**Fronteiras: Journal of Social, Technological, and Environmental Science**
http://periodicos.unievangelica.edu.br/fronteiras/
ISSN 2238-8869

OPEN ACCESS

*Article*

# Incorporation of *Campomanesia sessiliflora* (O. Berg) Mattos Leaf Extracts into Cosmetic Formulations

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**ABSTRACT**

According to the literature, the leaves of *Campomanesia sessiliflora* (O. Berg) Mattos exhibit high antioxidant potential. Based on this, creams were formulated incorporating an extract obtained from 2% C. sessiliflora leaves in 25% ethanol, at concentrations of 0.1% and 1% in the cream base. Assessments of metabolite content, UV/Vis spectroscopic scans, and chromatographic analyses were performed, in addition to stability tests on the creams. The extract exhibited high levels of phenolic compounds and flavonoids, including the presence of gallic acid identified by LC-DAD, as well as antioxidant and photoprotective potential. The addition of the extract altered the color of the creams, making the 1% formulation darker than the 0.1% formulation. Storage at 40 °C accentuated this change, indicating possible oxidation of the compounds present. In the centrifugation test, all samples analyzed exhibited phase separation during the first month of analysis. The pH increased over the storage period for all samples. At 40 °C, the cream containing 1% of the extract exhibited increased spreadability compared to the base cream, an effect that was less pronounced in the cream containing 0.1%. Furthermore, the cream containing 1% *C. sessiliflora* demonstrated instability at 40 °C, with liquid phase separation occurring after two weeks when left to stand. This behavior was not observed in the cream containing 0.1% *C. sessiliflora*, which demonstrated greater stability. Thus, the incorporation of 0.1% *C. sessiliflora* into the base cream proved to be more viable.

**Keywords:** Bioeconomy; Biocosmetics; Guavira.

**RESUMO**

As folhas de *Campomanesia sessiliflora* (O. Berg) Mattos apresentam elevado potencial antioxidante, segundo a literatura. Com base nisso, foram elaborados cremes incorporados com o extrato obtido a partir de 2% de folhas de *C. sessiliflora* em 25% de etanol, nas proporções de 0,1% e 1% em creme base. Foram realizadas avaliações dos teores de metabólitos, varreduras na região do UV/Vis e análises cromatográficas, além de testes de estabilidade dos cremes. O extrato apresentou elevado teor de compostos fenólicos e flavonoides, incluindo a presença de ácido gálico identificada por CL-DAD, além de potencial antioxidante e fotoprotetor. A adição do extrato alterou a coloração dos cremes, tornando a formulação incorporada a 1% mais escura que aquela incorporada a 0,1%. O armazenamento a 40 °C acentuou essa mudança, indicando possível oxidação dos compostos presentes. No teste de centrifugação, todas as amostras analisadas apresentaram formação de fase no primeiro mês de análise. O pH apresentou aumento ao longo do período de estocagem para todas as amostras. Na temperatura de 40 °C, o creme incorporado a 1% apresentou aumento da espalhabilidade em relação ao creme base, efeito menos expressivo no creme incorporado a 0,1%. Além disso, o creme incorporado a 1% demonstrou instabilidade a 40 °C, com formação de fase líquida após duas semanas, quando deixado em repouso. Esse comportamento não foi observado no creme incorporado a 0,1%, que demonstrou maior estabilidade. Dessa forma, a incorporação de 0,1% de *C. sessiliflora* ao creme base mostrou-se mais viável.

**Palavras-chave:** Bioeconomia; Biocosméticos; Guavira.

Submission: 16/02/2026 Accepted: 15/09/2026 Publication: 14/11/2026

Vol. 15, No. 3, 2026 • pp. 1–16. • DOI http://dx.doi.org/10.21664/2238-8869.2026v15i3.8610

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## Introduction

The genus *Campomanesia* holds great cultural significance in Mato Grosso do Sul, particularly due to the importance of the guavira to regional identity. This significance is evident in initiatives aimed at promoting and highlighting the fruit, such as the Guavira Festival, held in Bonito—a municipality recognized as the state's ecotourism capital (Bonito City Hall, 2024)— and the State Guavira Seminar, created to foster actions related to the promotion and utilization of this plant resource (7th State Guavira Seminar, 2024). These initiatives followed the enactment of Law No. 5,082, dated November 7, 2017, which recognized the guavira (*Campomanesia* spp.) as the symbolic fruit of Mato Grosso do Sul (Mato Grosso do Sul, 2017).

*Campomanesia sessiliflora* (O. Berg) Mattos is a fruit-bearing plant popularly known as guabiroba-verde (Lorenzi et al., 2000). The species varies in size, ranging from a shrub 0.5 to 2 m tall, according to Luber et al. (2017), to a tree 5 to 17 m tall, as described by Landrum (1986). Its fruits are available for harvesting from May through December (Lima et al., 2006) and can be eaten *fresh* (Lorenzi, 2000). The leaves are commonly used to make medicinal teas, primarily for treating diarrhea and bladder disorders (Piva, 2002).

In the literature, the antioxidant potential of *C. sessiliflora* leaves was first reported by Kataoka and Cardoso (2013), who evaluated extracts obtained as infusions and via hydroethanolic extraction (80:20, v/v). Subsequently, Catelan et al. (2019) described the sun protection factor (SPF) of the ethanolic extract from *C. sessiliflora* leaves, contributing to increased interest in the potential application of these extracts in cosmetic products. Castro et al. (2022) also reported antioxidant and photoprotective activity in aqueous extracts of *C. sessiliflora* leaves, obtained by 24-hour maceration and infusion. In another study, Castro et al. (2023) identified antioxidant potential and SPF in the ethanolic extract of the fruit peels. In addition to studies on the species' bioactive properties, Burigato et al. (2024) demonstrated that the *C. sessiliflora* leaf extract showed no acute or subacute toxicity in rats, providing further evidence of its safety for future investigations. Recently, Loureiro et al. (2025) optimized the extraction of compounds from *C. sessiliflora* leaves, finding that the extract obtained using 2% leaves and 25% ethanol in distilled water generally yielded the best results. In that same study, gallic acid, syringic acid, catechin, epicatechin, and rutin were identified.

Several studies have linked the antioxidant and photoprotective properties of *C. sessiliflora* to the presence of phenolic compounds (Kataoka and Cardoso, 2013; Catelan et al., 2019; Castro et al., 2022; Castro et al., 2023; Loureiro et al., 2025). Phenolic compounds constitute a broad class of secondary metabolites characterized by the presence of one or more aromatic rings containing hydroxyl groups and are widely recognized for their bioactive properties. A comprehensive literature review conducted by Hsouna et al. (2023) demonstrated that these compounds exhibit various biological activities, including antioxidant, antimicrobial, anti-inflammatory, and photoprotective properties, which may contribute to their application in the preservation and extension of the shelf life of different products. Thus, the presence of these metabolites in *C. sessiliflora* may be related to the antioxidant and photoprotective potential described for its extracts (Edo et al., 2025; Hsouna et al., 2023).

Typically, leaves from fruit-bearing plants, such as *C. sessiliflora*, are discarded as agroindustrial waste. However, since some of them are sources of bioactive compounds, they can be used to produce extracts (Dorosh et al. 2024). Thus, the valorization of these agroindustrial byproducts can make the cultivation of native wild fruits more economically viable.

In this context, the extract optimized by Loureiro et al. (2025), obtained from the leaves of *C. sessiliflora*, stands out as a promising matrix for the development of cosmetic formulations, due to its significant antioxidant and photoprotective activity, as well as the possibility of being obtained from pruning waste. Thus, the objective of this study was to investigate the stability of incorporating the hydroethanolic extract from *C. sessiliflora* leaves into a cosmetic base, thereby contributing to the utilization of plant waste in products with bioactive potential and sustainable applications.

## Materials and Methods

### *Material Collection*

The specimen was collected in the municipality of Dourados, Brazil (latitude 22° 11' 819" S and longitude 054° 55' 812" W). The plant was identified and deposited as a dried specimen in the herbarium of the Federal University of Grande Dourados (UFGD) under code 2133; it was also registered in the National System for the Management of Traditional Associated Knowledge (SisGen). The leaves were dried in an oven (40 ± 1 °C) and ground in a Wiley knife mill (Marconi, Brazil) using a 10-mesh sieve.

***Extraction***

The extraction method was selected based on the study by Loureiro et al. (2024), in which 25% ethanol in distilled water was used to extract compounds from the leaves at a concentration of 2% (m/v) for 24 h (22 ± 1 °C). Subsequently, the extract was filtered and dried under a fume hood. To calculate the yield, the process was performed in duplicate, following the procedure described above. The yield was calculated using Equation 1, where Me represents the mass of the extract, Mf represents the mass of the leaves, and Re represents the extract yield.

$$Re = \frac{100 \times Me}{Mf} \quad (1)$$

***Chemical Composition***

The extract was diluted to 1 mg $mL^{-1}$for the analysis of phenolic compounds, flavonoids, and UV/Vis spectroscopy. For the sun protection factor (SPF) determination, the extract was diluted to 0.2 mg $mL^{-1}$ in distilled water

For the analysis of chlorophyll α, β, and carotenoids, the extract was diluted to 1 mg $mL^{-1}$ in ethanol. For UPLC-DAD analysis, the extract was diluted to 1 mg $mL^{-1}$ in 25% ethanol.

*Phenolic compounds*

0.1 mL of the extract was added to 0.5 mL of Folin-Ciocalteu reagent and 1 mL of distilled water; after waiting 1 minute, 1.5 mL of 20% (m/v) sodium carbonate was added. The samples were allowed to react for two hours in the dark. The absorbance was measured on a spectrophotometer at a wavelength of 760 nm (Djeridane et al. 2006). Distilled water was used as the blank for the sample. A standard curve was prepared for gallic acid with concentrations ranging from 10 to 1000 μg $mL^{-1}$.

*Flavonoids*

1 mL of extract was added to 1 mL of 2% aluminum chloride in methanol (m/v), and the samples were allowed to react for 15 minutes. Measurements were taken on the spectrophotometer at a wavelength of 430 nm (Djeridane et al. 2006). Distilled water was used as a blank for the diluted extract. A routine standard curve was prepared with concentrations ranging from 5 to 500 μg $mL^{-1}$.

*Chlorophyll a, β, and carotenoids.*

The extract was analyzed on the spectrophotometer at wavelengths of 470, 649, and 665 nm, using ethanol as the blank. The concentrations of the compounds were calculated using the obtained absorbances.

Chlorophyll α (Cα) was calculated using Equation 2, chlorophyll β (Cβ) was calculated using Equation 3, and the carotenoids (Cx+c) were calculated using Equation 4 (Lichtenthaler and Wellburn, 1983).

$$clorofila\ \alpha = (13{,}95\ x\ Abs_{665}) - (6{,}88\ x\ Abs_{649}) \quad (2)$$

$$clorofila\ \beta = (24{,}96\ x\ Abs_{649}) - (7{,}32\ x\ Abs_{665}) \quad (3)$$

$$Carotenoides = \frac{1000 \times Abs_{470nm} - (2{,}05 \times clorofila\ \alpha) - (114{,}8 \times clorofila\ \beta)}{245} \quad (4)$$

*Absorbance scan in the ultraviolet and visible regions.*

The extract was diluted to a concentration of 0.2 mg $mL^{-1}$and placed in a quartz cuvette for analysis on a spectrophotometer (Global Trade Technology, Brazil) in the range of 800 to 200 nm, with a resolution of 1 nm. Absorbance scan in the ultraviolet and visible regions.

***Inhibitory concentration of the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical***

Samples were prepared at their respective ethanol-in-water concentrations ranging from 7.8 to 250 μg $mL^{-1}$. For every 100 μL of each sample dilution, 2000 μL of 0.1 $mmol/L^{-1}$ DPPH in methanol was added to each 100 μL of each sample dilution; the reaction was allowed to proceed for 30 min in the dark, and the absorbance was measured using a spectrophotometer at a wavelength of 517 nm (Capanoglu et al., 2006). Each sample used its own solvent as a blank. The percentage of inhibition was calculated using Equation 5, where Q is the inhibition, $A_0$is the absorbance of the control, and $A_c$is the absorbance of the sample after the reaction.

$$Q = \frac{100\times(A_0-A_C)}{A_0} \quad (5)$$

Taking into account the 21-fold dilution factor, the sample concentration during the analysis was determined to range from 0.4 to 23.8 μg $mL^{-1}$. To determine the average inhibitory concentration ($IC_{50}$), that is, the concentration required to inhibit 50% of the DPPH radical in the extracts, a linear regression was performed.

*Sun Protection Factor*

The extract was diluted to 0.2 mg $mL^{-1}$ in distilled water. It was then analyzed using a spectrophotometer at the wavelengths specified in Table 1. The SPF was calculated according to Equation 6. CF stands for correction factor, EE stands for the erythemal effect of radiation, and I stands for solar intensity (Mansur et al. 1986). Distilled water was used as the blank.

$$FPS = FC \sum_{290\ nm}^{320\ nm} EE_\lambda \times I_\lambda \times Absorbância_\lambda \quad (6)$$

The EE values were taken from the study by Sayre et al. (1979) (Table 1).

Table 1 – Erythemal efficiency values by wavelength.

| ***Wavelength (nm)*** | ***$EE_\lambda \times I_\lambda$ (Normalized)*** |
|---|---|
| **290** | 0.0150 |
| **295** | 0.0817 |
| **300** | 0.2874 |
| **305** | 0.3278 |
| **310** | 0.1864 |
| **315** | 0.0839 |
| **320** | 0.0180 |

Source: Sayre et al. (1979)

The critical wavelength (λc) was calculated based on the UV spectrum between 200 and 400 nm using Origin Pro 2018 version 9.5 by determining the wavelength equivalent to 90% of the spectral area (Aguiar and Novelli, 2020). The UVA/UVB ratio was calculated as the ratio of the spectral area between 320 and 400 nm to the spectral area between 290 and 320 nm (Velasco et al., 2011).

*Compound Identification by LC-DAD*

The analysis was performed on a liquid chromatograph coupled with a detector (LC-DAD) (Shimadzu, Japan). The binary system consisted of two LC-20AD pumps, a SIL-20A HT autosampler, a CTO-20A column oven, an SPD-M20A DAD, and a C18 column (100 mm × 75 mm) with 2.6 μm particles (Phenomex, USA).

The solvents used were 0.1% formic acid as solvent A and methanol as solvent B (Table 2), with a spectral range of 190 to 400 nm and a resolution of 1.2 nm. The column oven temperature was maintained at 30 °C during the analysis, and the flow rate was 0.45 mL $min^{-1}$.

Table 2 – Chromatographic program for the binary system

| Time (min) | A (%) | B (%) |
|---|---|---|
| **0** | **90** | **10** |
| **2** | **70** | **30** |
| **12** | **60** | **40** |
| **16** | **50** | **50** |
| **20** | **0** | **100** |
| **22** | **90** | **10** |
| **26** | **90** | **10** |

Source: Os autores (2026).

15 μL of the extract was injected. For qualitative analysis, 1 μL of the following standards was injected: benzoic acid, caffeic acid, carnosic acid, carnosol, catechin, cinnamic acid, epicatechin, ferulic acid, gallic acid, kaempferol, luteolin, naringenin, p-coumaric acid, quercetin, rosmarinic acid, rutin, salicylic acid, sinapic acid, vanillic acid, and vanillin standards (Sigma-Aldrich, USA) were prepared at 100 μg $mL^{-1}$. The retention time and DAD spectrum of the standards were compared with the sample data for identification.

After identifying the presence of gallic acid, a calibration curve was constructed based on the peak area at 270 nm, yielding a curve with concentrations ranging from 160 to 850 ng and an $R^2$ of 0.9964. The limits of quantification and detection were 12.5 and 37.5 ng, respectively. The results were expressed in mg $g^{-1}$ of dry extract.

### *Composition of the base cream*

A neutral semisolid formulation consisting of water, cetostearyl alcohol, glyceryl stearate, disodium EDTA, phenoxyethanol, methylisothiazolinone, liquid paraffin, lanolin alcohol, caprylic/capric triglyceride, cyclomethicone, and dimethicone (silicone oil) was used as the base cream.

### *Incorporation into the base cream*

To incorporate the extract into the cream at concentrations of 0.1% and 1%, 10 mg and 100 mg of dry extract, respectively, were added to 10 g of base cream and homogenized. For chemical composition analysis, UV-Vis spectroscopy, and pH measurements, dilutions were prepared using 10 mL of distilled water per 10 mg of dry extract and the same volume per 1 g of the base cream or the creams incorporating the extract.

### *Stability*

During the stability analysis, tests for pH, color, centrifugation, and spreadability were conducted on the cream containing 0.1% and 1% of the extract and on the base cream over a 3-month period. Analyses were performed on the day of incorporation and 1, 2, 3, 7, 22, 36, 64, and 92 days after the extract was incorporated into the cream, with the exception of the color analysis. The base cream and the creams containing 0.1% and 1% of the extract were stored in duplicate and placed at three different temperatures—in the refrigerator (4 °C), at room temperature (21 °C), and in an oven (40 °C)—to conduct stability analysis.

#### *pH*

The pH of the base cream and the creams containing 0.1% and 1% of the extract was measured using a pH meter. All samples were diluted to 100 mg/mL in distilled water.

#### *Color*

The color of the base cream and the creams containing 0.1% and 1% was analyzed in two different ways directly on the samples. First, photographs were taken to facilitate color comparison one week, one month, two months, and three months after incorporation. Second, a Chroma Meter CR-400 colorimeter (Konica Minolta, Japan) was used to evaluate color changes in the LAB color space on the day of incorporation and one week, one month, two months, and three months thereafter.

#### *Centrifugation*

1 g of the base cream and the cream incorporating the pigment at 0.1% and 1% concentrations were added to a test tube and centrifuged at increasing speeds of 1000, 1800, and 3000 rpm, with each centrifugation lasting 15 minutes. The test tubes were observed for phase separation (ANVISA, 2004).

*Spreadability*

0.5 g of the base cream and the cream incorporating 0.1% and 1% were weighed and placed in the center of a glass plate. Additional glass plates were placed on top of this one, and the spread was measured in centimeters until no further change in size occurred. Spreadability was calculated using Equation 7.

$$Espalhabilidade = \frac{diametro^2 \times \pi}{4} \quad (7)$$

## Results and Discussion

The average yield of the extract from *C. sessiliflora* leaves at 2% leaves-to-solvent in 25% ethanol in distilled water was 18.38 ± 0.39%. This result was lower than that obtained by Loureiro et al. (2025). This difference is due to the intrinsic variability in the production of secondary metabolites by plants, given that their production occurs in response to environmental stimuli that fluctuate over time (Zhao et al., 2023).

A molecular absorption analysis was performed, revealing peaks in the UV region (Figure 1). The analyzed sample exhibited absorption bands in the regions characteristic of phenolic compounds and hydroxycinnamic acid derivatives at 270 nm and 240 nm (Fuentes et al., 2012). The profile obtained is similar to the results described in the study by Loureiro et al. (2025), a relevant finding considering that these authors reported a correlation between the absorbance of the peaks in the UV region and the levels of phenolic compounds, flavonoids, and antioxidant potential.

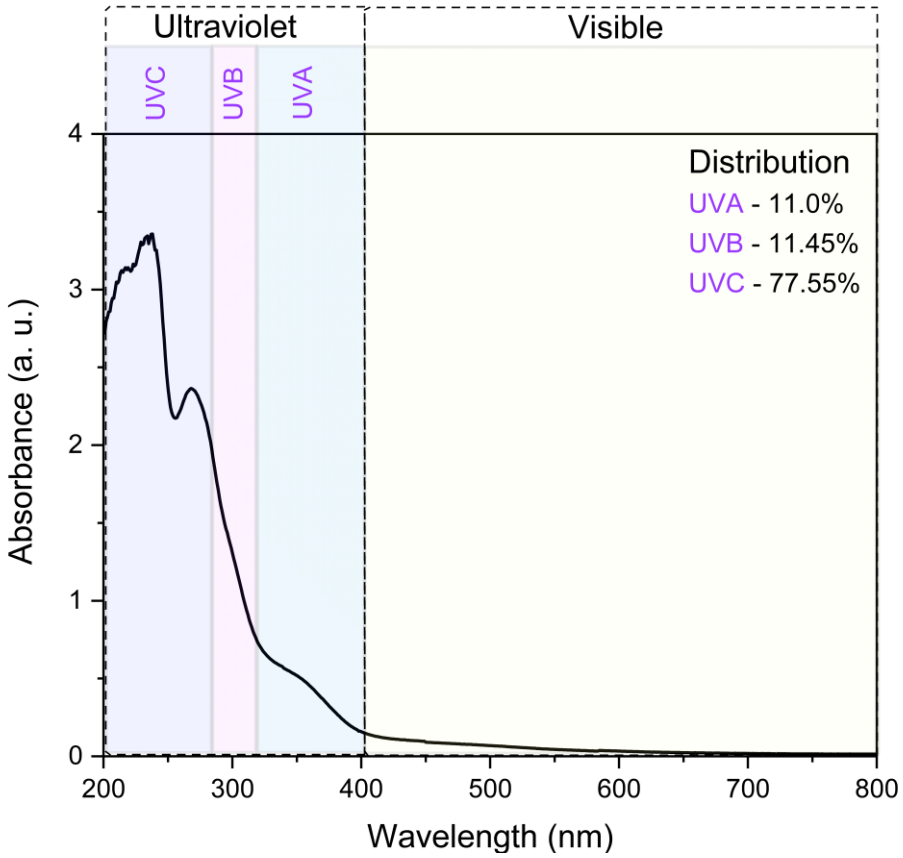



Figure 1 – Absorbance spectrum in the ultraviolet and visible regions (UV/Vis) of the *C. sessiliflora* leaf extract. Source: The authors (2026).

Compared to the literature, the levels of phenolic compounds and flavonoids in the 25% ethanol extract in distilled water from C. sessiliflora leaves (Table 3) were higher than those in the aqueous infusion extract (47.58 ± 0.20 mg RE $g^{-1}$; 106.50 ± 10.10 mg AGE $g^{-1}$ ) and the phenolic compound content of the maceration

extract (148.64 ± 1.01 mg AGE $g^{-1}$). However, the flavonoid content in the maceration extract was lower (63.39 ± 0.33 mg RE $g^{-1}$) (Castro et al. 2022). In the study by Castro et al. (2023a) on the ethanolic extract of *C. sessiliflora* fruit peel, the levels of phenolic compounds and flavonoids were lower than those presented in Table 3.

Table 3 – Results of the analyses (mean ± standard deviation) of phenolic compounds, flavonoids, antioxidant potential, FPS, chlorophyll α, chlorophyll β, and carotenoids in the *C. sessiliflora* leaf extract.

| Analyses of the extract | Concentrations |
|---|---|
| Phenolic compounds | 287.47 ± 2.52 mg AGE $g^{-1}$ |
| Flavonoids | 57.80 ± 2.17 mg RE $g^{-1}$ |
| Antioxidant potential | 8.26 $^{-1}$± 0.43 µg mL |
| SPF | 11.56 ± 0.17 |
| Chlorophyll α | 0.14 ± 0.01 mg $g^{-1}$ |
| Chlorophyll β | 0.44 ± 0.01 mg $g^{-1}$ |
| Carotenoids | 0.13 ± 0.01 mg $g^{-1}$ |

Source: Os autores (2026). AGE = Gallic acid equivalent; RE = Rutin equivalent.

The phenolic and flavonoid contents of the ethanolic extract from *C. sessiliflora* leaves (435.67 ± 9.14 mg AGE $g^{-1}$; 299.79 ± 11.12 mg RE $g^{-1}$) (Catelan et al. 2019) and of the 25% ethanol extract in distilled water from *C. sessiliflora* leaves (323.23 ± 4.13 mg AGE $g^{-1}$) (Loureiro et al. 2025) are higher than those presented in Table 3. This difference may be due to the seasonality of *C. sessiliflora*, as explained by Kataoka and Cardoso (2013).

Regarding the FPS (Table 3), the values reported in the literature are lower than those obtained in this study, corresponding to 9.98 and 6.74 for the *C. sessiliflora* leaf extracts obtained by infusion and maceration, respectively (Castro et al., 2022), as well as the value of 6.35 ± 0.52 for the ethanolic extract of *C. sessiliflora* fruit peels (Castro et al., 2023a) and 2.6 for the ethanolic extract of *C. sessiliflora* leaves (Catelan et al., 2019), with the exception of the FPS s for the 25% ethanol extract in distilled water from *C. sessiliflora* leaves (19.74 ± 0.07) (Loureiro et al., 2025) . The study by Loureiro et al. (2025) demonstrates a positive correlation between SPF and phenolic compound content, which may explain the higher SPF value reported in that study, as its phenolic compound content is also higher than that obtained in the present study.

To explore the absorption profile of the sample, supplementary analyses described by Castro et al. (2023b) were performed, namely: linearity in the UVB region, the UVA/UVB ratio, and the critical wavelength (Figure 2). The UVA/UVB ratio obtained for *C. sessiliflora* was 0.49, a value that reflects absorption predominantly in the UVB region. As a reference, values above 0.33 already indicate potential for broad-spectrum protection (European Commission, 2006), although ratios closer to 1 represent a more balanced protection between UVA and UVB. This finding reinforces the extract's potential in the formulation of sunscreen products, particularly those aimed at protecting against damage caused by UVB radiation.

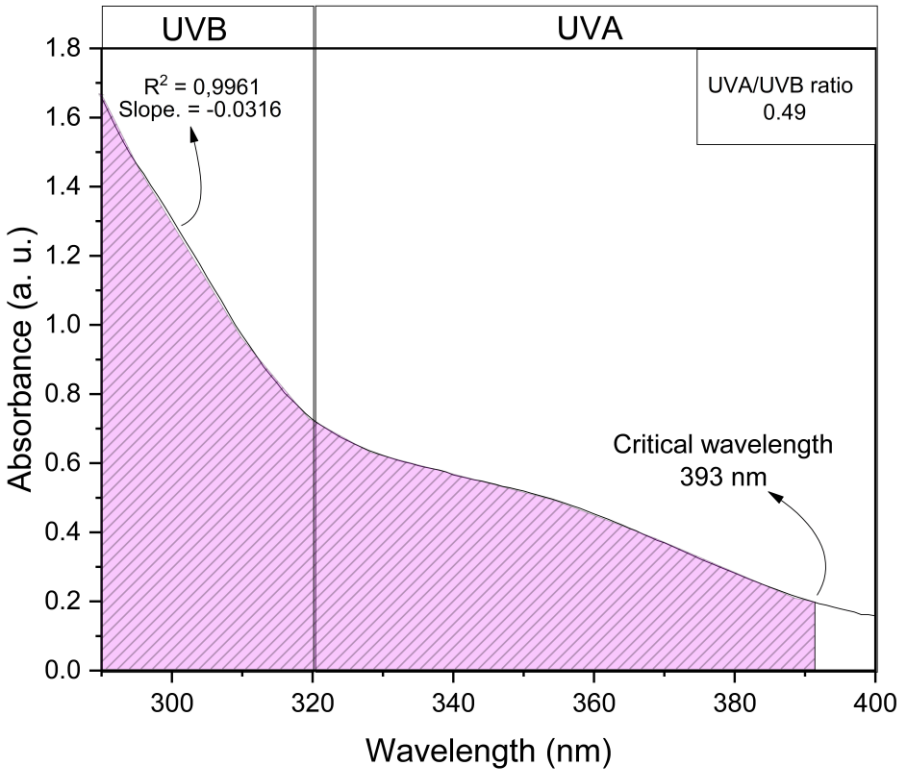



Figure 2 – Analysis of the absorption profile in the ultraviolet region of the 25% hydroethanolic extract from the leaves of *C. sessiliflora*. Source: The authors (2026).

The absorption spectrum in the UVB region exhibited linear behavior, as also observed for the hydroethanolic extracts of *Campomanesia adamantium* (Cambess.) O.Berg leaves by Castro et al. (2023b). This linearity allows for the analysis of the absorption distribution using the angular coefficient of the curve, which enables a comparison of photoprotective efficacy among species. In this regard, it is observed that the *C. sessiliflora* extract (Figure 2) has an angular coefficient of -0.0316, a value lower than that reported in the literature by Castro (2023b) for *C. adamantium* (between 0.0113 and 0.0262), indicating a narrower absorption distribution in the UVB range.

The critical wavelength obtained for the *C. sessiliflora* extract was 393 nm, a value that indicates effective protection in the UVA range, in addition to UVB protection. This parameter is essential for characterizing the extent of the sunscreen spectrum offered by the extract, since values equal to or greater than 370 nm are recommended to ensure broad-spectrum protection against the harmful effects of ultraviolet radiation (ANVISA, 2012). The result reinforces the extract's potential for use in cosmetic formulations, particularly those designed to protect the skin from damage caused by both UVA and UVB rays.

In the analysis of antioxidant potential using the DPPH assay, the lower the mean inhibitory concentration ($_{IC_{50}}$), the greater the antioxidant potential. Thus, for the infusion and maceration extracts of *C. sessiliflora* leaves, the values were 54.30 ± 0.20 μg $mL^{-1}$ and 52.37 ± 0.51 μg $mL^{-1}$ (Castro et al. 2022), whereas for the ethanolic extract of *C. sessiliflora* fruit peel, the value was 68.85 ± 2.73 μg $mL^{-1}$ (Castro et al. 2023a), with $_{IC_{50}}$ values higher than those shown in Table 3. However, the $IC_{50}$ of the 25% ethanol extract in distilled water from *C. sessiliflora* leaves (4.94 ± 0.19 μg/mL) was lower than that in Table 3 (Loureiro et al. 2025). These differences in the extract's antioxidant potential compared to values reported in the literature are consistent with the differences observed in its metabolite profile, as previously discussed.

The values reported in the literature for chlorophyll α and β in the ethanolic extract of *C. sessiliflora* leaves (2.70 ± 0.05 mg $g^{-1}$; 5.26 ± 0.10 mg $g^{-1}$ ) (Catelan et al. 2019) and of the 25% ethanol extract in distilled water from *C. sessiliflora* leaves (0.18 ± 0.01 mg $g^{-1}$ ; 0.46 ± 0.05 mg $g^{-1}$ ) (Loureiro et al. 2025) are higher than the levels described in Table 3. The carotenoid content is also higher in the 25% ethanol extract from the leaves of *C. sessiliflora* (0.16 ± 0.01 mg $g^{-1}$ ) (Loureiro et al. 2025).

The 25% ethanol extract in distilled water from *C. sessiliflora* leaves was analyzed using liquid chromatography with a diode array detector and yielded 73.55 ± 2.25 mg $g^{-1}$of gallic acid (Figure 3). Compared to the literature, the gallic acid content is higher (Table 4). In the study by Loureiro et al. (2025), using the same extract, additional compounds were identified, including gallic acid, syringic acid, catechin, epicatechin, and rutin. The lower number of compounds may be due to the lower quantified content of flavonoids and phenolic compounds in this extract (Table 3).

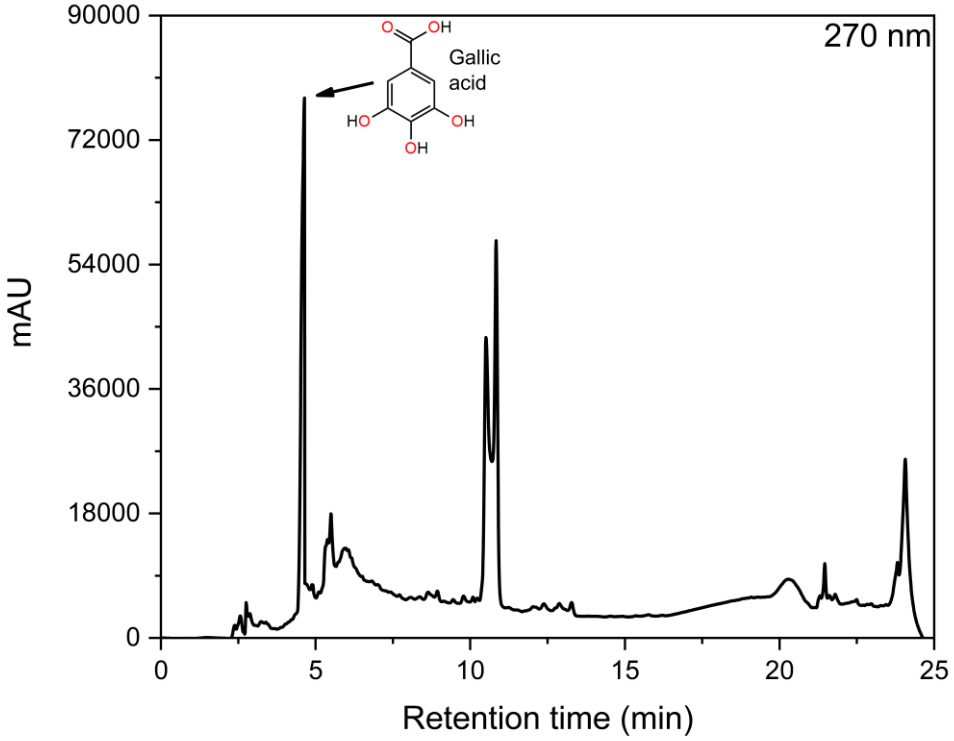



Figure 3 – Chromatographic analysis of the *C. sessiliflora* leaf extract. Source: The authors (2026)

Table 4 – Gallic acid content in the genus *Campomanesia*.

| ***Species*** | ***Plant part*** | ***Solvent*** | ***Gallic acid content (mg $g^{-}$)*** | ***Reference*** |
|---|---|---|---|---|
| *C. adamantium* | Root | Water | 2.83 | Espindola et al. (2016) |
| *C. xanthocarpa* | Leaf | Water | 31.9 | Pastori et al. (2013) |
| *C. adamantium* | Leaf | Water | 0.42 | Castro et al. (2023b) |
| *C. adamantium* | Leaf | Ethanol:Water (1:3 v/v) | 4.41 | Castro et al. (2023b) |
| *C. adamantium* | Leaf | Ethanol:Water (1:1 v:v) | 7.77 | Castro et al. (2023b) |
| *C. adamantium* | Leaf | Ethanol:Water (3:1 v/v) | 7.93 | Castro et al. (2023b) |
| *C. adamantium* | Leaf | Ethanol | 8.66 | Castro et al. (2023b) |
| *C. guazumifolia* | Leaf | Water | 36.33 | Castro et al. (2023c) |
| *C. sessiliflora* | Bark | Ethanol | 1.6 | Castro et al. (2023a) |

Source: Os autores (2026).

The extract had a high gallic acid content compared to other plants of the genus Campomanesia (Table 4), which contributes to its potential use in anti-aging products, given that this compound has been extensively studied in relation to cosmetic products (Zhang et al. 2022; Chaikul et al. 2019; Lee et al. 2021).

Gallic acid consists of an aromatic ring linked to three hydroxyl groups and a carboxyl group and acts through its phenolic structure. Its hydroxyl groups donate electrons or hydrogen atoms that are used to neutralize reactive oxygen species (ROS), thereby stabilizing them through the resonance present in the phenolic radicals (Kahkeshani et al. 2018).

After characterizing the extract, it was incorporated into the base cream at two concentrations: 0.1% and 1%. Stability analysis was conducted over a 3-month period on the base cream, as well as on the creams containing 0.1% and 1% of extract obtained from 2% *C. sessiliflora* leaves in 25% ethanol in distilled water .

The spreadability of the samples stored at 4 °C remained stable during the 3-month analysis period; the base cream exhibited the highest spreadability, while the creams containing 0.1% and 1% of the extract showed similar spreadability, with a reduction of 8 to 10% compared to the base cream.

The spreadability of the base cream when stored at 21 °C was higher than that of the creams containing 0.1% and 1%, showing a reduction of 1 to 2% compared to the base cream. The base cream exhibited greater spreadability than the creams containing the active ingredients; however, this difference was less pronounced than in the samples stored at 4 °C.

In terms of spreadability, the samples stored at 40 °C showed a reversal compared to those stored at 4 °C and 21 °C. The cream with 1% incorporation exhibited the highest spreadability, followed by the cream with 0.1% incorporation, and then the base cream, as evidenced by a 10% increase in spreadability for the cream with 0.1% incorporation and a 15% increase for the cream with 1% incorporation compared to the base cream. This may have occurred due to the degradation of the extract incorporated into the cream; thus, the more extract, the greater the spreadability. Monteiro and Silva (2013) reported increased spreadability with pseudoplastic and thixotropic behavior in a cream incorporating 5% (m/v) ethanolic cocoa extract (*Theobroma cacao* L.).

A liquid phase formed in the cream containing 1% extract stored at 40 °C after two weeks when left to stand for a long time (Figure 4), indicating that the extract increased the cream's wetting properties, which may be related to the increase in its spreadability.



Figure 4 – Image showing the formation of a liquid phase in the cream containing 1% extract stored in an oven (40 °C). Source: The authors.

In the base cream, the pH at the start of the analysis, for all three temperatures, averaged 6.2 ± 0.1, with a coefficient of variation of 1.6%. After three months of analysis, the final average pH for the three temperatures was 7.6 ± 0.1, with a coefficient of variation of 1.3%, representing a 22.6% increase compared to the initial pH.

For the cream incorporated at 0.1%, its average pH for all storage temperatures started at 6.5 ± 0.2 and, after three months, was 7.6 ± 0.3, with coefficients of variation of 3.1% and 3.9%, respectively. There was a 17.7% increase in pH compared to the start of the analysis.

In contrast, the cream formulated at 1% had an average pH, across all temperatures, of 6.4 ± 0.1 at the start and 7.9 ± 0.6 at the end, with coefficients of variation of 1.6% and 7.6%, respectively. There was a 24.2% increase compared to the start of the analysis.

While the liquid soap containing pomegranate extract (*Punica granatum* L.) showed a tendency toward acidification, with the initial pH decreasing from 6.50 to values between 5.32 and 5.94 over 60 days (Vieira Junior et al., 2022), the creams formulated with *C. sessiliflora* extract exhibited the opposite trend. This divergence suggests that pH changes may be primarily associated with the characteristics and stability of the respective matrices, with a possible contribution from the compounds present in the extracts. In the case of the cream containing *C. sessiliflora* ethanolic extract, the increase also observed in the formulation without the extract indicates that physicochemical changes in the emulsion components during storage may have played an important role in the alkalization of the system.

The base cream remained stable in color, but the different storage conditions affected the color of the cream containing 1% extract, with the sample stored in the oven having a darker color and exhibiting a change in texture. (Figure 5). Other extracts incorporated into cosmetic bases have been reported in the literature to affect product color; for example, the ethanolic extract of *Stemodia maritima* L. changed the base color from white to light brown (Leão et al., 2026).

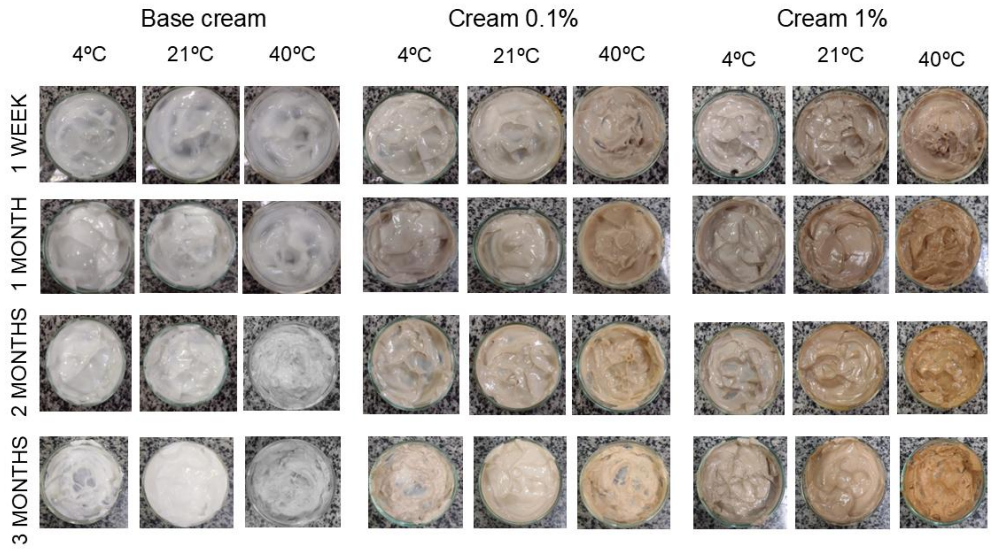



Figure 5 – Images of the base cream and creams containing 0.1% and 1% extract, stored in the refrigerator (4 °C), oven (40 °C), and at room temperature (21 °C) for 3 months. Source: The authors (2026).

The CIELAB (Lab) color system is used in the cosmetics industry to accurately measure and compare colors in a manner consistent with human visual perception. It uses three parameters: L* (luminance), a* (green–red), and b* (blue–yellow). Because it is device-independent and perceptually uniform, it allows for the evaluation of color changes in products such as foundations, lipsticks, and creams (Ly et al. 2020). The decrease in L* values with the addition of the extract indicates that the cream became visually darker, which may be related to the presence of phenolic compounds or naturally occurring pigments with intense coloration. The increase in a* and b* values reveals that, in addition to becoming darker, the product acquired hues closer to red (a*) and yellow (b*), suggesting a warmer and more intense color (Figure 6).

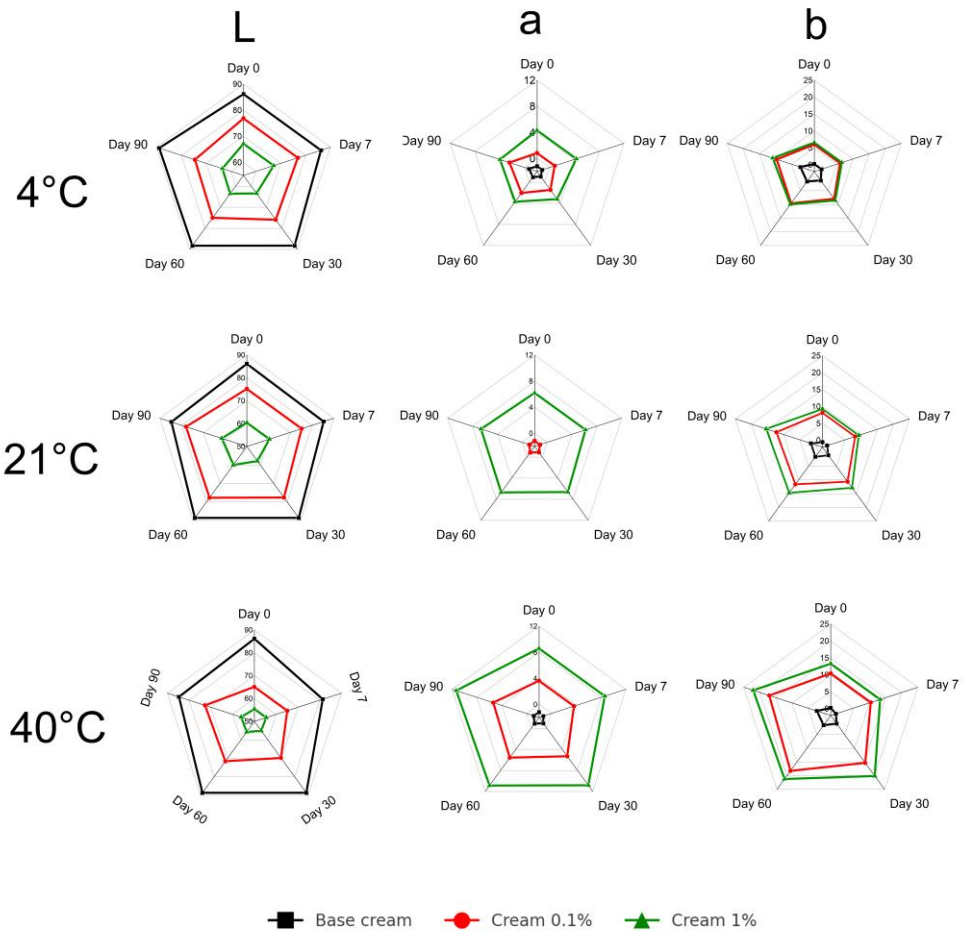



Figure 6 – Color change in the LAB system of the base cream and creams containing 0.1% and 1% extract, stored in the refrigerator (4 °C), in an oven (40 °C), and at room temperature (21 °C) for 3 months. Source: The authors (2026).

Regarding the effect of storage temperature, it was observed that higher temperatures intensified these changes: there was a further reduction in L*, accompanied by additional increases in a* and b*. This suggests that heat may be promoting chemical reactions, such as the oxidation of compounds present in the extract, resulting in darkening and intensification of hue. Such changes not only affect the product's appearance but may also indicate alterations in the physicochemical stability and quality of the formulation over time. The study by Leão et al. (2026) also reported darkening of the extract during storage of the cream incorporating an ethanolic extract of *S. marítima*.

Centrifugation is part of the stability test, as it acts on the sample by simulating an increase in gravitational force, thereby increasing the mobility of its particles and anticipating any instability (ANVISA, 2004).

Regarding the centrifugation test, the phases formed remained constant in size and consistency from the first observation through the last day of analysis (Figure 5). At 4 °C, phase formation was observed in the base cream and in the cream with 0.1% added starting on the seventh day at the first centrifugation speed (980 RPM) of the analysis; whereas for the cream with 1% incorporation, phase separation was observed starting on day 3 at the second centrifugation speed (1800 RPM) and on day 7 at the first centrifugation speed. Phase separation at 21 °C in the base cream and the cream with 0.1% incorporation was observed starting on day 22 at the first centrifugation speed analyzed; for the cream with 1% incorporation, phase separation occurred starting on day 7 at the first centrifugation speed. At a temperature of 40 °C, phase separation in the base cream and in the creams containing 0.1% and 1% extract was observed starting on day 7 at the first centrifugation speed. The phase that formed after centrifugation was not liquid; it had a thicker texture and greater luster than the rest of the cream (Figure 7).

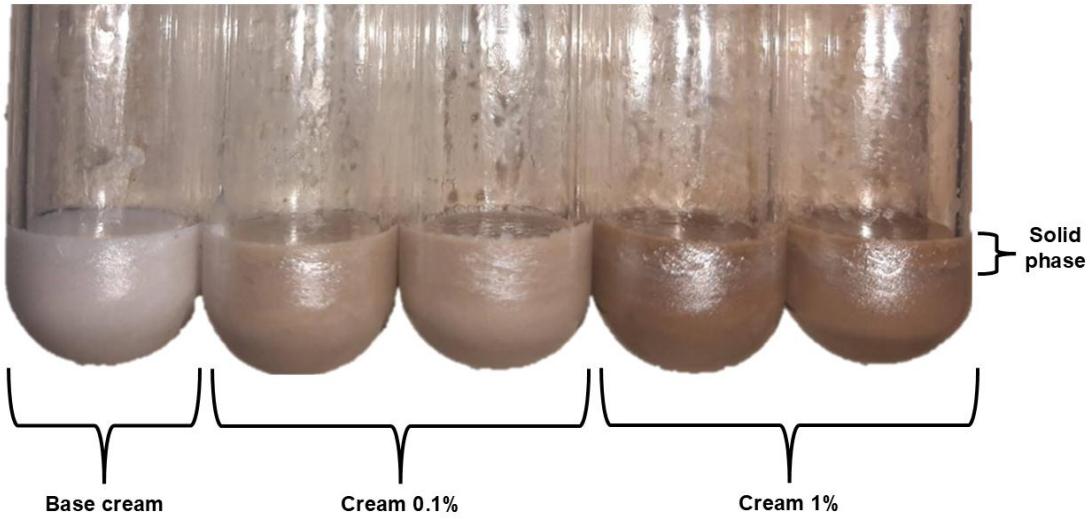



Figure 7 – Image of the phase formed during centrifugation of the base cream and the creams containing 0.1% and 1% extract on the last day of analysis.
Source: The authors (2026).

Based on the results obtained, it was found that the cream containing 1% extract is unstable when stored for a long period of time, whereas the cream containing 0.1% extract is stable.

## Conclusion

The extract obtained from 2% *C. sessiliflora* leaves in 25% ethanol in distilled water contains a significant concentration of phenolic compounds and flavonoids, which gives it high antioxidant potential and sun protection factor; in addition, the presence of gallic acid was detected.

The addition of the extract to the base cream altered its color, making the cream with a 1% concentration darker than the one with a 0.1% concentration. Storage at 40 °C accentuated this change, indicating possible oxidation of the compounds present. In the centrifugation test, all samples analyzed exhibited phase separation during the first month of analysis. The pH increased over the storage period for all samples. At 40 °C, the spreadability of the cream containing 1% increased, an effect that was less apparent in the cream containing 0.1%. The cream containing 1% *C. sessiliflora* showed instability at 40 °C, with liquid phase separation occurring after two weeks when left to stand, whereas this did not occur in the cream containing 0.1% *C. sessiliflora*, demonstrating greater stability. Thus, incorporating 0.1% *C. sessiliflora* into the cream proved to be more feasible.

## Acknowledgments

Rede BioDiversa Centro-Oeste (CAPES Project No. 88887.964845/2024-00 and FUNDECT Process No. 83/034.923/2024). State University of Mato Grosso do Sul for awarding the postdoctoral fellowship to Thiago Luis Aguayo de Castro. National Council for Scientific and Technological Development (CNPq) for the grant to Claudia Andrea Lima Cardoso (process 306065/2025-8) and the undergraduate research scholarship (PIBIC-CNPq-UEMS) to Raquel Parra Loureiro.

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