© 2025 Journal of Pharmacy & Pharmacognosy Research, 13 (2), 459-474, 2025
ISSN 0719-4250
https://jppres.com

DOI: https://doi.org/10.56499/jppres24.2031_13.2.459

Original Article

Potential of patchouli (*Pogostemon cablin*) and champaca (*Magnolia champaca*) oils incorporated in facial wash formulation for effective anti-aging on human skin

[Potencial de los aceites de pachulí (*Pogostemon cablin*) y champaca (*Magnolia champaca*) incorporados en la fórmula de lavado facial para un antienvejecimiento eficaz en la piel humana]

Nadia Isnaini[1,2,3], Essy Harnelly[2,4*], Zulkarnain Zulkarnain[5], Vicky Prajaputra[2,3,6], Syaifullah Muhammad[2,7], Aigia Syahraini[4], Cut Puspita Salsabila Syaharani[1], Nurfaizah Nurfaizah[1], Yuni Sarah[1]

[1]Department of Pharmacy, Faculty of Mathematics and Natural Sciences, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia.
[2]ARC PUI-PT Nilam Aceh, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia.
[3]Research Center for Marine Sciences and Fisheries, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia.
[4]Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia.
[5]Department of Biomedical, Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia.
[6]Department of Marine Sciences, Faculty of Marine and Fisheries, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia.
[7]Department of Chemical Engineering, Faculty of Engineering, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia.
*E-mail: essy.harnelly@usk.ac.id

Abstract

Context: The patchouli (*Pogostemon cablin*) and yellow champaca (*Magnolia champaca*) oils present a promising natural alternative compared to synthetic anti-aging products that may entail potential side effects in facial wash formulations.

Aims: To assess the safety and effectiveness of the combination of *P. cablin* and *M. champaca* oils in a facial wash formulation for preventing and reducing skin aging.

Methods: The antioxidant activity of *P. cablin* and *M. champaca* oil was assessed using DPPH, ABTS, and FRAP methods. The quality assessment of the facial wash included organoleptic, homogeneity, pH, viscosity, and foam height evaluations. Simultaneously, the stability test encompassed accelerated, prolonged, and centrifugation stability evaluations. The clinical testing of the formulation involved the assessment of elasticity, pigment, and moisture content.

Results: The results revealed that the antioxidant tests conducted on *P. cablin* and *M. champaca* oil, utilizing DPPH, ABTS, and FRAP methods, produced values IC_{50} (µg/mL) of 61.77 and 81.05, 36.33 and 69.60, and 101.85 and 132.06, respectively. These findings suggest that *P. cablin* and *M. champaca* oil could be effectively incorporated into a facial wash, meeting favorable evaluation criteria. The formulated product exhibited antioxidant activity, effectively enhanced elasticity and moisture content, reduced facial pigmentation, displayed no signs of irritation, including erythema and edema, and complied with standards for microbial and heavy metal contamination parameters.

Conclusions: The results affirm that *P. cablin* and *M. champaca* oil hold the potential to be developed as anti-aging agents in facial wash cosmetic products, as validated by clinical tests on human skin.

Keywords: antioxidant; anti-aging; facial wash; patchouli oil; yellow champaca oil.

Resumen

Contexto: Los aceites de pachulí (*Pogostemon cablin*) y champaca amarilla (*Magnolia champaca*) presentan una alternativa natural prometedora en comparación con los productos sintéticos antienvejecimiento que pueden conllevar posibles efectos secundarios en las formulaciones de lavado facial.

Objetivos: Evaluar la seguridad y la eficacia de la combinación de los aceites de *P. cablin* y *M. champaca* en una formulación de lavado facial para prevenir y reducir el envejecimiento de la piel.

Métodos: Se evaluó la actividad antioxidante del aceite de *P. cablin* y *M. champaca* utilizando los métodos DPPH, ABTS y FRAP. La evaluación de la calidad del lavado facial incluyó evaluaciones organolépticas, de homogeneidad, pH, viscosidad y altura de la espuma. Simultáneamente, la prueba de estabilidad abarcó evaluaciones de estabilidad acelerada, prolongada y de centrifugación. Las pruebas clínicas de la formulación incluyeron la evaluación de la elasticidad, el pigmento y el contenido de humedad.

Resultados: Los resultados revelaron que las pruebas antioxidantes realizadas en el aceite de *P. cablin* y *M. champaca*, utilizando los métodos DPPH, ABTS y FRAP, produjeron valores IC_{50} (µg/mL) de 61,77 y 81,05, 36,33 y 69,60, y 101,85 y 132,06, respectivamente. Estos hallazgos sugieren que el aceite de *P. cablin* y *M. champaca* podría incorporarse eficazmente en un lavado facial, cumpliendo con los criterios de evaluación favorables. El producto formulado exhibió actividad antioxidante, mejoró eficazmente la elasticidad y el contenido de humedad, redujo la pigmentación facial, no mostró signos de irritación, incluidos eritema y edema, y cumplió con los estándares para los parámetros de contaminación microbiana y de metales pesados.

Conclusiones: Los resultados afirman que el aceite de *P. cablin* y *M. champaca* tienen el potencial de desarrollarse como agentes antienvejecimiento en productos cosméticos de lavado facial, como lo validaron las pruebas clínicas en piel humana.

Palabras Clave: aceite de champaca amarilla; aceite de pachulí; antienvejecimiento; antioxidante; lavado facial.

ARTICLE INFO
Received: March 31, 2024.
Accepted: October 2, 2024.
Available Online: October 25, 2024.

AUTHOR INFO
ORCID:
0000-0001-6128-4316 (NI)
0000-0001-8515-7493 (EH)
0000-0002-5395-1892 (ZZ)
0000-0001-8838-9206 (VP)
0000-0003-0979-943X (SM)
0000-0002-6186-6364 (AS)
0009-0008-9788-0855 (CPSS)
0009-0007-0584-3460 (NN)
0009-0007-9086-3959 (YS)

INTRODUCTION

Facial skin, one of the most visible and delicate areas, is particularly susceptible to premature aging (Zouboulis et al., 2019). The occurrence of premature aging, characterized by the early onset of fine lines, wrinkles, and other visible signs, has become a significant concern for those striving to maintain youthful and vibrant facial skin. Premature aging of the skin is influenced by a combination of intrinsic and extrinsic factors (Liang et al., 2023). Intrinsic factors, such as genetic predispositions and hormonal changes, contribute to the skin's natural aging process (Kang et al., 2021; Lin et al., 2023). On the other hand, extrinsic factors, including prolonged sun exposure, smoking, exposure to pollutants, and high stress levels, can expedite the aging process (Nowruzi et al., 2020; Tobin, 2017). The clinical manifestations of premature aging on facial skin encompass a range of discernible characteristics, including heightened cutaneous dryness, diminished skin elasticity, the emergence of dynamic expression lines, and uneven pigmentation (Haydont et al., 2019; Konisky et al., 2023; Quan, 2023). The cumulative impact of these manifestations underscores the imperative for meticulous skincare interventions, particularly in the context of facial wash, as an integral facet of comprehensive skincare routines.

Facial wash, as a fundamental component of daily skincare practices, assumes a pivotal role in mitigating premature aging effects (Titani et al., 2022; Yogesh et al., 2022). It serves as a primary vehicle for cleansing the skin surface, removing accumulated impurities, and facilitating the renewal of skin cells (Salvioni et al., 2021). The choice of facial wash formulations becomes crucial, with an emphasis on those containing active ingredients known for their antioxidant properties, hydrating agents, and gentle exfoliants. Such formulations contribute not only to cleansing but also to fortifying the skin barrier, thereby aiding in the prevention of premature aging (Syaharani et al., 2023). Synthetic anti-aging agents have become integral components of facial wash formulations designed to address and mitigate the signs of aging on the skin (Alves et al., 2020; Syaharani et al., 2023). One commonly employed synthetic anti-aging agent is retinoids, which are derivatives of vitamin A (Berry et al., 2022; Kumar et al., 2024; Milosheska and Roškar, 2022). Retinoids, such as retinol and tretinoin, work by stimulating collagen production, promoting skin cell turnover, and reducing the appearance of wrinkles (Kumar et al., 2024; Sethupathi et al., 2024; Veiga et al., 2023). Kolli et al. (2019) conducted a systematic review of clinical studies and concluded that topical retinoids may cause side effects such as irritation, erythema, and dryness. Besides retinoids, peptides, another class of synthetic compounds, are often included for their role in supporting collagen synthesis and enhancing skin elasticity (Isnaini et al., 2024; Prajaputra et al., 2024; Zhang et al., 2024; Zhao et al., 2021). Common side effects of synthetic anti-aging agents include skin irritation, redness, dryness, and increased sensitivity to sunlight, especially with retinoids (Altay Benetti et al., 2023; Thawabteh et al., 2023). Excessive use or improper application can exacerbate these side effects. Additionally, individuals with sensitive skin may be more susceptible to adverse reactions (Patel et al., 2023).

Natural anti-aging sources derived from essential oils have gained significant attention as alternative active ingredients in cosmetic applications due to their diverse therapeutic properties (Gad et al., 2023). Essential oils, extracted from various aromatic plants, harbor compounds known for their antioxidant, anti-inflammatory, and skin-nourishing characteristics (Kalasariya et al., 2023; Taufik et al., 2024). Patchouli (*Pogostemon cablin* Benth., family *Lamiaceae*) is an aromatic medicinal plant in high demand for its essential oil (Srivastava et al., 2022; Swamy and Sinniah, 2016). Rahmi et al. (2021) confirmed the anti-aging activity of patchouli oil based on their analysis of the yeast model *Schizosaccharomyces pombe* and *in vivo* studies on animal skin. Additionally, yellow champaca (*Magnolia champaca* (L.) Baill. ex Pierre, family *Magnoliaceae*) is an essential oil-producing plant, with linalool being one of its main constituents (Cheng et al., 2022; Dhandapani et al., 2017). Linalool acts as a photoprotective agent, shielding human skin cells from oxidative damage caused by UVB radiation through the modulation of MAPK and NF-κB signaling in HDFa cells (Gunaseelan et al., 2016; 2017). However, the direct use of essential oil is deemed ineffective due to the volatile nature and potential skin irritation from plant-derived compounds (Carvalho et al., 2016; Sindle and Martin, 2021). Therefore, essential oil needs to be formulated into skincare products to ensure comfort during use.

In recent years, essential oil has been actively investigated as a natural anti-aging formulation ingredient (Ahmed et al., 2020; Michel et al., 2024). Numerous studies have delved into the utilization of essential oils in cosmetic application, examining their efficacy in cleansing, nourishing, and enhancing the overall health of facial skin (Duta et al., 2023; Infante et al., 2023; Singh and Pulikkal, 2022). Salem et al. (2022) investigated the anti-aging effects of coriander (*Coriandrum sativum* L.) essential oil in cream formulations. The result shows that *C. sativum* oil demonstrated promising results in reducing the appearance

of wrinkles and fine lines. Another study by Lacatusu et al. (2018) revealed that sunscreen formulations containing *Amaranthus cruentus* and pumpkin seed oils exhibited superior photoprotection and enhanced antioxidant properties. These attributes could potentially reduce the occurrence of skin cancer and delay the process of photoaging. However, to the best of our knowledge, no research has yet explored the utilization of patchouli and yellow champaca oils combined in cosmetic formulations. Therefore, their potential as anti-aging agents remains unknown. In this work, we evaluate the safety and efficacy of a facial wash containing a combination of patchouli and yellow champaca oils for preventing and reducing skin aging. Antioxidant activity was measured using DPPH, ABTS, and FRAP methods. The facial wash formulation was also assessed for its characteristics, including organoleptic, homogeneity, pH, viscosity, and foaming, as well as its stability and clinical testing on human skin.

MATERIAL AND METHODS

Materials

The materials used in this study included glassware, micropipettes, an analytical balance (MATRIX AJ1002B®), object glass, a refrigerator (LG GN-B200SQBB®), incubator (ECOCELL LSIS-B2V®), thermometer, hot plate (DLAB MS-H280-Pro®), homogenizer MSD-0420, pH meter, Rheometer (RM 200 Plus®), skin analyzer (EH-900U®), vortex (Biosan V-32®), Elisa plate reader (EZ Read 400 Biochrom®), and UV-Vis spectrophotometer (Shimadzu UV-1800®).

The chemicals used consisted of glycerine, distilled water, myristic acid, beeswax, sodium hydroxide, stearic acid, olive oil, lauric acid, polyquaternium-7, phenoxyethanol, cocamidopropyl betaine, moringa fragrance, DPPH, ethanol p.a, ascorbic acid, deionized water, 2,2-azinobis-3-ethylbenzothiazoline-6-sulfonic acid (ABTS), potassium persulfate, sodium acetate, concentrated acetic acid, $FeCl_3.6H_2O$, hydrochloric acid (HCl), and 2,4,6 tri-pyridyl-s-triazine (TPTZ) were purchased from Emsure®. Light fraction patchouli and yellow champaca oils were purchased from Atsiri Research Center (ARC) Universitas Syiah Kuala.

Antioxidant activity of oils

DPPH method (2,2-diphenyl-1-picrylhdrazine)

A DPPH solution was prepared at a concentration of 0.1 mM according to the method used in a previous study (Kasote et al., 2019). Then, the starting absorbance of 0.1 mM DPPH solution was measured at a wavelength of 492 nm. The patchouli oil (20-100 µg/mL), yellow champaca oil (20-100 µg/mL), and ascorbic acid standard (2-10 µg/mL) reaching 100 µL were added to 100 µL of 0.1 mM DPPH solution in a 96-well plate. The solution was incubated for 30 minutes and absorbance was measured at a wavelength of 492 nm using a microplate reader, followed by calculating the % inhibition. Each measurement had three replications. The % inhibition to obtain the IC_{50} value was calculated using the equation [1], as recommended previously (Zain et al., 2018).

$$\text{Inhibition (\%)} = \frac{\text{Blank Abs} - \text{Sample Abs}}{\text{Blank Abs}} \times 100 \quad [1]$$

ABTS method (2,2-azinobis(3-ethylbenzthiazolin-6-sulfonic acid))

A 7 mM ABTS solution and a 2.45 mM $K_2S_2O_8$ solution were each dissolved in 5 mL of distilled water. Subsequently, about 5.0 mL of ABTS solution was added with 5.0 mL of potassium persulfate followed by incubation in the dark at room temperature for 12-16 hours until a dark blue color was obtained. The maximum wavelength was determined by taking 1.0 mL of the ABTS solution and adjusting it with ethanol to 25.0 mL. The absorbance of the solution was measured at a wavelength range of 700-750 nm using a UV-Vis spectrophotometer, followed by determining the maximum wavelength. Then, the starting absorbance of ABTS solution was measured at a wavelength of 700-750 nm. The antioxidant test was conducted by taking 100 µL of patchouli oil (20-100 µg/mL), yellow champaca oil (20-100 µg/mL), and standard (ascorbic acid) (2-10 µg/mL), mixed with 2.9 mL of ABTS solution. After incubation for 6 minutes, absorbance for each sample and standard was measured with a UV-Vis spectrophotometer at the maximum wavelength (Noreen et al., 2017). Each measurement had three replications. The % inhibition to obtain the IC_{50} value was calculated using the formula described in a previous report (Zain et al., 2018).

FRAP method (Ferric Reduction of Antioxidant Power)

The FRAP reagent was prepared by mixing acetic acid buffer with pH 3.6, 10 mM TPTZ in 40 mM HCl, and 20 mM $FeCl_3.6H_2O$ in a 10:1:1 volume ratio, then distilled water was added to reach 100 mL in a volumetric flask. The maximum wavelength was determined by taking 1 mL of ascorbic acid solution with a concentration of 70 µg/mL and then adding 3 mL of the FRAP reagent (Kozłowska et al., 2021). Subsequently, the absorbance was measured using a UV-Vis spectrophotometer in the range of 500-600 nm until the maximum wavelength was obtained. Then, the starting absorbance of the FRAP solution was measured at a wavelength of 500-600 nm. The antioxidant activity test for each sample and standard was

performed by taking 1 mL of patchouli oil (20-100 µg/mL), yellow champaca oil (20-100 µg/mL), and ascorbic acid (2-10 µg/mL), mixed with 3 mL of the FRAP reagent. After vortexing for 1 minute and incubating in the dark at 37°C for 30 minutes, the absorbance for each sample was measured with a UV-Vis spectrophotometer at the maximum wavelength. Each measurement had three replications. The % RP (reducing power) to obtain the IC_{50} value was calculated using equation [2] as suggested by a previous study (Locatelli et al., 2017).

$$RP\ (\%) = [1-(1-\frac{\text{Sample Abs}}{\text{Ascorbic acid Control Abs}}) \times 100] \quad [2]$$

Preparation of light fraction patchouli and champaca oil loaded in facial wash

The formulation of facial wash was created by combining light fraction patchouli and champaca oil (Table 1) using the beaker method, which separated the oil and water phases. The materials in the oil phase, including myristic, stearic, and lauric acid, as well as beeswax (phase 1), were heated in a container at 70°C for 10 minutes until completely melted. Furthermore, the materials in the water phase, comprising glycerin, distilled water, propylene glycol, phenoxyethanol, cocamidopropyl betaine, and polyquaternium-7 (phase 2), were heated in a container at 70°C for 10 minutes. Phase 2 was gradually mixed with phase 1 using a homogenizer at a speed of 2500 rpm for 15 minutes until the mixture was fully homogeneous. Olive oil, light fraction patchouli oil, yellow champaca oil, and moringa fragrance were added and homogenized. Subsequently, the formulation was placed into primary packaging, sealed, labeled, and placed in secondary packaging along with the brochure. Each experiment had three replications.

Investigation of physicochemical properties

The organoleptic test was conducted by visually observing various aspects, including color, aroma, and the form or consistency of the formulation (Oliveira et al., 2017).

Homogeneity test

The facial wash samples were placed on a transparent glass slide and covered with another transparent glass slide. The formulation was considered good when a homogeneous structure was formed without the presence of coarse particles (Mawazi et al., 2022).

pH test

The pH value of facial wash was measured in triplicate using a digital pH meter. The pH determination was carried out directly on the formulation with a dilution of 1 g facial wash in 10 mL of distilled water. The measurement was conducted at a temperature of 25°C in line with a previous study (Songkro et al., 2022). According to the Indonesian National Standard (SNI), the quality standard for facial wash pH ranges from 4.5 to 7.8.

Table 1. Facial wash formulation.

Composition	Concentration (% w/w)	Material function
Yellow champaca oil	0.1	Active substance
Light fraction patchouli oil	0.5	Active substance
Moringa fragrance	0.5	Fragrance
Phenoxyethanol	1	Preservative
Polyquaternium-7	1	Softening agent
Lauric acid	1	Coemulsifier
Olive oil	1	Emollient
Sodium hydroxide	2	pH adjuster
Stearic acid	4	Emollient
Beeswax	5	Stiffening agent
Myristic acid	7	Emulsifier
Glycerin	10	Humectant
Cocamidopropyl betaine	11	Surfactant
Distilled water	55.9	Solvent

Viscosity and flow properties test

Viscosity and flow properties of the formulation were determined in triplicate using the Rheometer RM 200 Plus at a temperature of 27°C with a shear rate of 60 s^{-1}. An appropriate amount of facial wash was placed on the plate, and then a cone was installed to measure viscosity. The viscosity of cream-based facial wash was considered good at 500-20,000 cPs. Furthermore, flow properties were determined using five different shear rates (rpm) to create a rheogram. The measurement was conducted at 32°C, which was the skin surface temperature (Songkro et al., 2022).

Foam height test

A total of 0.5 g facial wash samples was placed in a reaction tube, then 5 mL of distilled water was added. The reaction tube was shaken using a vortex for 1 minute, and the foam height produced was measured. The tube was allowed to stand for 5 minutes, and the foam height was measured (Cavaletti et al., 2023). There were no minimum or maximum foam height requirements for facial wash formulation. Foam stability was expressed as the resilience of a bubble to remain stable after 5 minutes, withstanding between 60-70% of the initial volume. The foam stability value was obtained using equation [3]. Each experiment had three replications.

$$\text{Foam stability} = \frac{\text{Final foam height}}{\text{Initial foam height}} \times 100 \quad [3]$$

Stability of facial wash

Centrifugation test

The centrifugation test was performed on prepared facial wash with a sample of 5 g placed in a centrifuge tube (Navarro-Perez et al., 2021). The sample was then centrifuged at a speed of 3,000 rpm for 30 minutes. Physical appearance and homogeneity were evaluated through visual observation (Songkro et al., 2022). Each experiment had three replications.

Accelerated stability test

The facial wash samples were stored at a temperature of 40 ± 2°C in an incubator for 24 hours, then transferred to a refrigerator at 4 ± 2°C for 24 hours (one cycle). This test was repeated for seven cycles in line with a previous study (Hiola et al., 2018). The observation included organoleptic, homogeneity, pH, and viscosity tests.

Extended stability test

The facial wash samples were stored at a temperature of 30 ± 2°C RH 75 ± 5%, with adequate protection from direct sunlight for three months and in an incubator at 40 ± 2°C for three months (Lehmkemper et al., 2018). Organoleptic, homogeneity, pH, and viscosity tests were examined at intervals during storage for 1, 2, and 3 months. Each experiment had three replications.

Safety assessment of facial wash

Irritation test

The irritation test was conducted on 30 healthy volunteers (Lademann et al., 2021) with ethical clearance No.113015230923. The criteria for volunteers in this test were willingness to participate by signing a consent form after receiving an explanation (informed consent). Other criteria included women or men aged around 20-30 years, no history of skin allergies, and willingness to participate in the irritation test of antioxidant formulation to completion. The irritation test was carried out for 48 hours with the formulation applied to the back of the ear twice a day in the morning and evening after bathing.

Microbial contamination test

Pour plate method to determine TPC content: A total of 15-20 mL agar medium with a temperature below 48°C was poured into a Petri dish with a diameter of 85-100 mm. Furthermore, 1 mL of the initial suspension prepared was inoculated into the agar medium by pouring and gently shaking or tilting to optimize dispersion, then allowed to solidify at room temperature (ISO 21150:2015). Each experiment had three replications.

Spread plate method to determine MYC content: A total of 15-20 mL agar medium with a temperature below 48°C was poured into a Petri dish with a diameter of 85-100 mm. The agar medium was allowed to cool and solidify in the incubator, then about 0.1 mL of the available initial suspension was spread on the surface of the solidified medium (ISO 21150:2015). Each experiment had three replications.

Enrichment method to determine microbial contamination: This method was carried out to detect microbial contamination of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Candida albicans* (ISO 21150:2015). Detection was performed by inoculating 1 g samples in a non-selective liquid medium containing neutralizing and/or dispersing agents, followed by incubation at the appropriate temperature and time. The enrichment suspension was then inoculated into a non-selective agar medium and incubated at the appropriate temperature for 2-5 hours. Bacterial growth was detected and expressed as the presence or

absence of mesophilic aerobic bacteria per sample of the product. Each experiment had three replications.

Metal contamination test

The metal contamination test was conducted to detect As, Cd, Pb, and Hg contamination using the wet digestion method (Kilic et al., 2021). In this method, 0.15 grams of the samples were weighed, placed in a quartz tube, then added with 3 mL of concentrated HCl and 1 mL of 30% v/v H_2O_2. The tube was closed and left for 15 minutes, and digestion was carried out in a microwave system. After cooling to room temperature, 20 mL of deionized water was added, rinsed inside, and closed, then filtered with Whatman No.1 filter paper. Moreover, the filtrate was collected in a 50 mL measuring flask and diluted with deionized water to the mark. The analysis was carried out with inductively coupled plasma-optical emission spectrometry (ICP Thermo iCAP 7000 Series, Thermo Scientific, USA), and the metal content was calculated using equation [4]. Each experiment had three replications.

$$\frac{Cu}{Bu} = \frac{1}{100} \times F \qquad [4]$$

Where Cu: concentration of As, Cd, Pb, or Hg (in the example of the calibration curve); F: volume of test solution (mL); Bu: the weight of the test solution sample (g).

Bioactivity assessment of facial wash

Antioxidant test

A DPPH solution was prepared at a concentration of 0.1 mM, according to a previous study (Kasote et al., 2019). The facial wash sample solution measuring 20-100 µL/mL at each concentration was taken at 100 µL and added to 100 µL of 0.1 mM DPPH solution in a 96-well plate. The standard ascorbic acid solution (2-10 µL/mL) was treated the same as the sample solution. The solution was incubated for 30 minutes to allow for a complete reaction, then the absorbance was measured at a wavelength of 492 nm using a microplate reader, and the % inhibition was calculated. Each experiment had three replications.

Clinical anti-aging test

The clinical anti-aging test of the facial wash formulation was conducted on 30 volunteers with the same criteria as the irritation test. The volunteers were those whose skin had been tested through an irritation test and had not used any other facial wash for antioxidant therapy in the last two weeks. The test was conducted every week for two weeks, and the parameters for testing the effectiveness of the formulation were moisture, pigment, and elasticity using the EH-900U skin analyzer (Kim et al., 2018). Treatment was carried out by using facial wash regularly twice a day on facial skin every morning and evening

Statistical analysis

Data were expressed as mean ± standard deviation, and then the Shapiro-Wilk test (for data ≤50) was performed to determine whether the distribution was normal. In the test, data were considered normally distributed with the $p>0.05$. Once the normal distribution was confirmed, the Levene test was conducted to assess data homogeneity, and statistical comparisons were made using a one-way analysis of variance (ANOVA) followed by Tukey post hoc with a confidence level of 95% (Songkro et al., 2022). All statistical analyses were performed on SPSS version 25.

RESULTS AND DISCUSSION

Antioxidant activity of oil

The antioxidant activity test results obtained using the DPPH, ABTS, and FRAP methods on the patchouli and yellow champaca oil samples with ascorbic acid as the positive standard, along with IC_{50} values, are shown in Fig. 1.

The IC_{50} values obtained with the DPPH method was 61.774, 81.054, and 2.826 µg/mL for patchouli oil, yellow champaca oil, and ascorbic acid, respectively. In the ABTS method, the values were 36.334, 69.607, and 2.315 µg/mL, respectively. Meanwhile, for the FRAP method, the values were 101.851, 132.067, and 3.619 µg/mL. Based on the comparison of IC_{50} value, both patchouli and yellow champaca oil in all methods were found to have lower antioxidant activity compared to the positive standard, namely ascorbic acid. The ABTS method had the lowest IC_{50} value among the three methods, for all samples. These results were in line with Noreen et al. (2017), where the ABTS method had an IC_{50} of 432 µg/mL, which was lower than the DPPH method with 780 µg/mL. Therefore, the ABTS method can be considered more effective in radical scavenging than DPPH, possibly due to compatibility, polarity, and chemical properties causing varied bioactivity. As stated in another study by Zhou et al. (2020), which tested the antioxidant activity of blueberry anthocyanins, the ABTS IC_{50} values were lower than the DPPH method, namely 14.99 and 26.48 µg/mL, respectively. This occurs presumably because the DPPH reaction changes as oxygen dissolves in the reaction system, with antioxidants transferring oxygen to O_2^-. However, the reaction between O_2^- and $ABTS^+$ occurs more intensively than DPPH, leading to relatively higher antioxidant activity.

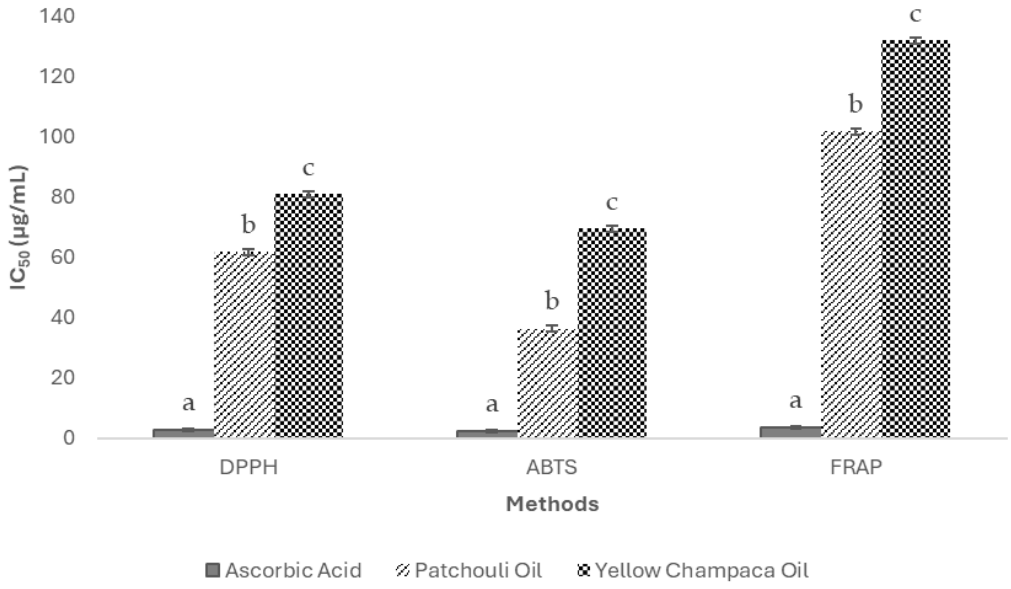

Figure 1. IC_{50s} of samples in different antioxidant methods.
Data are expressed as mean ± SEM (n = 3). Different alphabets indicate a statistical significance at p<0.001 based on Tuley post hoc.

The comparison of results from the three methods shown in Fig. 1 showed that the measured antioxidant activities were not the same. The values obtained in the ABTS method showed the highest activity both in patchouli and yellow champaca oil, while the activities obtained in the DPPH and FRAP methods were lower. This discrepancy was attributed to variation in the activity depending on the species being analyzed. These results differed from a study conducted by Chaves et al. (2020), which tested the antioxidant activity of 12 different plant species. It was found that the ABTS and FRAP methods had low sensitivity and showed lower activity compared to DPPH. Therefore, it is important to acknowledge that antioxidant compounds can respond differently to varying radical or oxidant compounds.

In patchouli oil, the main compound with antioxidant activity is patchouli alcohol (PA), which mitigates oxidative stress by reducing intracellular ROS and MDA levels. This compound also enhances the enzymatic activities of superoxide dismutase (SOD) and catalase (CAT), playing a crucial role as antioxidants in the body to counteract free radicals (Xie et al., 2023). Meanwhile, the main compound in yellow champaca oil with antioxidant activity is linalool. This compound has been reported as an ideal reducing agent due to its properties, including neutralizing reactive oxygen species (ROS) and converting a radical into its inactive form. This compound also protects skin cells from UVB-induced photoaging responses. Therefore, it is an effective method to prevent skin damage caused by sunlight radiation (Gunaseelan et al., 2017).

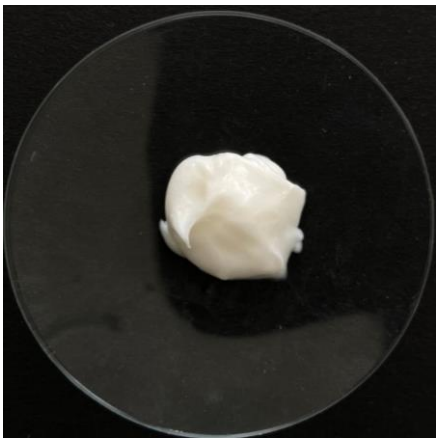

Figure 2. Photograph of facial wash formulation loaded with a combination of light fractions of patchouli and champaca oil.

Facial wash formulation

The produced facial wash formulation was whitish in color with a moringa fragrance and had a semi-solid thick consistency (Fig. 2). The homogeneity of the formulation was uniform with a pH of 5.6, a value within the safe range of 4.5-7.8 (Table 2). Statistical analysis showed a significant difference ($p<0.05$) between the pH values before and after seven cycles as well as after three months of storage at 30 ± 2°C. There was an increase in pH compared to the freshly prepared formulation, but the value was still within

Table 2. Physicochemical properties of facial wash formulation.

Evaluation	Freshly prepared	Freeze-thaw	Three months (30 ± 2°C)	Three months (40 ± 2°C)
pH	5.6 ± 0.25	6.1 ± 0.17*	5.9 ± 0.17*	5.9 ± 0.15
Viscosity(cPs)	2920 ± 143	994.3 ± 62*	2410 ± 761	1622 ± 107*
High Stability of foam (%)	87.9 ± 5.24	83.3 ± 5.77	NA	NA

Data are expressed as mean ± SD (n = 3).

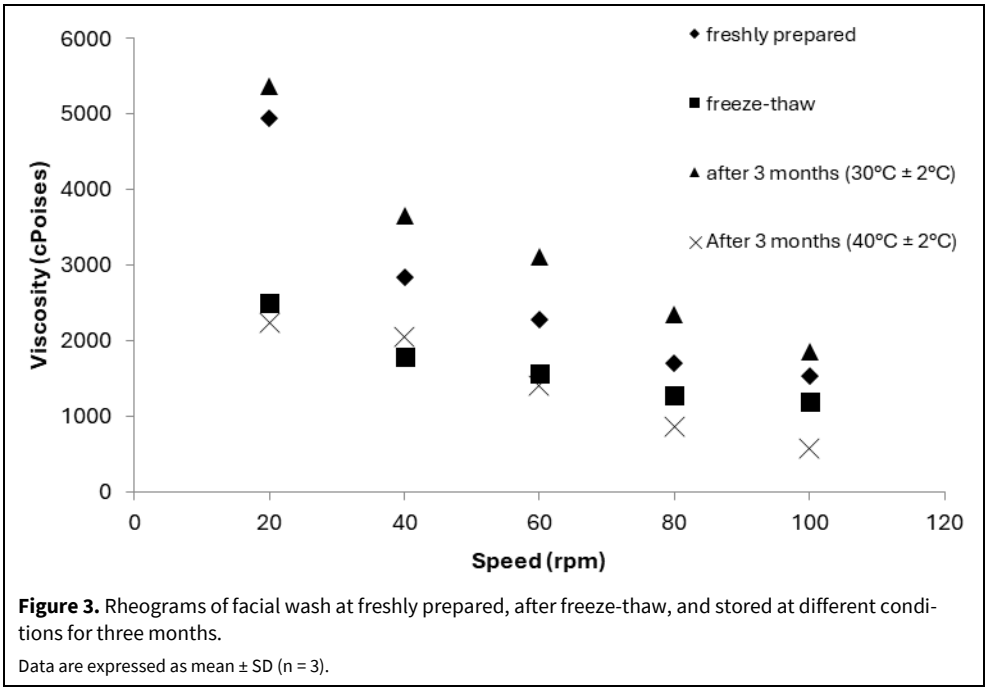

Figure 3. Rheograms of facial wash at freshly prepared, after freeze-thaw, and stored at different conditions for three months.

Data are expressed as mean ± SD (n = 3).

the standard range, ensuring the formulation remained safe for use (Table 2). The increase in pH value could be attributed to the decomposition of substances along with the rise in reaction temperature during storage (Soroush et al., 2022). Kamble et al. (2019) produced a facial wash pH of 5.9, while Mamillapalli et al. (2020) formulated a facial wash pH of 5.2. These pH values did not differ significantly from those in this study, where the pH remained within the standard range.

The facial wash formulation yielded a viscosity value of 2920 cPs, which fell within the specified standard viscosity range of 500-20,000 cPs. Statistical analysis showed a significant difference ($p<0.05$) between the viscosity values before and after the seventh cycle as well as after three months of storage at 40 ± 2°C. The facial wash formulation experienced a decrease in viscosity compared to the freshly prepared one, but the reduction remained within the standard range, ensuring that the formulation fulfilled the requirements. The decrease in viscosity could be attributed to the temperature influence during the stability test. This is because temperature changes can induce oxidative degradation in the surfactant polymer chain, leading to a decrease in viscosity (Yang et al., 2019). Kamble et al. (2019) produced a viscosity of 5549 cPs, while Mamillapalli et al. (2020) yielded a viscosity of 1520 cPs for facial wash. These values did not differ significantly from those obtained in this study, where the viscosity fell within the standard range.

The results obtained showed a decrease in viscosity with an increase in shear rate, as shown in Fig. 3. This trend suggests a non-Newtonian pseudoplastic flow type, as previously stated by (Liu et al., 2018). A similar study conducted by Putranti et al. (2022) found that the formulated facial wash showed pseudoplastic flow properties. Pseudoplastic flow properties offer an advantage as the formulation can be easily dispensed from the packaging, and its consistency is sufficiently high to maintain stability during storage (Ali et al., 2020).

The foam stability percentage obtained for the newly prepared formulation was 87.9%, which was consistent with the acceptable foam limit of 60-70%. Statistical analysis showed no significant difference

(p>0.05) between the foam height and stability percentage generated before and after the seventh cycle. This indicated that the foam height and stability remained consistent after the seventh cycle. Putranti et al. (2022) showed that the formulated facial wash produced foam properties within specifications with a foam range of 80-100%. The foam stability value did not differ significantly from this study, where the value remained within the standard range

Safety assessment of facial wash

Irritation test

Based on visual observation of the irritation test, all volunteers did not show positive irritation reactions such as erythema and edema. Therefore, it can be concluded that the produced facial wash formulation is safe for use (Abdellatif et al., 2021). A previous study related to an irritation test on neem-based facial wash conducted by Singh et al. (2015) produced a formulation devoid of irritation reactions. The irritation test on human volunteers for the combination of patchouli and yellow champaca oil in facial wash has not been previously reported. Therefore, the results of this study are expected to provide valuable insights into the development of an anti-aging formulation based on patchouli and yellow champaca oil, specifically facial wash.

Test for microbial and heavy metal contamination

Based on Table 3, the facial wash formulation fulfilled the criteria for all parameters. Phenoxyethanol has a broad spectrum of antimicrobial activity and is effective against various gram-negative bacteria, including *Pseudomonas aeruginosa* and gram-positive bacteria, namely *Staphylococcus aureus*, as well as fungi comprising *Candida albicans* (Dréno et al., 2019). The heavy metal content found in the facial wash also complied with all parameters. The study conducted by Kim et al. (2020) on heavy metals, including lead, arsenic, mercury, antimony, and cadmium, tested in 120 cosmetic samples, showed that none of the samples contained heavy metals. The cosmetic production process has the potential for cross-contamination risks from the surrounding environment, equipment, or personnel. The main risk factors for microbial contamination in cosmetics include transferring cosmetic raw materials to new containers. Moreover, the heat treatment during the process is a critical control point that can affect the adjusted microbiological levels of cosmetics (Kim et al., 2020). Contamination also arises from poor manufacturing practices, such as inadequate storage of raw materials and instability of primary packaging. Metal contamination is caused by cross-contamination from substances such as aluminum salts, iron oxide, titanium dioxide, zinc oxide, manganese dioxide, stannous fluoride, and others (Pratama et al., 2024). These contamination risk factors were not experienced during the facial wash production process in this study. Therefore, the test results showed that the facial wash formulation fulfilled the criteria for microbial and heavy metal parameters.

Antioxidant properties

The antioxidant activity of the facial wash formulation is summarized in Table 4. Based on the results, the antioxidant activity of ascorbic acid was measured to prove the accuracy of the method. The variable IC_{50} values of ascorbic acid when testing oil and facial wash formulations can be caused by different testing conditions, such as the impact of temperature, which can affect the results (Klu et al., 2016).

Table 3. Test results for microbial and heavy metal contamination in facial wash.

Parameters	Results	Condition	Standard
Total Plate Count (TPC)	<10 col/g	≤ 10^3 colonies/g	ISO 21149:2017
Mold Yeast Count (MYC)	<10 col/g	≤ 10^3 colonies/g	ISO 16212:2017
S. aureus	Negative/0.1 g	Negative/0.1 g	ISO 22718:2015
P. aeruginosa	Negative/0.1 g	Negative/0.1 g	ISO 22717:2015
Candida albicans	Negative/0.1 g	Negative/0.1 g	ISO 18416:2015
PK Cd	Negative	Max 5 ppm	ACM THA 05
PK As	1.6564 µg/g	Max 5 ppm	ACM THA 05
PK Hg	0.5040 µg/g	Max 1 ppm	ACM THA 05
PK Pb	2.8976 µg/g	Max 20 ppm	ACM THA 05

Table 4. Antioxidant activity of of patchouli and champaca oils loaded in facial wash.

Samples	Concentration (µg/mL)	EC_{50} (µg/mL)
Ascorbic acid	2-10	1.078
Facial wash formulation	20-100	25.41

However, the IC_{50} values are not significantly different. The antioxidant activity of the facial wash formulation formed with patchouli and yellow champaca oil resulted from the constituent phytochemical compounds.

This antioxidant activity can be attributed to the main components of patchouli oil, specifically monoterpene compounds, namely patchoulol and seychellene, as well as sesquiterpene compounds, namely α-guaiene (Luchesi et al., 2020). Based on the GC-MS results obtained, the patchoulol, seychellene, and α-guaiene compounds contained in the light fraction of patchouli oil were 20.88, 10.29, and 17.11%, respectively. Similarly, a previous study stated that the antioxidant activity of patchouli oil was attributed to its unsaturated cyclic compounds, acting as a proton donor to DPPH and leading to the formation of non-radical DPPH (Hussain et al., 2011).

The antioxidant activity of facial wash formulation can also be attributed to the components of yellow champaca oil, namely linalool, caryophyllene, and methyl ester (Addai et al., 2022; Jabir et al., 2018). Based on the GC-MS results obtained, the linalool, caryophyllene, and methyl ester compounds contained in yellow champaca oil amounted to 4.14%, 6.08%, and 0.77%, respectively. Jabir et al. (2018) showed that linalool (50 µg/mL) had high free radical scavenging activity, amounting to 50.57% in the *in vitro* DPPH test and 56.36% in H_2O_2.

The antioxidant activity between essential oils alone and in the formulation of facial wash has different IC_{50} values using the DPPH method, where the IC_{50} values of patchouli oil and yellow champaca oil were 61.774 and 81.054 µg/mL, respectively. While the IC_{50} value of patchouli oil and yellow champaca oil loaded in facial wash was 25.41 µg/mL. This indicated that the face wash prepared with a combination of patchouli and yellow champaca oils had a higher IC_{50} value compared to the value obtained with the single use of patchouli and yellow champaca oils.

Shabrina et al. (2020) formulated a patchouli oil microemulsion, resulting in an EC_{50} value of 73.13 µg/mL. This indicated that the facial wash prepared with the combination of patchouli and yellow champaca oil had a higher EC_{50} value (25.41 µg/mL) compared to the value obtained with the single use of patchouli oil.

Anti-aging properties

Photoaging is caused by continuous exposure to UV rays, which leads to skin damage. Loss of skin elasticity is a direct reflection of UV radiation, leading to changes in the arrangement of elastic fibers (Weihermann et al., 2017). Photographed skin of the volunteer after being treated with the facial wash formulation is presented in Fig. 4. Based on the data obtained after using facial wash for two weeks in Table 5, there was a significant difference in elasticity values ($p<0.05$) between before and after using the formulation. This implied that the content of facial wash formulation could prevent, inhibit, and control oxidation reactions from free radicals, causing structural damage to the skin and reducing elasticity. Patchouli oil contains polyphenolic compounds such as gallic acid, coumaric acid, and vanillin (Hikal et al., 2023). Meanwhile, the D-limonene compound contained in yellow champaca oil has potential anti-aging activity for the skin (Kintamani et al., 2023). The polyphenol content in patchouli oil and yellow champaca oil inhibits the activity of elastase as an enzyme that degrades elastin (Mawarni et al., 2020).

The increasing elasticity in this study was in line with Janaki et al. (2021), who investigated the effectiveness of liquid herbal supplements. The results showed a significant, progressive increase in skin elasticity. Sadowski and Sadowski (2020) also reported a significant increase in skin elasticity and firmness attributed to the activity of nutraceutical compounds. This was due to the rearrangement of elastin to form fibers in the extracellular matrix.

Based on the facial wash usage data for two weeks, the statistical test ($p<0.05$) showed a significant difference in moisture content before and after using the formulation (Table 5). This result was consistent with a study conducted by Waruwu and Maimunah (2022) on the effectiveness of patchouli oil cream as a moisturizer, showing an increase in skin moisture in volunteers after use. According to a previous study, patchouli oil has also been proven to be an effective emollient or moisturizer for eczema (Deliana et al., 2023). The effect observed in this study was related to linalool which caused an increase in superoxide dismutase (SOD), an intracellular antioxidant enzyme known to counteract free radicals. This leads to a decrease in malondialdehyde (MDA), increased skin moisture,

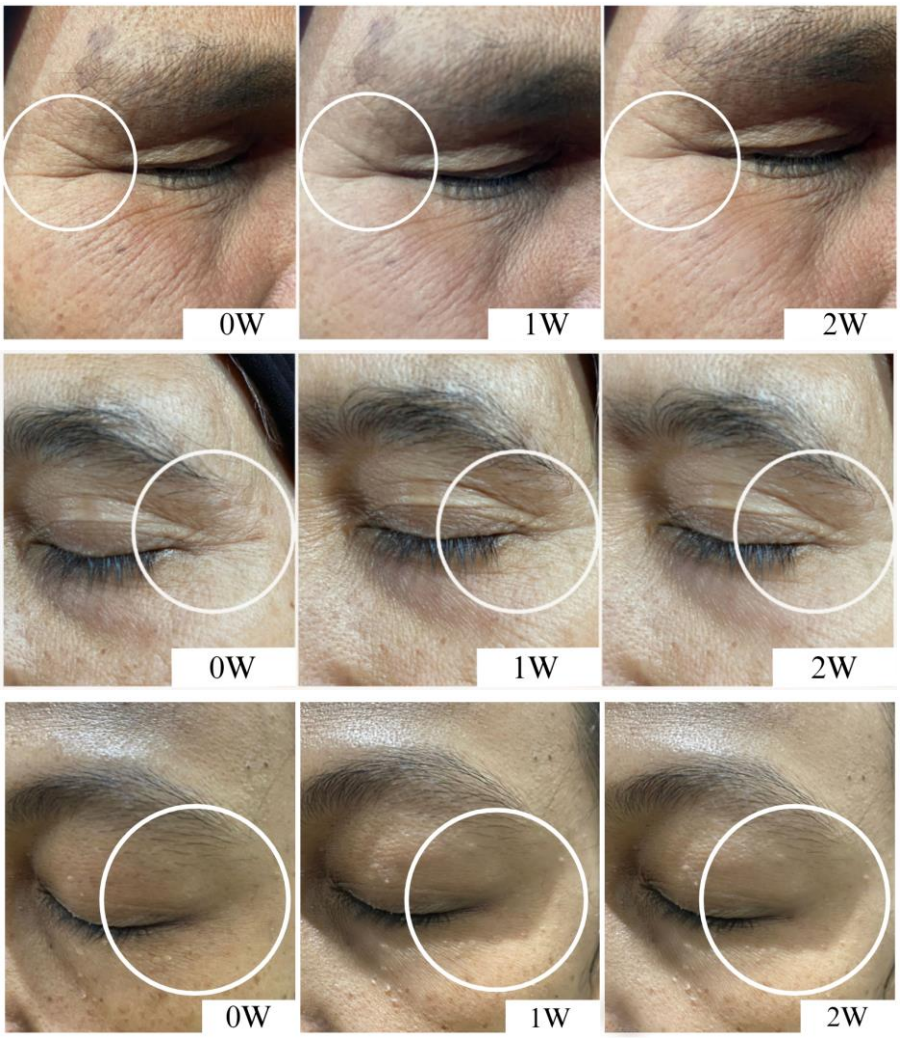

Figure 4. The different changes in the appearance of skin after applying light fraction patchouli and champaca oil loaded in the facial wash.

0W: before use, 1W: after 1 week of use, and 2W: after 2 weeks of use.

Table 5. Clinical anti-aging assessment of patchouli and champaca oils loaded in facial wash.

Parameter	Parameter percentage			Yield (%)	Description
	Before	Week			
		I	II		
Elasticity	58.33 ± 3.55	61.5 ± 3.44	68 ± 1.78	16.79 ± 4.54*	↑ Elasticity
Moisture	12.33 ± 1.03	19 ± 2.09	28.5 ± 2.58	131.01 ± 4.80*	↑ Moisture
Pigment	53.5 ± 2.94	41.83 ± 3.54	25.16 ± 3.18	53.05 ± 4.23*	↓ Pigment

Data are expressed as mean ± SD (n = 30). (↑), increase; (↓), reduce. *Statistically significant at $p<0.05$ based on Tukey post hoc.

heightened hydroxyproline (HYP) content, elimination of free oxygen radicals, and reduced lipid peroxidation. This suggests that these components have anti-aging effects on the skin (Chen et al., 2023). Skin moisture also greatly affects its elasticity because conformational changes in elastin only occur in proteins (Kim et al., 2018).

UV radiation damages the structure and function of the skin, leading to premature aging known as "photoaging," clinically characterized by coarse wrinkles, weakness, roughness, thickness, dryness, and irregular pigment (Wang et al., 2016). Based on the data on facial wash usage for two weeks in Table 5, a statistical test showed a significant difference in pigment values ($p<0.05$) between before and after the

application. The caryophyllene content was 3.72% in patchouli oil and 6.08% in yellow champaca oil. This caryophyllene content induces anti-melanogenesis activity by modulating the expression of melanogenesis-related proteins, including tyrosinase, microphthalmia-associated transcription factor (MITF), TRP-1, and TRP-2. Furthermore, caryophyllene reduces cellular melanogenesis by downregulating the expression regulation of melanogenesis-related proteins (Ho et al., 2023). The reduction in pigment was consistent with a previous study on natural ingredient-based pigment serums, which proved effective in significantly reducing skin pigment ($p<0.05$) (Shah and Chew, 2018). This suggests that the effectiveness of the formulated facial wash coincides with the effectiveness of natural ingredient-based pigment serums.

Limitations of the study

The limitation of this study is the short duration of the study, which means that long-term safety and efficacy cannot be evaluated. However, our study may be a new study that shows the use of skincare as a facial wash with a combination of patchouli and yellow champaca oils, so it can be a reference for future research on skincare-containing essential oils.

CONCLUSION

There have been growing studies on the potential of natural antioxidants in recent years, specifically essential oil, which can be developed into anti-aging ingredients for facial skincare products. Many products have promising facial skincare activities, both as anti-aging and antioxidants. However, using essential oils requires careful consideration to produce cosmetic products that meet safety criteria. This includes understanding the mechanisms of essential oil, evaluating cosmetic products, ensuring cleanliness and safety, and assessing economic feasibility. To date, facial wash products with a combination of patchouli and yellow champaca oil have not been commercially available. This situation presents challenges and opportunities for future studies to pioneer innovative and high-value cosmetic products from essential oil sources, contributing to the progress and development of cosmetics.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

ACKNOWLEDGMENTS

This study was facilitated by Syiah Kuala University and financially supported by the Ministry of Education, Culture, Research, and Technology through the Leading Research for Fiscal Year 2023, number: 108/UN11.2.1/PT.01.03/PNBP/2023 Date 3 May 2023.

REFERENCES

Abdellatif AAH, Alawadh SH, Bouazzaoui A, Alhowail AH, Mohammed HA (2021) Anthocyanins rich pomegranate cream as a topical formulation with anti-aging activity. J Dermatolog Treat 32(8): 983–990. https://doi.org/10.1080/09546634.2020.1721418

Addai ZR, Abood MS, Hlail SH (2022) GC-MS Profiling, antioxidants and antimicrobial activity of prickly pear (*Opuntiaficus indica*) pulp extract. Pharmacogn J 14(2): 262–267. http://dx.doi.org/10.5530/pj.2022.14.32

Ahmed IA, Mikail MA, Zamakshshari N, Abdullah AH (2020) Natural anti-aging skincare: Role and potential. Biogerontology 21(3): 293–310. https://doi.org/10.1007/s10522-020-09865-z

Ali A, Akhtar N, Khan H, Jamil QA, Shah SH, Naeem M, Asad MHHB (2020) Vicissitudes in polyphenolic extract-based high internal phase creams (HIPCs)-effect of storage temperature dependent characteristics. Pak J Pharm Sci 33(6): 2521–2527. https://doi.org/10.36721/PJPS.2020.33.6.REG.2521-2526.1

Altay Benetti A, Tarbox T, Benetti C (2023) Current insights into the formulation and delivery of therapeutic and cosmeceutical agents for aging skin. Cosmetics 10(2): 54. https://doi.org/10.3390/cosmetics10020054

Alves TF, Morsink M, Batain F, Chaud MV, Almeida T, Fernandes DA, da Silva CF, Souto EB, Severino P (2020) Applications of natural, semi-synthetic, and synthetic polymers in cosmetic formulations. Cosmetics 7(4): 75. https://doi.org/10.3390/cosmetics7040075

Berry K, Hallock K, Lam C (2022) Photoaging and topical rejuvenation. Facial Plast Surg Clin North Am 30(3): 291–300. https://doi.org/10.1016/j.fsc.2022.03.003

Carvalho IT, Estevinho BN, Santos L (2016) Application of microencapsulated essential oils in cosmetic and personal healthcare products – A review. Int J Cosmet Sci 38(2): 109–119. https://doi.org/10.1111/ics.12232

Cavaletti JCS, Prando WLM, Ribeiro EB, Valladão DMS (2023) Development and stability of intimate soap formulations using *Sapindus saponaria* L. extract as a natural surfactant. Braz J Biol 83: e276940. https://doi.org/10.1590/1519-6984.276940

Chaves N, Santiago A, Alías JC (2020) Quantification of the antioxidant activity of plant extracts: analysis of sensitivity and hierarchization based on the method used. Antioxidants 9(1): 76. https://www.mdpi.com/2076-3921/9/1/76#

Chen X, Shang S, Yan F, Jiang H, Zhao G, Tian S, Dang Y (2023) Antioxidant activities of essential oils and their major components in scavenging free radicals, inhibiting lipid oxidation and reducing cellular oxidative stress. Molecules 28(11): 4559. https://doi.org/10.3390/molecules28114559

Cheng KK, Nadri MH, Othman NZ, Rashid SNAA, Lim YC, Leong HY (2022) Phytochemistry, bioactivities and traditional uses of *Michelia alba*. Molecules 27(11): 3450. https://doi.org/10.3390/molecules27113450

Deliana F, Illian DN, Nadirah S, Sari F, Khairan K (2023) Therapeutic effects of patchouli (*Pogostemon cablin*) essential oil in relieving eczema symptoms in infants and toddlers: A literature review. J Patch Essent Oil Product 2(1): 1–8. https://doi.org/10.24815/jpeop.v2i1.32073

Dhandapani S, Jin J, Sridhar V, Sarojam R, Chua NH, Jang IC (2017) Integrated metabolome and transcriptome analysis of *Magnolia champaca* identifies biosynthetic pathways for floral volatile organic compounds. BMC Genomics 18: 463. https://doi.org/10.1186/s12864-017-3846-8

Dréno B, Zuberbier T, Gelmetti C, Gontijo G, Marinovich M (2019) Safety review of phenoxyethanol when used as a preservative in cosmetics. J Eur Acad Dermatol Venereol 33(57): 15–24. https://doi.org/10.1111/jdv.15944

Duta TF, Rizki DR, Purnama A, Rademaker M, Wollina U, Acharya Y, Abdeen Z, Rosa SGV, Nielsen HB, Subbaram K (2023) Essential oils for COVID-19 management: A systematic review of randomized controlled trials. Narra X 1(2): e84. https://doi.org/10.52225/narrax.v1i2.84

Gad HA, El Hassab MA, Elhady SS, Fahmy NM (2023) Insights on *Citrus clementina* essential oil as a potential antiaging candidate with a comparative chemometric study on different cultivars. Ind Crop Prod 194: 116349. https://doi.org/10.1016/j.indcrop.2023.116349

Gunaseelan S, Balupillai A, Govindasamy K, Muthusamy G, Ramasamy K, Shanmugam M, Prasad NR (2016) The preventive effect of linalool on acute and chronic UVB-mediated skin carcinogenesis in Swiss albino mice. Photochem Photobiol Sci 15: 851–860. https://doi.org/10.1039/C6PP00075D

Gunaseelan S, Balupillai A, Govindasamy K, Ramasamy K, Muthusamy G, Shanmugam M, Thangaiyan R, Robert BM, Nagarajan RP, Ponniresan VK, Rathinaraj P (2017) Linalool prevents oxidative stress activated protein kinases in single UVB-exposed human skin cells. PloS One 12(5): e0176699. https://doi.org/10.1371/journal.pone.0176699

Haydont V, Bernard BA, Fortunel NO (2019) Age-related evolutions of the dermis: Clinical signs, fibroblast and extracellular matrix dynamics. Mech Ageing Dev 177: 150–156. https://doi.org/10.1016/j.mad.2018.03.006

Hikal WM, Baz MM, Alshehri MA, Bahattab O, Baeshen RS, Selim AM, Alhwity L, Bousbih R, Alshourbaji MS, Ahl HASA (2023) Sustainable pest management using novel nanoemulsions of honeysuckle and patchouli essential oils against the west nile virus vector, *Culex pipiens*, under laboratory and field conditions. Plants 12(21): 3682. https://doi.org/10.3390/plants12213682

Hiola R, Rizky N, Hasan H, Thomas N (2018) Formulation and evaluation of lansat (*Lansium domesticum* Corr.) peel ethanol extracts lotion as anti-mosquito repellent. J Rep Pharm Sci 7(3): 250–259.

Ho Y-T, Liu I-H, Chang S-T, Wang S-Y, Chang H-T (2023) *In vitro* and *in vivo* antimelanogenesis effects of leaf essential oil from *Agathis dammara*. Pharmaceutics 15(9): 2269. https://doi.org/10.3390/pharmaceutics15092269

Hussain AI, Farooq A, Tahira I, Ijaz AB (2011) Antioxidant attributes of four Lamiaceae essential oils. Pak J Bot 43(2): 1315–1321.

Infante VH, Campos PMM, Darvin M, Lohan S, Schleusener J, Schanzer S, Lademann J, Meinke M (2023) Cosmetic formulations with *Melaleuca alternifolia* essential oil for the improvement of photoaged skin: A double-blind, randomized, placebo-controlled clinical study. Photochem Photobiol 99(1): 176–183. https://doi.org/10.1111/php.13660

Isnaini N, Prajaputra V, Syafhira T, Maryam S, Arisa II, Karina S, Agustina S, Haridhi HA (2024) Recent update: collagen extraction from marine resources as a promising natural antiaging. BIO Web of Conf 87: 03020. https://doi.org/10.1051/bioconf/20248703020

ISO-International Organization for Standardization (2015) ISO 21150:2015 Cosmetics-microbiology-detection of *Escherichia coli*. https://www.iso.org/standard/68311.html

Jabir MS, Taha AA, Sahib UI (2018) Antioxidant activity of linalool. Eng Technol 36(1B): 64–67. https://doi.org/10.30684/etj.36.1B.11

Janaki CS, Sachdev M, Ritambhara KR (2021). A pilot, exploratory study to demonstrate the efficacy of a novel adjuvant herbal liquid supplement for skin rejuvenation and anti-aging. Int J Res Dermatol 7(6): 792–799. https://doi.org/10.18203/issn.2455-4529.IntJResDermatol20214203

Kalasariya HS, Pereira L, Patel NB (2023) Comprehensive phytochemical analysis and bioactivity evaluation of *Padina boergesenii*: Unveiling its prospects as a promising cosmetic component. Mar Drugs 21(7): 385. https://doi.org/10.3390/md21070385

Kamble M, Selwate T, Dhabarde D, Ingole A, Baheti J (2019) Formulation and evaluation of anti-acne face wash gel using guava seed extract. J Drug Deliv Ther 9(3): 5–7. https://doi.org/10.22270/jddt.v9i3.2595

Kang HY, Lee JW, Papaccio F, Bellei B, Picardo M (2021) Alterations of the pigmentation system in the aging process. Pigment Cell Melanoma Res 34(4): 800–813. https://doi.org/10.1111/pcmr.12994

Kasote DM, Jayaprakasha GK, Patil BS (2019) Leaf disc assays for rapid measurement of antioxidant activity. Sci Rep 9: 1884. https://doi.org/10.1038/s41598-018-38036-x

Kilic S, Kilic M, Soylak M (2021) The determination of toxic metals in some traditional cosmetic products and health risk assessment. Biol Trace Elem Res 199: 2272–2277. https://doi.org/10.1007/s12011-020-02357-8

Kim DU, Chung HC, Choi J, Sakai Y, Lee BY (2018) Oral intake of low-molecular-weight collagen peptide improves hydration, elasticity, and wrinkling in human skin: A randomized, double-blind, placebo-controlled study. Nutrients 10(7): 826. https://doi.org/10.3390/nu10070826

Kim HW, Seok YS, Cho TJ, Rhee MS (2020) Risk factors influencing contamination of customized cosmetics made on-the-spot: Evidence from the national pilot project for public health. Sci Rep 10: 1561. https://doi.org/10.1038/s41598-020-57978-9

Kintamani E, Batubara I, Kusmana C, Tiryana T, Mirmanto E, Asoka SF (2023) Essential oil compounds of andaliman (*Zanthoxylum acanthopodium* DC.) fruit varieties and their utilization as skin anti-aging using molecular docking. Life 13(3): 754. https://doi.org/10.3390/life13030754

Klu MW, Addy BS, Oppong EE, Sakyi ES, Mintah DN (2016) Effect of storage conditions on the stability of ascorbic acid in some formulations. Int J Appl Pharm 8(4): 26–31.

Kolli SS, Pecone D, Pona A, Cline A, Feldman SR (2019) Topical retinoids in acne vulgaris: A systematic review. Am J Clin Dermatol 20: 345–365. https://doi.org/10.1007/s40257-019-00423-z

Konisky H, Bowe WP, Yang P, Kobets K (2023) A clinical evaluation of the efficacy and tolerability of a novel topical antioxidant formulation featuring vitamin C, astaxanthin, and fermented turmeric. J Cosmet Dermatol 22(11): 3088–3094. https://doi.org/10.1111/jocd.15967

Kozłowska M, Ścibisz I, Przybył J, Ziarno M, Żbikowska A, Majewska E (2021) Phenolic contents and antioxidant activity of extracts of selected fresh and dried herbal materials. Pol J Food Nutr Sci 71: 269–278. https://doi.org/10.31883/pjfns/139035

Kumar V, Kumar N, Singh G (2024) Natural products and derivatives applied for skin care: An updated review. Curr Trad Med 10(1): e180123212858. http://dx.doi.org/10.2174/2215083809666230118141457

Lacatusu I, Arsenie LV, Badea G, Popa O, Oprea O, Badea N (2018) New cosmetic formulations with broad photoprotective and antioxidative activities designed by amaranth and pumpkin seed oils nanocarriers. Ind Crop Prod 123: 424–433. https://doi.org/10.1016/j.indcrop.2018.06.083

Lademann J, Mansouri P, Nahavandi A, Ahlers A, Zibakalam-Mofrad F, Brower B, Jung S (2021) *In vivo* skin penetration, radical protection, and structural changes after topical application of a herbal oil cream compared to topical calcipotriol in mild to moderate psoriasis. Skin Pharmacol Physiol 34(6): 337–350. https://doi.org/10.1159/000518970

Lehmkemper K, Kyerematen SO, Bartels M, Degenhardt M, Sadowski G (2018) Physical stability of API/polymer-blend amorphous solid dispersions. Eur J Pharm Biopharm 124: 147–157. https://doi.org/10.1016/j.ejpb.2017.12.002

Liang Y, Su W, Wang F (2023) Skin ageing: A progressive, multi-factorial condition demanding an integrated, multilayer-targeted remedy. Clin Cosmet Investig Dermatol 16: 1215–1229. https://doi.org/10.2147/CCID.S408765

Lin ZC, Hsu CY, Hwang E, Wang PW, Fang JY (2023) The role of cytokines/chemokines in an aging skin immune microenvironment. Mech Ageing Dev 210: 111761. https://doi.org/10.1016/j.mad.2022.111761

Liu Z, Zhang L, Malfliet A, Blanpain B, Guo M (2018) Non-Newtonian behavior of solid-bearing silicate melts: An experimental study. J Non Cryst Solids 493: 65–72. https://doi.org/10.1016/j.jnoncrysol.2018.04.042

Locatelli DA, Nazareno MA, Fusari CM, Camargo AB (2017) Cooked garlic and antioxidant activity: Correlation with organosulfur compound composition. Food Chem 220: 219–224. https://doi.org/10.1016/j.foodchem.2016.10.001

Luchesi LA, Paulus D, Busso C, Frata MT, Oliveira JB (2020) Chemical composition, antifungal and antioxidant activity of essential oils from *Baccharis dracunculifolia* and *Pogostemon cablin* against *Fusarium graminearum*. Nat Prod Res 36(3): 849–852. https://doi.org/10.1080/14786419.2020.1802267

Mamillapalli V, Katamaneni M, Tiyyagura VM, Kanajam P, Namagiri AP, Thondepu H, Khantamneni P (2020) Formulation, phytochemical, physical, biological evaluation of polyherbal vanishing cream, and facewash. Res J Pharm Dosage Form Technol 12(3): 139–149. https://doi.org/10.5958/0975-4377.2020.00024.5

Mawarni E, Ginting CN, Chiuman L, Girsang E, Handayani RAS, Widowati W (2020) Antioxidant and elastase inhibitor potential of petals and receptacle of rose flower (*Rosa damascena*). Pharm Sci Res 7(2): 105–113. https://doi.org/10.7454/psr.v7i2.1016

Mawazi SM, Ann J, Othman N, Khan J, Alolayan SO, Al Thagfan SS, Kaleemullah M (2022) A review of moisturizers; history, preparation, characterization, and applications. Cosmetics 9(3): 61. https://doi.org/10.3390/cosmetics9030061

Michel P, Żbikowska HM, Rudnicka K, Gonciarz W, Krupa A, Gajewski A, Machała P, Olszewska MA (2024) Anti-inflammatory, antioxidant and photoprotective activity of standardised *Gaultheria procumbens* L. leaf, stem, and fruit extracts in UVA-irradiated human dermal fibroblasts. J Ethnopharmacol 319(Part 2): 117219. https://doi.org/10.1016/j.jep.2023.117219

Milosheska D, Roškar R (2022) Use of retinoids in topical antiaging treatments: A focused review of clinical evidence for conventional and nanoformulations. Adv Ther 39: 5351–5375. https://doi.org/10.1007/s12325-022-02319-7

Navarro-Perez MY, Cedeno-Linares E, Norman-Montenegro O, Ruz-Sanjuan V, Mondeja-Rivera Y, Hernandez-Monzon MA, Gonzalez-Bedia MM (2021) Prediction of the physical stability and quality of o/w cosmetic emulsions using full factorial design. J Pharm Pharmacogn Res 9(1): 98–112. https://doi.org/10.56499/jppres20.908_9.1.98

Noreen H, Semmar N, Farman M, McCullagh JS (2017) Measurement of total phenolic content and antioxidant activity of aerial parts of medicinal plant *Coronopus didymus*. Asian Pac J Trop Med 10(8): 792–801. https://doi.org/10.1016/j.apjtm.2017.07.024

Nowruzi B, Sarvari G, Blanco S (2020) The cosmetic application of cyanobacterial secondary metabolites. Algal Res 49: 101959. https://doi.org/10.1016/j.algal.2020.101959

Oliveira LBA, Oliveira RPd, Oliveira C, Raposo NRB, Brandão MAF, Ferreira ADO, Polonini H (2017) Cosmetic potential of a liotropic liquid crystal emulsion containing resveratrol. Cosmetics 4(4): 54. https://doi.org/10.3390/cosmetics4040054

Patel P, Pal R, Butani K, Singh S, Prajapati BG (2023) Nanomedicine-fortified cosmeceutical serums for the mitigation of psoriasis and acne. Nanomedicine 18(24): 1769–1793. https://doi.org/10.2217/nnm-2023-0147

Prajaputra V, Isnaini N, Maryam S, Ernawati E, Deliana F, Haridhi HA, Fadli N, Karina S, Agustina S, Nurfadillah N, Arisa II, Desiyana LS, Bakri TK (2024) Exploring marine collagen: Sustainable sourcing, extraction methods, and cosmetic applications. S Afr J Chem Eng 47: 197–211. https://doi.org/10.1016/j.sajce.2023.11.006

Pratama YA, Kadir MYA, Rivaldi A, Mulya IC, Amirah S, Iqhrammullah M (2024) Bibliometric analysis of the impact of environmental degradation on women and the importance of women's representation. Glob J Environ Sci Manag 10(3): 939–954. https://doi.org/10.22034/gjesm.2024.03.01

Putranti AR, Budipramana K, Salim MF (2022) The formulation and evaluation of facial wash containing snow mushroom (*Tremella fuciformis*) extract. Farmasains: J Farm Il Kes 7(1): 20–34. https://doi.org/10.22219/farmasains.v7i1.20063

Quan T (2023) Human skin aging and the anti-aging properties of retinol. Biomolecules 13(11): 1614. https://doi.org/10.3390/biom13111614

Rahmi D, Yunilawati R, Jati BN, Setiawati I, Riyanto A, Batubara I, Astuti RI (2021) Antiaging and skin irritation potential of four main Indonesian essential oils. Cosmetics 8(4): 94. https://doi.org/10.3390/cosmetics8040094

Sadowski G, Sadowski J (2020) Safety and efficacy of a novel antiaging skin care regimen containing neutraceuticals and growth factors on the facial skin of women: A 12-week open-label study. J Clin Aesthet Dermatol 13(6): 24–34. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7442306/

Salem MA, Manaa EG, Osama N, Aborehab NM, Ragab MF, Haggag YA, Ibrahim MT, Hamdan DI (2022) Coriander (*Coriandrum sativum* L.) essential oil and oil-loaded nano-formulations as an anti-aging potentiality via TGFβ/SMAD pathway. Sci Rep 12: 6578. https://doi.org/10.1038/s41598-022-10494-4

Salvioni L, Morelli L, Ochoa E, Labra M, Fiandra L, Palugan L, Prosperi D, Colombo M (2021) The emerging role of nanotechnology in skincare. Adv Colloid Interface Sci 293: 102437. https://doi.org/10.1016/j.cis.2021.102437

Sethupathi SK, Poole M, Darji K, Fehlman J (2024) Cosmetic dermatology concerns in older adults. Clin Geriatr Med 40(1): 197–210. https://doi.org/10.1016/j.cger.2023.09.009

Shabrina A, Pratiwi AR, Muurukmihadi M (2020) Physical stability and antioxidant activity microemulsion of patchouli oil with Tween 80 and PEG400 variation. Med Farm 16: 185–192. https://doi.org/10.32382/mf.v16i2.1720

Shah S, Chew SK (2018) Efficacy and safety of topical depigmenting agent in healthy human fair skin female volunteers: A single-arm study. J Cosmet Dermatol 17(5): 830–839. https://doi.org/10.1111/jocd.12435

Sindle A, Martin K (2021) Art of prevention: Essential oils-natural products not necessarily safe. Int J Womens Dermatol 7(3): 304–308. https://doi.org/10.1016/j.ijwd.2020.10.013

Singh HP, Samnhotra N, Gullaiya S, Kaur I (2015) Anti-acne synergistic herbal face wash gel: Formulation, evaluation and stability studies. World J Pharm Res 4(9): 1261–1273.

Singh IR, Pulikkal AK (2022) Preparation, stability and biological activity of essential oil-based nano emulsions: A comprehensive review. OpenNano 8: 100066. https://doi.org/10.1016/j.onano.2022.100066

Songkro S, Isnaini N, Sungkharak S, Tanmanee N, Maneenuan D, Kaewnopparat N (2022) Characterization, antioxidant and antibacterial potentials of *Tamarindus indica* L. fruit pulp extract loaded o/w nanoemulsions. Braz J Pharm Sci 58: e19373. https://dx.doi.org/10.1590/s2175-97902022e19373

Soroush S, Ronsse F, Verberckmoes A, Verpoort F, Park J, Wu D, Heynderickx PM (2022) Production of solid hydrochar from waste seaweed by hydrothermal carbonization: Effect of process variables. Biomass Conv Bioref 14: 183–197. https://doi.org/10.1007/s13399-022-02365-9

Srivastava S, Lal RK, Singh VR, Rout PK, Padalia RC, Yadav AK, Bawitlung L, Bhatt D, Maurya AK, Pal A, Chanotiya CS (2022) Chemical investigation and biological activities of Patchouli (*Pogostemon cablin* (Blanco) Benth) essential oil. Ind Crop Prod 188(Part A): 115504. https://doi.org/10.1016/j.indcrop.2022.115504

Swamy MK, Sinniah UR (2016) Patchouli (*Pogostemon cablin* Benth.): Botany, agrotechnology and biotechnological aspects. Ind Crop Prod 87: 161–176. https://doi.org/10.1016/j.indcrop.2016.04.032

Syaharani CPS, Isnaini N, Harnelly E, Prajaputra V, Maryam S, Gani FA (2023) A systematic review: Formulation of facial wash containing essential oil. J Patch Essent Oil Prod 2(1): 9–15. https://doi.org/10.24815/jpeop.v2i1.32261

Taufik M, Rizal S, Harnelly E, Muhammad S, Syahrizal D, Prajaputra V, Isnaini N (2024) The therapeutic potential of aceh patchouli oil (*Pogostemon cablin* Benth.) in enhancing full-thickness wound healing in mice. Trop J Nat Prod Res 8(1): 5840–5844. https://www.doi.org/10.26538/tjnpr/v8i1.19

Thawabteh AM, Jibreen A, Karaman D, Thawabteh A, Karaman R (2023) Skin pigmentation types, causes and treatment—A review. Molecules 28(12): 4839. https://doi.org/10.3390/molecules28124839

Titani M, Nuraini D, Rahmasari D (2022) Pharmacist knowledge level about the selection of facial wash. KnE Med 2: 677–684. https://doi.org/10.18502/kme.v2i3.11922

Tobin DJ (2017) Introduction to skin aging. J Tissue Viability 26(1): 37–46. https://doi.org/10.1016/j.jtv.2016.03.002

Veiga E, Ferreira L, Correia M, Pires PC, Hameed H, Araújo AR, Cefali LC, Mazzola PG, Hamishehkar H, Veiga F, Paiva-Santos AC (2023) Anti-aging peptides for advanced skincare: Focus on nanodelivery systems. J Drug Deliv Sci Tech 89: 105087. https://doi.org/10.1016/j.jddst.2023.105087

Wang XF, Huang YF, Wang L, Xu LQ, Yu XT, Liu YH, Li CL, Zhan JYX, Su ZR, Chen JN, Zeng HF (2016) Photo-protective activity of pogostone against UV-induced skin premature aging in mice. Exp Gerontol 77: 76–86. https://doi.org/10.1016/j.exger.2016.02.017

Waruwu TPA, Maimunah S (2022) Formulasi sediaan minyak nilam (pogostemon oil) sebagai pelembab. J Ilm Kes Mandira Cend 1(1): 1-9.

Weihermann AC, Lorencini M, Brohem CA, De Carvalho CM (2017) Elastin structure and its involvement in skin photoageing. Int J Cosmet Sci 39(3): 241–247. https://doi.org/10.1111/ics.12372

Xie J, Lin Z, Xian Y, Kong S, Lai Z, Ip S, Chen H, Guo H, Su Z, Yang X, Xu Y, Su Z (2016) (-)-Patchouli alcohol protects against *Helicobacter pylori* urease-induced apoptosis, oxidative stress and inflammatory response in human gastric epithelial cells. Int Immunopharmacol 35: 43–52. https://doi.org/10.1016/j.intimp.2016.02.022

Yang B, Mao J, Zhao J, Shao Y, Zhang Y, Zhang Z, Lu Q (2019) Improving the thermal stability of hydrophobic associative polymer aqueous solution using a "triple-protection" strategy. Polymers 11(6): 949. https://doi.org/10.3390/polym11060949

Yogesh HR, Gajjar T, Patel N, Kumawat R (2022) Clinical study to assess efficacy and safety of Purifying Neem Face Wash in prevention and reduction of acne in healthy adults. J Cosmet Dermatol 21(7): 2849–2858. https://doi.org/10.1111/jocd.14486

Zain MZM, Baba AS, Shori AB (2018) Effect of polyphenols enriched from green coffee bean on antioxidant activity and sensory evaluation of bread. J King Saud Univ Sci 30(2): 278–282. https://doi.org/10.1016/j.jksus.2017.12.003

Zhang H, Lin X, Cao X, Wang Y, Wang J, Zhao Y (2024) Developing natural polymers for skin wound healing. Bioact Mater 33: 355–376. https://doi.org/10.1016/j.bioactmat.2023.11.012

Zhao X, Zhang X, Liu D (2021) Collagen peptides and the related synthetic peptides: A review on improving skin health. J Funct Food 86: 104680. https://doi.org/10.1016/j.jff.2021.104680

Zhou L, Xie M, Yang F, Liu J (2020) Antioxidant activity of high purity blueberry anthocyanins and the effects on human intestinal microbiota. LWT - Food Sci Technol 117: 108621. https://doi.org/10.1016/j.lwt.2019.108621

Zouboulis CC, Makrantonaki E, Nikolakis G (2019) When the skin is in the center of interest: An aging issue. Clin Dermatol 37(4): 296–305. https://doi.org/10.1016/j.clindermatol.2019.04.004

AUTHOR CONTRIBUTION:

Contribution	Isnaini N	Harnelly E	Zulkarnain Z	Prajaputra V	Muhammad S	Syahraini A	Syaharani CPS	Nurfaizah N	Sarah Y
Concepts or ideas	x	x	x	x	x	x	x	x	x
Design	x	x	x	x	x	x	x	x	x
Definition of intellectual content	x	x	x	x	x				
Literature search	x	x	x	x	x	x	x	x	x
Clinical trial	x	x	x				x	x	x
Experimental studies	x						x	x	x
Data acquisition	x	x	x	x	x	x	x	x	x
Data analysis	x	x	x	x	x	x	x	x	x
Statistical analysis							x	x	x
Manuscript preparation	x	x	x	x	x	x	x	x	x
Manuscript editing	x	x	x				x	x	x
Manuscript review	x	x	x	x	x	x	x	x	x

Citation Format: Isnaini N, Harnelly E, Zulkarnain Z, Prajaputra V, Muhammad S, Syahraini A, Syaharani CPS, Nurfaizah N, Sarah Y (2025) Potential of patchouli (*Pogostemon cablin*) and champaca (*Magnolia champaca*) oils incorporated in facial wash formulation for effective anti-aging on human skin. J Pharm Pharmacogn Res 13(2): 459–474. https://doi.org/10.56499/jppres24.2031_13.2.459

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Open Access: This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/ licenses/by/4.0/), which permits use, duplication, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.