fig body scrub

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Original Research Article

Application of Fig (*Ficus carica* L.) Leaf Extract as a Herbal Antibacterial Body Scrub

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ABSTRACT

The leaf extract of *Ficus carica* L. has been shown to exert antibacterial activity against *Propionibacterium acnes* and *Staphylococcus epidermidis*, which are acne-causing bacteria. Acne occurs when the skin pores are blocked with dead skin, oil, or bacteria. This study aimed to formulate and evaluate fig leaf extract body scrub for *P. acnes* and *S. epidermidis*. The stability of the developed body scrub was evaluated during storage at ambient temperature for 56 days. The body scrub was formulated with 3% fig leaf extract as the active ingredient and varying concentrations of silica sand (1%–3%) as the scrubbing agent. Furthermore, organoleptic evaluation and hedonic test of the body scrub were performed, and pH, viscosity, spreadability, antibacterial activity against *P. acnes* and *S. epidermidis*, and irritation were assessed. The fig leaf extract body scrub with varying concentrations of silica sand (1%–3%) had a light green color, specific scent, rough texture, viscosity range of 7750–9550 cps, pH of 6.8–7.3, spreadability of 4.9–6.2 cm, and inhibition zones of 14.56–14.68 mm for *P. acnes* and 15.67–15.69 mm for *S. epidermidis*. Moreover, it was nonirritant on the back of the volunteer's hand and remained stable for 56 days at ambient temperature. The silica sand concentration was found to affect viscosity and roughness. In 30 volunteers, the formula with 3% silica sand was the preferred preparation based on color, scent, and texture. Therefore, fig leaf extract can be formulated into a body scrub with good physical characteristics and dermatologically tested.

Keywords: Silica sand, dermatologically tested, nonirritant, stable

Introduction

Ficus carica L., or fig, belongs to the family Moraceae. It is one of the largest genera of Angiospermae, with over 800 species of trees, epiphytes, and shrubs in subtropical and tropical regions worldwide. It is a native plant of the southwestern part of Asia Minor, which is now found globally.[1] Figs' fruits, leaves, and roots are used for their anti-inflammatory, antidiabetic, antioxidant, antiobesity, and anticancer properties; moreover, figs have been used to treat Alzheimer's disease.[2] Figs can grow in Indonesia. The Ciwidey District in West Java Province is a known area for fig cultivation.[3] The fig leaf is broad ovate or nearly orbicular and deeply lobed; it has 10–20 blades, a 5–7.5 cm petiole, and is rough above and pubescent below.[4] Fig leaves from Ciwidey District contain alkaloids, saponins, steroids, terpenoids, tannins, flavonoids, and phenolic compounds.[3,5,6] The ethanolic fig leaf extract comprises a phenolic content of 2.52 ± 0.24 mg GAE/g simplicia and a flavonoid content of 2.03 ± 0.01 mg RE/g simplicia.[4] Phenolic compounds such as 3-O-caffeoylquinic acid, 5-O-caffeoylquinic acid, quercetin3-O-glucoside, quercetin3-O-rutinoside, ferulic acid, psoralen, bergapten, pyrogallic, 3,5-dimethoxyphenol, coumaric acid, pinocembrin, chrysin, galangin, proto catechol, vanillin, cinnamic, quercetin, and pinostrobin.[7]

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Other flavonoids have been identified in fig leaf such as luteolin, luteolin-6C-hexose-8C pentose, quercetin, quercetin rutinoside, quercetin glucoside, quercetin acetyl glucoside, biochanin-A, apigenin rutinoside, and kaempferol rutinoside.[8] The 30%–60% ethanolic fig leaf extract exerts antibacterial activity against *Propionibacterium acnes* and *Staphylococcus epidermidis*.[9] An increase in the concentration of the extract from 30% to 60% increases the inhibition zone, indicating an increase in antibacterial activities. *S. epidermidis* is a human skin microorganism,[10] whereas *P. acnes* is localized in the follicle.[11] Both bacteria are involved in acne pathogenesis.[10,11] Long-term antibiotic use causes antibiotic resistance; thus, herbal remedies have been developed to treat acne.[12] In our previous study, fig leaf extract was successfully formulated into a cream with antibacterial activity against *P. acnes* and *S. epidermidis*.[13] Notably, the concentration of flavonoids and phenolic compounds is associated with antibacterial activity. Currently, no standardized topical formulation with good efficacy, safety, and stability for extract,[14] including fig leaf extract. Thus, this study aimed to formulate and evaluate fig leaf extract body scrub for *P. acnes* and *S. epidermidis*. The developed body scrub was assessed for stability during storage at ambient temperature for 56 days. The body scrub was formulated using 3% fig leaf extract as the active ingredient and varying concentrations of colloidal silicon dioxide (silica sand) (1%–3%) as the scrubbing agent. Furthermore, organoleptic evaluation and hedonic test of the body scrub were performed, and pH, viscosity, spreadability, antibacterial activity against *P. acnes* and *S. epidermidis*, and irritation were assessed. This study is crucial for scientifically evaluating the efficacy, safety, and quality of herbal preparations.[15] The novelty of this study was the utilization of fig leaf waste from Ciwidey District, Indonesia, increasing the economic value of fig leaf and reducing plant waste. Currently, only fig fruits have economic value, whether consumed fresh or processed into food or cosmetic products.

Materials and Methods

Materials

The fig leaf extract was obtained from a previous study in 2022.[3] Whereas fig leaves were collected from Ciwidey District (GPS coordinates of 7° 4' 59.0232" S and 107° 26' 52.7100" E), West Bandung Regency, West Java Province, Indonesia. Silica sand, stearic acid, cera alba, vaseline album, methyl paraben, propyl paraben, propylene glycol, and triethanolamine (TEA) were of cosmetic grade and purchased from TTK Science Co. (Thailand). *P. acnes* ATCC 1223 and *S. epidermidis* ATCC 12228 were obtained from the Microbiology Laboratory, School of Pharmacy, Bandung Institute of Technology. Analytical-grade sulfuric acid, barium chloride, and dimethyl sulfoxide (DMSO) were purchased from Sigma-Aldrich (Germany) and bacteriology-grade Mueller–Hinton agar (MHA) from Oxoid (UK).

Formulation of body scrub

The body scrub formula was based on Chasanah's modified formula.[16] The oil phase consisted of 12.5% stearic acid, 0.5% cera alba, and 10% vaseline album, which were heated at 70℃ in a water bath, and 0.02% propylparaben was added. The water phase included distilled water, which was heated at 70°C in a water bath, and 0.18% methylparaben, 15% propylene glycol, and 1.5% TEA were added. The water phase was mixed with the oil phase in a mixing tank (Cosmo Machinery, China) for 15 min. Fig leaf extract (3%) and silica sand (1%, 2%, and 3%) were added to the body scrub base and homogenized in the mixing tank.

Evaluation of body scrub

All body scrubs were observed for 56 days at ambient temperature. Evaluations were conducted every week for 8 weeks with three repetitions. The evaluation methods were as follows:[13]

1. The organoleptic properties, namely, colour, scent, and texture, of the body scrubs were assessed.
2. Homogeneity was analyzed through visual inspection for appearance and clog existence.
3. The pH of the 30% body scrub was measured using a calibrated pH meter (Beckman, Germany).
4. Viscosity was determined for 100 g of body scrub using a CAP-2000 Brookfield viscometer with spindle no. 64 at 60 rpm and 25°C. The results were recorded after a stable value was reached.
5. Spreadability was determined by placing 1 g of the body scrub in the center between two watch glasses. A weight of 150 g was placed on the upper watch glass and left for 60 seconds. Then, the diameter of the spreadable body scrub was measured.

Antibacterial activity assay

Antibacterial activity assay was performed as described by Saptarini *et al*.[17] The 0.5 McFarland solution was used as the turbidity standard for *P. acnes* and *S. epidermidis* suspensions prepared from a mixture of 1% sulfuric acid solution and 1.175% barium chloride solution (9.95:0.05). Petri dishes containing 20 mL of MHA and 20 µL of bacterial suspension were left to solidify. Then, the agar was perforated with a perforator and filled with 50 µL of 1% DMSO or body scrub, which was prepared by dispersing 1 g of body scrub in 1 mL of 1% DMSO. Each inhibition zone was measured using a caliper.[13,17]

Irritancy and preference test

Ethical clearance for irritancy and preference tests was obtained from the Health Research Ethics Committee of Dr. Hasan Sadikin Hospital, West Java, Indonesia (ethical approval letter no. 476/UN6.KEP/EC/2023). The test was performed according to the method described by Saptarini et al.:[13] An irritation test was performed on 10 volunteers using a patch test technique. The body scrub was applied on the dorsal left-hand surface of the volunteers with an area of 2.5×2.5 cm^2 and was observed for 24 hours. An irritation reaction was indicated by redness, itching, or swelling on the skin of the treated hand.[13] The preference test (hedonic) was conducted on 30 volunteers comprising men and women aged 20–25 years using a questionnaire. The volunteers were asked for their responses regarding the skin's color, scent, and texture, with a rating of 4, very like; 3, like; 2, dislike; and 1, very dislike.[13]

Data analysis

Data were analyzed using SPSS 21. Moreover, statistical analysis was performed using one-way ANOVA, repeated measures ANOVA for parametric analysis, and Kruskal–Wallis and Friedman tests for nonparametric analysis ($p < 0.05$).

Results and Discussion

The developed body scrub contains scrubbing agents that can exfoliate dead skin and provide a relaxing effect. Moreover, this preparation increases the absorption of extracts, thereby exerting a better antibacterial effect.[18] The fig leaf extract has a thick consistency, dark brownish-green color, and a distinctive fig scent. Moreover, this extract contains phenolic and flavonoid compounds that induce antibacterial activity against *P. acnes* and *S. epidermidis*.[13] The present study used fig phytoconstituents to formulate an antibacterial body scrub. Three body scrub formulations were prepared with varying silica sand concentrations (1%–3%). These three formulations had a similar appearance, i.e., a light brown semisolid preparation with a distinctive fig scent (Figure 1). Silica sand removes dead skin cells without causing irritation or damage to the skin.[19]

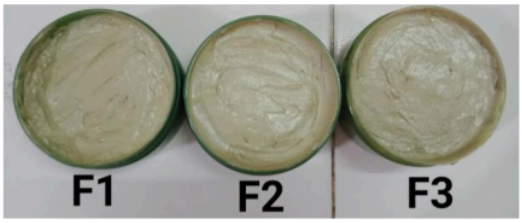

Figure 1: Body scrub with 1% (F1), 2% (F2), and 3% (F3) silica sand. The appearance of body scrubs within 56 days was stable without any changes, i.e., 1%–3% silica sand had a light green color, a specific scent, and a rough texture.

Different concentrations of silica sand were used to optimize its function as a mild mechanical exfoliant, which helps remove dead skin cells and promotes a smoother, rejuvenated skin surface. Dead skin can clog skin pores and cause acne. In addition, a body scrub provides physical stimulation to the skin through a massage effect.[20,21] The choice of exfoliator affects scrub performance. Hence, the present study used silica sand because of its water-insoluble abrasives.[20] In this study, TEA was used to neutralize fatty acids such as stearic acid, adjust and buffer the pH to neutral, and solubilize oil in a formula that was not completely soluble in water.[22] Stearic acid is used as a surfactant and softening agent in cosmetics and as a thickening agent and emulsifier in soap and detergents. Furthermore, it can be used to smoothen the skin.[23] As emulsifiers, stearic acid, and TEA reduce surface tension and prevent the separation of the oil and aqueous phases. The advantage of using oil-in-water cream is that it is easily washed off with water.[24]

Organoleptic observation showed that the body scrub was semisolid and light brown and had a distinctive fig leaf scent. No form, color, or scent alteration was noted after being stored for 56 days. This was because of the preservative methyl and propylparaben, which prevent the growth of microorganisms.[25] An air-tight and light-resistant container was crucial in maintaining a stable scent.

Homogeneity observation revealed no clogging of the extract or silica sand owing to the appropriate mixing of oil and water phases. In topical preparations, such as body scrubs, stearic acid acts as an emulsifying and solubilizing agent.[23] Combining stearic acid and TEA causes stearic acid to be partially neutralized to form a creamy base, with its appearance and plasticity depending on the TEA concentration.[26] Furthermore, combining TEA with stearic acid forms fine-grained and

stable oil-in-water emulsions.[24] A TEA concentration of 1.5% in the formulation was considered optimally effective and safe for skin and hair preparations. Higher TEA concentrations can cause irritation and redness.[27,28]All three formulations had a neutral pH of 7.1 ± 0.06 (Figure 2), fulfilling the topical preparations requirements.[23]

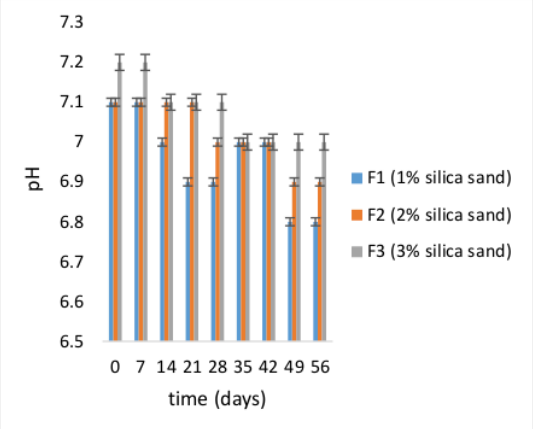

Figure 2: pH of the fig leaf extract body scrub within 56 days (n = 3)

The pH of the three formulations was not statistically significant (p = 0.07). Only the concentration of silica sand varied among the three formulations; however, silica sand was neutral, and thus, it did not affect the pH of the body scrub.[19] After 56 days of storage, a significant change was noted in the pH (p = 0.04). The pH decreased by 0.2–0.4 due to the presence of carbon dioxide from the air, which reacted with the water phase and led to the addition of hydrogen ions, thereby decreasing the pH. However, the reduced pH remained within the pH requirements of topical preparations.[24]

Viscosity was attributed to the excipients and formulation process. Viscosity was assessed to ensure body scrub sensation and behavior on the skin.[29] TEA also functions as a thickening agent and formulation stabilizer.[26] In the present study, the body scrub's viscosity ranged from 9200 to 9500 cPs (Figure 3). An increase in the concentration of silica sand was inversely proportional to the viscosity of the body scrub; however, no significant difference was found among the three formulations (p = 0.56). The viscosity of the three formulations was within the limit recommended in SNI 16-4399-1996 for cosmetic products, i.e., 2000–50000 cPs.[30] However, following 56 days of storage, the viscosity of the three formulations decreased by 1400–1620 cPs ($p = 4.7 \times 10^{-9}$) and was 7800–7850 cPs (Figure 3). This value was still within the limit of viscosity recommended for cosmetic products; however, the decreased viscosity was undesirable. Decreased viscosity in each formulation was probably due to nonoptimal mixing time and TEA function as a thickening agent. A previous study has shown that a mixing time of 25 min and a temperature of 70°C can affect the effectiveness of TEA as an emulsifier.[31] Therefore, increasing the mixing time to 25 min is recommended for body scrub formulations.

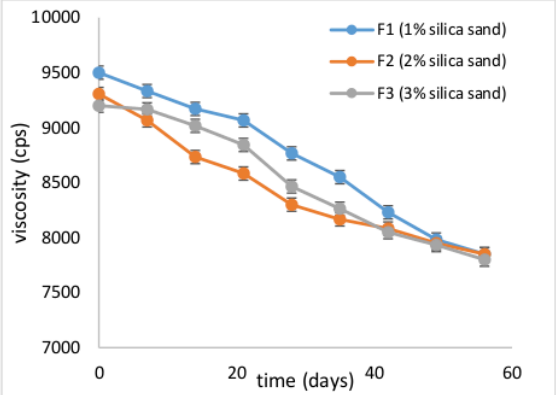

Figure 3: Viscosity of the fig leaf extract body scrub within 56 days (n = 3)

The spreadability of the three formulations ranged from 5.00 to 5.26 cm (Figure 4), meeting the requirements for good spreadability of 5–7 cm.[31] An increase in the concentration of silica sand was inversely proportional to the diameter of the spreadability. However, statistically, the spreadability of the three formulations was not significantly different (p = 0.39). However, spreadability increased in all three formulations and significantly differed during 56 days of storage ($p = 3.99 \times 10^{-8}$). This was related to viscosity; a decrease in viscosity increased the diameter of spreadability.[32] Spreadability increased from 5.96 to 6.10 cm (Figure 4) due to decreased viscosity caused by nonoptimal TEA mixing time.

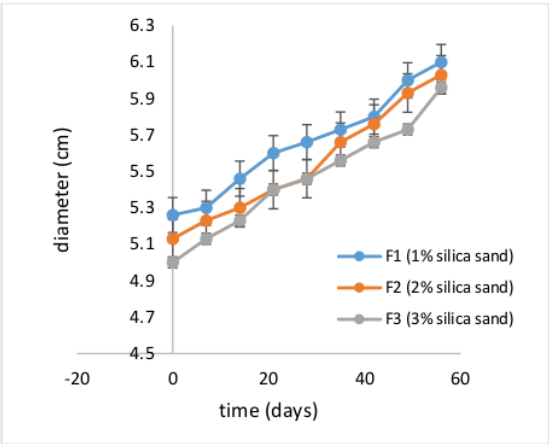

Figure 4: Spreadability of the fig leaf extract body scrub within 56 days (n = 3)

A viability test was conducted to assess the ability of bacteria to grow on an MHA medium. As shown in Figure 6, turbidity in the MHA medium indicated successful bacterial growth, confirming that the bacteria were viable for antibacterial activity testing. Figure 7 demonstrated that all three body scrub formulations could diffuse through the MHA medium, as evidenced by inhibition zones. Body scrub formulations with varying silica sand concentrations and 3% fig leaf extract provided significantly different results when compared with 1% DMSO as a solvent. However, no significant differences were observed when compared with 1% clindamycin as a standard (p = 0.089 for *P. acnes* and p = 0.134 for *S. epidermidis*). This indicates that the

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excipients do not affect the diffusion ability/ of the fig leaf extract. The inhibition zone of the body scrub against *S. epidermidis* was bigger than that against *P. acnes* and showed a significant difference ($p = 3.47 \times 10^{-12}$). The compatibility of the body scrub base with the fig leaf extract determines the distribution of secondary metabolite compounds in the base and the diffusion ability of secondary metabolites in the agar containing *P. acnes* or *S. epidermidis*. Results in Table 1 indicated that *S. epidermidis* was more sensitive to the secondary metabolites of fig leaf extract than *P. acnes*. This finding was consistent with that of previous studies.[9,17]

The results of 10 volunteers demonstrated that all volunteers were negative for irritation reaction parameters, i.e., red skin, itching, and swelling. Therefore, the scrub developed in this study was safe for use due to using cosmetic grade raw materials.

Table 1: Results of antibacterial activity of fig leaf extract body scrub

Sample	Inhibition zone (mm)	
	P. acnes	*S. epidermidis*
1% DMSO	0	0
1% clindamycin	14.72 ± 0.56	15.76 ± 0.47
F1 (1% silica sand)	14.56 ± 0.42	15.67 ± 0.53
F2 (2% silica sand)	14.62 ± 0.43	15.68 ± 0.23
F3 (3% silica sand)	14.68 ± 0.45	15.69 ± 0.36

Note: The perforator diameter was 6 mm

In addition, the composition of the ingredients in the formulation was adjusted to the limits for using these materials in body scrub preparations. Stearic acid is a nontoxic and nonirritant material.[23] Moreover, no adverse reactions to parabens have been reported, although they are associated with hypersensitivity reactions.[27] Silica sand is regarded as a nontoxic and nonirritant excipient.[19] TEA is safe for skin and hair at 1%–3% concentrations. A higher concentration can cause irritation and redness.[27] In the present study, only 1.5% TEA was used, below the maximum concentration of 3%.[27]

A preference test was conducted on 30 volunteers, who evaluated the three formulations for their color, scent, and texture on the skin. Figure 5 shows that the volunteers liked the color and texture of all formulas, whereas the scent was less preferred. The volunteers did not like the scent because of the low volatile compounds in the fig leaf extract, which made the scent too weak to be detected by olfactory sensory neurons. The concentration of the fig leaf extract was the same for all three formulations; thus, the color and scent demonstrated almost the same value and were not statistically significant ($p = 0.91$). The volunteers preferred Formula 3, with the highest silica sand concentration based on the sensory test results on the skin.[33]

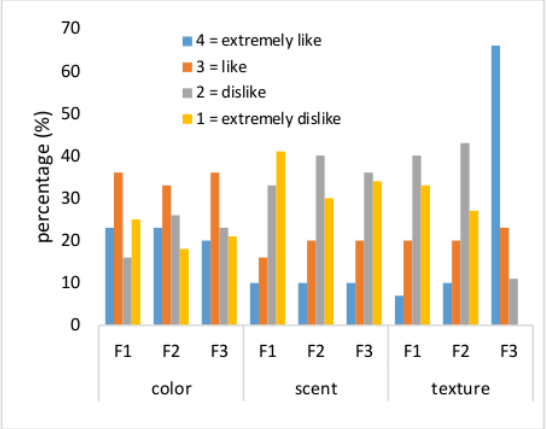

Figure 5: Preference test on the fig leaf extract body scrub (n = 30)

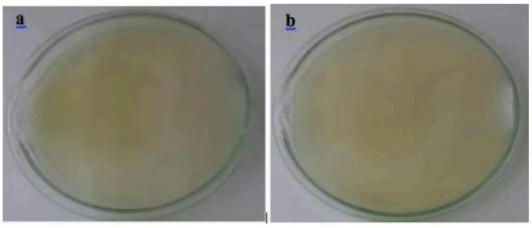

Figure 6: Viability test of (a) *P. acnes* and (b) *S. epidermidis* showed that both bacteria grew in MHA, characterized by media turbidity.

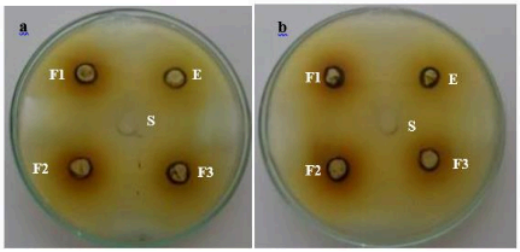

Figure 7: Inhibition zones of F1 (1% silica sand), F2 (2% silica sand), F3 (3% silica sand), E (3% extract), and S (DMSO) against (a) *P. acnes* and (b) *S. epidermidis*.

Conclusion

Fig leaf extract contains secondary metabolites that exhibit antibacterial activity. Therefore, it can be formulated into a body scrub. Silica sand removes dead skin that promotes the growth of acne-causing bacteria, such as *P. acnes* and *S. epidermidis*. Fig leaf extract can be formulated into a body scrub with good and safe physical characteristics after being stored for 56 days. It thus can be developed into an effective and safe herbal antibacterial body scrub.

Conflict of Interest

Authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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