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Sun protection factor value of *Rosa centifolia* and *Rosa alba* from Merapi mountain Indonesian National Park and its potency as sunscreen

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Abstract

The potential wild *Rosa centifolia* L. and *Rosa alba* extracts in the Sapuangin region of Merapi Mountain National Park have not been explored. This study investigated the phytochemical content, antioxidant activity, and potential of extracts from *R. centifolia* and *R. alba* as sunscreen. *R. centifolia* and *R. alba* simplicia were extracted with methanol and ethanol to obtain four rose extract types. Phytochemical content was investigated using qualitative assay. Spectrophotometry was used to determine total flavonoid (TFC) and phenolic content (TPC). Antioxidant activity was evaluated using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) method. Potential extracts as sunscreen were evaluated with sun protection factor (SPF) assay. The qualitative phytochemical assay showed both ethanolic and methanolic extracts of *R. centifolia* contained saponin, tannin, flavonoid, and triterpenoid. Alkaloids were only contained in the methanolic extracts of *R. centifolia*. Ethanolic and methanolic extract of *R. alba* contained saponin and flavonoid. Alkaloid was present in the ethanolic extract of *R. alba*, while tannin is only in the methanolic extract of *R. alba*. The highest TFC was shown by methanolic extract of *R. alba* (68.132 ± 0.484 mg /QE/g). Methanolic extract of *R. centifolia* showed the highest TPC (253.090±2.530 mg GAE/g). Methanolic extract of *R. centifolia* exhibited IC_{50} values of DPPH scavenging 22,622 µg/mL and was categorized as a strong antioxidant activity. Likewise, the SPF value is the highest among the other extracts, namely 32.602 ± 0.430 at a concentration of 500 ppm. *R. centifolia* and *R. alba* ethanolic and methanolic extracts have the potential to be used as candidates for antioxidant and sunscreen sources.

Keywords

Rosa alba; Rosa centifolia; rose; SPF; sunblock

Introduction

The skin, as a protecting layer, a thermoregulator, decipherer of stimuli, the site of synthesis of vitamin D and immune system collaborator, is the largest organ of the human body. It acts as a protective barrier against microorganisms and chemicals and also protects the body internal organs from free radicals and sunlight. Skin disorder involved every age group can affect the body intimately and externally (1, 2). Overexposure to sunlight can burn the skin resulting in sunburns, premature aging signs such as age spots. It also increases the risk of developing skin cancer. Stratum corneum thickness is increased by UVB rays, causing disruptions of barrier permeability thereby leading to reduced hydration within the epidermis (2, 3).

Using sunscreen is an effective way to protect the skin from UV damage. Sunscreens with high SPF protect against UV-A and UV-B radiation and contained antioxidants that neutralize UV rays. Antioxidants, as compounds capable of reducing the activity of free radicals and converting them into non-radical compounds, are a determining factor in achieving a higher SPF value (4).

The rose (*Rosa* sp.) has aesthetic value and is most widely used in medicine and cosmetics (5). Formerly, roses have been utilized to alleviate issues such as inflammation, burning, conjunctivitis, coughs, skin diseases, heart complications, fevers and recurrent weakness (6). Several chemical constituents that were found in the *R. centifolia* flower petals or the red rose were several as was ascertained by gas chromatography. Some of the main components of these oils are phenyl ethanol (43%), geranyl acetate (15.6%), geraniol (10.5%), linalool (6.9%), benzyl alcohol (3.3%), benzaldehyde (1.5%), nerol (5-10%), and citronellyl acetate (0.3%). Additionally, the petals are composed of tannins, oligomeric proanthocyanidins, saccharine matter, mineral salts, salts of malic acid and tartaric acid, pectin (11%), riboflavin, sugars, and purgative glycosides multiflorin A and B. Red rose contains phytochemical factors such as the alkaloids, phenolic acids, and flavonoids that give it antioxidant, antidiabetic, anti-inflammatory and antibacterial properties. Red roses also contain carbohydrates and amino acids as pointed out by researchers (7).

Rosa alba or white rose contains flavonoids, terpenoids, tannins, and phenolic compounds in various quantities. Its essential oils contain citronellol, geraniol, nerol, and citral and have powerful antimicrobial and antioxidant activity (8, 9). This plant has demonstrated various biological activities, including antioxidant, antifungal, and antimicrobial. It has been used in traditional medicine to treat heart palpitations, headaches, colds, leprosy, and other illnesses (10).

Red roses (*R. centifolia* L) and white flowers (*R. alba*) are common in the Sapuangin area of Merapi Mountain National Park but used mostly as cut flowers. Scientific work devoted to their phytochemical profiles and antioxidant capacity with specific emphasis on sunscreens remains limited. Therefore, the need to investigate the exact antioxidant activity cannot be overemphasized to provide a basis for evaluating their potential as possible candidates for sunscreens. Hence, it is pertinent to assess their antioxidant potentials by employing the DPPH technique, the *in vitro* antioxidant analysis to estimate the IC_{50} value, total phenolic content (TPC) and total flavonoid content (TFC). The ability of these extracts to act as sunscreens will also be determined, whereby their sun protection factor (SPF) will be ascertained as well.

Materials and Methods

R. centifolia L and *R. alba* flowers were carefully collected from the Sapuangin Region of Merapi Mountain National Park, located in Klaten, Central Java, Indonesia. These samples were then accurately identified by the Industrial Biotechnology Laboratory at Universitas Atma Jaya Yogyakarta with identification letter number 24/X/FTb/2024 for *R. centifolia* and 23/X/FTb/2024 for *R. alba*. The herbariums were stored in Industrial Biotechnology Laboratory, Universitas Atma Jaya Yogyakarta.

Chemicals and reagents

Absolute methanol, absolute ethanol (Merck, Germany), distilled water, quercetin standard, 1,1-diphenyl-2-picrylhydrazyl (DPPH) solution, Wagner reagent, Meyer reagent, Dragendorf reagent, Folin-Ciocalteu reagent, HCl, H_2SO_4, magnesium powder, Liebermann Burchard reagent, chloroform, ammonia.

Samples preparation

Extraction was done using maceration method and the solvents were used absolute ethanol and absolute methanol. One hundred grams of dry samples were placed into an Erlenmeyer flask and 500 mL ethanol was added to flask, where the powder had settled down. The Erlenmeyer flask was covered by aluminium foil and placed into the shaking incubator with temperature range of 27-30°C and the shaking velocity of 130 rpm for three times 24 hours. The same procedure was repeated with absolute methanol. It was then filtered using Whatman filter paper and the macerate was then packaged and stored in airtight containers. Every sample was remacerated with 500 mL of solvent for one cycle and allowing 24 hours for the process to take place, followed by filtration. To concentrate the filtrate, the rotary vacuum evaporator temperature was set at 50°C while speed was set at 70 rpm. The extract could be further concentrated in an oven at a temperature of 50°C (approximately 3 times in 24 hours), then stored in a chiller.

Phytochemical screening test

Saponin: A total of 0.1 g of the sample was added to water and heated for 5 minutes, then filtered. The filtrate was placed into a reaction tube, shaken vigorously for 10 seconds, and allowed to stand for 10 minutes. The presence of saponin was confirmed by the formation of stable foam (11).

Flavonoid: A total of 1 g sample was added to distilled water, heated, filtered, and the obtained filtrate was mixed with magnesium powder, concentrated hydrochloric acid (HCl), and amyl alcohol. A positive result in flavonoid test was indicated by the presence of red, yellow, or orange coloration (12).

Tanin: 0.1 g of extract was placed into a test tube. Warm water was added (10 mL), shaken and filtered. The obtained filtrate was added with 5 drops of 1% iron chloride ($FeCl_3$). A positive result was indicated by a color change to dark blue or dark green (13).

Alkaloid: 1 g of rose extract is placed in a reaction tube, followed by the addition of 1 mL of ammonia and 10 mL of chloroform, which were then mixed thoroughly and filtered. The resulting filtrate was combined with 2 N sulfuric acid (H_2SO_4), shaken, and left for 1 minute. The upper layer of sulfuric acid was transferred to three

separate reaction tubes, where 3 drops each of Meyer, Dragendorff, and Wagner reagents were added. A positive test with Meyer reagent formed white precipitate, Dragendorff reagent formed brown precipitate, and Wagner reagent formed orange precipitate (14).

Triterpenoid and Steroid: 1 mg of rose extract was placed on a drop plate, to which 6 drops of anhydrous acetic acid were added and mixed. One drop of concentrated H_2SO_4 was then added. A positive result for steroids was indicated by a color change to blue or green, while triterpenoids are indicated by a purple or orange color (15).

Determination of total flavonoid content (TFC)

Preparation of standard quercetin for calibration curve: Total flavonoids content (TFC) in extract was determined from the aluminium trichloride colorimetric method with slight modifications (16). To prepare quercetin stock solution of 100 ppm the following was done: An initial solution of the quercetin standard was prepared by dissolving 5 mg of quercetin in 25 mL methanol. This solution was serially diluted to obtain the concentrations of 12, 18, 30 and 36 ppm respectively. To each concentration, 2 mL of the quercetin solution was mixed with 2 mL of 10% $AlCl_3$. The reaction mixture was stirred for 8 minutes after which 2 mL of 1 M NaOH was added. The volume of the final solution was made up to 10 mL by addition of distilled water. The amount of the substance in the samples of the quercetin series was defined in a UV-VIS spectrophotometer at the wavelength of 435 nm. Flavanoids content was evaluated in terms of quercetin from the calibration equation obtained for the standard.

Preparation of samples for total flavonoid content

From a stock solution, 100 mg of rose extract was dissolved in 2 mL solvent to make the stock solution of 50,000 ppm. The stock solution was then diluted to achieve concentration of 500 ppm. One milliliter of 10% $AlCl_3$ was added, to 1 mL of extract solution and the mixture allowed to stand for eight minutes. This was succeeded by the addition of 1 mL of 2 N sodium acetate solution and left to settle for 30 minutes before absorbance was measured at 435 nm. All determinations were done in triplicate, and the mean absorbance value was used in calculations of the total flavonoid content. The flavonoid content was calculated as quercetin equivalent (mg QE/g) with the help of the equation obtained with reference to the calibration curve (16).

Determination of total phenolic content (TPC)

Preparation of standard gallic acid for calibration curve: The Folin–Ciocalteu colorimetric methods, with some modifications, were utilized to determine the total phenolic contents (TPC) of the extracts (16). To prepare a 100-ppm solution, 10 mg of gallic acid was dissolved in 100 mL of methanol. Different concentrations of gallic acid solutions (20, 40, 60, and 80 ppm) in methanol were made by diluting this solution. The standard solution of 1 mL of gallic acid series was mixed with 5 mL of 7.5% Folin-Ciocalteu reagent and 4 mL of 1% NaOH. The combination was allowed to incubate for one hour. The absorbance of the series was measured at 615 nm. Each experiment was conducted three times, and the average absorbance values for various concentrations of gallic acid were plotted to create the calibration curve.

Preparation of samples for total phenolic content

The rose extract was weighed at 20 mg and dissolved in a solvent volume of 2 mL, to achieve an initial concentration of stock at a final concentration of 10,000 ppm. This stock solution was diluted to achieve a final concentration of 250 ppm. Five milliliters of 7.5% Folin–Ciocalteu reagent (FCR) were added to the 250 ppm extract solution and incubated for five minutes. Four milliliters of 1% NaOH was added and incubated for one hour. The wavelength used to measure the total phenolic content was 615 nm. For accuracy, the samples were prepared and measured in triplicate, and the average absorbance was utilized to create a calibration curve for assessing the phenolic content in the extracts. Total phenolic content was measured in milligrams of gallic acid equivalents (mg/GAE) per gram sample on dry weight basis (mg/g). Total phenolic contents were calculated from a formula, which was applied for every test sample (16).

Antioxidant activity

The radical scavenging capacity was determined using a spectrophotometer by DPPH assay method with some modifications (17). A 20 mg of rose extract was dissolved with 2 mL solvent (methanol/ethanol) to obtain a final solution concentration as high as 10,000 ppm. Subsequentially, 0.25 mL of the original solution was diluted with methanol or ethanol, up to a final concentration in one volume equal to 100 ppm. The solution was further made into five standard series solutions namely 20 ppm, 40 ppm, 60 ppm, 80 ppm and 100 ppm. In summary, 1 mL of each test sample of varying concentrations was taken and mixed with 3 ml of DPPH solution. This mixture was thoroughly vortexed after which residual DPPH was measured at 460 nm after 30 minutes. Ascorbic acid served as the standard antioxidant for activity comparison. DPPH radical-scavenging is calculated by the following equation, as DPPH scavenging effect (%) = [(Absorbance of control – Absorbance of sample)/Absorbance of control] × 100. The effectiveness was expressed in terms of inhibitory concentration 50% (IC_{50}) values (µg/mL), which indicate the inhibition concentration for 50% inhibition.

Sun protection factors (SPF)

A rose flower extract was weighed at 50 mg and dissolved in 50 mL of solvent, resulting in a 1000 ppm rose extract solution. This solution was then diluted to concentrations 500 ppm from the stock extract solution. The absorbance of the extract was measured at 5 nm increments from wavelengths of 290 to 320 nm. Three replications were conducted, and the sun protection factor (SPF) was calculated using the formula (18):

$$SPF = CF \, X \sum_{290}^{320} EE \ (\lambda) \ X I \ (\lambda) \ Abs \ (\lambda)$$

Note:

EE: Erythemal effect spectrum

I: Intensity of the sunlight spectrum

Abs: Absorbance of the sunscreen product

CF: Correction factor (10)

Statistical analysis

All assays were conducted in triplicate, and the results are presented as the mean ± standard deviation. Statistical analysis among different treatments was performed using one-way ANOVA in SPSS 16.0. A statistical significance of $p < 0.05$ was considered to be significant.

Results and Discussion

Phytochemical compounds of R. centifolia and R. alba

Rosa centifolia and *Rosa alba* flowers that are used in this study are usually grown by the local community in the Sapuangin area of Merapi Mountain National Park (Fig. 1). *R. alba* also referred to as Bulgarian White Rose, is amongst the very old type of rose, said to either belong to the Mediterranean or Middle Eastern region. It is considered as an ancestor of *R. damascena*. Historically, *R. alba* was sowed and harvested in combination with *R. damascena* Mill. for commercial reasons. Meanwhile, *R. centifolia* has gained significant research interest due to its beneficial nutrition, as its petals are high in molecules with antioxidant activities, desirable organoleptic properties, and antimicrobial activities (19).

Phytochemical investigation in this study reveals that the ethanolic and methanolic extract of *R. centifolia* has saponin, tannin, flavonoids, and triterpenoids (Table 1). The key distinction lies in the presence of alkaloids, which are detected exclusively in the methanolic extract of *R. centifolia*. Crude extract of *R. centifolia* analyzed in this study revealed the same alkaloids, saponins, flavonoids, tannins, and terpenoids as highlighted in (20). However, a slightly different profile was reported wittingly in ethanol extract of *R. centifolia* other than preceding works (21). In this study, some of the detected compounds including carbohydrates, steroids, triterpenoids, glycosides, saponins, flavonoids, alkaloids, tannins, and phenolics. On the other hand, alkaloids and steroids were not detected in this study on the ethanol extract. A preliminary analysis from another study on the crude extract of *R. centifolia* identified various bioactive compounds, including carbohydrates, glycosides, alkaloids, flavonoids, and amino acids (13).

Such variations might be due to differences in the extraction process, the state of the plant or the state of environment from which it was extracted from (22). The extraction of bioactive compounds is a critical step in natural product research. Maceration is a simple extraction method that involves soaking the plant prepared raw material in a coarse or powder form in a solvent of interest at room conditions for at least three days with intermittent agitation. It is crucial to select an appropriate solvent in the maceration as the solvent will delineate the phytochemicals classes salvaged from the samples. The solvent could also enable the extraction of thermolabile phytochemicals. The application of heat during the extraction process can improve the yield and

Fig. 1. *Rosa centifolia* (A) and *Rosa alba* (B) flower sourced from the Sapuangin Region of Merapi Mountain National Park, located in Klaten, Central Java, Indonesia.

Table 1. Phytochemical test results of *R. centifolia* and *R. alba* extract

Indicators	*R. centifolia* ethanolic extract	*R. centifolia* methanolic extract	*R. alba* ethanolic extract	*R. alba* methanolic extract
Saponin	+	+	+	+
Tanin	+	+	-	+
Flavonoid	+	+	+	+
Alkaloid	-	+	+	-
Steroid	-	-	-	-
Triterpenoid	+	+	-	-

diversity of phytochemicals extracted compared to the traditional maceration method (23, 24).

In this study, the methanol extract of *R. alba* did not respond positively to the presence of alkaloids, steroids and triterpenoids but observed positive for saponin, tannin and flavonoids. Ethanol extract of *R. alba* contained saponins, flavonoids and alkaloids for which the plant has been used traditionally to treat various ailments. These phytochemicals are slightly different from those, which encompasses proteins, amino acids, carbohydrate, tannins, terpenoids and glycosides (25). Such differences can be attributed to the used extraction methods, as Soxhlet extraction with heating and it allows obtaining more groups of phytochemicals (25).

The growing environment of a plant also significantly influences the phytochemical content it produces. Environmental factors such as soil type, humidity, temperature, light intensity, altitude, rainfall, and exposure to pollutants play a crucial role in regulating the production of secondary metabolites, including alkaloids, flavonoids, tannins, and phenolic compounds. Favorable environmental conditions can stimulate plants to produce higher levels of phytochemicals as an adaptive response to environmental stresses such as drought, pathogen attacks, or UV radiation.

Total phenolic content (TPC) and total flavonoid content (TFC)

The flavonoids subclass belongs to low molecular weight phenolic compounds and can be regarded as the major group of natural products and secondary metabolites in plants. All these compounds are extremely vital to the synthesis of plant structures and in their protection system. Furthermore, many flavonoids are involved in the formation of primary pigments of flowers in most of the plants (26, 27).

The phenolic compounds are generally classified into two main categories non-flavonoids and flavonoids. Moreover, flavonoids come under the polyphenols category that contains at least two phenolic rings, and they are further categorized into different sub-class such as flavonols, flavonones, flavones, flavanolols, flavan-3-o1s, and isoflavones. The phenolic and flavonoids compounds antioxidant activity is directly correlated with the presence of the sample's hydroxyl (-OH) group. Further, the positions of hydroxyl groups also decide the generation of free radical scavenging activity. The phenolic compounds have already been proven to have many therapeutic effects such as antimicrobial, antioxidant, anticancer, and antidiabetic (28, 29).

In general, the extraction using methanol has higher flavonoid and phenol content as compared to ethanol extraction which has also observed in this study for both plant collections of *R. centifolia* and *R. alba* (Table 2). Most notably, the methanol extract of *R. alba* contained the highest amount of TFC, and the methanol extract of *R. centifolia* contained the highest amount of TPC. Higher phenolic compounds level in *R. centifolia* rather than *R. alba,* but flavonoids were almost similar in both species.

The presence of a high content of phenolic in plant extract as bioactive compounds are mainly responsible for antioxidant (29). TPC value for the ethanol extract of *R. centifolia* is lower than a TPC value of 388 ± 0.01 mg GAE/g (30). However, the TFC value for the ethanol extract obtained is comparatively higher than TFC value to be 17.8 ± 1.1 mg QE/g (30). The TPC of ethanol and metanol extract of *R. alba* in this study is higher compared to the previous researches, where the TPC obtained was 72.72 µg GAE/mL (31). Such difference may arise from differences in extraction techniques as well as the reagents used to carry out the extraction.

Each of ethanol and methanol can be used for the extraction of the bioactive compounds which include flavonoids and phenolics in the plants. Ethanol is moderately polar thus it can dissolve both polar and slightly non-polar compounds that enables it to dissolve a wide range of phenolics and flavonoids. Whereas, methanol, due to its higher polarity, is more effective at extracting highly polar phenolic compounds (29).

IC50 and antioxidant activity

Antioxidant can be defined as bioactive compounds that inhibit or delay the oxidation of molecules. The antioxidant potency of compounds is well measured for its

Table 2. Total flavonoid content (TFC) and total phenolic content (TPC) of *R. centifolia* and *R. alba* extract

Extract	TFC (mg QE/g)	TPC (mg GAE/g)
R. centifolia ethanolic extract	51.443 ± 0.846[a]	179.710 ± 2.580[a]
R. centifolia methanolic extract	62.395 ± 0.726[a]	253.090 ± 2.530[a]
R. alba ethanolic extract	48.373 ± 1.055[a]	116.117 ± 1.106[a]
R. alba methanolic extract	68.132 ± 0.484[a]	166.121 ± 1.143[a]

Statistical analysis was conducted using one-way ANOVA in SPSS 16.0, with $p < 0.05$ considered significance.

efficiency of an inhibitory concentration 50% (IC_{50}) value. It defines the amount required to scavenge 50% of a specific oxidative reaction or free radicals in the assay sample. A lower IC_{50} indicates stronger antioxidant activity (28, 32). Regarding flavonoid and phenolic compounds classified under antioxidant point of view these may act to inhibit lipids of cell membranes from oxidation which in any case will be beneficial to health. Antioxidants directly scavenge free radicals by accepting an electron or hydrogen ion and thus, forestalling the damaging impact of these species on keys biomolecules such as DNA, lipids, and proteins. They are involved in cell protection and aging process regulation (33).

The classification of antioxidant activity based on IC_{50} values are as follows: inactive if the IC_{50} value is above 250 μg/mL, weak if between 100 and 250 μg/mL, moderate if between 50 and 100 μg/mL, strong if between 10 and 50 μg/mL, and very strong if the IC_{50} value is less than 10 μg/mL (34, 35).

From these results it can be widely concluded that the phenolic as well as the flavonoid compounds existing in the extract were positively correlated with the antioxidant activity. These findings are consistent, where low IC_{50} value corresponds to higher TFC, TPC, thereby indicating that extract has higher antioxidant activity (Table 3). Importantly, the current study showed that *R. centifolia* possessed a higher antiradical activity compared to *R. alba* and this implies that the level of phytochemicals with antioxidant potential in *R. centifolia* is significantly higher. *R. centifolia* extract which contains phenolic acids, flavonoids, tannins, anthocyanins, citronellol, geraniol, eugenol and vitamin C have been identified to exhibit antioxidant activities. These are important in the antioxidant activity since they are capable of donating hydrogen atoms or electrons to the free radicals (7, 29).

SPF value of R. centifolia and R. alba extract

Sun protection factor or SPF refers to the level of protection that sunscreens provide against the UV radiation, particularly the UV-B radiation. These UV-B rays are the main cause of sunburn, and they play a significant role in skin malignancy. SPF value is a theoretical measure of the factor by which protection from erythema or sunburn is achieved through the application of sunscreen compared to exposure on unprotected skin (36).

The absorbance and SPF values of the four extracts are presented in Table 4. It was observed that all tested extracts demonstrated UV protection capabilities. Several observations were noted the samples tested for UV protectants, showed protection from the UV light. Concerning ultra-protection, the methanolic extracts both from *R. centifolia* and *R. alba* have revealed rather similar level of activity, whereas the ethanolic extract of *R. centifolia* and *R. alba* presented maximum protection activity. The SPF value at 500 ppm was high in the methanolic extract of *R. centifolia* and the results followed in order by the methanolic extract of *R. alba*, the ethanolic extract of *R. centifolia*, and at last the ethanolic extract of *R. alba*.

The research findings show that extracts with increased phenolic and flavonoid content have a higher SPF value. Such combination is attributed to the powerful antioxidant character of these compounds that in turn boosts their capacity to prevent and absorb noxious UV rays. The present study establishes a strong and statistically significant relationship between TPC and TFC and SPF of different rose extracts support the proposed hypothesis that phenolic and flavonoid compounds play a very crucial role in improving the sun protection factors.

Conclusion

Methanol has higher extraction efficiency for flavonoids and phenolic compounds compared to ethanol from both

Table 3. Inhibitory concentration 50% (IC_{50}) and antioxidant activity of *R. centifolia* and *R. alba* extract

Extract	IC_{50} (μg/ml)	Antioxidant Activity
R. centifolia ethanolic extract	99.338	Strong
R. centifolia methanolic extract	22.622	Very strong
R. alba ethanolic extract	142.974	Moderate
R. alba methanolic extract	68.438	Strong

Table 4. Absorbance and sun protection factor (SPF) Value of *R. centifolia* and *R. alba* extract

Wavelength (nm)	*R. centifolia* ethanolic extract	*R. centifolia* methanolic extract	*R. alba* ethanolic extract	*R. alba* methanolic extract
290	0.028	0.036	0.023	0.034
295	0.152	0.250	0.119	0.212
300	0.484	0.966	0.389	0.717
305	0.485	1.092	0.399	0.727
310	0.241	0.609	0.204	0.369
315	0.096	0.256	0.083	0.149
320	0.019	0.051	0.017	0.030
SPF Value	15.042 ± 0.199	32.602 ± 0.430	12.331 ± 0.162	22.318 ± 0.297

Note:

2-4 : minimal
4-6 : moderate
6-8 : extra
8-15 : maximum
>15 : ultra

R. centifolia and *R. alba*. A comparative analysis showed that *R. centifolia* has a higher probability of developing as a sunscreen compared to *R. alba* due to higher values of TPC, TFC, antioxidant activity and SPF than *R. alba*. The methanolic extract of *R. centifolia* had the highest SPF value and the strongest radical scavenging activity and showed a good protective action against ultraviolet radiation. Subsequent studies for the complete identification of the phytochemical constituents in *R. centifolia* and *R. alba* should employ the Gas Chromatography-Mass Spectrometry (GC-MS).

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Authors' Contributions

SSW designed and led the research, provided materials and tools, and conducted statistical analysis and interpretation of phytochemical data, TPC, TFC, antioxidant activity, and SPF measurements. NT carried out the extraction procedures, analyzed the results, and contributed to discussions on TPC, TFC, antioxidant activity, and SPF, while also offering guidance on the research and writing process. Both SSW and NT jointly gathered references and participated in discussions. All authors reviewed and approved the final manuscript.

Compliance with Ethical Standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Chat GPT to improve language and readability. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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