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Mini Review

Chemical, Biological and Pharmacological Studies of *Bunchosia* Geuus (*Malpighiaceae*)

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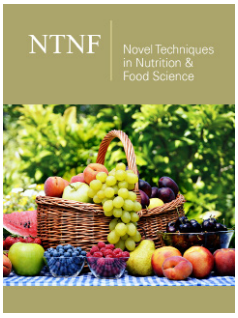

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Abstract

The genus *Bunchosia*, which belongs to the *Malpighiaceae* family, comprises at least 98 species, occurring mainly in Latin America. This article aims to compile relevant information on the chemistry and properties of the genus *Bunchosia*, in order to outline a profile and direct future research with its species. Research on this genus is quite scarce, being basically limited to 3 species, *B. glandulifera, B. armeniaca* and *B. swartziana*. Among the works are bromatological studies, identification and quantification of compounds, antioxidant activity and some properties little explored. In particular, there is an interest in the fruits, due to their carotenoid content and technological potential.

Mini Review

The *Malpighiaceae* family comprises about 1300 species of Angiosperms, shrubs and vines distributed in about 77 genera. Its fruits are drupaceous and when ripe they can be yellow, orange or red [1-3]. The genus *Bunchosia* comprises at least 98 species, occurring mainly in Latin America (GBIF 2021), of which at least 14 are distributed in Brazilian regions [4]. Although the product has been disclosed, whether it is classified as a product, whether it is considered as biological or biological, only for analysis, which has been disclosed, that is, biological, for analysis, which has been presented. and 4 book chapters indexed in Scopus or Google Scholar. The purpose of this article was compiled as relevant information regarding the chemistry and properties of the genus *Bunchosia* to direct research with the species of the genus.

Bunchosia glandulifera

It is the species with the highest number of references, being the greatest interest in the study of its fruits, due to the content of carotenoids, mainly β-carotene and lycopene, and its antioxidant potential. The fruits of *B. glandulifera* have high moisture content in their pulp and seeds (72.00±0.06 and 55.00 ± 0.55%). The pulp has a high sugar content (6.25±0.09%) and (11.72±0.01 ºBx) Brix degree, in addition to the seed having a high protein content (7.00±0.09%). The most abundant minerals in the pulp and seed are potassium (1538.89±117.50 and 2022.63±378.90mg/100g), phosphorus (161.37±14.80 and 364.81±73.20mg/100g), calcium (132.70±11.50 and 207.96±40.00mg/10.00mg/100gg), sulfur (86.94±9.80 and 181.96±35.00mg/100g) and magnesium (74.4±6.90 and 152.41±31.00mg/100g). Fatty acids were also found in the pulp and seeds, including palmitic (C16:0, 67.26 and 38.57%), stearic (C18:0, 7.40 and 13.28%), myristoleic (C14:1, 7.89 and 9.22%), linoleic (C18:2, n-6, 1.79 and 23.23%) and oleic (C18:1, n-9, 4.55 and 6.20%) [5].

The methanol/ethanol/acetone extract (45/45/10%) from the fruit pulp was evaluated for total phenolic content (2,245mg/100g of fruit pulp), total flavonoids (138mg/100g of fruit) and total anthocyanins (15.9mg/100g of fruit pulp), the presence of β-carotene (8.10mg/100g of fruit pulp), lycopene (16.38mg/100g of fruit pulp), vitamin C (32.95mg/100g of fruit pulp) and caffeine (206.35mg/100g of fruit pulp) [6]. The carotenoid content of the pulp was evaluated by Raman spectroscopy, in which the pulps dried at 65 and 85 °C varied from 91.61±2.91 to 39.74±0.25mg/100g at 65 °C, and from 84.47±0.84 to 31.69±0.07mg/100g at 85 °C, resulting in carotenoid degradation by about 75% and 80%, respectively (Carvalho et al. 2019). The bioactive compounds were sensitive to high temperatures during pulp drying, while drying time mainly affected antioxidant activity, β-carotene and lycopene content. The fresh pulp (500 mg/mL) showed the best antioxidant activity with 46.57% ($DPPH^{\cdot}$) and phenolic content of 6,061.91 mg/100 g compared to the dry material [7].

The chemical composition of the pulp and seeds of the fruits evaluated in 4 stages of maturation through the methanol, ethanol and acetone extracts showed during its ripening a great change in color, ranging from green to red. As the fruits matured, an increase in the content of total phenolic compounds, flavonoids, caffeine, vitamin C, β-carotene and lycopene was observed. At the end of ripening, the pulp had the highest content of vitamin C (31.25±0.40mg/100g) and β-carotene (6.75±0.17mg/100g), the seeds had the highest concentration of caffeine (820.73±12.90mg/100g). The pulp and seed extract showed the best antioxidant activities in their last stage of maturation, corresponding to 13.24±0.66% and 7.65±0.64%, respectively. During the ripening stages of the fruits, a positive Pearson correlation was observed between the antioxidant activity of the pulp and the concentration of phenolic compounds (0.99), flavonoids (0.86), β-carotene (0.83) and lycopene (0.86) [8].

The juice mix from the fruits of *B. glandulifera* and Euterpe edulis (20:80:100g/g/v) did not present significant changes in the content of anthocyanins, phenolic compounds, antioxidant activity, pH, titratable acidity, soluble solids and parameters of color after pasteurization at 80 °C. After 45 days of refrigerated storage, there was a significant change in the content of anthocyanins (79.02±0.14 to 53.21±3.08mg eq. cyanidin-3-glycoside/100mL of juice), phenolic compounds (679, 67±0.14 to 629.35±17.67 total phenolics/100mL of juice) and antioxidant activity (56.11±0.22 to 46.59±0.56%) of the juices. While the storage of juices under freezing maintained the content of anthocyanins and phenolic compounds but provided a change in antioxidant activity from 56.11±0.22 to 49.14±0.55%. The content of β-carotene (0.870±0.01mg/100mL) and lycopene (0.462±0.01mg/100mL) in natura did not present significant changes when submitted to different forms of storage (refrigerated or frozen for 45 days), but there was a reduction in vitamin C content (39.17±0.48 to 32.79±0.21mg of ascorbic acid/100mL) [9].

Seed extracts were obtained by sequential extractions with (1) supercritical carbon dioxide, (2) pressurized liquid extraction using ethanol and (3) water, and conventional methods. The sequential extractions proved to be quite selective for caffeine, with concentrations of 8.44±0.06, 3.32±0.03 and 0.18±0.02mg/g extract for the three phases of sequential extractions, respectively. However, the conventional extraction with water showed the best overall yield (43.1±0.8%). The best total phenolic content was obtained by conventional extractions with ethanol (2248±20μg GAE/g extract) and water (1298±10μg GAE/g extract), with EC50 of antioxidant activity corresponding to 42±0.3 and 55±0.6μg ext./g $DPPH^{\cdot}$. Conventional extraction with hexane allowed a higher content of α-tocopherol, β-γ-tocopherol, δ-tocopherol and α-tocotrienol, with a total tocol content of 3810±80μg/kg extract. The supercritical extract had a total tocol content of 1800±50μg/kg extract, however it was more selective for the extraction of β-γ-tocotrienol (220±10μg/kg extract) and δ-tocotrienol (220±10μg/kg extract). Among the different extractions, fatty acids were also obtained, mainly palmitic (C16:0), oleic (C18:1, n-9), linoleic (C18:2, n-6), stearic (C18:0), palmitoleic (C16:1) and linolenic (C18:3, n-3) [10].

Ethanol extracts from seed, pulp, bark, leaf and root were evaluated for their antioxidant activity by $ABTS+^{\cdot}$, FRAP and Cyclic Volumetry (CV) assays. The best activities were presented by roots ($ABTS+^{\cdot}$1,148.99±42.1μmol trolox g^{-1}, FRAP 1,592.86±62.1μmol $FeSO_4$ g^{-1}, CV 348.2±24.0mg ascorbic acid g^{-1}) and leaves ($ABTS+^{\cdot}$309.41±25.15μmol trolox g^{-1}, FRAP 1,746.1±56.1μmol $FeSO_4 g^{-1}$, CV 341.1±19.2mg ascorbic acid g^{-1}) [11]. The fruit pulp was extracted with a methanol:ethanol:acetone solution (45/45/10%) and showed antioxidant activity by FRAP (19,285.21μM $FeSO_4$), $ABTS+^{\cdot}$(8,928.57μM Trolox) and $DPPH^{\cdot}$ (EC50 0.27g $DPPH^{\cdot}$) [6].

Bunchosia armeniaca

This is the second most explored species of the genus. There is a predominance of studies with its fruits that have phenolic compounds, especially phenolic acids and flavonoids. The leaves have antibacterial activity; however, it is still little explored. It is cultivated throughout Brazil, commonly consumed in natura, with high culinary potential [12].

The fruits are acidic with a pH of 5.77±0.12 and titratable acidity of 0.41±0.20%, they have a high moisture content (68.74±1.28%), followed by carbohydrates (16.06±1.35 %), lipids (11.22±0.91%), ash (2.23±0.66%), proteins (1.75±0.01%) and 11.68±0.07 ºBx [13].

Em seeds and pericarp aqueous extracts of ripe fruit a phytochemical profile revelou a presença de flavonoids, alkaloids, phenols, phytosterols, saponins and tannins [14]. Among its compounds were identified the phenolic acids p-coumaric acid, chlorogenic acid, ferulic acid, salicylic acid, sinapic acid, syringic acid and vanillic acid, the flavonoids (-) epicatechin, hesperetin, naringenin, quercetin, naringenin-7-glucoside, quercetin-3-arabinoside, isoquercitrin, rutin and other compounds, pterostilbene, resveratrol and scopoletin by UHPLC-MS/MS [15]. The color of the shell's changes throughout the maturation process, and influences its volatile profile, where compounds of the organic group's ketones, alcohols, aldehydes and carboxylic acids were

identified, identified by GC-MS [16]. In the ethanolic extract of the leaves, a mixture of flavonoids was identified, consisting of rutin (83.5%), afzelin (10.9%) and isoquercitrin (5.6%) by 1H and 13C NMR [17].

The methanolic pulp extract has a total polyphenol content of 33.27mg GA/L of extract, and antioxidant activity (DPPH˙), with an IC50 value of 13.44±0.29mg/mL, while the IC50 of gallic acid standard was of 0.0036mg/mL [18]. The ethanolic extracts (70%) of pericarp and seed showed antioxidant activity by DPPH˙ (1.5±0.1µg TE/mg extract) and ORAC (10.7±1.0 and 27.3±2.6µg TE/mg extract). Its Total Phenolic Content (TPC) was 6.5±0.7µg GAE/mg extract to pericarp and 3.6±0.7µg GAE/mg extract to seed. These extracts showed low anti-proliferative activity against Hep-G2, HT-29 and MRC-5, with IC50 greater than 500µg/mL [15]. Fruit pulp tea showed antioxidant activity through the capture of DPPH˙ (238.4±3.5µM ET) and ABTS+˙(380.8±5.1µM ET) radicals. No phenolic compounds were detected by the Folin-Ciocalteu assay [19].

The ethanolic extract of the leaves showed excellent antibacterial activity against Staphylococcus aureus, with Minimal Inhibitory Concentration (MIC) of 87.5µg/mL, and moderate activity against Escherichia coli and Pseudomonas aeruginosa with MIC of 175 and 350µg/mL, respectively. Fractionation with butanol resulted in a yellow precipitate, consisting of a mixture of flavonoids, which presented MIC of 3.0, 1.5 and 1.5µg/mL against *S. aureus*, *E. coli* and *P. aeruginosa*, respectively. Potent anti-inflammatory action was observed in the ethanolic extract of the leaves through the reduction in signs of the inflammatory process (exudate increase and leukocyte influx), which reveals that the species has potential for the treatment of patients with infectious and inflammatory diseases [17]. The aqueous extract of the seeds showed bacteriostatic action against Escherichia coli, with an inhibition halo of 13.2±0.04, 14.3±0.13 and 16.2±0.03mm, at concentrations of 250, 500 and 1000µg/mL, respectively. No antibacterial or antifungal activity was observed by aqueous or ethanolic extracts of pericarp of *B. armeniaca* [14].

Seeds were evaluated for desiccation tolerance at 22 ºC and 85% relative humidity in the laboratory, and 24 ºC and 80% relative humidity in a vegetation. In both conditions, seed drying is viable for up to 24 hours at most; after this time, there is a reduction from 62.6% to 57%, this is a critical level, which compromises the physiological quality of the seeds [20].

Bunchosia swartziana

In this species, the leaves are the most explored part through extracts. Special attention is paid to its tannin content. In general, chemical and biological activities have not yet been well explored. The fresh leaves are composed of 36% dry matter, 10.9% ash, 32.0% neutral detergent fiber, 25.5% acid detergent fiber, 16.5% crude protein, 3.8% condensed tannins, 3.8% total phenols and 3.8 % of total tannins [21]. In another study, foliage showed 45.9% dry matter, 11.7% ash, 38.6% neutral detergent fiber, 30.0% acid detergent fiber, 16.2% crude protein and 0.2% condensed tannins [22]. The fresh leaves hydromethanolic extract showed 35.28% of condensed tannins, 24.27% of total phenols and 10.39% of total tannins. Anthelmintic activity against Haemonchus contortus eggs was tested, with an effective concentration of 50% (EC50) of 3180.8µg/mL, much lower than the activity of the same extract of *Leucaena leucocephala* and *Senegalia gaumeri*, with an EC50 of 139.9 and 186.3µg/mL, respectively. No significant relationship was found between the content of de condensed tannins, total phenols and total tannins of the evaluated extracts and the EC50 [23].

Acetone:water extract (70:30) from fresh leaves has 22.7% total phenols, 18.5% total tannins and 40.3% condensed tannins. The extract showed an EC50 of 260.8µg/mL against Haemonchus contortus using the larvae exsheathment inhibition assay. Therefore, its anthelmintic activity is lower than that of the same extract from other plants, such as Senegalia gaumeri and Mimosa bahamensis, with EC50 of 83.1 and 93.5µg/mL, respectively [21]. The ethanolic extract of the leaves showed anti-advanced glycation end-products (Anti-AGEs) against vesperlysine-like AGEs with an IC50 of 1mg/mL, similar to aminoguanidine. While the ethanolic extracts of stems and roots and the aqueous infusion of dry plant material presented IC50 greater than 1mg/mL [24]. The ethanolic extract of the roots showed antioxidant activity by DPPH˙ method, with an IC50 of 290±1µg/mL, much lower than the ascorbic acid (IC50 of 51.0±1.4µg/mL). The ethanolic extracts of stems and leaves and the aqueous infusion of dry plant material presented IC50 above 300µg/mL [24].

Conclusion

The knowledge about the characteristics, chemical composition and biological and pharmacological properties of the genus *Bunchosia* is still very limited, due to the few species explored. Studies with new species can help to draw a more in-depth profile about the genus. Based on the available literature, fruits are the most explored part, have a high content of carotenoids and are potential candidates for the food industry. Leaf extracts indicate good anti-advanced glycation end-products potential and antibacterial activity. It is hoped that this article will direct future studies to its technological applications based on the main properties.

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