80 ppm was employed. These discs were then placed on nutrient agar media pre-inoculated with *P. acnes* and incubated at 37°C for 24 hours. The formation of an inhibition zone around the discs was observed.

Formulation of the face mask

The peel-off gel mask was formulated using polyvinyl alcohol (PVA), hydroxypropyl methylcellulose (HPMC), distilled water, cempedak leaf extract, nipagin, glycerin, and ethanol (Table 1) [6]. PVA and HPMC

were each mixed with distilled water at 90°C until expanded. These mixtures were then combined and stirred until a homogeneous solution was achieved. Nipagin, previously heated with distilled water, was added to the mixture, followed by the gradual addition of the ethanol-dissolved cempedak leaf extract, stirring continuously to form a homogeneous gel.

Mask characteristic test

The produced masks underwent several evaluations, including organoleptic analysis, pH measurement, drying time, spreadability, homogeneity, and irritation tests on respondents.

Results

FTIR analysis

Fourier Transform Infrared Spectroscopy (FTIR) analysis was conducted to identify the functional groups present in the ethanol extract of cempedak leaves, based on absorption at specific wavenumbers. The outcomes of the FTIR analysis are depicted in Figure 1 and detailed in Table 2.

The analysis revealed the presence of tannins, flavonoids, and alkaloids within the ethanol extract, as evidenced by specific absorption peaks. The identification of these secondary metabolites is supported by the observed functional groups: The presence of tannins is reinforced by O-H groups found at wave number 3424.22 cm⁻¹, aromatic C=C groups found at wave number 1518.72 cm⁻¹, C-O groups at wave number 1106.94 cm⁻¹, and C-H groups at wave number 1448.77 cm⁻¹. Additionally, the presence of phenolics is corroborated by the O-H group at 3424.22 cm⁻¹, alongside the aromatic C=C group at 1518.72 cm⁻¹. Alkaloids are confirmed by the C-N group at 1251.63 cm⁻¹, alongside the aromatic C=C group at 1518.72 cm⁻¹.

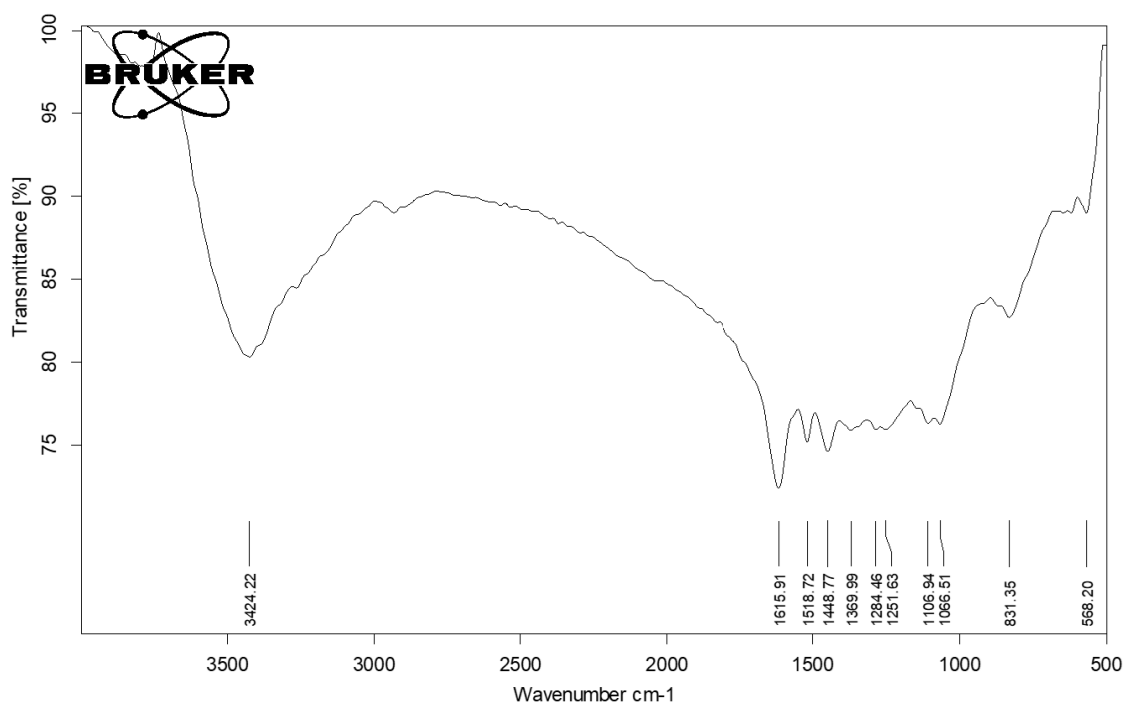


Figure 1. FTIR spectrum of cempedak leaf extract

Table 2. Infrared absorption regions and corresponding functional groups in cempedak leaf extracts

Absorption region (cm ⁻¹)	Bonding and type of functional group
3424.22	O-H stretch
1615.91	C-H stretch, alkene
1518.72	C=C aromatic
1448.77	C-H bending
1251.63	C-N bending
1106.94	C-O stretch

Note, see [7].

Table 3. Measurement data of growth inhibition zone diameters

Sample	Diameter of inhibition zone (mm)	Category
Extract 20 ppm	0.47	Weak
Extract 40 ppm	3.62	Weak
Extract 60 ppm	9.37	Fair
Extract 80 ppm	13.37	Strong
Amoxicillin	10.47	Strong
DMSO	0	-

Antibacterial activity analysis

The evaluation of the antibacterial activity of cempedak leaf extract on *P. acnes* is presented in Table 3, showcasing the measurement data for the growth inhibition zone. Analysis of the inhibition zone diameter reveals that the ethanol extract of cempedak leaves

exhibits a range of antibacterial activity from weak to strong against *P. acnes*. Notably, a concentration of 80% cempedak leaf ethanol extract demonstrates significant effectiveness in inhibiting the growth of *P. acnes*, evidenced by the larger diameter of the inhibition zone compared to the positive control.

Table 4. Organoleptic test results for cempedak leaf extract peel-off gel mask

Identification	Formula I	Formula II	Formula III
Color	Dark brown	Dark brown	Dark brown
Odor	Odorless	Odorless	Odorless
Consistency	Very thick	Thick	Thick

Table 5. Summary of physical test results

Parameters	Formula I	Formula II	Formula III
pH	6	5.5	5
Homogeneity	Homogen	Homogen	Homogen
Drying time (min)	15	30	45
Spreadability (cm)	5.2	6	7

Table 6. Irritation test results for respondents

Parameters	Respondent 1 (Formula 1)	Respondent 2 (Formula 2)	Respondent 3 (Formula 3)
No irritation (24 h)	v	v	v
No irritation (48 h)	v	v	v
No irritation (72 h)	v	v	v
Redness, itching (24 h)	-	-	-
Redness, itching (48 h)	-	-	-
Redness, itching (72 h)	-	-	-
Redness, itching, swelling (24 h)	-	-	-
Redness, itching, swelling (48 h)	-	-	-
Redness, itching, swelling (72 h)	-	-	-

The organoleptic test was conducted to observe any changes in color, odor, and consistency of the mask (Table 4). The three formulas produced are gel-shaped, this is due to the addition of PVA to the mask preparation. Formula I produced a thicker gel than formulas II and III due to the difference in PVA concentration in each formula. The organoleptic test results of the peel off gel face mask of cempedak leaf extract can be seen in Table 5.

Evaluation of cempedak leaf extract peel-off gel mask

The formulation of the cempedak leaf extract peel-off gel mask underwent preliminary evaluations, including organoleptic and physical evaluation. The organoleptic test aimed to assess changes in the mask's color, odor, and consistency, providing an insight into the sensory attributes of the final product.

The addition of polyvinyl alcohol (PVA) to the formulation resulted in a gel-like consistency across all three tested formulas. However, variations in PVA concentration led to differences in the thickness of the gel produced by each formula. Formula I exhibited a thicker consistency compared to Formulas II and III, attributed to its higher PVA content. The results of the organoleptic assessment for the peel-off gel masks are summarized in Table 4.

The physical properties of three formulated peel-off gel masks containing cempedak leaf extract were rigorously tested to ensure their compatibility with skin application standards. The evaluations included pH measurement, drying time, and spreadability tests, alongside an assessment of homogeneity (Table 5).

The pH levels of all three mask formulations were within the optimal skin pH range of 4.5 to 6.5, adhering to dermatological standards. A pH below 4.5 could lead to skin irritation due to excessive acidity, whereas a

pH above 6.5, indicating a more basic nature, could result in scaly skin.

It was observed that the drying time of the peel-off gel masks inversely correlated with the concentration of polyvinyl alcohol (PVA) used in the formulations. Higher concentrations of PVA expedited the drying process, which is a desirable characteristic for user convenience and product efficiency.

The spreadability of the masks, an indicator of ease of application, was found to decrease with an increase in PVA concentration. A higher PVA content, while beneficial for drying time, resulted in a thicker formulation that spread less easily across the skin surface. This aspect is crucial for user experience, as it affects the ease of mask application and removal.

Irritation test of cempedak leaf extract peel-off gel mask

Irritation testing on respondents was conducted using three different formulations of the peel-off gel mask. Each mask preparation was applied to approximately 5 cm² of facial skin on three respondents. The treated area was closely monitored for any changes indicative of a skin reaction. After a three-day observation period, the results indicated that the peel-off gel masks containing cempedak leaf extract did not provoke any irritation reactions.

Discussion

The antibacterial activity of the ethanol extract of cempedak leaves was assessed using the agar diffusion method, employing paper disks to facilitate the process. Nutrient agar medium served as the base for the antibacterial test, enabling the visualization of inhibition zones formed against *P. acnes* following a 24-hour incubation period. The mechanism of action involves the diffusion of the cempedak leaf extract from the paper disk into the agar medium, effectively inhibiting bacterial growth. This inhibition is visually represented by a clear zone surrounding the disk, with the zone's diameter indicative of the antibacterial efficacy. The diameter of each inhibition zone was meticulously measured using a caliper. Notably, there is a direct correlation between the concentration of the extract and the size of the inhibition zone, illustrating that higher concentrations result in more substantial bacterial growth inhibition.

Phenolic compounds represent the predominant group of natural antioxidants found in plants, with their abundance directly influencing antioxidant capacity.

The drying time test is designed to ascertain the duration required for the peel-off gel face mask to dry completely on the skin. This duration is measured from the moment the mask is applied until it forms a dried layer. Notably, an increased concentration of polyvinyl alcohol (PVA) accelerates the drying process of the mask preparation.

The spreadability test evaluates how swiftly the peel-off gel face mask spreads upon application to the skin. An ideal face mask preparation demonstrates a spreadability value within the range of 5-7 cm. The findings indicate that higher concentrations of PVA, coupled with glycerin, result in a decrease in spreadability. This reduction is attributed to the enlargement of molecular units that absorb the solvent, thereby retaining the liquid and augmenting resistance to flow and spread.

The assessments conducted on the peel-off gel face mask formulations reveal that the mask following Formula I adheres to the established standards for peel-off gel face masks. For commercialization prospects, further research is recommended to enhance the mask's formulation to meet marketing standards.

Conclusion

Cempedak leaf extract is characterized by the presence of aromatic C=C, C-O, and O-H functional groups and boasts a significant total phenolic content of 342.35 mg EAG/g on a dry weight basis. This extract exhibits antibacterial properties against acne-causing *P. acnes*, achieving an inhibition zone larger than that of the positive control. Given the promising outcomes of the peel-off gel face mask formulation incorporating cempedak leaf extract, it demonstrates potential as an effective antibacterial and anti-aging skincare solution.

Acknowledgment

None.

Conflict of Interest

None.

Author contributions

FAP, W, S, RGM conceptualized the study design; FAP investigated the data; Fap, W, S wrote original

draft, RGM reviewed and edited the final version, RGM supervised all experiment. All authors have read the final manuscript.

Received: 13 October 2021

Revised: 21 June 2022

Accepted: 4 July 2022

Published online: 31 December 2022

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