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ARTIGO

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Profile of bioactive compounds, photoprotective and antioxidant potential of *Cinnamomum triplinerve* (Ruiz & Pav.) Kosterm. leaf extracts

Perfil de compostos bioativos, potencial fotoprotetor e antioxidante de extratos das folhas de Cinnamomum triplinerve (Ruiz & Pav.) Kosterm.

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ABSTRACT

Plant extracts with photoprotective activity have been widely incorporated into cosmetics, especially as sunscreens, due to their ability to absorb UV radiation and neutralize free radicals generated in the skin after sun exposure. This study evaluated the photoprotective and antioxidant activities of 70% and 50% hydroethanolic and aqueous extracts from the leaves of *Cinnamomum triplinerve*. Phenols, flavonoids, proanthocyanidins, hydrolyzable tannins, and total alkaloids were quantified by visible spectrophotometry. Photoprotective activity was determined in vitro by calculating the Sun Protection Factor (SPF), and antioxidant potential was evaluated through the scavenging of DPPH$^{\bullet}$ (2,2-diphenyl-1-picrylhydrazyl) and ABTS$^{\bullet+}$ (2,2'-azinobis(3-ethylbenzothiazoline-6-sulfonic acid)) radicals. The extracts showed high SPF values (23.91 ± 0.27 to 25.65 ± 0.30 at 1000 µg mL^{-1}) and considerable antioxidant activity. The 70% hydroethanolic extract stood out, presenting the highest levels of phenols, proanthocyanidins, and alkaloids. The results suggest that the observed potentials are associated with the concentration of bioactive metabolites and highlight the leaf extract of *C. triplinerve* as a promising natural source for cosmetic and pharmaceutical formulations.

Keywords: Phytochemistry. Biological activities. Polyphenols.

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RESUMO

Extratos vegetais com atividade fotoprotetora têm sido amplamente incorporados em cosméticos, especialmente como protetores solares, devido à capacidade de absorver a radiação UV e neutralizar os radicais livres gerados na pele após a exposição solar. Este estudo avaliou as atividades fotoprotetora e antioxidante dos extratos hidroetanólicos a 70% e 50% e aquosos das folhas de *Cinnamomum triplinerve*. Fenóis, flavonoides, proantocianidinas, taninos hidrolisáveis e alcaloides totais foram quantificados por espectrofotometria visível. A atividade fotoprotetora foi determinada in vitro pelo cálculo do Fator de Proteção Solar (FPS), e o potencial antioxidante foi avaliado por meio da capacidade de sequestro dos radicais $DPPH^{\bullet}$ (2,2-difenil-1-picrilhidrazil) e $ABTS^{\bullet+}$ (ácido 2,2'-azinobis(3-etilbenzotiazolina-6-sulfônico)). Os extratos apresentaram altos valores de FPS (23,91 ± 0,27 a 25,65 ± 0,30 em 1000 µg mL^{-1}) e considerável atividade antioxidante. O extrato hidroetanólico a 70% destacou-se, apresentando os maiores teores de fenóis, proantocianidinas e alcaloides. Os resultados sugerem que os potenciais observados estão associados à concentração de metabólitos bioativos e destacam o extrato foliar de *C. triplinerve* como uma fonte natural promissora para formulações cosméticas e farmacêuticas.

Palavras-chave: Fitoquímica. Atividades biológicas. Polifenóis.

1. INTRODUCTION

Plant-based products with photoprotective potential have been increasingly used in the cosmetic industry as natural sunscreen agents as a result of the search for sustainable and safer skin care formulations. Plant extracts that are rich in bioactive compounds, with proven photoprotective and antioxidant activities, can enhance protection against ultraviolet (UV) radiation and neutralize free radicals generated in the skin after sun exposure (RAMOS et al., 2022). Incorporating these extracts into topical formulations can complement the action of synthetic UV filters, mitigating radiation-induced oxidative stress and reducing the adverse effects associated with these filters (SHABRINA et al., 2025; AYAD et al., 2023).

Among the categories of secondary metabolites produced by plants, phenolic compounds can absorb UV radiation and prevent cellular damage caused by oxidative stress. *Camellia sinensis* (green tea) extract, for example, stands out for its antioxidant and photoprotective properties related to the production of phenols and flavonoids, and is frequently present in pharmaceutical formulations (GODINHO et al., 2017; LIMA et al., 2023; TEICHENNÉ et al., 2025). Similarly, the proanthocyanidins present in *Cinnamomum camphora* extract have demonstrated strong UV protection and potential use in the cosmetics industry (LIU et al., 2024).

In this context, the Lauraceae family is represented by approximately 3,000 species, distributed across 56 genera. These species are widely distributed throughout the planet's tropical and subtropical regions (WORLD FLORA ONLINE, 2024). Many species are economically important because they produce essential oils, which have a wide variety of uses in folk medicine, cuisine, perfumery, and construction (FANTINI; SIMINSKI, 2017; GRECCO et al., 2018). Chemically, they are rich in secondary metabolites, such as neolignans, phenolics, and alkaloids, many of which display bioactive properties (ALTIN et al., 2025).

Within this family, the *Cinnamomum* genus comprises a variety of species widely used as food, spices, and in traditional medicine to treat various diseases. The essential oils of these plants have varied compositions of phenylpropanoids, monoterpenes, and sesquiterpenes (GUO et al., 2024; SHARIFI-RAD et al., 2021). Their extracts are characterized by the presence of polyphenols, saponins, terpenoids, and coumarins, which have relevant biological activities such as anticancer, antimicrobial, and antioxidant

properties. This makes them promising for cosmetic and pharmaceutical applications (SHARIFI-RAD et al., 2021).

Cinnamomum triplinerve (Ruiz & Pav.) Kosterm. is a tree species widely distributed throughout the Americas. In Brazil, it is found in several biomes, such as the Atlantic Forest, Amazon, and Cerrado. Traditionally, its wood has been used in the construction of houses, bridges, and industrial floors (TROPICAL PLANTS DATABASE, 2024). Few studies have analyzed its chemical composition and biological activity, including its acaricidal and antioxidant effects, which are attributed to phenolic compounds (SILVA et al., 2019; CUCA-SUÁREZ et al., 2012; ARGOTI et al., 2011). This is the first report on the photoprotective potential of *C. triplinerve*.

Therefore, the present study aimed to evaluate the photoprotective and antioxidant activities, as well as to determine the total phenolic and alkaloid contents of hydroethanolic and aqueous extracts of *C. triplinerve* leaves. This contributes to the chemical characterization of the species and its potential incorporation into natural cosmetic formulations.

2. MATERIAL AND METHODS

Chemicals

All chemicals used in this study were of analytical grade. Gallic acid, anhydrous sodium carbonate, aluminum chloride, ferric chloride, ethanol, methanol, tannic acid, hydrochloric acid, and 1,10-phenanthroline were purchased from Dinâmica® (Brazil). (+)-Catechin and potassium iodate were purchased from Chem-Gold (Brazil), and potassium persulfate from Neon (Brazil). Folin-Ciocalteu reagent, ABTS [2,2′-azinobis(3-ethylbenzothiazoline-6-sulfonic acid)], DPPH (2,2-diphenyl-1-picrylhydrazyl), quercetin, and yohimbine hydrochloride were obtained from Sigma-Aldrich® (Brazil).

2.1 Collection of plant material

Leaves of *C. triplinerve* were collected in November 2024 in a rural area of the municipality of Sete Quedas, Mato Grosso do Sul, Brazil (23°57'33.06" S, 55°04'13.63" W). A voucher specimen was deposited at the “Ernesto Vargas Batista” Herbarium of the State University of Mato Grosso do Sul under number 121.

2.2 Preparation of extracts

Leaves were air-dried at room temperature and ground in a Wiley mill, yielding 140 g of powdered material. The material was evenly divided into three portions for extraction. Two portions were subjected to cold maceration with 70% and 50% hydroethanolic solutions (v/v), for 72h with occasional stirring, and the third portion was extracted with water at 98 °C for 60 min. After filtration and concentration under reduced pressure at 40 °C using a rotary evaporator (Quimis®), 4.87 g (70%) and 3.81 g (50%) of hydroethanolic extracts were obtained, respectively. The aqueous extract was filtered, partially concentrated, lyophilized, and yielded 2.98 g.

2.3 Quantification of phenols, flavonoids, proanthocyanidins, hydrolyzable tannins and alkaloids

Phenolic content was determined using the Folin-Ciocalteu method (NOREEN et al., 2017). The total phenolic content was calculated from a gallic acid standard curve (R^2 = 0.9966) and expressed as milligrams of gallic acid equivalents per gram of extract (mg GAE.g^{-1}). All the spectrophotometric analyses were carried out using UV-Vis spectrophotometer (Tecnal, Brazil).

Flavonoid quantification was performed using the colorimetric aluminum chloride method (LIN; TANG, 2007). The total flavonoid content was determined from a quercetin standard curve (R^2 = 0.9992) and the results were expressed as milligrams of quercetin equivalents per g of extract (mg QE.g^{-1}).

Proanthocyanidins was determined using the vanillin-HCl method, following Sun et al. (1998). The total proanthocyanidins content was calculated from a catechin calibration curve (R^2 = 0.992) and expressed as milligrams of catechin equivalents per gram of extract (mg CE·g^{-1}).

Hydrolyzable tannins were determined using the potassium iodate method (HAIDA et al., 2020). The hydrolyzable tannin content was calculated from a tannic acid calibration curve (R^2 = 0.9965) and expressed as milligrams of tannic acid per gram of extract (mg TAE.g^{-1}).

Alkaloid content was determined using the 1,10-phenanthroline method described by Singh et al. (2004). The total alkaloid content was quantified from a yohimbine hydrochloride

calibration curve (R^2 = 0.9965) and expressed as milligrams of yohimbine equivalents per gram of extract (mg YE.g^{-1}).

2.4 Determination of Sun Protection Factor (SPF)

The UVB sun protection factor (SPF) of the extracts was determined according to the method proposed by Mansur et al. (1986). Extract solutions (100 - 1000 µg.mL^{-1}) were subjected to spectral scanning in the range between 280 - 400 nm at 5 nm intervals, using a UV-Vis spectrophotometer with a 1 cm quartz cuvette, in order to verify absorption in the ultraviolet A (UVA) and B (UVB) regions. The absorbance values obtained between 290 and 320 nm were applied to the Mansur et al. (1986) equation to calculate the in vitro SPF, considering the erythemogenic effect and the radiation intensity (EE × I) data reported by Sayre et al. (1979).

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

Where: CF = Correction factor, which is 10 (based on the measurement of the 8% homosalate standard, whose SPF is 4). EE = Erythemogenic effect of radiation of wavelength λ. I (λ) = Intensity of sunlight at wavelength λ. Abs (λ) = Spectrophotometric reading of the absorbance of the sample solution at wavelength λ.

2.5 Total antioxidant capacity - Phosphomolybdenum assay

Total antioxidant capacity was determined by the phosphomolybdenum reduction method (PRIETO et al., 1999). Extracts solutions (100 µg.mL^{-1}) were mixed with the reagent (sodium phosphate monobasic (0.1 M), ammonium molybdate solution (0.04 M), and sulfuric acid (3 M) in aqueous medium) and incubated in a water bath at 95 °C for 90 min. After cooling, absorbance was measured at 695 nm using a UV-Vis spectrophotometer. Antioxidant capacity was quantified using an ascorbic acid standard curve (R^2= 0.998) and expressed as milligrams of ascorbic acid equivalents per gram of extract (mg AAE.g^{-1}).

2.6 Antioxidant activity by DPPH$^{\bullet}$ and ABTS$^{\bullet+}$ assays

The antioxidant activity of the extracts was evaluated using two free-radical scavenging assays: the 2,2-diphenyl-1-picrylhydrazyl (DPPH$^{\bullet}$) method and the 2,2'-(azinobis-3-ethylbenzothiazoline-6-sulfonic acid) cation radical (ABTS$^{\bullet+}$) method (SALACHNA et al., 2021).

For the DPPH$^{\bullet}$ assay, aliquots of the extract solutions (12.5 - 100 μg.mL^{-1}) were mixed with DPPH$^{\bullet}$ solution (40 μg.mL^{-1}). After 30 min., the absorbance of the reaction mixtures was measured at 515 nm. For the ABTS$^{\bullet+}$ assay, the radical cation was previously generated by reaction with potassium persulfate and then added to the extract solutions (12.5 - 100 μg.mL^{-1}). After 6 min the absorbance was measured at 734 nm. In both assays, absorbance performed on a UV-Vis spectrophotometer. The radical scavenging activity was expressed as a percentage of inhibition, calculated using the following equation:

$$\%\ \text{Inhibition} = \frac{(A_{\text{control}} - A_{\text{sample}})}{A_{\text{control}}} \times 100$$

where $A_{control}$ is the absorbance of the radical solution without extract, and A_{sample} is the absorbance in the presence of the extract.

The IC_{50} value (i.e., the concentration of extract required to inhibit 50% of the radicals) was obtained by regression analysis of the inhibition percentages versus extract concentrations and extrapolation of the resulting curve. Quercetin, prepared under the same experimental conditions, served as the positive control. The antioxidant activity index (AAI) was calculated by the following equation (SCHERER; GODOY, 2009):

$$\text{AAI} = \frac{\text{Final concentration of DPPH } (\mu\text{g. mL}^{-1})}{\text{IC}_{50}\ (\mu\text{g. mL}^{-1})}$$

The scale of AAI was considered poor (< 0.5), moderate (0.5 - 1.0), strong (1.0 - 2.0) and very strong (> 2.0).

2.7 Statistical Analysis

The assays were performed in triplicate and the results expressed as mean ± standard deviation. Data were analyzed by one-way ANOVA followed by Tukey's test ($p < 0.05$) in OriginLab 2025 (OriginLab Corporation, Northampton, MA, USA). Pearson's correlation coefficient (r) was calculated using the same software.

3. RESULTS AND DISCUSSION

Phytochemical screening of *C. triplinerve* leaf extracts identified alkaloids, flavonoids, and tannins. Chemical composition is one of the key factors determining the effectiveness of natural products as photoprotective agents. Phenolic compounds and alkaloids, widely reported in plant extracts, are associated with both UV radiation absorption and free radical

neutralization. These properties confer photoprotective and antioxidant effects (VIOLANTE et al., 2009; BOUTECHE et al., 2024).

Accordingly, the contents of phenols, flavonoids, proanthocyanidins, hydrolyzable tannins, and total alkaloids in *C. triplinerve* extracts were quantified, and their photoprotective and antioxidant activities were evaluated. The levels of these compounds were determined by interpolating the sample absorbance values against the corresponding standard calibration curves (Table 1).

Table 1. Contents of phenols, flavonoids, proanthocyanidins, hydrolyzable tannins, and total alkaloids in leaf extracts of *Cinnamomum triplinerve.*

Extract	Phenols mg GAE.g^{-1}	Flavonoids mg QE.g^{-1}	Proanthocyanidins mg CE.g^{-1}	Hydrolyzable tannins mg TAE.g^{-1}	Alkaloids mg YE.g^{-1}
Hydroethanolic 70%	150.29 ± 2.07^{a}	135.64 ± 2.86^{c}	53.23 ± 0.41^{a}	ND	295.60 ± 3.84^{a}
Hydroethanolic 50%	133.78 ± 1.29^{b}	149.88 ± 7.69^{b}	33.86 ± 1.87^{b}	ND	250.71 ± 5.05^{b}
Aqueous	109.81 ± 0.43^{c}	171.98 ± 3.05^{a}	22.20 ± 0.52^{c}	ND	196.38 ± 8.39^{c}

Values are mean ± standard deviations. Different letters in the same column differ significantly according to one-way ANOVA followed by Tukey's test ($p < 0.05$). ND, not detected.

The use of 70%, 50%, and aqueous hydroethanolic solvents aimed to optimize the extraction of bioactive compounds from *C. triplinerve* leaves (TOURABI et al., 2025; ZHANG et al., 2020), resulting in statistically significant differences in yields ($p < 0.05$). Increasing the proportion of ethanol in the solvent enhanced the extraction of phenols, proanthocyanidins, and alkaloids, which supports the use of ethanol as an effective co-solvent for metabolites of different polarities. Similar patterns have been reported in studies with other plant species, indicating higher levels of bioactive compounds in ethanol-rich hydroethanolic solvents (ALTIN et al., 2025; RAKASIVI et al., 2022).

The 70% hydroethanolic extract showed the highest contents of phenols (150.29 ± 2.07 mg GAE·g^{-1}), proanthocyanidins (53.23 ± 0.41 mg CE.g^{-1}), and alkaloids (295.60 ± 3.84 mg YE.g^{-1}), followed by the 50% hydroethanolic extract. The aqueous extract exhibited lower levels of these compounds, but had the highest flavonoid content (171.98 ± 3.05 mg QE.g^{-1}). These results are consistent with analyses that identified bioactive compounds in different parts of the plant (ARGOTI et al., 2011; CUCA-SUÁREZ et al., 2012), but differ from those reported by Silva et al. (2019), who found lower levels of phenols and flavonoids in ethanolic extracts of leaves, bark and fruits.

Hydrolyzable tannins were not detected under the tested conditions, suggesting a predominance of condensed tannins (proanthocyanidins) in the extracts. This pattern has been previously described for other *Cinnamomum* species, in which proanthocyanidins can occur at high levels (SIMBINE et al., 2022; NAM et al., 2020; MATEOS-MARTÍN et al., 2012).

Prolonged exposure to ultraviolet (UV) radiation is associated with an increased incidence of skin cancer, cataracts, and immune system damage. UVB radiation (280 - 320 nm), which is highly energetic, predominantly affects the epidermis, causing edema, erythema, and burns. UVA radiation (320 - 400 nm), on the other hand, penetrates deeper into the skin, reaching the dermis and contributing to photoaging (TANG et al., 2024).

The absorption spectra of the extracts, obtained by spectrophotometric scanning between 280 and 400 nm, revealed broad bands in the UVA and UVB regions, with a maximum peak (λ_{max}) around 280 nm and intensity proportional to the concentration (Figure 1).

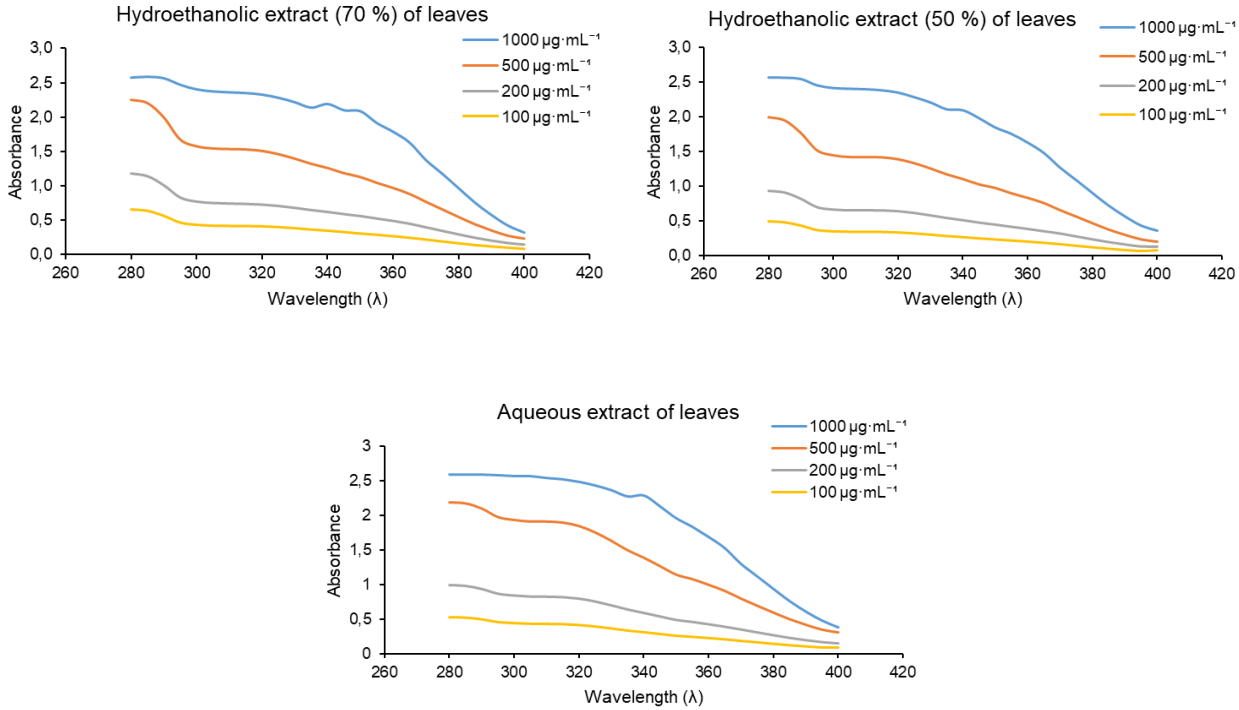

Figure 1. UV-Vis absorption spectra (280 - 400 nm) of hydroethanolic (70% and 50 %) and aqueous leaf extracts of *Cinnamomum triplinerve*.

The SPF values obtained for *C. triplinerve* extracts are listed in Table 2. At the highest concentration (1000 μg.mL^{-1}), the SPF values ranged from 23.91 ± 0.27 to 25.65 ± 0.30. The anti-UV capacity at this concentration was also determined using the formula implied by Xie et al. (2018). The extracts exhibited KUVB > 2.0 and KUVA > 1.0. Comparing with the results previously reported by Yasmeen and Gupta (2021), it is observed that *C. triplinerve* exhibits strong absorption in the UVB and UVA regions, demonstrating a high capacity for protection against ultraviolet radiation.

Table 2. Sun Protection Factor (SPF) and anti-UV capacity for UVB and UVA of hydroethanolic (70% and 50%) and aqueous leaf extracts of *Cinnamomum triplinerve*.

Extract	SPF (Sun Protection Factor)				Anti-UV capacity
	100 μg.mL^{-1}	200 μg.mL^{-1}	500 μg.mL^{-1}	1000 μg.mL^{-1}	K_{UVB}/K_{UVA}
Hydroethanolic 70%	4.30 ± 0.05	7.72 ± 0.02	15.70 ± 0.31	23.91 ± 0.27	2.40 ± 0.42/1.63 ± 0.21
Hydroethanolic 50%	3.43 ± 0.03	6.54 ± 0.03	14.37 ± 0.08	24.12 ± 0.09	2.41 ± 0.02/1.48 ± 0.06
Aqueous	4.49 ± 0.09	8.32 ± 0.06	19.20 ± 0.12	25.65 ± 0.30	2.57 ± 0.50/1.53 ± 0.04

Values are mean ± standard deviations. Note: K_{UVB} = A_{300}/C and K_{UVA} =A_{365}/C (A is the absorbance at the indicated wavelength and C is the concentration of the extracts in 1 mg.mL^{-1}).

An increase in SPF was observed with increasing concentration, consistent with the spectrophotometric profiles (Figure 1). These profiles recorded high absorbance in the UVB and UVA regions, proportional to the concentration. Similar patterns have been reported for other plant species that present higher SPF values at higher concentrations (MEDEIROS et al., 2021; SUTAR; CHAUDHARI, 2020).

A product is considered suitable for application in photoprotective cosmetics when it shows an SPF ≥ 6.0, according to the minimum requirement established by the Brazilian Health Regulatory Agency (ANVISA, 2012). Therefore, extracts of *C. triplinerve* at concentrations of 200, 500, and 1000 μg.mL^{-1} are promising for use in photoprotective formulations.

Because of the complex composition of plant extracts, the total antioxidant activity was first determined using the phosphomolybdenum method. The assay showed values ranging from 137.40 ± 2.67 to 168.18 ± 5.18 mg AAE.g^{-1} (Table 3), with the 70% hydroethanolic extract exhibiting the highest total antioxidant activity. Then, the extracts were evaluated

using the DPPH$^{\bullet}$ and ABTS$^{\bullet+}$ radical scavenging assays, and the results were expressed as IC_{50} values.

The extracts exhibited similar IC_{50} profiles in both assays (Table 3). Consistent with this trend, the 70% hydroethanolic extract exhibited the greatest radical scavenging activity, with IC_{50} values of 28.30 ± 0.71 μg.mL^{-1} (DPPH$^{\bullet}$) and 5.91 ± 1.24 μg.mL^{-1} (ABTS$^{\bullet+}$). The aqueous extract showed the lowest antioxidant activity, confirming the influence of solvent composition on the extraction of active compounds.

Furthermore, according to the scale proposed by Scherer and Godoy (2009), which ranges from weak to very strong antioxidant activity, the hydroethanolic 70% and 50% extracts showed moderate AAI values (0.96 and 0.71, respectively), while the aqueous extract was classified as weak (0.45) (Table 3). However, the AAI of the standard (quercetin) was found considerably higher (6.29), which may be due to the complex mixture of compounds present in the extracts.

Table 3. Antioxidant activity and values for the Antioxidant Activity Index (AAI) of hydroethanolic (70% and 50%) and aqueous leaf extracts of *Cinnamomum triplinerve*.

Extract	Phosphomolybdenum (mg AAE.g^{-1})	IC_{50} (μg.mL^{-1})		AAI
		DPPH	ABTS	
Hydroethanolic 70%	168.18 ± 5.18^{a}	28.30 ± 0.17^{c}	5.91 ± 1.24^{c}	0.96
Hydroethanolic 50%	155.92 ± 2.96^{b}	38.19 ± 0.40^{b}	9.26 ± 0.12^{b}	0.71
Aqueous	137.40 ± 2.67^{c}	60.48 ± 1.42^{a}	19.55 ± 0.30^{a}	0.45
Quercetin	-	4.29 ± 0.39	3.53 ± 0.03	6.29

Values are mean ± standard deviations. Different letters in the same column differ significantly according to one-way ANOVA followed by Tukey's test ($p < 0.05$).

Pearson's correlation analysis, although calculated using a limited number of extract groups, suggested a positive association between total phenols and proanthocyanidins with total antioxidant activity (r ranging from 0.93 to 0.96) and a tendency for a negative relationship between these compounds and the IC_{50} values in the DPPH$^{\bullet}$ and ABTS$^{\bullet+}$ assays (r ranging from -0.89 to -0.99), indicating that higher levels of these metabolites are associated with greater antioxidant capacity.

Alkaloids also showed a positive association with antioxidant activity, suggesting that this group may also contribute to the observed effects. In contrast, flavonoids showed an inverse tendency in the three antioxidant assays, indicating that these compounds were not

associated with higher antioxidant responses; however, they may contribute to the absorption of UV radiation exhibited by the extracts. The interaction among all analyzed compounds appears to influence the antioxidant capacity and photoprotective potential of *C. triplinerve* leaves.

In general, compounds present in plant extracts such as phenols, flavonoids, proanthocyanidins, and alkaloids contain chromophoric groups capable of absorbing UV radiation and hydroxyl groups that can donate hydrogen or electrons, neutralizing reactive species and conferring photoprotective and antioxidant properties (TANG et al., 2024; VIOLANTE et al., 2009). These results are in line with previous studies that reported antioxidant activity in extracts of *C. triplinerve*, which was attributed to phenolic compounds (SILVA et al., 2019; ARGOTI et al., 2011).

4. CONCLUSION

C. triplinerve extracts exhibited high SPF values and considerable antioxidant activity, which are associated with their phenolic and alkaloid content. This study represents the first report of the photoprotective potential of this species, providing new contributions to the Lauraceae family. It also highlights the leaf extract of *C. triplinerve* as a promising natural source for application in cosmetic and pharmaceutical formulations. However, further studies are necessary to isolate and characterize the compounds responsible for its biological properties, as well as to evaluate in vivo efficacy and safety, especially regarding skin toxicity.

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REFERENCES

ALTIN, S. et al. Therapeutic potential of *Laurus nobilis* extract by experimental and computational approaches: phenolic content and bioactivities for antioxidant, antidiabetic, and anticholinergic properties. **Frontiers in Chemistry**, v. 13, p. 1541250, 2025. 10.3389/fchem.2025.1541250

ANVISA - Agência Nacional de Vigilância Sanitária. Resolução RDC N° 30, de 1º de junho de 2012. Aprova Regulamento Técnico do MERCOSUL sobre protetores solares em cosméticos. Diário Oficial da União. Brasília. 04 jun 2012;(Seção 1): p. 83-84.

ARGOTI, J. C. et al. Antioxidant activity and free radical-scavenging capacity of a selection of wild-growing Colombian plants. **Journal of the Science of Food and Agriculture**, v. 91, n. 13, p. 2399-2406, 2011. 10.1002/jsfa.4476

AYAD, R. et al. Photoprotection strategies with antioxidant extracts: a new vision. **Physical Sciences Reviews**, v. 9, n. 6, p. 2273-2286, 2023. 10.1515/psr-2022-0313

BOUTECHE, A. et al. Phenolic constituents, photoprotective effect, and antioxidant capacities of *Achillea ligustica* All. **Molecules**, v. 29, n. 17, p. 4112, 2024. 10.3390/molecules29174112

CUCA-SUÁREZ, C. L. E. et al. Actividad acaricida de extractos de lauráceas sobre los ácaros intradomiciliarios Dermatophagoides farinae y Blomiatropicalis. **Revista Cubana de Plantas Medicinales**, v. 17, n. 4, p. 308-319, 2012.

FANTINI, A. C.; SIMINSKI, A. Manejo de florestas secundárias da Mata Atlântica para produção de madeira: possível e desejável. **Revista Brasileira de Pós-Graduação**, v. 13, n. 32, 2017. 10.21713/2358-2332.2016.v13.1013

GODINHO, M. et al. Photoprotectors profile in Brazilian sunscreens. **Surgical & Cosmetic Dermatology**, v. 9, n. 3, p. 243-246, 2017. 10.5935/scd1984-8773.20179305

GRECCO, S. S. et al. Neolignans isolated from twigs of *Nectandra leucantha* Ness & Mart (Lauraceae) displayed in vitro antileishmanial activity. **Journal of Venomous Animals and Toxins including Tropical Diseases**, v. 24, n. 27, p. 1-7, 2018. 10.1186/s40409-018-0164-9

GUO, J. et al. Therapeutic potential of *Cinnamon* Oil: Chemical composition, pharmacological actions, and applications. **Pharmaceuticals**, v. 17, n. 12, p. 1700, 2024. 10.3390/ph17121700

HAIDA, S.; KRIBII, A.; KRIBII, A. Chemical composition, phenolic content and antioxidant capacity of *Haloxylon scoparium* extracts. **South African Journal of Botany**, v. 131, p. 151-160, 2020. 10.1016/j.sajb.2020.01.037

LIMA, F. M.; LIMA, W. L. S.; COSTA, S. C. C. Avaliação da capacidade fotoprotetora e estabilidade de formulações contendo extrato de *Camellia Sinensis*. **Brazilian Journal of Development**, v. 9, n. 10, p. 29213-29229, 2023. 10.34117/bjdv9n10-110

LIN, J. Y.; TANG, C. Y. Determination of total phenolic and flavonoid contents in selected fruits and vegetables, as well as their stimulatory effects on mouse splenocyte proliferation. **Food Chemistry**, v. 101, n. 1, p. 140-147, 2007. 10.1016/j.foodchem.2006.01.014

LIU, Z. et al. Characterization and anti-ultraviolet radiation activity of proanthocyanidin-rich extracts from *Cinnamomum camphora* by ultrasonic-assisted method. **Molecules**, v. 29, n. 4, p. 796, 2024. 10.3390/molecules29040796

MANSUR, J. S.; BREDER, M. N. R.; MANSUR, M. C. A.; AZULAY, R. D. Determinação do fator de proteção solar por espectrofotometria. **Anais Brasileiros de Dermatologia**, v. 61, n. 3, p. 121-124, 1986.

MATEOS-MARTÍN, M. L. et al. New identification of proanthocyanidins in cinnamon (*Cinnamomum zeylanicum* L.) using MALDI-TOF/TOF mass spectrometry. **Analytical and Bioanalytical Chemistry**, v. 402, n. 3, p. 1327-1336, 2012. 10.1007/s00216-011-5557-3

MEDEIROS, M. A. C. et al. Avaliação da atividade fotoprotetora do extrato aquoso de *Rhaphiodon echinus* (Nees & Mart.) Schauer. **Scientia Plena**, v. 17, n. 4, 2021. 10.14808/sci.plena.2021.044601

NAM, J. W. et al. Targeting trimeric and tetrameric proanthocyanidins of *Cinnamomum verum* bark as bioactives for dental Therapies. **Journal of Natural Products**, v. 83, n. 11, p. 3287-3297, 2020. 10.1021/acs.jnatprod.0c00570

NOREEN, H. et al. Measurement of total phenolic content and antioxidant activity of aerial parts of medicinal plant *Coronupus didymus*. **Asian Pacific Journal of Tropical Medicine**, v. 10, n. 8, p. 792-801, 2017. 10.1016/j.apjtm.2017.07.024

PRIETO, P.; PINEDA, M.; AGUILAR, M. Spectrophotometric quantitation of antioxidant capacity through the formation of a phosphomolybdenum complex: specific application to the determination of vitamin E. **Analytical Biochemistry**, v. 269, n. 2, p. 337-341, 1999. 10.1006/abio.1999.4019

RAMOS, P. et al. Compostos fitoquímicos com atividade fotoprotetora: uma revisão integrativa. **Research, Society and Development**, v. 11, n. 14, 2022. 10.33448/rsd-v11i14.36286

SALACHNA, P.; PIETRAK, A.; ŁOPUSIEWICZ, L. Antioxidant potential of flower extracts from *Centaurea* spp. depends on their content of phenolics, flavonoids and free amino acids. **Molecules**, v. 26, n. 24, p. 1-10, 2021. 10.3390/molecules26247465

SAYRE, R.M. et al. A comparison of in vivo and in vitro testing of sunscreening formulas. **Photochemistry and Photobiology**, v. 29, n. 3, p. 559-566, 1979. 10.1111/j.1751-1097.1979.tb07090.x.

SCHERER, R.; GODOY, H. T. Antioxidant activity index (AAI) by the 2,2-diphenyl-1-picrylhydrazyl method. **Food Chemistry**, v. 112, n.3, p. 654-658, 2009. 10.1016/j.foodchem.2008.06.026

SHABRINA, A. M. et al. Potential of natural-based Sun Protection Factor (SPF): A systematic review of curcumin as sunscreen. **Cosmetics**, v. 12, n. 1, p. 10, 2025. 10.3390/cosmetics12010010

SHARIFI-RAD, J. et al. *Cinnamomum* species: bridging phytochemistry knowledge, pharmacological properties and toxicological safety for health benefits. **Frontiers in Pharmacology**, v.12, n. 600139, 2021. 10.3389/fphar.2021.600139

SILVA, A. F. G. et al. Antioxidant activity and quantification of phenols, flavonoids and total tannins of *Cinnamomum triplinerve* (Lauraceae). **Ciência e Natura**, v. 41, 2019. 10.5902/2179460X35292

SIMBINE, E. O. et al. *Cinnamomum zeylanicum* extracts reduce lipid oxidation in broadband anchovy (*Anchoviella lepidentostole*) minced fish. **Food Science and Technology**, v. 42, 2022. 10.1590/fst.46420

SIMÕES, C. M. O. et al. (Orgs). **Farmacognosia: da planta ao medicamento**. 6. ed. Porto Alegre: UFRGS: Florianópolis: UFSC, 2010.

SINGH, D. K.; SRIVASTAVA, B.; SAHU, A. Spectrophotometric determination of Rauwolfia alkaloids: estimation of reserpine in pharmaceuticals. **Analytical Sciences**, v. 20, n. 3, p. 571-573, 2004. 10.2116/analsci.20.571

SUN, B.; SILVA, R. J. M.; SPRANGER, I. Critical factors of vanillin assay for catechins and proanthocyanidins. **Journal of Agricultural and Food Chemistry**, v. 46, n. 10, p. 4267-4274, 1998. 10.1021/jf980366j

SUTAR, M.; RAVINDRA, C. Screening of in vitro sun protection factor of some medicinal plant extracts by ultraviolet spectroscopy method. **Journal of Applied Biology & Biotechnology**, v. 8, n. 6, p. 48-53, 2020. 10.7324/JABB.2020.80608

TANG, X. et al. Current insights and future perspectives of ultraviolet radiation (UV) exposure: Friends and foes to the skin and beyond the skin. **Environment International**, v. 185, p. 108535, 2024. 10.1016/j.envint.2024.108535

TEICHENNÉ, J. et al. Photoprotective and anti-inflammatory potential of polyphenol-rich extracts from agricultural by-products of chicory leaves, red onion peel, vineyard pruning, and olive pruning in UV-B-exposed 3D human skin equivalents. **Journal of Agriculture and Food Research**, v. 23, p. 102201, 2025. 10.1016/j.jafr.2025.102201

TOURABI, M. et al. Optimization of extraction process and solvent polarities to enhance the recovery of phytochemical compounds, nutritional content, and biofunctional properties of *Mentha longifolia* L. extracts. **Bioresources and bioprocessing**, v. 12, n. 1, p. 24, 2025. 10.1186/s40643-025-00859-8

TROPICAL PLANTS DATABASE. **Ken Fern. tropical.theferns.info**. Available in <tropical.theferns.info/viewtropical.php?id=Cinnamomum+triplinerve> Access in: 02 oct. 2025.

VIOLANTE, I. M. P. et al. Avaliação in vitro da atividade fotoprotetora de extratos vegetais do cerrado de Mato Grosso. **Revista Brasileira de Farmacognosia**, v. 19, n. 2, p. 452-457, 2009. 10.1590/S0102-695X2009000300020

WORLD FLORA ONLINE - WFO (2024): **Laurales Juss**. Available in: <http://www.worldfloraonline.org/taxon/wfo-7000000321>. Access in: 19 mar. 2024.

XIE, P. et al. Skincare effects of dandelion leaf extract and stem extract: antioxidant properties, tyrosinase inhibitory and molecular docking simulations. **Industrial Crops and Products**, v. 111, n. 3, p. 238-246, 2018. 10.1016/j.indcrop.2017.10.017

YASMEEN, S.; GUPTA, P. Cosmeceutical and anticancer potential of aqueous extracts of *Dalbergia sissoo* Roxb. aerial parts. **Journal of Herbal Medicine**, v. 29, n. 9, p. 100456, 2021. 10.1016/j.hermed.2021.100456

ZHANG, Y. et al. Optimization of the extraction and purification of *Corydalis yanhusuo* W.T. Wang based on the Q-marker uniform design method. **BMC Chemistry**, v. 14, n. 1, p. 9, 2020. 10.1186/s13065-020-00666-6