Journal of Social Research

E-ISSN: 2828-335x
Vol. 5, No. 12, November 2026, pp. 6031-6043
DOI: 10.55324/josr.v5i12.3580
Journal of Social Research

Optimization of Physical Characteristics of Nanoemulsions & Evaluation of Preparation of Face Mist Preparation of White Nusa Indah Leaf Extract (Mussaenda Philippica A. Rich)

Wanna Khoirul Badriah*, Mokhamad Mahroji, Ahmad Bagus Mindiarto
Universitas Bina Bangsa, Indonesia
Email: kbadriah61@gmail.com*, ojierasyidi11@gmail.com, bagusmindi69@gmail.com

Keywords:
Spontaneous nanoemulsion; Face mist; Mussaenda philippica; Antioxidant.

This is an open access article under the CC BY-SA license.

Copyright © 2026 by Author. Published by
International Journal Labs

Abstract

Air pollution can contribute to skin dryness and oxidative damage, highlighting the potential benefits of topical antioxidant formulations. White nusa indah (Mussaenda philippica A. Rich.) leaves exhibit strong antioxidant activity, with a reported half-maximal inhibitory concentration (IC_{50}) of 8.13 ppm. This study aimed to optimize a nanoemulsion-based facial mist containing white nusa indah leaf extract and evaluate its physicochemical characteristics. The extract was obtained through multistage maceration using 96% ethanol for 72 hours. Nanoemulsion base optimization was performed by varying the concentration of Tween 80 (1%, 2%, and 3%). The formulations were evaluated for organoleptic properties, pH, viscosity, Tyndall effect, spray pattern, drying time, and particle size distribution using a particle size analyzer (PSA). Data were analyzed using descriptive quantitative methods. Phytochemical screening confirmed the presence of secondary metabolites, with an extraction yield of 28.78%. The formulation containing 1% Tween 80 was selected as the optimal base. Formula F2, containing 2% extract, exhibited the most favorable physicochemical characteristics, including a pH of 4.82, viscosity of 1.818 cP, drying time of 2 minutes and 33 seconds, spray distance of 14.33 cm, a positive Tyndall effect, mean particle size of 190.97 nm, polydispersity index (PDI) of 0.282, and zeta potential of −68.60 mV, suggesting favorable electrostatic stability.

INTRODUCTION

Air pollution remains a significant environmental health concern in Indonesia, with particulate matter concentrations exceeding the air quality guidelines established by the World Health Organization (World Health Organization [WHO], 2025). Java has been identified as a highly polluted region, with an average particulate matter concentration of 35.5 µg/m³ (Iqbal & Arumingtyas, 2025). Serang Regency in Banten Province is among the areas experiencing particularly poor air quality. According to an IQAir report from June 2023, the Air Quality Index (AQI) in Serang Regency reached 160, indicating unhealthy air quality, while fine particulate matter ($PM_{2.5}$) concentrations exceeded 100 µg/m³. Industrial activities, particularly

those associated with steel manufacturing and metal smelting in the Modern Cikande Industrial Estate, have been identified as potential contributors to local air pollution (Laily et al., 2026). The Serang Regency Environmental Agency identified Ciruas, Kragilan, Kibin, and Cikande as four districts experiencing particularly severe air pollution (IQAir, 2023, as cited in Ridho & Arief, 2023).

Exposure to air pollutants can impair the skin barrier, increase transepidermal water loss, and contribute to skin dryness and a dull complexion (Bachri et al., 2025). These effects may compromise skin health and appearance. Topical antioxidants may help mitigate pollution-induced oxidative stress by neutralizing reactive oxygen species and limiting lipid peroxidation in skin cell membranes. Consequently, cosmetic formulations containing natural antioxidant compounds have attracted attention as potential approaches to protecting the skin against environmental stressors (Fernanda et al., 2023).

Indonesia is recognized as a megadiverse country with extensive plant biodiversity and considerable potential as a source of bioactive compounds. The sustainable utilization of plant-derived ingredients has gained increasing attention in cosmetic development, particularly as consumer awareness of product safety and preferences for naturally derived cosmetic ingredients have increased (Nusaibah et al., 2022).

Facial mist formulations offer a convenient approach to topical skin care because they can be applied without direct contact with the facial surface, potentially reducing contamination during application. These liquid formulations are designed to provide temporary hydration and a cooling sensation, particularly when the skin is exposed to environmental stressors such as ultraviolet (UV) radiation (Bachri et al., 2025).

Conventional cosmetic formulations containing plant extracts may exhibit limitations related to the solubility, stability, and skin delivery of certain bioactive compounds (Malahayati et al., 2024). These limitations can reduce the availability of active ingredients at the intended site of action and potentially compromise formulation performance (Bachri et al., 2025). Nanoemulsion technology has therefore been investigated as a strategy to improve the dispersion, formulation stability, and topical delivery of bioactive compounds in facial mist preparations (Aisyah et al., 2025).

Nanoemulsions are colloidal dispersions of two immiscible liquids, typically oil and water, stabilized by surfactants, with droplet sizes commonly ranging from approximately 20 to 200 nm. Their small droplet sizes and relatively large interfacial surface areas may improve the dispersion and delivery of certain active ingredients while supporting the development of transparent or translucent formulations (Aisyah et al., 2025). Nanoemulsions are also kinetically stable systems that may resist phase separation over a defined storage period, although their stability depends on formulation composition and storage conditions (Vats, 2023).

Previous studies have explored the development of facial mist formulations incorporating natural ingredients. Bachri et al. (2025) optimized a facial mist formulation intended to improve skin hydration, while Badriyah and Ifandi (2022) reported favorable physical stability in a facial mist containing 15% cucumber extract. Khotimah et al. (2023) investigated nanoemulsion technology using butterfly pea (Clitoria ternatea) flowers as a source of antioxidant compounds. Malahayati et al. (2024) developed a nanoemulsion-based facial mist incorporating bioactive compounds derived from jasmine flowers. Similarly, Nida et al. (2025)

formulated a nanoemulsion-based facial mist combining tomato extract and Aloe vera juice to improve facial skin hydration. Despite these developments, the formulation of white nusa indah (Mussaenda philippica A. Rich.) leaf extract into a nanoemulsion-based facial mist using spontaneous emulsification remains insufficiently explored.

This research gap highlights the need to investigate white nusa indah leaf extract as a potential bioactive ingredient in nanoemulsion-based facial mist formulations. Accordingly, this study aimed to optimize the formulation of a facial mist containing Mussaenda philippica A. Rich. leaf extract using spontaneous emulsification and evaluate its physicochemical characteristics, including pH, viscosity, droplet size, polydispersity index, zeta potential, and other relevant physical properties. The study sought to identify a formulation with favorable physicochemical characteristics and potential suitability for topical cosmetic applications.

The findings were expected to contribute to the development of plant-based nanoemulsion cosmetics using Indonesia's botanical resources and provide a scientific foundation for further investigation of Mussaenda philippica as a topical antioxidant ingredient. The optimized formulation may serve as a basis for subsequent studies assessing antioxidant activity, skin hydration, dermal safety, and storage stability. Furthermore, the spontaneous emulsification approach offers a potentially energy-efficient formulation strategy for future cosmetic product development, although its reproducibility and scalability require further evaluation.

RESEARCH METHODS

This study employed a quantitative laboratory experimental design conducted from April to July 2026. White nusa indah (Mussaenda philippica A. Rich.) leaves were collected using purposive sampling, followed by botanical identification, preparation of dried plant material, and extraction through maceration with 96% ethanol for 72 hours. The resulting extract was concentrated using a rotary evaporator, and the extraction yield was calculated. Phytochemical screening was performed to identify secondary metabolites.

Nanoemulsion-based facial mist formulations were prepared using the spontaneous emulsification method. Formulation optimization involved varying Tween 80 concentrations (1%, 2%, and 3%), followed by incorporating extract concentrations of 0%, 1%, 2%, and 3%. Physicochemical evaluations included organoleptic properties, pH, viscosity, Tyndall effect, spray performance, and drying time. The optimal formulation was further characterized using particle size analysis to determine mean droplet size, polydispersity index (PDI), and zeta potential. All measurements were performed in triplicate, and the results were analyzed descriptively and presented as mean values in tables.

RESULTS AND DISCUSSION

Plant Determination Results

Based on the results of the determination carried out at the Depokensis Herbarium (UINDEP), UI Biota Collection Room, Department of Biology, Faculty of Mathematics and Natural Sciences, University of Indonesia, Depok. The leaf samples used in this study were identified/determined to the species level as Mussaenda philippica A. Rich (Rubiaceae tribe). The results of this determination show that the samples used are in accordance with the species that are the object of the research, so that the data obtained can be scientifically accounted for.

Yield Yield

Table 1. Yield Yield

Yes	Parameters	Yield %
1	Moisture content of fresh leaves	73,8%
2	Weight loss	4,4%
3	Thick extract	28,78
4	Moisture content of thick extract	7,1%

Based on calculations, the fresh leaves of Nusa Indah Putih have a very high moisture content of 73.8%. The high water content causes the leaves to be more sensitive to microbial growth (Elvira et al., 2024). The drying process is carried out for 3-7 days by aerating in the shade and reversing every 12 hours aims to reduce the moisture content until it reaches the criteria of good dry simplicia, which is easily brittle when broken and does not feel damp (Ministry of Health of the Republic of Indonesia, 2020).

The shrinkage of white nusa indah leaf simplicia mill was obtained by 4.4%. This weight loss is caused by mechanical factors during the grinding process, namely the attachment of the powder to the surface of the blender, the discharge of fine particles that fly during the grinding process, and the rest of the powder that sticks to the sieve (mesh 40-60). In addition, it is necessary to carry out mitigation strategies such as cleaning the tool with a brush or spatula after grinding, grinding in a closed condition to prevent particles from flying, and using a sieve with the help of stirring so that the powder does not accumulate on the sieve (Mehmood et al., 2026).

The extract was thickened using a rotary evaporator and waterbath by the UPTD (PPMHP Fishery Product Quality Testing and Application, Banten Provincial Marine and Fisheries Service), the viscous extract obtained was 100.14 grams from 348 grams of simplicia powder. The yield value of 28.78% showed that the maceration process with 96% ethanol was effective and was included in the high category. This method takes a long time because it only uses soaking so that the dissolution process of compounds takes place statically despite the remaceration method. However, this method is very safe for active substances that are not heat-resistant (Wijaya et al., 2018)

The determination of the moisture content of the extract aims to determine the water content that is still left in the condensed extract, which affects the stability and shelf life of the extract. Based on the test results, the moisture content of the white nusa indah leaf extract was 7.1%. This value states that the moisture content of the extract is classified as good because it is not more than 10.0% (Ministry of Health of the Republic of Indonesia, 2017). Thus, the extract randemen has met the requirements and shows that the resulting extract is relatively stable against microbial contamination (Elvira et al., 2024).

Phytochemical Screening Results of White Nusa Indah Leaf Extract

Table 2. Results of Phytochemical Screening of Extracts

Compounds	Reagents	Observation results	Remarks	Requirements (Tiwari et al., 2011)
Alkaloids	Dragendroff	Orange deposits are formed	Positive (+)	Orange sediment
	Mayer	White deposits are formed	Positive (+)	White deposits

	Wagner	Brown deposits are formed	Positive (+)	Brown deposits
Flavonoids	Mg+HCl concentrate	Turns deep red	Positive (+)	Red, orange, purple color
Tannins	FeCl3 1%	Blackish discoloration	Positive (+)	Dark green, dark blue, blackish color
Saponins	Water+Shake	Stable foam formation + 10 cm	Positive (+)	Stable foam: 1-10 cm
Terpenoids	Chloroform + $CH_{3COOH + H2SO4}$	Red is formed at the top	Positive (+)	Red or purple color on the top layer
Phenolics	FeCl3 1%	Blackish discoloration	Positive (+)	Green, blue, or black color

The results of phytochemical screening showed that positive white nusa indah leaf extract contained alkaloids, flavonoids, tannins, saponins, terpenoids, and phenolics, which were characterized by the formation of deposits or specific color changes after the addition of reagents. These results are in line with the research of Umoh et al. (2022) who reported the same compound content in this plant.

The presence of flavonoids and phenolics is very important because these two compounds act as antioxidants that are able to protect the skin from oxidative damage due to free radicals (Ramadhani et al., 2024). The antioxidant activity of white nusa indah leaf extract has been proven by Mercury et al. (2016) with an IC_{50} value of 8.13 ppm, which is equivalent to a strong antioxidant standard. Thus, this rich phytochemical profile confirms the potential of white nusa indah leaves as an active ingredient in face mist preparations for antioxidant protection on the skin (Mercury et al., 2016).

Optimization Results of Face Mist Nanoemulsion

Organoleptic Tests

Table 3. Organoleptic Test Results

Preparation	Color, Shape, Aroma & Homogeneity	
	Organoleptic (Base)	**Organoleptic (Formulation)**
1	Bluish clear white, liquid, sakura, homogeneous	Light brown, liquid, sakura, homogeneous
2	Clear white reddish, liquid, sakura, homogeneous	Brown, liquid, sakura, homogeneous
3	Clear white reddish, liquid, sakura, homogeneous	Dark chocolate, liquid, sakura, homogeneous

Organoleptic tests were carried out to evaluate the physical properties of the preparation. The three bases showed almost uniform characteristics, namely liquid, homogeneous, and sakura-scented. The difference lies in the color, where Base 1 is bluish-clear white, while Base 2 and 3 are clear reddish-white. This is due to Tween 80 which is a yellow to yellowish-brown liquid, so higher concentrations produce a reddish color (Dhumal, 2026). In addition, the bluish-white color indicates the tyndall effect so that the product is on a nanoscale (JP et al., 2024). The entire base is homogeneous without deposits, indicating that spontaneous nanoemulsions have succeeded in forming a stable dispersion system (Nida et al., 2025).

Based on the observations in Table 4.3, all face mist formulations (F1, F2, and F3) produce liquid preparations and have a consistent cherry blossom aroma. The brown-like intense color

in face mist preparations is caused by the presence of natural pigmentation and secondary metabolite compounds (such as flavonoids, phenolics, and tannins) extracted in certain concentrations (Nusaibah et al., 2022).

The homogeneity of the formulation was shown to be homogeneous because no coarse particles or solid clumps were found in the preparation, which indicates that the active ingredients and excipients are evenly dispersed. Significant physical differences were seen in the color of the preparation, where the base formula without extract (F0) was clear white, F1 (1%) was light brown, F2 (2%) was brown, and F3 (3%) was reddish-brown. This color change is directly influenced by the concentration of extracts added, where the higher the concentration of extracts in the preparation, the more intense the color intensity will be (Nida et al., 2025).

pH Test

Table 4. pH Test Results

Preparation	Preparation pH Test Results		pH conditions (Nida et al., 2025)
	pH Base	pH Formulation	
1	6,67	4,72	**4,5 – 6,5**
2	6,74	4,82	
3	7,44	4,66	

The pH test is carried out to determine the degree of acidity of the preparation and ensure compatibility with the pH of the skin. Human skin has a weak acidic physiological pH of around 4.5–6.5 which functions to protect the skin from the growth of pathogenic microorganisms and maintain the function of the epidermal skin layer. The pH value of the three bases increases with the concentration of Tween 80. Based on the physiological pH range of the skin, Base 1 with a pH of 6.67 is the closest to the optimal range, so it is chosen as the best base for the next formulation (Nida et al., 2025).

The pH measurement results in Table 4.4 show that the control formula F0 (0%) has a pH value of 6.74. The addition of extracts to F1 (1%), F2 (2%), and F3 (3%) causes a decrease in the pH value of the preparation, with an average pH value of 4.72 (F1), pH value of 4.82 (F2), and pH value of 4.66 (F3). The decrease in pH value in formulations containing this extract is caused by the presence of natural bioactive compounds that are acidic in plant extracts. Extracts will be acidic when there are tannins in the active ingredient compounds. Tannins are one of the antioxidant compounds (Nusaibah et al., 2022).

Based on the results of these tests, all face mist formulations are safe and suitable for use on facial skin. Overall, the resulting face mist preparations are in the pH range of 4.61 to 6.74. This value has met the standards and criteria for safe skin physiological pH for topical cosmetics, which is in the range of 4.5–6.5 or close to the skin pH. Adjusting the pH of the preparation to the physiological range of the skin is very important to maintain the balance of the skin barrier, because preparations with a pH that is too acidic risk triggering irritation and burning in the skin, while a pH that is too alkaline can cause the skin to become dry and dull (Nida et al., 2025).

Viscosity Test Results

Table 5. Viscosity Test Results

Preparation	Viscosity Test Results		Viscosity Requirements (Fitri et al., 2026)
	Base (cP)	Formulation (cP)	
1	1,188	1,509	< 5 cP and easy to apply
2	1,259	1,818	
3	1,356	2,031	

Viscosity testing is carried out to determine the level of viscosity of the preparation or the resistance of a liquid to flow, which greatly affects the ease of use of face mist preparations when applied. In spray preparations, low viscosity is crucial so that the preparation can be optimally atomized into fine grains through a spray pump mechanism without causing blockages in the applicator pipe.

Based on the calculation results in Table 4.5, an increase in the concentration of Tween 80 causes an increase in viscosity, because Tween 80 is a viscous liquid so the higher the concentration, the higher the viscosity of the preparation (Dhumal, 2026). All bases meet the viscosity requirements for face mist preparations, which are < 5 cP (Fitri et al., 2026). In addition, an average value of F1 (1%) of 1,509 cP, F2 (2%) of 1,818 cP, and F3 (3%) of 2,031 cP.

The data show a trend of gradually increasing the viscosity value along with the increasing concentration of extracts added to the preparation. This increase in viscosity is due to the increase in density and number of dissolved solids components of plant extracts, which increases the internal friction between molecules in the liquid phase of the preparation (Nida et al., 2025). The low viscosity value and consistency of the preparation can be sprayed evenly with a good spread diameter, comfortable to use on the face, and quickly absorbed into the skin layer without leaving a sticky feeling.

Tyndall Effect Test Results

Table 6. Tyndall Effect Test Results

Preparation	Tyndall Effect Test Results		Requirements (JP et al., 2024)
	Basics	Formulation	
1	Colloid, light refraction	Colloid, light refraction	Colloid, light refraction
2	Colloid, light refraction	Colloid, light refraction	
3	Colloid, light refraction	Colloid, light refraction	

Based on Table 4.6 All three bases show a positive Tyndall effect, proving that the preparations are on a colloidal scale (JP et al., 2024). Although the formulation of face mist preparations shows a deep brown color along with the increase in the concentration of extracts added, the preparations still have transparent/translucent physical properties. This confirms that the preparations have been successfully dispersed at the nanoscale (20–200 nm) (Aisyah et al., 2025).

The discoloration to pure brown is influenced by the intensity of natural pigments and secondary metabolite compounds such as flavonoids and phenolics from plant extracts, not by the formation of clumping macroparticles (Nusaibah et al., 2022). In optical theory, nanometer-sized dispersion systems have a smaller droplet size compared to the wavelength of visible

light, so that light scattering by droplets is minimal and allows the preparation to remain penetrated by light beams or translucent (Vats, 2023).

Spraypower Test Results

Table 7. Results of the Sprayer Power Test

Preparation	Spraypower Test Results		Requirements (Dewi & Pratiwi, 2024)
	Base (cm)	Formulation (cm)	
1	13,5	14,3	Diameter 5-15 cm
2	14,5	14,3	
3	15,0	14,3	

The spray power test was carried out to evaluate the ability of face mist preparations to form a fine mist that is evenly distributed when sprayed (Dewi & Pratiwi, 2024). Based on Table 4.7, all formulas show a good spray pattern, namely spreading in circles with a spread diameter that meets the optimal range of 5–15 cm, namely, F1 (14.3 cm), F2 (14.3 cm), and F3 (14.8 cm), so that the preparation can form a fine mist that is evenly distributed on the surface of the skin (Dewi & Pratiwi, 2024).

The increase in dispersion diameter as the extract concentration increases is thought to be caused by a decrease in surface tension by the active compounds in the extract, especially flavonoids and saponins that are naturally surfactant, thereby increasing atomization and producing a smoother mist that spreads more widely when sprayed (Baki & Alexander, 2023). A spray pattern that is too narrow (< 5 cm) indicates suboptimal atomization, while a spray pattern that is too wide (> 15 cm) can reduce the efficiency of delivering the active ingredient to the surface of the skin (Kurniawan et al., 2023). All formulas show an even circular spray pattern, indicating that the nanoemulsion system formed has good flow characteristics and the spray nozzle works optimally (Rahmawati et al., 2023).

Dry Time Test Results

Table 8. Dry Time Test Results

Preparation	Dry Time Test Results		Requirements (Sari & Wahyuni, 2023)
	Basics	**Formulation**	
1	1’ 53”	2’ 06”	2 – 5 minutes
2	2’ 19”	2’ 33”	
3	2’ 54”	3’ 41”	

A dry-time test was performed to determine how quickly the preparation dries after being applied to the skin, which affects the user's comfort (Sari & Wahyuni, 2023). Based on Table 4.8, there is an increase in drying time along with increased concentration. Base 1 was chosen as the best base because of its lowest viscosity for ease of spraying and optimal atomization, the pH closest to the physiological of the skin, and the fast drying time that gives the leave-on preparation a fresh sensation (Sari & Wahyuni, 2023).

The average value of dry wax was at F1 (2 minutes 06 seconds), F2 (2 minutes 33 seconds), and F3 (3 minutes 41 seconds). This increase is due to the content of polysaccharides and polyphenol compounds in the extracts that are humectants, thus attracting and binding water for longer on the surface of the skin, which slows down the evaporation process (Wulandari et al., 2025). In addition, the increase in viscosity along with the concentration of the extract also

contributes to the length of drying time because thicker liquids take longer to evaporate (Fitri et al., 2026).

Based on the literature, F0 and F1 have the fastest drying time (about 2 minutes) which provides a fresh and practical sensation for the user, while F3 has the longest drying time (3 minutes 27–56 seconds) which is still relatively comfortable and does not leave an excessive sticky feeling (Williams & Schmitt, 2022). Thus, F1 and F2 are the most ideal formulas because they have a dry time that is balanced between the comfort of use and enough time for the active ingredient to penetrate into the skin (Loden & Maibach, 2023).

Based on all evaluation parameters, Formula F2 (extract concentration of 2%) was chosen as the best formula because it has optimal spraying power (14.3 cm) with a perfect spreading pattern forming a circle, appropriate viscosity (1.818 cP), and comfortable drying time (2 minutes 33 seconds), so that F2 has the best balance between active ingredient activity and comfort of use as a face mist preparation (Nida et al., 2025).

Particle Size Test Results

Table 9. Particle size test results

Parameters	Duplicate 1	Duplicate 2	Duplicate 3	Average ± elementary school
Z – Average (nm)	192,6	194,5	185,8	190.97 ± 4.58
Polydispersity Index (PI)	0,267	0,229	0,351	0.282 ± 0.063
Zeta Potential (mV)	-70,6	-66,0	-69,2	-68.60 ± 2.36
Electrophoretic Mobility (cm2/Vs)	-0,000545	-0,000510	- 0,000535	-0.000530 ± 0.000018
Conductivity (mS/cm)	0,235	0,235	0,235	0.235 ± 0.000

The Particle Size Analyzer (PSA) test was conducted to measure the size and distribution of nanoemulsion droplets using the principle of Dynamic Light Scattering (DLS) (Nida et al., 2025). Based on Table 4.9 on the formula F2 (extract concentration of 2%), the average particle size (Z-Average) obtained was 190.97 ± 4.58 nm. This value is still within the nanoemulsion range of < 200 nm (Nida et al., 2025), but close to the upper limit. Sizes close to 200 nm can be caused by the phytochemical complexity of extracts such as tannins and flavonoids that increase the internal viscosity of droplets (Dhumal, 2026).

The average Polydispersity Index (PDI) obtained was 0.282 ± 0.063. This value < 0.5 which indicates a relatively homogeneous (monodispersal) particle size distribution (Nida et al., 2025). This low PDI value indicates that droplets have a uniform size, so that the physical stability of the preparation is more guaranteed and the emulsification process is well underway (Rao & McClements, 2011).

The average zeta potential obtained was -68.60 ± 2.36 mV. This value was well above the stability threshold (±25 mV) (Nida et al., 2025), indicating that the repulsive force between droplets was so strong that it effectively prevented aggregation and coalescation (Angelita & Saragih, 2025). This high zeta potential confirms that nanoemulsions have excellent kinetic stability (Vats, 2023).

The mean electrophoretic mobility of -0.000530 ± 0.000018 cm²/Vs and the conductivity of 0.235 ± 0.000 mS/cm indicate the consistency of the droplet surface charge between duplicates, indicating that the nanoemulsion manufacturing process is reproducible. Thus, based on all PSA parameters, Formula F2 (extract concentration 2%) has the characteristics of a nanoemulsion that meets the requirements as a topical cosmetic preparation with particle size in the nanorange, homogeneous size distribution, and excellent physical stability (Nida et al., 2025).

CONCLUSION

The findings demonstrated that white nusa indah (Mussaenda philippica A. Rich.) leaf extract contained several classes of secondary metabolites, including alkaloids, flavonoids, tannins, saponins, terpenoids, and phenolic compounds, as confirmed by phytochemical screening. Base 1, containing 1% Tween 80, was identified as the optimal nanoemulsion base, exhibiting the lowest viscosity (1.188 cP), a pH of 6.67, a positive Tyndall effect, a spray distance of 13.5 cm, and a drying time of 1 minute and 53 seconds. Variations in extract concentration influenced the physicochemical characteristics of the nanoemulsion-based facial mist, with increasing concentrations resulting in more intense coloration, lower pH, higher viscosity, longer drying times, and greater spray distances. All formulations (F0–F3) met the specified physical evaluation criteria, including acceptable organoleptic properties, pH (4.61–6.74), viscosity (less than 5 cP), a positive Tyndall effect, spray distance (13–15.5 cm), and drying time (2–5 minutes). Formula F2, containing 2% extract, exhibited the most favorable physicochemical characteristics, including a brown, homogeneous liquid appearance, pH of 4.82, viscosity of 1.818 cP, a positive Tyndall effect, a spray distance of 14.33 cm with a uniform circular spray pattern, and a drying time of 2 minutes and 33 seconds. Particle size analysis revealed a mean droplet size of 190.97 ± 4.58 nm, a polydispersity index of 0.282 ± 0.063, and a zeta potential of −68.60 ± 2.36 mV, indicating strong electrostatic stabilization and suggesting favorable resistance to droplet aggregation.

FUNDING

This research was funded entirely using the first author's personal funds, without receiving financial assistance or grants from funding institutions in the public, commercial, or non-profit sectors.

CONFLICT OF INTEREST

The authors state that there are no conflicts of interest, either financial or non-financial, that could affect the objectivity or outcome of this study.

AUTHOR'S CONTRIBUTION

All authors contributed to the study. Wanna Khoirul Badriah was responsible for conceptualization, methodology, data collection, formal analysis, drafting of the initial draft, draft editing and visualization. Mokhamad Mahroji and Ahmad Bagus Mindiarto contributed to the supervision, critical review of the manuscript, and methodological validation.

GENERATIVE ARTIFICIAL INTELLIGENCE USAGE STATEMENT

During the drafting process, the authors used generative artificial intelligence tools. DeepSeek is used to assist in the initial search of literature references and identify scientific journals relevant to the research topic. Gemini is used to paraphrase text, detecting typos (typo), and translate the digest into an English abstract. After the process, the author manually checks,

validates, and re-edits all outputs. The author is fully responsible for the correctness of references, authenticity, and accuracy of the content of this manuscript.

REFERENCES

Aisyah, N., Sriwidodo, Husni, P., & Sinala, S. (2025). Antioxidant activity analysis of plant-based nanoemulsions in pharmaceutical and cosmetic applications: A literature review. *Media Kesehatan Politeknik Kesehatan Makassar, 20*(1), 139. https://doi.org/10.32382/medkes.v20i1

Angelita, F., & Saragih, H. (2025). Nanoemulsion of a mixture of flower musk oil and lily essential oil using PEG 40 hydrogenated castor oil surfactant and its size stability test. *Jurnal Fisika Unand, 14*(6), 595–605. https://doi.org/10.25077/jfu.14.6.595-605.2025

Bachri, N., Cristy, D., Sari, K., Utami, T. P., Utami, Y. P., Auliah, N., & Asri, M. (2025). Formulation and activity test of coffee bean peel extract facemist preparation (Coffea arabica) using DPPH (2,2-diphenyl-1-picrylhydrazyl) method. *Archives Pharmacia, 7*(2), 167–170. https://doi.org/10.47007/ap.v7i2.9950

Badriyah, L., & Ifandi, S. (2022). Formulation and physical test of cucumber face mist extract (Cucumis sativus L.). *Journal of Estu Utomo Health Science, 16*(1), 1–7. https://ejurnal.stikeseub.ac.id/index.php/JEU/article/view/790

Baki, G., & Alexander, K. S. (2023). *Introduction to cosmetic formulation and technology* (2nd ed.). John Wiley & Sons.

Dewi, N. K., & Pratiwi, R. (2024). Spraying power and physical characteristics of face mist rosella flower extract. *Indonesian Journal of Pharmacy, 19*(1), 45–52.

Dhumal, R. S. (2026). Tween 80 in nanoemulsion: A comprehensive review. *Journal of Cosmetic Science, 77*(2), 89–98.

Elvira, I., Baihaqi, B., Faradilla, R. H. F., Rejeki, S., & Suci, I. A. (2024). Effect of processing methods on water content, ash content, and vitamin C content of moringa leaves (Moringa oleifera). *Journal of Agroscience, 17*(1), 9–11.

Fernanda, M. D., Sibero, H. T., & Mutiara, H. (2023). Air pollution and skin problems. *Medical Profession Journal of Lampung, 13*(1), 66–71. https://doi.org/10.53089/medula.v13i1.590

Fitri, T. N., Kurniawan, T. D., Putri, D. K., Mulia, P., & Saris, R. I. P. (2026). Formulation and evaluation of bay leaf extract toner preparation (Syzygium polyanthum) using sonication method. *Health Research Journal of Indonesia, 4*(5), 557–564. https://doi.org/10.63004/hrji.v4i5.1166

Iqbal, D., & Arumingtyas, L. (2025, August 17). *Polusi udara menyebabkan penuaan dini dan keriput pada kulit* [Air pollution causes premature aging and wrinkles in the skin]. Mongabay Indonesia. https://mongabay.co.id/2025/08/17/polusi-udara-menyebabkan-penuaan-dini-dan-keriput-pada-kulit/

J. P., S. B., Sahu, P., Vinod, R., Patel, A., Alomary, M. N., Begum, M. Y., Jamous, Y. F., Siddiqua, A., Al Fatease, A., & Ansari, M. A. (2024). Antimicrobial nanoemulsion: A futuristic approach in antibacterial drug delivery system. *Journal of Saudi Chemical Society, 28*, Article 101896. https://doi.org/10.1016/j.jscs.2024.101896

Khotimah, K., Ulfa, A. M., & Nofita. (2023). Potential of nanoemulsion spray preparation of telang flower extract (Clitoria ternatea L.) as an antioxidant. *Jurnal Analis Farmasi, 8*(1), 171–182. https://ejurnalmalahayati.ac.id/index.php/analisfarmasi/article/view/9933

Kurniawan, D., Hidayat, R., & Sari, W. (2023). Evaluation of spray patterns and atomization of face mist preparations. *Journal of Pharmaceutical Technology, 11*(2), 67–74.

Laily, F. N., Izzuddin, M. Y., Kalevi, M. R., & Pratama, R. (2026). Preliminary study on atmospheric dispersion modeling of Cesium-137 radioactive incident at KIM Cikande, Indonesia: General analysis. *Applied Radiation and Isotopes*, 112896.

Loden, M., & Maibach, H. I. (2023). *Dry skin and moisturizers: Chemistry and function* (3rd ed.). CRC Press.

Malahayati, S., Nastiti, K., Audina, M., & Noval. (2024). Formulation of nanoemulsion of jasmine flower extract (Jasminum sambac L.) with self-nanoemulsifying drug delivery system (SNEDDS) technique as anti-acne. *Jurnal Surya Medika, 10*(1). https://doi.org/10.33084/jsm.v10i1.7236

Mehmood, R. Y., Miano, T. F., Ali, M., Gul, S., & Abid, Y. (2026). Influence of grinding-induced particle size reduction on the physicochemical, functional, and sensory properties of Moringa oleifera leaf powder. *International Journal of Agriculture Innovations and Cutting-Edge Research, 4*(3), 28–41. https://doi.org/10.67244/jai.bwo-researches.v4i3.a248

Mercury, A., Agustina, R., & Rijai, L. (2016). Screening of activity of ethyl acetate fraction of nusa indah leaves (Mussaenda philippica A. Rich). In *Proceeding of Mulawarman Pharmaceuticals Conferences IV*. Universitas Mulawarman. https://repository.unmul.ac.id/handle/123456789/1635

Ministry of Health of the Republic of Indonesia. (2017). *Farmakope herbal Indonesia* (2nd ed.). Ministry of Health of the Republic of Indonesia.

Ministry of Health of the Republic of Indonesia. (2020). *Farmakope Indonesia* (6th ed.). Ministry of Health of the Republic of Indonesia.

Nida, L., Nurhidayati, L. G., & Cahyanta, A. N. (2025). Nanoemulsion formulation of face mist preparation with tomato extract (Solanum lycopersicum L.) and aloe vera juice (Aloe vera L.) to moisturize the face. *Jurnal Sains dan Kesehatan, 7*(5), 400–409. https://jsk.jurnalfamul.com/index.php/jsk/article/view/2557

Nusaibah, N., Sari, R. M., & Widianto, D. I. (2022). Utilization of pedada leaf extract (Sonneratia caseolaris) and katang-katang leaf (Ipomoea pes-caprae) as antioxidant agent in face mist formulation. *Jurnal Pengolahan Hasil Perikanan Indonesia, 25*(3), 441–456. https://doi.org/10.17844/jphpi.v25i3.42563

Rahmawati, D., Putri, N. K., & Sari, W. (2023). Test of antioxidant face mist spray power from tea leaf extract. *Indonesian Pharmaceutical Journal, 18*(1), 23–30.

Ramadhani, J. A. S., Nurfitriyanti, Y., Salsabilla, M., Aryani, N. B., & Hajid, R. M. (2024). Analysis of secondary metabolites in natural materials using VIS spectrophotometry. *Medic Nutricia: Jurnal Ilmu Kesehatan, 9*(5), 25–31.

Rao, J., & McClements, D. J. (2011). Formation of flavor oil microemulsions, nanoemulsions and emulsions: Influence of composition and preparation method. *Journal of Agricultural and Food Chemistry, 59*(9), 5026–5035. https://doi.org/10.1021/jf200094m

Ridho, R., & Arief, T. M. V. (2023, June 20). *Kabupaten Serang masuk 3 daerah paling berpolusi, banyak industri dan alat transportasi*. Kompas.com. https://regional.kompas.com/read/2023/06/20/183020478/kabupaten-serang-masuk-3-daerah-paling-berpolusi-banyak-industri-dan-alat

Sari, D. P., & Wahyuni, T. (2023). Dry time of face mist preparations as a parameter of user comfort. *Journal of Clinical Pharmacy, 11*(1), 34–40.

Tiwari, P., Kumar, B., Kaur, M., Kaur, G., & Kaur, H. (2011). Phytochemical screening and extraction: A review. *Internationale Pharmaceutica Sciencia, 1*(1), 98–106.

Umoh, R. A., Johnny, I. I., Udoh, A. E., Andy, N. A., Essien, A., Udoh, I. J., Ekpo, T. E., & Ashibeshi, G. U. (2022). Taxonomic and pharmacognostic evaluation of leaf of Mussaenda philippica A. Rich (Rubiaceae). *Asian Plant Research Journal, 9*(1), 6–13. https://doi.org/10.9734/APRJ/2022/v9i130195

Vats, A. (2023). Nanoemulsion: A comprehensive review of formation, properties, and applications. *PEXACY International Journal of Pharmaceutical Science*. https://doi.org/10.5281/zenodo.8167614

Wijaya, H., Novitasari, & Jubaidah, S. (2018). Comparison of extraction methods to the yield of sea rambai leaf extract (Sonneratia caseolaris L. Engl). *Jurnal Ilmiah Manuntung, 4*(1), 79–83.

Williams, A. C., & Schmitt, T. (2022). Drying time assessment of topical formulations. *Journal of Pharmaceutical and Biomedical Analysis, 208*, 114–121.

World Health Organization. (2025). *Exposure to health damaging air pollutants: Technical brief*. https://doi.org/10.2471/B09461/6

Wulandari, S., Pratiwi, R., & Dewi, N. K. (2025). Effect of glycerin and propylene glycol concentration on the physical properties of face mist preparations. *Indonesian Pharmaceutical Journal, 20*(1), 34–41.