Flavanone Glycosides, Triterpenes, Volatile Compounds and Antimicrobial Activity of *Miconia minutiflora* (Bonpl.) DC. (*Melastomataceae*)

Nathália Siso Ferreira 1, Márcia Moraes Cascaes 1,*, Lourivaldo da Silva Santos 1, Mozaniel Santana de Oliveira 2*, Maria das Graças Bichara Zoghbi 2, Isabella Santos Araújo 3, Ana Paula Trovatti Uetanabaro 3, Eloisa Helena de Aguiar Andrade 1,2* and Giselle Maria Skelding Pinheiro Guilhon 1

1 Programa de Pós-Graduação em Química, Universidade Federal do Pará, Avenida Augusto Coronel 01, Belém 66075-110, PA, Brazil; nathisiso@gmail.com (N.S.F.); lss@ufpa.br (L.S.S.); eloisa@museu-goeldi.br (E.H.d.A.A.); giselle@ufpa.br (G.M.S.P.G.)

2 Laboratório Adolpho Ducke, Coordenação de Botânica, Museu Paraense Emílio Goeldi, Avenida Perimetral, 1901, Belém 66077-830, PA, Brazil; mozaniel.oliveira@yahoo.com.br (M.S.d.O.); zoghbi@museu-goeldi.br (M.d.G.B.Z.)

3 Programa de Pós-Graduação em Biotecnologia, Universidade Estadual de Feira de Santana, Avenida Transversal S/n, Feira de Santana 44036-900, BA, Brazil; araujo_isabella@yahoo.com (I.S.A.); uetanabaro@yahoo.com (A.P.T.U.)

* Correspondence: cascaesmm@gmail.com; Tel.: +55-91-3201-8099

Abstract: Chemical composition of the essential oils and extracts and the antimicrobial activity of *Miconia minutiflora* were investigated. The flavanone glycosides, pinocembrinose and pinocembrin-7-O-[4",6"-HDDP]-β-D-glucose, were identified, along with other compounds that belong mainly to the triterpene class, besides the phenolics, gallic acid and methyl gallate. Sesquiterpenes and monoterpenes were the major compounds identified from the essential oils. Screening for antimicrobial activity from the methanolic extract of the leaves showed that the MIC and MMC values against the tested microorganisms ranged from 0.625 to 5 mg·mL⁻¹ and that the extract was active against microorganisms, *Staphylococcus aureus*, *Escherichia coli*, and *Bacillus cereus*.

Keywords: pinocembrinose; pinocembrinose derivative; ursolic acid; essential oils; antimicrobial assays

1. Introduction

*Melastomataceae* comprises 166 genera and around 4500 species [1]. About 1470 species were cataloged in Latin America distributed in countries such as Brazil, Uruguay, Mexico, Argentina, Colombia, Ecuador, and Venezuela [2]. More than 1400 species within 69 genera occur in Brazil spread throughout the Amazon to the Uruguay frontier [3]. *Miconia* is the most representative genus of *Melastomataceae*, with a wide distribution in the American continent including 1057 species and representing the largest genus of woody flowering plants with a distribution restricted to tropical America [4].

Some *Miconia* species were widely used in folk medicine to treat diarrhea and stomachache [5]. Isolated compounds and *Miconia* extracts have demonstrated diverse pharmacological activities. The aqueous extract of *M. laterecens* (DC.) Naudin leaves showed a high antioxidant effect and high antibacterial activity [4]. The cytotoxic and mutagenic potential of extracts from *M. cabucu* Hoehne, *M. rubiginosa* (Bonpl.), *M. stenostachya* DC., and *M. albicans* (Sw.) Steud were investigated and the results confirmed the safe use of *Miconia* extracts and reinforced the therapeutic properties and their protective effects on doxorubicin-induced mutagenicity [6]. The ethanolic leaf extract of *M. albicans* shows an anti-arthritic profile [7]. The ethanolic extract of *M. willdenovii* Klotzsch ex Naudin showed schistosomicidal [8], antimicrobial activities, and anti-*L. amazonensis* effects, as well as
evidence that the most abundant constituent, the benzoquinone derivative primin, is the major bioactive metabolite [9].

Previous studies on Miconia species have revealed the presence of triterpenes [10], tannins [4], flavanone glycosides [11], benzoquinones [8], saponins, and leucoanthocyanins [12].

This work reports the chemical composition of extracts and essential oils and the antimicrobial activity of the methanolic extract from the leaves of Miconia minutiflora (Bonpl.) DC. A survey of the literature shows one study on the volatiles of M. minutiflora inflorescences, which were characterized by the presence of α-copaene and β-caryophyllene as major constituents [13]. Another study on M. minutiflora showed the anti-inflammatory and antinociceptive effects of the leaf methanol extract; in the same work, the authors tentatively identified the compounds casaurinin (4 isomers), ellagic acid, HHDP-galloylglucose (one isomer), myricetin-galloyl-deoxihexoside (one isomer), myruianthic acid (two isomers), and arjunolic acid (seven isomers) using UPLC-DAD-QTOF-MS/MS [14]. Effects of the extracts of seven Miconia species, including M. minutiflora, were evaluated on Lactuca sativa seeds and seedlings growth, the extract of M. minutiflora showed no allelopathic effects on the rootlets of the tested plant [15].

2. Results

2.1. Non-Volatiles

Chemical investigation of M. minutiflora leaves' extract led to a mixture containing, mainly, a mixture of hydrocarbons (octacosane 16.95%, nonacosane 3.18%, triacontano 39.66%, untriacontano 5.13%, and dotriacontano 33.15%) (M1), the triterpene squalene [16] (S1), a mixture of the terpenoids β-amirin, α-amyrin, taraxerol and lupeol [17] (M2), a mixture of phytol [18], β and α-amyrin [19], and fatty acids (palmitic and linoleic acids) [20] (M3), and a mixture of the steroids, stigmasterol [21], spisinasterol [22] and sitosterol [23] (M4). Fractionation of the methanol extract from the leaves led to a mixture of the phenolics compounds, gallic acid and methyl gallate [24] (M5), and isolation of the flavanones, pinocembrone [25] (S4) and pinocembrin-7-O-[4′,6′-HHDP]-β-glucose [26] (S5).

Study of the M. minutiflora stems led to the isolation of sitosterol (S2), a mixture of triterpenes β and α-amyrin and fatty acids (M6), besides that a mixture of fatty acids (M7), besides a mixture of the steroids, stigmasterol and sitosterol (M8), and the triterpene ursolic acid [27] (S3). The structures of the major isolated compounds from the leaves' extracts, pinocembrone (S4) and pinocembrin-7-O-[4′,6′-HHDP]-β-glucose (S5), are shown in Figure 1. Although the chemical composition of M. minutiflora found in this research is in accordance with other Miconia species, this is the first time that flavanone glycosides (pinocembrone and pinocembrin-7-O-[4′,6′-HHDP]-β-glucose) were isolated from Miconia.

2.2. Volatile Compounds

The percentage of the compounds identified in the essential oils and the sequence of their retention indices are listed in Table 1. Leaves, primary and secondary branches of M. minutiflora yield below 0.1% of essential oils, just enough to perform the chemical characterization. In total, 67 compounds were identified. The major constituents in the essential oils from the leaves were (3Z)-hexenol (9.73%), 1-octen-3-ol (8.16%), (3Z)-hexenylbutanoate (9.77%), cis-3-hexenyl isovalerate (8.65%), (3Z)-hexenyl hexanoate (10.91%), and phytol (7.34%). (9Z,12Z)-Octadecadienoic acid (48.71%) and n-hexadecanoic acid (32.65%) were the major compounds in the primary branches and in the secondary branches, the main compounds were n-hexadecanoic acid (42.75%), (9Z,12Z)-octadecadienoic acid (35.65%), and dodecanoic acid (6.36%).

Zoghbi and coworkers (2000) [13] obtained the volatile concentrate by micro-simultaneous distillation extraction from M. minutiflora inflorescences using pentane as a solvent and the main compounds identified were the sesquiterpenes α-copaene (22.82%) and β-caryophyllene (14.46%). The volatiles of the inflorescences of two other species of Miconia, also extracted
by micro-simultaneous distillation extraction, shown as major compounds were \((E,E)\)-α-farnesene (14.7%) and \(p\)-cymene (10.3%) in *M. ciliata* (Rich.) DC., while α-copaene (32.9%) and nonanal (18.5%) were the major constituents of *M. rubiginosa* (Bonpl.) DC. [13]. The main compounds identified in the essential oil of the aerial parts of *M. ferruginata* were the sesquiterpenes, \(\beta\)-caryophyllene (56.2%) and \(\alpha\)-humulene (7.3%), the hydrocarbon, 8-heptadecene (16.8%), and the alcohol, 11-octen-3-ol (9.5%) [28].

Table 1. Constituents (%) identified in the essential oils of the leaf, primary and secondary branches of *Miconia minutiflora*.

| RI_L | RI_C | Constituents                  | Leaf  | Branch-1 | Branch-2 |
|------|------|-------------------------------|-------|----------|----------|
| 801  | 799  | Hexanal                       | 0.55  | 0.03     | 0.14     |
| 846  | 846  | \((2E)\)-Hexenal              | 0.38  | 0.04     |          |
| 850  | 851  | \((3Z)\)-Hexenol              | 9.73  | 0.03     | 0.1      |
| 854  | 857  | \((2E)\)-Hexenol              | 0.77  |          |          |
| 863  | 864  | Hexanol                       | 1.39  |          |          |
| 907  | 908  | \((2E,4E)\)-Hexadienal        | 0.52  |          |          |
| 947  | 914  | \((2E)\)-Heptenal             | 0.15  |          |          |
| 952  | 953  | Benzaldehyde                  | 0.33  | 0.02     | 0.05     |
| 959  | 960  | Heptanal                      | 0.25  |          |          |
| 974  | 974  | 1-Octen-3-ol                  | 8.16  | 0.15     |          |
| 981  | 981  | 6-methyl-5-Hepten-2-one       | 0.27  |          |          |
| 984  | 985  | 3-p-Menthe                     | 0.29  |          |          |
| 989  | 990  | 6-methyl-5-Hepten-2-ol        | 0.28  |          | 0.05     |
| 1005 | 1005 | \((2E,4E)\)-Heptadienal       | 0.32  |          |          |
| 1004 | 1008 | \((3Z)\)-Hexenylacetate       | 0.54  |          |          |
| 1024 | 1026 | Limonene                      | 0.25  | 0.05     | 0.07     |
| 1036 | 1038 | Benzeneacetaldehyde           | 0.07  |          | 0.09     |
| 1044 | 1044 | \((E)\)-β-Ocimene             | 0.35  |          |          |
| 1063 | 1063 | \(n\)-Octanol                 | 0.23  |          |          |
| 1086 | 1086 | Terpinolene                   | 0.14  |          |          |
| 1089 | 1090 | \(p\)-Cymene                  | 0.28  |          |          |
| 1095 | 1096 | Linalool                      | 1.19  |          |          |
| RI<sub>L</sub> | RI<sub>C</sub> | Constituents                   | Leaf | Branch-1 | Branch-2 |
|-----------|-------------|--------------------------------|------|----------|----------|
| 1100      | 1100        | Nonanal                        | 0.25 | 0.1      | 0.15     |
| 1102      | 1115        | (2E,4E)-Octadienal             | 0.07 |          |          |
| 1142      | 1142        | (3Z)-Hexenylisobutanoate       | 0.75 |          |          |
| 1152      | 1152        | (3Z)-Nonen-1-ol                | 0.44 |          |          |
| 1157      | 1157        | (2E)-Nonen-1-al                | 0.15 | 0.11     | 0.12     |
| 1184      | 1183        | (3Z)-Hexenylbutanoate          | 9.77 |          |          |
| 1191      | 1186        | Hexylbutanoate                 | 0.37 | 0.05     |          |
| 1186      | 1188        | α-Terpineol                    | 0.72 | 0.13     |          |
| 1196      | 1196        | Safranal                       | 0.17 |          |          |
| 1201      | 1202        | Decanal                        |      |          | 0.13     |
| 1210      | 1210        | (2E,4E)-Nonadienal             | 0.05 |          |          |
| 1232      | 1226        | *cis*-3-Hexenyl isovalerate    | 8.65 |          |          |
| 1249      | 1248        | Geraniol                       | 0.13 |          |          |
| 1260      | 1260        | (2E)-Decenal                   | 0.25 | 0.05     |          |
| 1279      | 1275        | *cis*-3-hexenyl valerate       | 0.26 |          |          |
| 1285      | 1286        | Safrole                         | 0.18 | 0.09     |          |
| 1293      | 1294        | 2-Undecanone                   | 0.28 |          |          |
| 1315      | 1315        | (2E,4E)-Decadienal             | 0.27 | 0.08     |          |
| 1330      | 1330        | Hexyl tiglate                  | 0.26 |          |          |
| 1364      | 1365        | Decanoic acid                  |      | 0.11     |          |
| 1374      | 1374        | α-Copaene                      | 0.97 |          |          |
| 1383      | 1382        | (E)-β-Damascenone              | 0.57 |          |          |
| 1378      | 1385        | (3Z)-Hexenyl hexanoate         | 10.91|          |          |
| 1417      | 1417        | (E)-Caryophyllene              | 2.66 |          |          |
| 1428      | 1428        | (E)-α-Ionone                   | 0.78 |          |          |
| 1432      | 1432        | trans-α-Bergamotene            | 0.19 |          |          |
| 1453      | 1453        | Geranyl acetone                | 0.72 | 0.05     |          |
| 1452      | 1454        | α-Humulene                     | 0.98 |          |          |
| 1487      | 1488        | (E)-β-Ionone                   | 1.89 | 0.05     |          |
| 1495      | 1495        | 2-Tridecanone                  | 0.34 |          |          |
| 1505      | 1505        | (E,E)-α-Farnesene              | 0.36 |          |          |
| 1514      | 1515        | β-Curcumene                    | 1.28 |          |          |
| 1561      | 1562        | *E*-Nerolidol                  | 0.69 |          |          |
| 1565      | 1566        | Dodecanoic acid                | 0.91 | 2.3      | 6.36     |
| 1565      | 1568        | (3Z)-Hexenyl benzoate          | 1.93 |          |          |
| 1594      | 1595        | Ethyl dodecanoate              | 0.31 |          |          |
| 1722      | 1725        | Tetradecanoic acid             | 0.59 | 2.6      | 4.48     |
| 1946      | 1940        | Isophytol                      | 0.34 | 0.29     |          |
| 1942      | 1941        | Phytol                         | 7.34 |          |          |
| 1959      | 1959        | n-Hexadecanoic acid            | 1.83 | 32.65    | 42.75    |
| 2029      | 2117        | (9Z,12Z)-Octadecadienoic acid | 48.71| 35.65    |          |
| 2124      | 2130        | Octadecanoic acid              | 0.1  | 1.48     |          |
| 2500      | 2501        | Pentacosane                    | 0.2  |          | 0.44     |
| 2600      | 2603        | Hexacosane                     | 0.12 | 0.72     | 0.2      |
| 2700      | 2705        | Heptacosane                    | 0.12 | 0.38     | 0.09     |
| **Total** |            |                                | 85.44| 88.54    | 94.26    |

RI<sub>C</sub> = Calculated retention index; RI<sub>L</sub> = Literature retention index; Branch-1: primary branches; Branch-2: secondary branches.

2.3. Antimicrobial Activity

The minimal inhibitory concentration (MIC) and minimum microbicidal concentration (MMC) of the methanol extract from *M. minutiflora* against the tested microorganisms ranged from 0.625 to 5 mg·mL<sup>−1</sup>, these data are shown in Table 2. The methanol extract was active against chloramphenicol resistant microorganisms, *E. coli* CCMB 261 (MIC = 0.625 and MMC = 1.25 mg·mL<sup>−1</sup>), *S. aureus* CCMB 262 (MIC = 0.625 and MMC = 1.25 mg·mL<sup>−1</sup>), *S. aureus* CCMB 263 (MIC = 0.625 and MMC = 1.25 mg·mL<sup>−1</sup>), *S. aureus* CCMB 285
(MIC = 0.625 and MMC = 1.25 mg·mL⁻¹), *B. cereus* CCMB 282 (MIC = 0.625 and MMC = 1.25 mg·mL⁻¹), and a nystatin resistant *C. parapsilosis* CCMB 288 (MIC = 5 and MMC = 10 mg·mL⁻¹).

### Table 2. Antimicrobial potential of the methanol extract of *Miconia minutiflora* leaves.

| Microorganism            | MIC (mg mL⁻¹) | MMC (mg mL⁻¹) | Control Nist/Chlorf DMSO (mg mL⁻¹) |
|--------------------------|---------------|---------------|-----------------------------------|
| *Escherichia coli* CCMB 261 | 0.625         | 1.25          | R 5.00                            |
| *Pseudomonas aeruginosa* CCMB 268 | 1.25         | 2.5           | 0.31 5.00                         |
| *Salmonella* sp. CCMB 281 | 1.25          | 2.5           | 0.16 5.00                         |
| *Staphylococcus aureus* CCMB 262 | 0.625         | 1.25          | 0.31 10.00                        |
| *S. aureus* CCMB 263     | 0.625         | 1.25          | 0.31 10.00                        |
| *S. aureus* CCMB 285     | 0.625         | 1.25          | R 10.00                           |
| *Bacillus cereus* CCMB 282 | 0.625         | 1.25          | 0.16 5.00                         |
| *Candida albicans* CCMB 286 | 2.5           | 5             | 0.63 10.00                        |
| *C. albicans* CCMB 266   | 2.5           | 5             | 0.08 10.00                        |
| *C. parapsilosis* CCMB 288 | 5             | 10            | R 10.00                           |

R: resistant, Nyst: nystatin, Chlorf: chloramphenicol.

Rodrigues and coworkers (2008) tested the dichloromethane extract of *M. cabucu* against *C. albicans* and obtained an MIC value of 1.5 mg·mL⁻¹ and the methanol extract of *M. stenostachya* against *B. cereus* showed an MIC of 3.0 mg·mL⁻¹ [29]. The ethanol extract of *M. albicans* and *M. rubiginosa* showed antimicrobial activity using the well diffusion method [30].

Some compounds obtained from *Miconia* species also demonstrated antimicrobial activity such as the mixture of ursolic and oleanolic acids isolated from *M. ferruginata* leaves that was active against *S. aureus, E. coli*, *Bacillus subtilis*, and *Pseudomonas aeruginosa* [31]. The antifungal activity of the isolated compound pinocembrin-7-O-[4",6"-HHDP]-β-glucose showed antibacterial activity on *E. coli, S. aureus, Enterococcus faecalis, Lactobacillus rhamnosus*, and *Bacillus subtilis* [37].

The antimicrobial activity observed for the methanol extract of *M. minutiflora* can be explained by the presence of substances in the studied extracts indicating that this species is a valuable source for the discovery of new antimicrobial products.

### 3. Materials and Methods

#### 3.1. Plant Material

Leaves and stems of *M. minutiflora* were collected in the Municipality of Belém (Estrada do Paiol, Km 5), State of Pará, Brazil in June 2010 for the study of its non-volatile compounds. A voucher specimen was identified and deposited at the Herbarium of the Museu Paraense Emílio Goeldi (Belém—Pará—Brazil) under the reference number MG-204.906. Another collection (leaves, primary and secondary branches) was taken in the same municipality at the Museu Paraense Emílio Goeldi—research campus in November 2014 for the identification of the volatile compounds; this specimen was identified at the same herbarium by comparison with the same voucher.
3.2. Extraction, Isolation, and Identification of the Non-Volatile Compounds

Leaves (2.00 Kg) and stems (2.00 Kg) of *M. minutiflora* were extracted by maceration with hexane (7 days × 2) and MeOH (14 days × 2) at room temperature. The filtrates were concentrated under reduced pressure to yield the hexane extracts (30.00 g of leaves extract and 7.00 g of stems extract) and the methanolic extracts (267.00 g of leaves extract and 118.00 g of stems extract). Part of the methanolic extracts (40.00 g each) was suspended in MeOH-H$_2$O 3:1 and extracted with CH$_2$Cl$_2$, EtOAc, and n-BuOH yielding the leaves phases (CH$_2$Cl$_2$ phase: 7.00 g, EtOAc phase: 13.87 g, n-BuOH: 8.00 g) and the stems phases (CH$_2$Cl$_2$ phase: 3.00 g, EtOAc phase: 2.54 g, n-BuOH: 1.19 g) of the methanolic extracts.

The hexane extracts of the leaves (20.00 g) and of the stems (6.00 g), the CH$_2$Cl$_2$ phase of the stems (3.00 g), and the EtOAc phase of the leaves (14.03 g) were purified using column chromatography (CC) over silica gel using mixtures of hexane–EtOAc and EtOAc–MeOH with increasing polarity. When necessary, the resulting fractions were rechromatographed using similar techniques. The hexane extract of the leaves afforded M1 (1401 mg), S1 (772 mg), M2 (20 mg), M3 (21 mg), and M4 (56 mg). The hexane extract of the stems afforded M6 (44 mg), M7 (17 mg), and S2 (205 mg). The CH$_2$Cl$_2$ phase from stems afforded M8 (38 mg) and S3 (7 mg). Fractions of the EOAc phase of the leaves eluted with EtOAc–MeOH 50% and MeOH were reunited and fractionated by CC affording MM1 (100 mg) and MM2 (600 mg). Part of fraction MM1 (10 mg) was purified on an SPE cartridge eluted with 3 × 1 mL ACN:H$_2$O 90:10 yielding M5 (4 mg). Fraction MM2 was submitted to fractioning by semipreparative HPLC using as eluent the system ACN:H$_2$O 38:62 and flow of 4.7 mL.min$^{-1}$ yielding S4 (18 mg) and S5 (19 mg). Spectra and spectral data ($^1$H, $^{13}$C) of S4 and S5 are provided in the Supplementary Material along with chemical and instruments.

3.3. Extraction of the Essential Oils

Samples of leaves, primary and secondary branches (120 g) were hydrodistilled for 3 h, using a Clevenger-type apparatus with maintenance of the refrigeration water at 15 °C in accordance with the works described in the literature [38,39].

Analysis of the Essential Oils

The chemical composition of the volatile compounds of the *Miconia minutiflora* (Bonpl.) DC. (*Melastomataceae*) was analyzed using gas chromatography coupled to mass spectrometry, using a Thermo DSQ-II system equipped with a DB-5MS silica capillary column (30 m × 0.25 mm; 0.25 mm). For this analysis, the same protocols described previously by our research group were followed [40,41]. The volatile compounds present in the essential oil were identified by comparison with the literature [42,43].

3.4. Antimicrobial Analysis

The analysis of the antimicrobial potential of the methanolic extract from the leaves of *M. minutiflora* was realized against the microorganism *C. parapsilosis* CCMB 288 (resistant to anfoterycin-B), *C. albicans* CCMB 286, *C. albicans* CCMB 266, *B. cereus* CCMB 282, *P. aeruginosa* CCMB 268, *Salmonella* sp. CCMB 281, *S. aureus* CCMB 263, *S. aureus* CCMB 285, *S. aureus* CCMB 262 (resistant to streptomycin and dihydrostreptomycin), and *E. coli* CCMB 261 (sensitive to trimetoprine and resistant to sulphonamide).

3.4.1. Well Diffusion Test

The antimicrobial activity of the methanol extract was first evaluated using the well diffusion test as follows. A swab of the microorganism was transferred to 6 mL of a 0.45% saline solution and the resulting suspension was adjusted to 0.1 mL of a 1.5 × 108 cels·mL$^{-1}$ (bacteria) and 1.5 × 105 cels·mL$^{-1}$ (yeast). The cells suspension was added to 120 mL of MHA. The resulting mixture was transferred to Petri dishes (100 mm). After cooling the mixture, six equidistant wells (6 mm in diameter) received 65 µL of the methanol extract, at 200 mg·mL$^{-1}$ in DMSO-water 1:1. Positive controls were chloramphenicol at...
30 µg·mL⁻¹ for bacteria and nystatin at 10 µg·mL⁻¹ for yeast. The negative control was DMSO. Petri dishes were incubated at 37 °C for 24 h (bacteria) and at 28 °C for 48 h (yeast). The results were reported as the diameter of the zone of inhibition (in mm) (CLSI, 2003, with adaptations) [44].

3.4.2. Minimum Inhibitory Concentration (MIC) and Minimal Microbicidal Concentration (MMC)

The minimum inhibitory concentration (MIC) and minimal microbicidal concentration (MMC) of the methanol extract of the leaves of M. minutiflora were performed following the same protocols described in previous works [45,46].

4. Conclusions

This study showed that the extracts of M. minutiflora is an important source of glycosylated flavanones, which are very often identified from Miconia. This is the first time that the flavanones, pinocembrone and pinocembrin-7-O-[4",6"-HHDP]-β-glucose, were isolated from a Miconia species. Compounds (3Z)-hexenol, 1-octen-3-ol, (3Z)-hexenylbutanoate, cis-3-hexenyl isovalerate, (3Z)-hexenyl hexanoate, and phytol were the major constituents of the essential oils from the leaves, while n-hexadecanoic acid and (9Z,12Z)-octadecadienoic acid were the major constituents from the primary branches and (9Z,12Z)-octadecadienoic acid, dodecanoic acid, tetradecanoic acid and n-hexadecanoic acid were the major constituents from the secondary branches. The antimicrobial screening showed that the leaves’ methanol extract is active against E. coli, S. aureus, and B. cereus and these activities can be in part explained by the presence of known bioactive compounds in the extracts.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/molecules27062005/s1. Chemical and instruments, spectra and spectral data (¹H, ¹³C) of pinocembrone (S4) and pinocembrin-7-O-[4",6"-HHDP]-β-glucose (S5), 300 MHz, DMSO-d₆.

Author Contributions: Conceptualization, N.S.F., M.M.C. and G.M.S.P.G.; methodology, N.S.F., I.S.A., M.d.G.B.Z. and M.M.C.; writing—original draft preparation, N.S.F., M.M.C., M.S.d.O. and G.M.S.P.G.; writing—review and editing, G.M.S.P.G., A.P.T.U., L.d.S.S. and E.H.d.A.A.; visualization, M.S.d.O., G.M.S.P.G. and E.H.d.A.A.; supervision, G.M.S.P.G.; project administration, G.M.S.P.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The author M.M.C. thanks CAPES for the Ph.D. scholarship process number: [88887.497476/2020-00]. The author M.S.d.O., thanks PCI-MCTIC/MPEG, as well as CNPq for the scholarship process number: [301194/2021-1]. The authors would like to thank the Universidade Federal do Pará/PROPESP Edital 02/2022, Programa de Apoio à Publicação Qualificada.

Conflicts of Interest: The authors declare no conflict of interest.

Sample Availability: Not applicable.

References
1. Clausing, G.; Renner, S.S. Molecular Phylogenetics of Melastomataceae and Memecylaceae: Implications for Character Evolution. Am. J. Bot. 2001, 88, 486–498. [CrossRef] [PubMed]
2. Goldenberg, R.; Almeda, F.; Caddah, M.K.; Martins, A.B.; Meirelles, J.; Michelangeli, F.A.; Weiss, M. Nomenclator Botanicus for the neotropical genus Miconia (Melastomataceae: Miconieae). Phytotaxa 2013, 106, 1–171. [CrossRef]
3. Baumgratz, J.F.A.; Caddah, M.K.; Chiavegatto, B.; Goldenberg, R.; Guimarães, P.J.F.; Koschmiede, C.; Kriebel, R.; Lima, L.F.G.; Martins, A.B.; Michelangeli, F.A.; et al. Melastomataceae in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Disponível em. Available online: http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/Fb161 (accessed on 29 October 2021).
4. Gontijo, D.C.; Gontijo, P.C.; Brandão, G.C.; Diaz, M.A.N.; de Oliveira, A.B.; Fietto, L.G.; Leite, J.P.V. Antioxidant study indicative of antibacterial and antimutagenic activities of an ellagitannin-rich aqueous extract from the leaves of Miconia latexcernata. *J. Ethnopharmacol.* **2019**, *236*, 114–123. [CrossRef] [PubMed]

5. Hoene, F.C. *Plantas E Substâncias Vegetais Tóxicas E Medicinais*; Graphiears: São Paulo, Brazil, 1939.

6. Serpeloni, J.M.; Barcelos, G.R.M.; Mori, M.P.; Yanagui, K.; Vilegas, W.; Varanda, E.A.; Cólus, I.M.S. Cytotoxic and mutagenic evaluation of extracts from plant species of the *Miconia* genus and their influence on doxorubicin-induced mutagenicity: An in vitro analysis. *Exp. Toxicol. Pathol.* **2011**, *63*, 499–504. [CrossRef] [PubMed]

7. Quintans-Júnior, L.J.; Gandi, S.R.; Passos, E.R.S.; Heimfarth, L.; Pereira, E.W.M.; Monteiro, B.S.; Dos Santos, K.S.; Duarte, M.C.; Abreu, L.S.; Nascimento, Y.M.; et al. Dereplication and quantification of the ethanol extract of *Miconia albicans* (Melastomataceae) by Hplc-Dad-Esi-/Ms/Ms, and assessment of its anti-hyperalgesic and anti-inflammatory profiles in a mice arthritis-like model: Evidence for involvement of TNF-α, IL-1β and IL-6. *J. Ethnopharmacol.* **2020**, *258*, 112993. [CrossRef]

8. Viegas, F.P.D.; de Castro, A.T.; Castro, A.P.; Siqueira, C.; Rosa, W.; Espuri, P.F.; Coelho, L.F.L.; Marques, M.J.; Soares, M.G. In vitro schistosomicidal activity of the crude extract, fractions and Primin, the major active benzoquinone constituent from the leaves of *Miconia weildenovii* (Melastomataceae). *A. Afr. J. Bot.* **2017**, *111*, 365–370. [CrossRef]

9. Viegas, F.P.D.; Espuri, P.F.; Oliver, J.C.; Silva, N.C.; Dias, A.L.T.; Marques, M.J.; Soares, M.G. Leishmanicidal and antimicrobial activity of primin and primin-containing extracts from *Miconia weildenovii*. *Fitoterapia* **2019**, *138*, 104297. [CrossRef]

10. Cunha, W.R.; Crevelin, E.J.; Arantes, G.M.; Crott, M.; Silva, M.L.A.; Furtado, N.A.J.C.; Sérgio, A.; Ferreira, D.S. A study of the trypanocidal activity of triterpene acids isolated from *Miconia* species. *Phyther. Res.* **2006**, *20*, 474–478. [CrossRef]

11. Tarawneh, A.H.; León, F.; Ibrahim, M.A.; Pettaway, S.; Mccurdy, C.R.; Cutler, S.J. Flavanones from *Miconia prasina*. *Phytochem. Lett.* **2014**, *7*, 130–132. [CrossRef]

12. Lima, T.C.; Matos, S.S.; Carvalho, T.F.; Silveira-Filho, A.J.; Couto, L.P.S.M.; Quintans-Júnior, L.J.; Quintans, J.S.S.; Silva, A.M.O.; Heimfarth, L.; Passos, F.R.S.; et al. Evidence for the Involvement of IL-1β And Tnf-A in anti-inflammatory effect and antioxidative stress profile of the standardized dried extract from *Miconia albicans* Sw. (Triana) Leaves (Melastomataceae). *J. Ethnopharmacol.* **2020**, *259*, 112908. [CrossRef]

13. Zogghi, M.G.B.; Andrade, E.H.A.; Maia, J.G.S. *Aroma de Flores na Amazônia*; Museu Para: Belém, Brazil, 2000.

14. Gatis-Carrazzoni, A.S.S.G.; Mota, F.V.B.; Leite, T.C.C.; de Oliveira, T.B.; da Silva, S.C.; Bastos, I.V.A.; de Souza Maia, M.B.; Pereira, P.S.; Neto, P.P.M.; de Oliveira Chagas, E.C.; et al. Anti-Inflammatory and Antinoceptive Activities of the Leaf Methanol Extract of *Miconia minutiflora* (Bonnpl.) De. and Characterization of Compounds by Uplc-Dad-Qtof-Ms/Ms. *Naunyn Schmiedebergs Arch. Pharmacol.* **2019**, *392*, 55–68. [CrossRef] [PubMed]

15. dos Santos, M.A.F.; da Silva, M.A.P.; Bezerra, J.W.A.; dos Santos, A.C.B.; Alencar, S.R.; Barbosa, E.A. Atividades biológicas de *Miconia* spp. Ruiz & Pavon (Melastomataceae Juss.). *Gaia Sci.* **2017**, *11*, 157–170. [CrossRef]

16. Breitmaier, E.; Voelter, W. *Carbon-13 Nmr Spectroscopy*, 3rd ed.; Vch: Weinhein, Germany, 1987.

17. Ahmad, V.U.; Rahman, A.U. *Handbook of Natural Products Data: Pentacyclic Triterpenoids*; Elsevier: Amsterdam, The Netherlands, 1994.

18. Miranda, M.L.D.; Souza, A.F.; Rodrigues, E.D.; Garcez, F.R.; Garcez, W.S. Constituintes quimicos das folhas de riediellia graciliflora Harms (Leguminosae). *Quim. Nova* **2012**, *35*, 1306–1311. [CrossRef]

19. Okoye, N.N.; Ajaghaku, D.L.; Okeke, H.N.; Iloiddge, E.E.; Nworu, C.S.; Okoye, F.B.C. Beta-Amyrin and alpha-Amyrin acetate isolated from the stem bark of alstonia boonei display profound anti-inflammatory activity. *Pharm. Biol.* **2014**, *52*, 1478–1486. [CrossRef]

20. Di Pietro, M.E.; Mannu, A.; Mele, A. Nmr Determination of Free Fatty Acids in Vegetable Oils. *Processes* **2020**, *8*, 410. [CrossRef]

21. Zhang, L.; Yang, X.D.; Xu, L.Z.; Zou, Z.M.; Yang, S.L. A new sterol glycoside from securidaca inappendiculata. *J. Asian Nat. Prod. Res.* **2005**, *7*, 649–653. [CrossRef]

22. Forgo, P.; Köver, K.E. Gradient enhanced selective experiments in the 1H nmr chemical shift assignment of the skeleton and side-chain resonances of stigmasteral, a phytosterol derivative. *Steroids* **2004**, *69*, 43–50. [CrossRef]

23. Nes, W.D.; Norton, R.A.; Benson, M. Carbon-13 Nmr studies on sitosterol biosynthesized from [13C]Mevalonates. *Phytochemistry* **1992**, *31*, 805–811. [CrossRef]

24. Thang, P.T.; Dung, N.A.; Giap, T.H.; Oanh, V.T.K.; Hang, N.T.M.; Huong, T.T.; Thanh, L.N.; Huong, D.T.M.; Van Cuong, P. Preliminary study on the chemical constituents of the leaves of macaranga balansae gagnep. *Vietnam J. Chem.* **2018**, *56*, 632–636. [CrossRef]

25. Hammond, S.; Jannet, H.B.; Bergaoui, A.; Ciavatta, L.; Cimino, G.; Mighir, Z. Isolation and structure elucidation of a flavanone, a flavanone glycoside and vomifoliol from echiochilon fruticosum growing in Tunisia. *Phytochem. Lett.* **2004**, *9*, 602–608. [CrossRef]

26. Hegde, V.R.; Pu, H.; Patel, M.; Das, P.R.; Butkiewicz, N.; Arreaza, G.; Gullo, V.P.; Chan, T.M. Two antiviral compounds from the plant stigloyl caffeiuflora as inhibitors of Hcv Ns3 protease. *Bioorg. Med. Chem. Lett.* **2003**, *13*, 2925–2928. [CrossRef]

27. Taketa, A.T.C.; Breitmaier, E.; Schenkel, E.P. Triterpenes and triterpenoidal glycosides from the fruits of ilex paraguariensis (Maté). *J. Braz. Chem. Soc.* **2004**, *15*, 205–211. [CrossRef]

28. Barroso, P.R.; Otoni, T.J.O.; Mendes, J.P.G.; Machado, E.L.M.; Martins, H.R.; Gregorio, L.E. Analysis of volatiles from aerial parts of miconia ferruginata by Hs-spme And Gc-Ms. *Chem. Nat. Compd.* **2017**, *53*, 167–168. [CrossRef]

29. Rodrigues, J.; Michelin, D.C.; Rinaldo, D.; Zocolo, G.J.; Dos Santos, L.C.; Vilegas, W.; Salgado, H.R.N. Antimicrobial activity of *Miconia* Species (Melastomataceae). *J. Med. Food* **2008**, *11*, 120–126. [CrossRef] [PubMed]
30. Celotto, A.C.; Nazario, D.Z.; Spesso, M.A.; Martins, C.H.G.; Cunha, W.R. Evaluation of the in vitro antimicrobial activity of crude extracts of three Miconia species. *Braz. J. Microbiol.* 2003, 34, 339–340. [CrossRef]

31. Cunha, G.O.S.; Terezan, A.P.; Matos, A.P.; Burger, M.C.M.; Vieira, P.C.; Fernandes, J.B.; Da Silva, M.F.G.; Menezes, A.C.S. Antimicrobial activity of isolated compounds and semisynthetic derivatives from Miconia ferruginata. *Acta Bras. 2020*, 4, 49–52. [CrossRef]

32. Chen, C.; Wan, C.; Peng, X.; Chen, J. A Flavonone pinocembrin derivative inhibits penicillium italicum growth and blue mold development in 'newhall' navel oranges by targeting membrane damage mechanism. *Pestic. Biochem. Physiol.* 2019, 165, 104505. [CrossRef]

33. Chen, C.; Cai, N.; Chen, J.; Wan, C. UHPLC-Q-TOF/MS-Based Metabolomics approach reveals the antifungal potential of pinocembrin against citrus green mold phytopathogen. *Plants* 2020, 9, 17. [CrossRef]

34. Sorrentino, E.; Succi, M.; Tipaldi, L.; Fannella, G.; Maiuro, L.; Sturchio, M.; Coppola, R.; Tremonte, P. Antimicrobial Activity of gallic acid against food-related pseudomonas strains and its use as biocontrol tool to improve the shelf life of fresh black truffles. *Int. J. Food Microbiol.* 2018, 266, 183–189. [CrossRef]

35. Choi, J.G.; Kang, O.H.; Lee, Y.S.; Oh, Y.C.; Chae, H.S.; Jang, H.J.; Shin, D.W.; Kwon, D.Y. Antibacterial activity of methyl gallate isolated from gala hois or carvacrol combined with nalidixic acid against nalidixic acid resistant bacteria. *Molecules* 2009, 14, 1773–1780. [CrossRef]

36. Serna, D.M.O.; Martinez, J.H.I. Phenolics and polyphenolics from melastomataceae species. *Molecules* 2015, 20, 17818–17847. [CrossRef]

37. Ding, Q.; Jin, Z.; Dong, J.; Wang, Z.; Jiang, K.; Ye, Y.; Dou, X.; Ding, B. Bioactivity evaluation of pinocembrin derivatives from *Penthorum chinense* pursh stems. *Nat. Prod. Commun.* 2019, 14, 1–9. [CrossRef]

38. Cascaes, M.M.; Silva, S.G.; Cruz, J.N.; Santana De Oliveira, M.; Oliveira, J.; De Moraes, A.A.B.; Da Costa, F.A.M.; Da Costa, K.S.; Diniz Do Nascimento, L.; De Helena Aguiar Andrade, E. First Report on the *Annona exsucca* dc. essential oil and in silico identification of potential biological targets of its major compounds. *Nat. Prod. Res.* 2021, 35, 1–4. [CrossRef] [PubMed]

39. Ferreira, O.O.; Neves Da Cruz, J.; De Jesus Pereira Franco, C.; Silva, S.G.; Da Costa, W.A.; De Oliveira, M.S.; De Aguiar Andrade, E.H. First report on yield and chemical composition of essential oil extracted from *Myrcia eximia* (myrtaceae) from the Brazilian amazon. *Molecules* 2020, 25, 783. [CrossRef] [PubMed]

40. Mesquita, K.D.S.M.; Feitosa, B.D.S.; Cruz, J.N.; Ferreira, O.O.; Franco, C.D.J.P.; Cascaes, M.M.; Oliveira, M.S.D.; Andrade, E.H.D.A. Chemical composition and preliminary toxicity evaluation of the essential oil from *Peperomia circinnata* link var. circinnata. (Piperaceae) in *Artemia salina* leach. *Molecules* 2021, 26, 7359. [CrossRef] [PubMed]

41. De Oliveira, M.S.; Cruz, J.N.; Ferreira, O.O.; Pereira, D.S.; Pereira, N.S.; Oliveira, M.E.C.; Venturieri, G.C.; Guilhon, G.M.S.P.; Souza Filho, A.P.D.S.; Andrade, E.H.D.A. Chemical Composition of volatile compounds in apis mellifera propolis from the Northeast region of Pará State, Brazil. *Molecules* 2021, 26, 3462. [CrossRef] [PubMed]

42. Adams, R.P. *Identification of Essential Oil Components by Gas Chromatography/Mass Spectroscopy*, 4th ed.; Adams, R.P., Ed.; Allured Publishing Corporation: Carol Stream, IL, USA, 2007; ISBN 1932633219.

43. Stein, S.; Mirokhin, D.; Tchekhovskoi, D.; Mallard, G.; Mikaia, A.; Zaikin, V.; Sparkmann, D. The Nist Mass Spectral Search Program for the Nist/Epa/Nih Mass Spectra Library. In *Standard Reference Data Program of the National Institute of Standards and Technology*; National Institute of Standards and Technology: Gaithersburg, MD, USA, 2011.

44. CLSI. *Performance Standards for Antimicrobial Disk Susceptibility Tests*, 8th ed.; Clinical and Laboratory Standards Institute: Mayne, BC, Canada, 2003.

45. Cascaes, M.M.; Guilhon, G.M.S.P.; Zoghbi, M.D.G.; Andrade, E.H.A.; Santos, L.S.; Da Silva, J.K.R.; Trovatti Uetanabaro, A.P.; Araujo, I.S. Flavonoids, antioxidant potential and antimicrobial activity of *Myrcia rufipila* mcvaugh Leaves (myrtaceae). *Nat. Prod. Res.* 2019, 35, 1717–1721. [CrossRef]

46. Peixoto, R.N.S.; Guilhon, G.M.S.P.; Das Graças, B.; Zoghbi, M.; Araujo, I.S.; Uetanabaro, A.P.T.; Santos, L.S.; Brasil, D.D.S.B. Volatiles, a glutarimide alkaid and antimicrobial effects of *Croton pullei* (Euphorbiaceae). *Molecules* 2013, 18, 3195–3205. [CrossRef]