Pharmaciana
Vol.14, No.3, Nov 2024, Page. 337-345
ISSN: 2088 4559; e-ISSN: 2477 0256
DOI: 10.12928/pharmaciana.v14i3.27001

The potential of swiftlet bird's nest extract (*Aerodramus fucipaghus*) as an antioxidant in serum formulation

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Submitted: 22-08-2023 ***Reviewed: 02-08-2024*** ***Accepted: 06-11-2024***

ABSTRACT

The white swiftlet bird's nest (*Aerodramus fucipaghus*) constitutes one of nature's treasures endowed with diverse health benefits. The swiftlet bird's nest is a potential source of antioxidants, capable of counteracting free radicals contributing to premature ageing. It can be harnessed as a serum formulation featuring small molecules, facilitating deeper skin penetration, efficient delivery of highly concentrated active agents, and expedited resolution of skin issues. This study aimed to ascertain the swiftlet bird's nest serum's physical properties, physical stability, and antioxidant activities. Serum formulations span a range of concentrations: 10%, 20%, 30%, and 40%. Physical attributes of the serum, including organoleptic properties, homogeneity, pH, spreadability, and viscosity, were observed. Serum stability was assessed over a 21-day storage period. The antioxidant activity of the serum was gauged via DPPH assay, determining the IC_{50} values. The serum, across varying concentrations, exhibited commendable physical characteristics, satisfying stipulated criteria. Antioxidant activity was detected in the serum across a spectrum of concentrations, revealing IC_{50} values of 250.00±1.58 µg/mL, signifying a range from weak to strong efficacy (90.137±0.4 µg/mL). The swiftlet bird's nest serum with its concentration variants demonstrated physical stability during the 21-day storage duration. Drawing from the research, it can be deduced that the swiftlet bird's nest holds promise for development into a serum formulation that fulfils both physical and stability criteria, endowed with robust antioxidant activity. Notably, the swiftlet bird's nest serum in formula 4 at a 40% concentration exhibited good physical, stability and potent antioxidant activity, manifesting an IC_{50} value of 90.137±0.4 µg/mL.

Keywords: swiftlet bird's nest, *Aerodramus fucipaghus*, serum, antioxidant, DPPH

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INTRODUCTION

The white swiftlet bird's nest (*Aerodramus fucipaghus*) is a natural treasure extensively harvested by Asian nations. Indonesia, in particular, is the world's largest exporter, contributing over 75% of the global supply of swiftlet bird's nests. Revered for its myriad health benefits, the swiftlet bird's nest serves as a dietary supplement renowned for its roles in skin lightening, prebiotic functions, and even burn wound healing (Chan et al., 2015; Anggraini & Kasmawati, 2017; Babji & Daud, 2019; Acharya & Satheesh, 2023).

The swiftlet bird's nest constitutes a promising source of antioxidants. Prior studies have revealed the antioxidant activity of swiftlet bird's nest at a concentration of 4 ppm, yielding an IC_{50} value of 4.0240 mg/g (Nadia et al., 2017). The glycoproteins within the swiftlet bird's nest function to counteract Reactive Oxygen Species (ROS) such as H2O2, thereby mitigating the escalation of free radicals and concurrently enhancing the antioxidant activity of the enzyme catalase (Dewi, 2020).

Free radicals constitute the foremost contributors to premature ageing, inducing skin pigmentation, collagen degradation, and damage to DNA, mitochondria, proteins, and lipid membranes (Krutmann et al., 2017; Nakai & Tsuruta, 2021). Skin ageing poses a prevalent concern within modern society. The emergence of fine wrinkles on the face, heightened skin dryness, and alterations in skin colouration characterise skin ageing. Premature ageing is brought about by free radicals, such as those originating from cigarette smoke, pollution, and exposure to UV rays (Zahruddin & Damayanti, 2018).

Antioxidants can impede the oxidation of oxidant molecules. Superoxide dismutase is a natural antioxidant synthesised by the body. Additionally, natural antioxidants can be obtained from natural sources, exemplified by vitamins A, C, and E, which derive from natural substances (Silvia, 2018). The human body lacks an abundant reserve of antioxidants; thus, additional antioxidants are required to inhibit the process of premature ageing.

Swiftlet bird's nest can be developed into cosmetic formulations, including serums. Serums are preparations with small molecules capable of penetrating the skin's deeper layers, delivering highly concentrated active ingredients, proving effective and swift in addressing various skin issues (Thakre, 2017).

This research aimed to harness the potential of white swiftlet bird's nest (*Aerodramus fucipaghus*) as an antioxidant serum. Serum possesses a lightweight texture, facilitating easy application to the face while refraining from leaving an oily residue on the skin. The serum is formulated across 10%, 20%, 30%, and 40% concentrations

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MATERIALS AND METHOD

Materials

The instruments employed encompassed UV-Vis Spectrophotometer (Agilent Technologies Carry 60 UV-Vis), Brookfield Viscometer, pH meter (Mettler Toledo), analytical balance (Dj. Series Excellent Scale), aluminum foil, and glassware. The utilized materials comprised 2,2-diphenyl-1-picrylhydrazyl (DPPH), methanol, and distilled water (aqua dest). All employed chemical substances were of analytical grade (p.a). White swiftlet bird's nest (*Aerodramus fucipaghus*) was employed as the active ingredient for the serum formulation. Excipients for the serum formulation consisted of Carbopol (Sigma-Aldrich), propylene glycol (Sigma-Aldrich), glycerin (Sigma-Aldrich), and nipagin (Sigma-Aldrich) obtained from PT Medikalab Indo Raya, Semarang.

Method

Sample preparation

The swiftlet bird's nest was thoroughly washed and cleaned to remove impurities and subsequently air-dried until completely dry. The dried white swiftlet bird's nest (*Aerodramus fucipaghus*) was finely blended to minimize the surface area, thereby enhancing the contact between the swiftlet nest particles and the solvent and optimizing the extraction of active compounds. The powdered swiftlet bird's nest

was then soaked in distilled water using a low-temperature water bath (maximum 71°C) for 10 minutes to facilitate expansion, after which it was finely ground (Anggraini & Kasmawati, 2017).

Preparation of white swiftlet bird's nest extract serum

The swiftlet bird's nest serum was formulated in four different concentrations, as outlined in Table 1. The swiftlet bird's nest serum production followed the methodology established in the referenced research study (Kurniawati & Wijayanti, 2018) with slight modifications. Carbopol was hydrated in distilled water overnight to form a gel, which was then stirred thoroughly to achieve uniformity and prevent clumps. Glycerin was gradually added while continuously stirring (mass 1). Nipagin was dissolved in propylene glycol (mass 2). Masses 1 and 2 were mixed, followed by the addition of the extract according to its concentration. Distilled water was added to reach the desired final volume.

Table 1. The formula for white swiftlet bird's nest extract serum

Materials	Concentration			
	F1	F2	F3	F4
Swiftlet Bird's Nest (*Aerodramus fuciphagus*)	10%	20%	30%	40%
Glycerin	15	15	15	15
Carbopol	0.5	0.5	0.5	0.5
Nipagin	0.2	0.2	0.2	0.2
Propylene Glycol	3	3	3	3
Distilled Water	ad 100	ad 100	ad 100	ad 100

Evaluation of physical properties of white swiftlet bird's nest extract serum

Organoleptic test

Visual observation of the preparation regarding the formulated serum's form, color, and aroma. Typically, serums exhibit a transparent white color and possess a moderately viscous texture.

Homogeneity test

This test was conducted by applying a serum sample onto a glass slide. The serum should exhibit a homogeneous composition without coarse particles (Kurniawati & Wijayanti, 2018).

pH Test

pH observation of the serum was conducted by immersing a pH meter into the formulation.

Viscosity Test

Viscosity testing was performed by placing a 100 mL sample in a Brookfield viscometer with the spindle immersed up to a specific limit, rotating at 60 rpm. An optimal facial serum viscosity typically falls within 230-1150 cps (Wijayanti & Faizatun, 2011).

Physical stability of the serum

The evaluation of the physical stability of the formulation was conducted to ensure that the preparation retained consistent properties post-production and continued to meet predefined criteria throughout storage. The serum's physical stability test involved observing the serum's organoleptic characteristics after storage for 21 days at room temperature (15-30°C (Ariyanti et al., 2020).

Antioxidant activity of swiftlet bird's nest serum

Determination of wavelength and operating time

Antioxidant activity is carried out by DPPH method (Rispriandari et al., 2024). A solution of 0.1 mM DPPH was prepared by dissolving 10 mg of DPPH powder in 250.0 mL of methanol. The maximum wavelength and blank were determined by adding 2 mL of 0.1 mM DPPH solution to 2 mL

of methanol p.a. The mixture was then measured using a UV-Vis spectrophotometer at 400 to 600 nm wavelengths. To determine the operating time, 50 µL of a standard vitamin C solution was added to 4 mL of 0.1 mM DPPH solution. The mixture was homogenized using a stirrer for 1 minute, and its absorbance was measured at 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, and 60 minutes at the maximum wavelength (Widyowati et al., 2014).

Determination of antioxidant potential

A standard solution at a 100 µg/mL concentration was prepared by dissolving 10 mg of vitamin C in 100 mL of methanol. A dilution series was prepared at concentrations of 1 µg/mL, 4 µg/mL, 7 µg/mL, 10 µg/mL, and 13 µg/mL. For each concentration, 2.0 mL of 0.1 mM DPPH solution was added to a volumetric flask containing 2 mL of the standard solution. Test solutions were prepared by dissolving 25 mg in 50 mL of methanol to achieve a concentration of 500 µg/mL, followed by dilution series at concentrations of 50 µg/mL, 100 µg/mL, 150 µg/mL, 200 µg/mL, and 250 µg/mL. Again, for each concentration, 2.0 mL of 0.1 mM DPPH solution was added to a volumetric flask containing 2 mL of the test solution. Both test and standard solution flasks were vortexed for 30 seconds and then incubated for 30 minutes in a dark room. Absorbance was measured using a UV-Vis spectrophotometer at the predetermined maximum wavelength. The obtained absorbance results were substituted into the following equation 1.

$$\%\text{Inhibition} = \frac{Blank\ Absorbance - Sample\ Absorbance}{Blank\ Absorbance}\ x\ 100\ \% \quad \text{.....(1)}$$

The values of the extract or standard concentration, along with their respective inhibition percentages, were plotted on the x and y axes using the equation 2.

$$y = a + bx \quad \text{.....(2)}$$

A linear regression equation was employed to determine the IC_{50} values of each sample by expressing the y-value as 50 and the x-value as IC_{50}. The IC_{50} value indicated the sample concentration required to reduce 50% of the DPPH free radicals.

Data Analysis

Data analysis was conducted using SPSS. Viscosity, spreadability, and adhesion data were assessed using the Shapiro-Wilk test to ascertain their normal distribution. Homogeneity was examined using the Levene test. Normally distributed and homogenous data were further analyzed through parametric One-Way ANOVA followed by Post Hoc Tests. Non-normally distributed data was assessed using Kruskal-Wallis and Mann-Whitney tests. Stability data were analyzed using Repeated Measures ANOVA.

RESULT AND DISCUSSION

Physical properties of white swiftlet bird's nest extract serum

The white swiftlet bird's nest extract (*Aerodramus fuciphagus*) utilized in this research was obtained from a bird nest breeding facility in Sukamara Regency, Southeast Kalimantan. White swiftlet bird's nest extract was formulated into a serum preparation and subsequently subjected to physical property tests, encompassing organoleptic assessment, homogeneity, pH, viscosity, spreadability, and adhesion. Organoleptic test results revealed that the white swiftlet bird's nest extract serum exhibited a dull white color, carried a distinct swiftlet bird's nest aroma (musty), and possessed a dense texture akin to serum (Figure 1, Table 2).

Figure 1. White swiftlet bird's nest serum

Based on the observations (Figure 1), formula 1 with a 10% concentration yields a serum color that is clearer and brighter. As the concentration of white swiftlet bird's nest extract increases, the resulting serum color tends to become a darker dull white.

Table 2. The results of organoleptic and homogeneity tests on the serum

Formula	Color	Aroma	Form	Homogeneity
F1	Dull White	Distinct	Viscous	Homogeneous
F2	Dull White	Distinct	Viscous	Homogeneous
F3	Dull White	Distinct	Viscous	Homogeneous
F4	Dull White	Distinct	Viscous	Homogeneous

Homogeneity testing was conducted to observe whether the preparation is uniform by examining the presence of large or coarse particles in the serum. The test results for the preparation (Table 2) indicate the absence of coarse particles, thus confirming that the white swiftlet bird's nest serum (*Aerodramus fuciphagus*) is considered homogeneous.

Table 3. The pH test results of the serum

Formula	Day				p-Value
	1	7	14	21	
F1	5.03±0.1	4.93±0.4	4.97±0.2	5.05±0.5	0.024
F2	4.84±0.4	4.91±0.3	4.87±0.1	4.99±0.4	
F3	4.92±0.2	4.64±0.5	4.66±0.1	4.70±0.3	
F4	4.97±0.1	4.87±0.3	4.66±0.5	4.64±0.3	

The results of the physical test on the white swiftlet bird's nest extract serum (Table 3) at various concentrations reveal pH values ranging from 4.64 to 5.05, falling within the pH range suitable for topical formulations, which is 4 to 5.5 (Thakre, 2017). pH measurement determines whether the formulated product is safe and non-irritating when applied to the skin. An excessively low pH value can lead to skin irritation due to its acidic nature, while a high pH value can cause skin dryness (Putri & Anindhita, 2022). At varying concentrations, the antioxidant serum with white swiftlet bird's nest extract significantly influences the resulting pH with a significance value of 0.024 ($p<0.05$). Meaningful differences are observed between the 10% (F1) concentration and the 30% (F3) and 40% (F4) concentrations. Across the serum formulations at different concentrations, no significant difference was observed between pH and storage time with $p=0.324$ ($p>0.05$). The results of the spreadability test for the white swiftlet bird's nest extract serum (*Aerodramus fuciphagus*) can be observed as follows Table 4.

The spreadability test aimed to determine the ability of the serum preparation to spread. The spreadability test results (Table 4) for various formulations meet the criteria for good serum spreadability: having a diameter within the range of 4-7.5 cm (Montenegro et al., 2015). The analysis of the white swiftlet bird's nest serum formula (*Aerodramus fuciphagus*) at various concentrations

reveals a significant difference with a significance value of 0.004 ($p<0.05$). Meaningful differences are observed between concentrations F1 and F4 and between F1 and F3. The spreadability of the serum during a 21-day storage period indicates good stability across various concentrations, with no significant difference observed at $p=0.553$ ($p>0.05$) concerning storage time. The spreadability value is inversely proportional to viscosity, where an increase in formulation thickness leads to a decrease in spreadability (Mudhana & Pujiastuti, 2021).

Table 4. The Results of the spreadability test (cm) on the serum

Formula	Day				p-Value
	1	7	14	21	
F1	6.8 ±0.1	6.8 ±0.3	7±0.2	7±0.1	0.004
F2	5.5±0.2	5.8±0.4	5.8±0.4	5.9±0.6	
F3	5±0.2	5.2±0.5	5.2±0.6	5±0.3	
F4	5.2±0.1	5±0.2	5±0.2	5±0.3	

The viscosity values of the swiftlet bird's nest extract serum (Table 5) indicate that higher extract concentrations result in thicker serum viscosity and lower spreadability values. In the viscosity test, the data analysis reveals significance between the serum formulations at 10% and 40% concentrations. The higher the extract concentration, the higher the viscosity. The viscosity of the formulation can be influenced by various factors, including temperature changes, variations in manufacturing conditions, and raw material quality (Thakre, 2017), including the concentration of the active ingredient (Mardhiani et al., 2018). The concentration of added swiftlet bird's nest extract in the serum impacts viscosity due to the texture of swiftlet bird's nest being similar to agar, necessitating a balance with increased water phase to achieve the desired viscosity. Stability analysis of the serum across all four formulations reveals no significant difference, with $p=0.506$ ($p>0.05$), in viscosity during a 21-day storage period.

Table 5. The results of the serum viscosity test (cps)

Formula	Day				p-Value
	1	7	14	21	
F1	224±0.6	256±0.5	273±0.6	274±0.7	0.003
F2	362±0.2	421±0.4	421±0.6	425±0.3	
F3	4210±0.2	4430±0.6	4060±0.6	4020±0.4	
F4	7392±0.3	7283±0.2	7308±0.6	7308±0.5	

Antioxidant activity of white swiftlet bird's nest extract serum

The results of the antioxidant test using the DPPH method on the White Swiftlet Bird's Nest Extract Serum (*Aerodramus fuciphagus*) at concentrations of 10%, 20%, 30%, and 40% can be observed in the following Table 6. The antioxidant activity test on the white swiftlet bird's nest extract serum (*Aerodramus fuciphagus*) uses the DPPH method (Sabandar et al., 2023), which involves a nitrogen radical compound. The DPPH reaction mechanism operates through electron transfer. The DPPH method is chosen due to its simplicity, ease of use, sensitivity, and requirement of only a tiny sample (Rahmawati et al., 2016). Antioxidant activity in this reaction can be observed through the change of colour from purple to yellow. Before reading the absorbance, the sample solution is incubated for 30 minutes to allow the donation reaction between the free radicals and the sample solution to be tested for its antioxidant activity (Martiani et al., 2017).

The antioxidant test results using the DPPH method on the white swiftlet bird's nest extract serum (*Aerodramus fuciphagus*) at concentrations of 10% (F1), 20% (F2), 30% (F3), and 40% (F4) are 250.00±1.58 µg/mL, 132.31±0.74 µg/mL, 118.57±0.37 µg/mL, and 90.13±0.4 µg/mL respectively.

These results will be compared with the positive control, a commercially available serum (Vitamin C Serum), and the negative control in the form of the serum base.

Table 6. The results of the antioxidant activity test on the serum

Formula	Concentration (µg/mL)	% Inhibition	lC50 (µg/mL)
F1	50	12.033±0.06	250.00±1.58
	100	21.352±0.12	
	150	29.240±0.08	
	200	36.792±0.14	
	250	53.058±0.16	
F2	50	27.237±0.07	132.31±0.74
	100	41.492±0.05	
	150	52.870±0.06	
	200	68.341±0.15	
	250	85.395±0.23	
F3	50	30.521±0.09	118.57±0.37
	100	47.487±0.05	
	150	60.444±0.15	
	200	66.666±0.17	
	250	85.351±0.28	
F4	50	40.2597±0.26	90.137±0.4
	100	50.7499±0.38	
	150	66.1113±0.43	
	200	81.0967±0.64	
	250	92.5357±0.48	
Control (+): Vitamin C Serum			138.17±0.4
Control (-): Base (Placebo)			2415.37±0.59

From the antioxidant test results on the white swiftlet bird's nest extract serum using the DPPH method (Table 6), it can be observed that the serum formulation exhibits antioxidant activity ranging from strong to weak. At a concentration of 10%, the white swiftlet bird's nest serum shows weak antioxidant activity with an IC_{50} value of 250.00±1.58 µg/mL. The limited antioxidant effect of the swiftlet bird's nest might be attributed to the relatively small amount of peptide bonds that have undergone hydrolysis, subsequently reducing the number of amino groups and consequently decreasing its pharmacological effectiveness (Ramachandran et al., 2018). The weak antioxidant effect of the white swiftlet bird's nest serum formulation can also be attributed to the relatively low concentration or content of the swiftlet bird's nest used in the 10% concentration formulation. The white swiftlet bird's nest serum formulation at 20% and 30% exhibits moderate antioxidant activity with IC_{50} values of 132.31±0.74 µg/mL and 118.57±0.37 µg/mL, respectively. The formulation at 40% concentration shows vigorous antioxidant activity with an IC_{50} value of 90.13±0.4 µg/mL. Compared to the positive control (Vitamin C Serum) with an IC_{50} value of 138.17±0.4 µg/mL, the white swiftlet bird's nest serum at a 20% extract concentration already falls within the range of commercially available serums. In the case of the negative control, the obtained IC_{50} value is 2415.37±0.59 µg/mL, indicating the absence of antioxidant activity in the negative control formulation (Base) due to the absence of white swiftlet bird's nest (*Aerodramus fuciphagus*) content.

Swiftlet bird's nests contain various amino acids, including cysteine, methionine, histidine, tyrosine, tryptophan, and phenylalanine (Ali et al., 2019). Hydrophobic amino acids, including tyrosine, activate the antioxidant in the white swiftlet bird's nest. The mechanism of free radical inhibition by the amino acid tyrosine involves the activity of the ROO• group, which acts as a proton

donor in the tyrosine peptide. The ROO• radical acquires a proton from the hydroxyl group of tyrosine, forming a neutral molecule ROOH. Tyrosine transforms into a new radical, which can resonate to become a stable ketone group (Esfandi et al., 2019).

White swiftlet bird's nest (*Aerodramus fuciphagus*) contains Epidermal Growth Factor (EGF), which can be utilized as an anti-ageing agent. EGF functions by improving skin texture and tissue, leading to skin rejuvenation. EGF plays a significant role in regenerating skin cells, accelerating the metabolism of the skin layers, and repairing dead skin cells (Rohmah, 2019). Hence, aside from being a nutritious and healthy dietary source, swiftlet bird's nest can also be developed into various cosmetic formulations within the beauty industry.

CONCLUSION

Based on the research, it can be concluded that a swiftlet bird's nest can be developed into a serum formulation that meets the physical and stability criteria with potent antioxidant activity. The swiftlet bird's nest serum in formula 4 at a concentration of 40% exhibited good physical, stability and potent antioxidant activity, with an IC_{50} value of 90.137±0.4 µg/mL.

ACKNOWLEDGEMENT

The authors would like to thank the Faculty of Pharmacy, Universitas Islam Sultan Agung, which has facilitated and helped research until it can be completed well.

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