Urban ethnobotany and phytochemical profiles of plants cultivated by Chinese migrants in Buenos Aires, Argentina

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Research

Abstract

Background: In the Area Metropolitana de Buenos Aires, Chinese farmers grow fresh plants that supply Buenos Aires' Chinatown. These crops can be considered Neglected and Underutilized Species since they are little known to the majority of the urban population, who are unaware of their uses and nutritional value. The main objective of this work is to update the ethnobotanical data on plants grown organically and conventionally by Chinese farmers and to determine their phytochemical profile.

Methods: Fieldwork was conducted at two sites in Buenos Aires where two Chinese producers grow plants linked to the traditions of their country. The methodology used consisted of ethnobotanical walks, free listings, and open and semi-structured interviews with farmers and community members. The phytochemical profiles were analyzed using UHPLC-MS/MS, and the data were processed using multivariate analysis to evaluate the differences between the cultivation systems.

Results: *Brassica juncea* and *B. rapa* var. *chinensis* are the most common species in Chinatown and are sold year-round. They are grown conventionally and organically, are linked to Asian culinary traditions, and are produced from imported seeds. Organic crops showed higher concentrations of kaempferol and isorhamnetin derivatives (compounds associated with antioxidant and hepatoprotective properties), which differentiates them from conventional samples.

Conclusions: Urban ethnobotany highlights the role of migrant communities in increasing local agrobiodiversity. Organic farming not only promotes sustainable agriculture, but also improves the biochemical quality of crops.

Keywords: Biocultural diversity, Botanical Knowledge, Organic agriculture, Pearson correlation, PCA, PLS-DA, UHPLC-PDA.

Background

Urban ethnobotany focuses on the study of botanical knowledge in urban areas, which is the result of the complex relationships between humans and plants in their environment (Hurrell & Pochettino 2014). The Laboratorio de Etnobotánica y Botánica Aplicada (LEBA), located in the Área Metropolitana de Buenos Aires (AMBA), Argentina, has conducted research characterizing biocultural diversity through the circulation of plant products and associated knowledge in urban areas (Hurrell 2014, Hurrell & Pochettino 2014, Puentes 2017). Through continuous monitoring in the urban area, it was possible to identify the origin of fresh plants sold by immigrant segments from peri-urban gardens, mainly located in the so-called “green belt” of the AMBA, one of the largest in the country in terms of size and production volume (Pochettino 2010).

In this area of study, research on peri-urban gardens (commercial and family) approached from the perspective of urban ethnobotany has demonstrated their importance for the conservation of agrobiodiversity and the recording of crops in the Buenos Aires region (Hurrell *et al*. 2011, Pochettino 2010, Pochettino *et al*. 2012, 2017). It has been shown how migrant communities recreate their cultural heritage through the introduction of medicinal and food plants linked to their traditions of origin (Ladio & Albuquerque 2014, Medeiros *et al*. 2012, Puentes 2017). Other researchers have studied the importance and close link between Asian communities and medicinal plants in contexts linked to traditions (Ma *et al*. 2019), as well as highlighting the relevance of urban markets and cultivated plants consumed in cities (Panda *et al*. 2023, Perveen *et al*. 2024).

In Argentina, specifically in the AMBA, the groups that have been studied for years are Bolivians and Chinese, as these are the communities that have dedicated themselves to the commercial sale of medicinal and edible plants in the city (Hurrell & Puentes 2017, Puentes & Hurrell 2015). The registration of the plants that these migrant groups sell has made it possible to identify them in their fresh state as coming from crops produced in the peri-urban areas of Buenos Aires exclusively by migrants (Puentes 2024, Puentes *et al*. 2019). These plants are invisible to most of the urban population, but they play an important role in the cultural heritage and gastronomy of migrant groups. These characteristics allow these plants to be grouped into the category of Neglected and Underutilized Species (NUS), which are plants cultivated on a small scale but with a fundamental role within a local community (Hurrell *et al*. 2019, Padulosi *et al*. 2013, Ulian *et al*. 2020).

Interviews are being conducted with two producers who supply their crops to Barrio Chino de Belgrano (BCB), using two different production models (Puentes 2024). One model is conventional, commonly used in crops around the world, while the other is based on organic farming. According to the FAO (2025), the term “organic agriculture” refers to the process that uses methods that respect the environment, from the production stages to those of handling and processing, based on the minimum use of external inputs, avoiding synthetic fertilizers and pesticides, which are used in the conventional model. Organic farming practices cannot guarantee that products are completely free of residues produced by general environmental pollution. However, these practices use methods to minimize air, soil, and water pollution. These two commercial gardens produce a variety of crops that are unique to the BCB and are a source of fresh plants linked to traditions in China and other Asian countries (Puentes 2024).

There are studies that have examined the chemical composition of crops, especially species of agronomic importance and/or ethnobotanical relevance (Suárez-Rebaza *et al*. 2023, Torres-Guevara *et al*. 2020, 2021, 2023). This can be approached from an ethnopharmacological perspective, where ethnobotanical studies are complemented by phytochemical analyses using different techniques to evaluate the potential nutritional and/or medicinal properties of the plants surveyed (Dutta *et al*. 2021). The plants grown in the peri-urban areas of Buenos Aires and sold exclusively in the Chinatown neighborhood of Belgrano have not been chemically studied. The overall objective of this study was to update the ethnobotanical data on crops produced by farmers of Chinese tradition and to evaluate whether there are significant differences in the chemical composition of these plants produced conventionally and organically. These studies will lay the groundwork for ethnopharmacological studies of different species and botanical varieties cultivated in the region by Chinese migrant communities in the AMBA.

Materials and Methods

Study area

The study area (Fig. 1) for the surveys being conducted on Chinese migrants corresponds to the AMBA, which comprises two contiguous urban agglomerations: Gran Buenos Aires and Gran La Plata. According to the latest census (INDEC, 2022), the population of Gran Buenos Aires is estimated at 10,849,299 inhabitants, with 3,121,707 in the Ciudad Autónoma de Buenos Aires and 768,470 in La Plata. This urban agglomeration is the largest in terms of area and population in the country, the second largest in South America, the third largest in Latin America, the fifth largest in the Americas, and the seventeenth largest in the world (Forstall *et al*. 2004). With regard to the location of migrants crops, the areas surveyed to date are found in the districts of Monte Grande and Pilar, both within the province of Buenos Aires. In Argentina, the Chinese community currently comprises around 120,000 immigrants, of whom some 4,000 are Taiwanese. It is the fourth largest community of recent immigrants in the conurbation, after the Bolivian, Paraguayan, and Peruvian groups, the latter two being groups of immigrants from neighboring countries. There are three significant periods of Chinese immigration in our country: 1) between 1914 and 1949 (during the Chinese Revolution); 2) between the early 1980s and the 1990s, a significant flow of Taiwanese arrived. Unlike the first period, they arrived with their entire families and enough capital to start their lives in this new country, especially engaged in commercial activities; 3) from the 1990s onwards, immigrants came mainly from the coastal provinces of mainland China, and most settled in the metropolitan area with the aim of developing commercial ventures. By 1999, according to data from the National Directorate of Migration, 10,124 Chinese were residing in the country. At the beginning of the 21st century, the number of Chinese was estimated at 60,000; between 2005 and 2006, the number reached 100,000 (Bogado Bordazar 2003, Sassone & Mera 2007). Currently, it is estimated that there are around 180,000 Chinese residents in our country.

Figure 1. Study area: location of de crops organic (Pilar) and conventional (Monte Grande).

Ethnobotanical study

Various methodologies and qualitative techniques commonly used in ethnobotanical surveys were employed in the fieldwork: ethnobotanical walks, free listing, open and semi-structured interviews, which were applied in accordance with the specific comments and suggestions of various authors (Albuquerque *et al*. 2014, Bernard 2000, Cotton 1996, Martin 1995). For the interviews, farmers of Chinese and Taiwan origin (two in total) who supply the BCB with plants grown in the districts of Pilar and Monte Grande in the province of Buenos Aires were contacted through members of the Chinese community. The interviews were recorded (with prior informed consent) using a mobile phone and then transcribed in the office where the information obtained was processed. A photographic record was made for the subsequent identification of the species cultivated by the farmers interviewed. For this preliminary study, several crops were selected that are exclusive to the Chinatown neighborhood of Belgrano and are produced organically and conventionally (Fig. 2). They are grown year-round and are therefore among the best-selling plants. Photos were taken of parts of the plants, such as flowers and fruits, which are the reproductive parts that allow the scientific name of the species to be determined. The samples were stored and deposited with an alphanumeric code in the LEBA reference herbarium to be later identified using specific literature in the office.

Review work

A literature review was conducted to complement the fieldwork, based on the biological activity and effects evaluated for each species surveyed. Various databases available on the internet were consulted, particularly PubMed (2025). This type of review was also carried out in a previous contribution (Puentes *et al.* 2019) which compiled studies linked to Chinese functional foods marketed in the Barrio Chino de Buenos Aires. This review is conducted because it allows us to know which uses have been studied to date and have academic backing, which is useful for evaluating the correlation between the assigned local uses and those studied.

Figure 2. Crops. A: organic, B: conventional.

Specimen collection

In August 2024, five different crops were selected, identified as: 1) **chapaichai** (*Brassica rapa* L. var. *chinesis* Tokyo Bekana) (conventional cultivation, Picar locality) (M1), 2) **chinese mustard** (*Brassica juncea* (L.) Czernj. Cosson) (conventional crop, Picar locality) (M2), 3) **chapaichai** (*Brassica rapa* L. var. *chinesis* Tokyo Bekana) (organic crop, Monte Grande locality) (M3), 4) **chinese mustard** (*Brassica juncea* (L.) Czernj. Cosson) (organic cultivation, Monte Grande locality) (M4), and 5) **pak choi** (*Brassica rapa* L. var. *chinesis*) (organic cultivation, Monte Grande locality) (M5) (Fig. 3). Ten specimens of each selected crop were collected from each of the two commercial gardens surveyed.

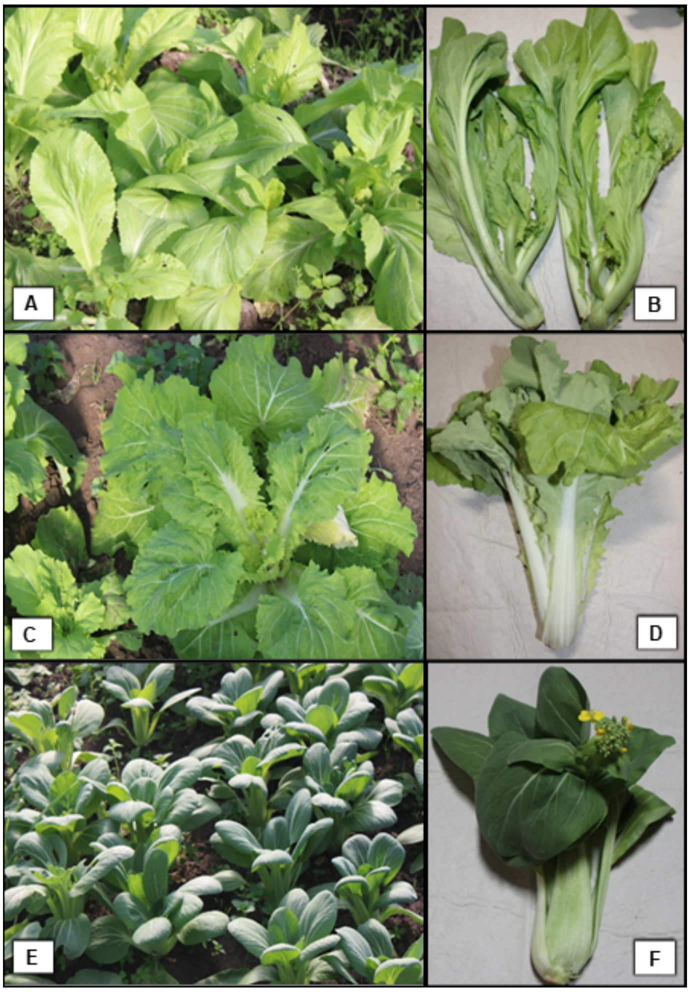

Figure 3. Surveyed plants and samples obtained. A and B: **chinese mustard** (*Brassica juncea* (L.) Czernj. Cosson), C and D: **chapaichai** (*Brassica rapa* L. var. *chinensis* Tokyo Bekana), E and F: **pak choi** (*Brassica rapa* L. var. *chinesis*).

Phytochemical analysis

Sample pretreatment

Brassica leaves were stabilized at 40 °C in a forced-air oven for 72 hours. To do this, the leaves were crushed to a particle size of 345 µm in diameter. For extraction, 1 g of fine leaf powder from each *Brassica* was weighed and placed in Erlenmeyer flasks with 50 mL of methanol, then placed in an ultrasonic bath for 15 minutes. The extract was filtered and dried by vacuum evaporation. Each dry extract was diluted with 40 mL of ultrapure water and then filtered, after which they were purified with Amberlite XAD7HP (Benites *et al*. 2019). The retained compounds were desorbed with 50 mL of methanol. Finally, the extracts were rotary evaporated to dryness (Ganoza-Yupanqui *et al*. 2021). The five dry extract samples were dissolved in LC-MS grade methanol at 2 mg/mL. They were then centrifuged at 9,000 rpm for 15 min at 25 °C. The supernatants were placed in amber glass vials.

Analysis by UHPLC-MS/MS and UHPLC-PDA

The extracts were analyzed using a UHPLC chromatograph coupled to a triple quadrupole mass spectrometer (Waters®, Xevo TQ-XS, USA). They were analyzed by ESI (electrospray ionization) in negative mode between *m/z* 50 and 1,500. Desolvation temperature of 500 °C, with a flow rate of 900 L/h and capillary voltage of 2.5 kV. In addition, with cone voltage of 30 V and collision energy of 30 eV. Separation was performed on an Acquity UPLC BEH RP-C18 column (100 mm x 2.1 mm, 1.7 µm, Waters®) with a precolumn filter at 40 °C, with a flow rate of 0.3 mL/min and an injection volume of 2 µL. The mobile phase was a combination of A (0.1% formic acid in water) and B (0.1% formic acid in acetonitrile). The gradient elution was: 0-1.40 min (5% B), 2.80 min (7% B), 6.40 min (10% B), 7.00 min (12% B), 16.70 min (20% B), 18.10 min (24% B), 20.80 min (31% B), 22.20 min (35% B), 25.00 min (42% B), 26.40 min (48% B), 27.80 min (56% B), 30.60-32.00 min (95% B), 33.40-36.20 min (5% B). To obtain the λmax, a photodiode array detector (PDA) was used, with readings taken between 190 and 600 nm, with an injection volume of 4 µL (de Albuquerque *et al*. 2025, Marin-Tello *et al*. 2024, Ortiz *et al*. 2023, Valdiviezo-Campos *et al*. 2024).

Statistical analysis

Using MetaboAnalyst 6.0 http://www.metaboanalyst.ca/ (accessed July 14, 2025), which is open source software, we analyzed the bioactive compounds tentatively identified by UHPLC-MS/MS, including Pearson correlation analysis, principal component analysis (PCA) and Partial Least Squares Discriminant Analysis (PLS-DA) and heat maps, this multivariate data, where the tentative names and absolute intensity of the precursor mass of the tentatively identified compound (expressed in Counts) were used, were studied to find variations in bioactive compounds and *Brassica* species, also associated with the cultivation method**.**

Results

Ethnobotanical study

Table 1 shows two selected taxa (one species and one variety), their origin, their vernacular names, and the products marketed exclusively in Belgrano's Chinatown, along with the alphanumeric code of the reference collection. The uses assigned belong to the accounts of the farmers who were interviewed and interviews with members of the Chinese community who frequent Chinatown (a total of 30 interviews). Uses linked to traditions in the country of origin were investigated from different bibliographic sources in order to compare them with the local uses assigned. Likewise, the biological activity and studied effects of the species mentioned are cited based on an update of the review carried out in Puentes *et al*. (2019). In the case of **chapaichai** (*B. rapa* L. var. *chinensis Tokyo Bekana*) there are few studies that refer to its academic studies, and most belong to **pak choi**. This is why the information in the last two columns refers to this crop. On the other hand, the assigned local uses of these two crops are similar.

Phytochemical analysis

The phytochemical profile of the five *Brassica* samples mainly revealed derivatives of kaempferol, hexadecenoic acid, and octadecenoic acid. **Chinese mustard** (*Brassica juncea* (L.) Czernj. Cosson) (M2) had the highest number of identified molecules (54.9%). All five samples contain Kaempferol-3-O-sophoroside-7-O-glucoside (Table 2).

Hierarchical cluster analysis (dendrogram) of phenolic compound profiles revealed by UHPLC-MS/MS showed a marked distinction and clustering of the five samples analyzed, indicating notable variability in chemical composition between different species, cultivation methods (conventional versus organic), and locations. Euclidean distance showed a maximum variability of 1.2 x 10^{10} units between samples. Samples were placed in two main groups (Fig. 4). Cluster A (composed of M1 and M2) and Cluster B (which includes M3, M4, and M5).

Table 1. *Brassica* species used by Chinese migrants in Buenos Aires, Argentina.

Species	Vernacular name	Products	Assigned local uses	Uses linked to traditions from other countries	Biological activity and effects studied
Brassica juncea (L.) Czernj.	Warm Asia: **Jie cai**, **chinese mustard**, **mustard**	Fresh leaves in bundles [F184] Pickled leaves in bundles [B048] Pickled leaves in packs [B047]	Raw, boiled, stir-fried or pickled leaves as vegetable and condiment, for salads and as a dress for various basic meals. Crushed seeds to make mustard. Sprouted seeds for salads.	Mustard leaves are used in salads, cooked with ham or salted pork, and in stews and soups (Huang *et al*., 2012). Pickled tubers are widely used worldwide. Fermented mustard is called kimchi in Korea, zha cai pickles in China, and achar in Nepal. In Japanese cuisine, it is used under the name takana and is often used as a condiment and marinated to fill rice balls. It is frequently used in Russian margarines, canned products, and baked goods (Tian and Deng 2020). Medicinal uses in China: seeds for suppressing hyperactive liver and hemostasis (Zhang *et al*. 2023).	Anticancer, antiviral, antifungal antibacterial, antioxidant, anti-obesity, hypotriglyceridemic, hypocholesterolemic antiamnesic, antidepressant, antidiabetic antinociceptive (Puentes *et al*. 2019). Anti-parkinson (Saleem *et al*. 2021). Anti-arthritic (Lakshmanan *et al*. 2022). Anti-hipertensive, diuretic, stimulant, analgesic, emetic, rubefacient, galactagogue (Rahman *et al*. 2024).
Brassica rapa L. var. *chinensis* (L.) Kitam.	China: **pak choi** **Xiao bai cai**, **chapaichai**. ['Chinensis' Group]	Fresh leaves in bundles: **Pak choi** [RF26] [R005] **Xiao bai cai/ Chapaichai** [RF77]	Boiled, steamed, stir-fried and pickled leaves as cabbage, for soups, sauces, stews and meat dishes. Raw young leaves for salads.	Stir-frying adds to soups, to the final minutes of cooking, as an ingredient of meat, fish, chicken, and noodle dishes. In Taiwan, they are served with their leaves splayed out in a star-like-shape. In the Orient coarser-leaved varieties of **pak choi** are very popular for making salt pickles (Larkcom 2008). Medicinal uses in China: also used for expectorant and tourniquet relieving, detoxifying, and swelling reducing (Zhang *et al*. 2023).	Anticancer, pulmonary protective, antioxidant, hepatoprotective, cardiovascular protective anti-inflammatory, antiplatelet, antimicrobial, immunostimulant, detoxifying, anti-allergic analgesic, antidepressant (Choi *et al*. 2023, Puentes *et al*. 2019).

Table 2. Phytochemical profile of bioactive substances from *Brassica* species identified by UHPLC-PDA-MS/MS.

N°	Substances	RT (min)	$[M-H]^-$	Main fragments (*m/z*)	λ_{max} (nm)	Samples
1	Quinic acid	0.95	191	59, 81, 83, 85(100), 87, 93, 109	257	M1
2	Kaempferol-3-O-triglucoside-7-O-glucoside	6.56	933	771(100), 914	265	M1
3	Kaempferol-3-O-sophoroside-7-O-glucoside	6.55-6.85	771	284, 285, 446, 609(100), 651	265, 340	M1, M2, M3, M4, M5
4	Kaempferol-3-O-sophoroside-7-O-galactoside	6.80	771	284, 609(100)	265, 340	M2
5	Kaempferol-3-O-hydroxyferuloylsophoroside-7-O-glucoside	7.60-7.95	963	609, 801(100)	269, 340	M2, M3, M4
6	Kaempferol-3-O-caffeoylsophoroside-7-O-glucoside	7.95-8.39	933	161, 179, 591, 609, 771(100)	268, 330	M2, M3, M4, M5
7	Rhamnosyl quinate isomer 1	8.79	337	67, 85, 87, 93, 111, 119, 127, 163, 173, 191(100)	311	M1
8	Kaempferol-3-O-glucarate	8.79	477	75, 97(100), 119, 127, 129, 191, 275, 284	311	M1
9	Kaempferol-3-O-sinapoylsophoroside-7-O-glucoside	9.19-9.44	977	591, 609, 623, 815(100)	266, 339	M4, M5
10	Kaempferol-3-O-glucoside-7-O-glucoside	9.19-9.44	609	283, 285(100), 327, 351, 371, 446, 447, 460	265, 345	M3, M4, M5
11	Kaempferol-3-O-feruloylsophoroside-7-O-glucoside	9.44-9.73	947	591, 609, 785(100)	269, 329	M2, M3, M4, M5
12	Kaempferol-3-O-glucuronate	9.58	431	71, 85, 89, 101, 113, 138, 153(100), 159, 161, 205	228, 309	M1
13	Sinapoyl chorismate	9.58	431	89, 113, 138, 153(100), 161, 205	266, 339	M2
14	Isorhamnetin-3-O-sophoroside	9.69-9.93	639	151, 313, 315(100), 337, 357, 381, 461, 476, 477(98), 519	254, 352	M2, M3, M4, M5
15	Kaempferol-3-O-(*p*-coumaroylsophoroside)-7-O-glucoside	9.69-9.93	917	179, 609, 610, 639, 755(100), 854	254, 351	M2, M3, M4
16	Ferulic acid	10.53-10.83	193	65, 91, 93(100), 121, 122, 123	289	M2, M3, M4, M5
17	Quercetin-3-O-sophoroside	10.78-10.83	625	179, 299, 300(100), 445	255, 346	M3, M5
18	Rhamnosyl quinate isomer 2	10.87	337	85, 93, 119, 127, 173, 191(100)	295	M1
19	Kaempferol-3-O-sophoroside	11.97-12.37	609	179, 284(100), 327, 429	265, 347	M3, M4, M5
20	Kaempferol-3-O-hydroxyferuloylsophoroside	12.41	801	191, 284, 285, 502, 515, 609(88)	265, 345	M2
21	Kaempferol-7-O-sophoroside	12.41	609	151, 179, 284(100), 429	264, 339	M2
22	Kaempferol-3-O-caffeoylsophoroside	12.81-13.26	771	161, 284, 285, 609(100)	266, 327	M2, M4, M5
23	Sinapoyl glutamate	12.86	351	85, 117(100), 119, 127, 145(100), 163, 173	266, 328	M3
24	Kaempferol-3-O-sinapooylsophoroside	13.61-14.20	815	191, 284, 285, 429, 591, 609(100), 623, 783	268, 332	M2, M4, M5
25	Kaempferol-3-O-sinapoylglucoside	14.75	653	296, 328, 440, 441, 459, 461, 473, 501, 593, 621(100)	268, 317	M3
26	Kaempferol-3-O-feruloylsophoroside	14.80-15.30	785	161, 284, 285, 429, 485, 591, 609(71)	268, 331	M2, M3, M4, M5
27	Kaempferol-3-O-coumaroylsophoroside	15.10-15.59	755	145, 284, 285, 429, 445, 591, 609(100)	267, 317	M2, M4
28	Kaempferol-3-O-glucoside	15.30-16.39	447	107, 151, 241, 257, 284, 285(100)	265, 340	M2, M3, M4, M5
29	Kaempferol-3-O-galactoside	15.79-15.79	447	227, 255, 284(100)	265, 340	M2, M3
30	Isorhamnetin-3-O-galactoside	16.09-16.59	477	243, 257, 271, 285, 299, 314(100)	254, 353	M4, M5

31	Isorhamnetin-3-O-glucoside	16.58-16.98	477	151, 243, 257, 271, 285, 299, 314(100)	254, 353	M2, M3, M4
32	Kaempferol-7-O-glucoside	16.58	447	151, 152, 257, 284, 285(100)	254, 353	M2
33	13,14-Dihydroxy-7,10-hexadecadienoic acid isomer 1	20.46	299	84, 95, 97(100), 125, 127, 135, 137, 139, 143, 149, 155, 165, 175, 18, 183	298	M4
34	13,14-Dihydroxy-7,10-hexadecadienoic acid isomer 2	20.67-20.74	299	85, 97, 109, 139, 149, 155, 163, 183(100), 185, 241, 281	323	M1, M4
35	13,14-Dihydroxy-7,10-hexadecadienoic acid isomer 3	20.70-20.71	299	57, 59, 71, 80, 85, 85, 95, 97(100), 99, 106, 109, 111, 113, 121, 139, 143, 149, 155, 165, 183, 201	270	M2, M3, M5
36	Kaempferol-3-O-feruloylglucoside-7-O-glucoside	21.15-21.40	785	161, 179, 283, 284, 285, 429, 283, 284, 285, 591, 609(100), 623	269, 325	M3, M4, M5
37	13-Hydroxy-10-hexadecenoic acid	23.10	285	93, 107, 109, 117(100), 119, 131, 136, 154, 159, 164, 169, 186, 195, 203, 239	-	M2
38	7,15,16-Trihydroxy-9,12-octadecadienoic acid isomer 1	23.88-24.03	327	85, 97, 125, 127, 165, 167, 171, 183, 185, 193, 209, 211(100), 229	220	M3, M4, M5
39	7,15,16-Trihydroxy-9,12-octadecadienoic acid isomer 2	23.93-24.07	327	57, 69, 85, 97, 125, 127, 137, 171(100), 201, 211	220, 312	M1, M2
40	7,15,16-Trihydroxy-9,12-octadecadienoic acid isomer 3	24.03-24.27	327	83, 85, 97, 125, 127, 165, 167, 171, 183, 185, 193, 209, 211(100), 229	220	M1, M2
41	7,15,16-Trihydroxy-9-octadecenoic acid	24.92-25.12	329	83, 99, 127, 139, 155, 165, 171, 183, 193, 209, 211(100), 229, 293	221	M2, M3, M4
42	7,15,16-Trihydroxy-12-octadecenoic acid	25.06	329	99, 127, 139, 171, 183, 209, 211(100), 229	221	M1
43	4,15,16-Trihydroxy-6,9,12-octadecatrienoic acid isomer 1	26.36-27.45	325	170, 183(100), 197, 210	221, 315	M1, M3, M4
44	4,5,15,16-Tetrahydroxy-6,9,12-octadecatrienoic acid	26.90	339	170, 183(100), 185, 211, 225, 239	221, 315	M1
45	15,16-Dihydroxy-6,12-octadecadienoic acid	26.90-27.16	307	65, 71, 97, 119, 121(100), 123, 125, 137, 185, 209	221, 315	M1, M2, M4
46	15-Hydroxy-12-octadecenoic acid	27.31	297	79, 183(100), 233	213	M4
47	4,15,16-Trihydroxy-6,9,12-octadecatrienoic acid isomer 2	27.79	325	170, 183(100), 198, 239, 261	222, 319	M1
48	15-Hydroxy-6,9,12-octadecatrienoic acid	27.90-28.04	293	97, 108, 148, 149, 165, 177,192, 205, 220, 221(100), 236	222, 321	M1, M4
49	15,16-Dihydroxy-12-octadecenoic acid	27.99	305	71, 79, 97, 106, 120, 123, 125, 135(100), 137, 161, 163, 185, 205	222, 320	M2
50	4,15,16-Trihydroxy-6,9,12-octadecatrienoic acid isomer 2	29.19	325	170, 183(100), 198, 239, 261	222, 319	M2
51	15,16-Dihydroxy-6,9,12-octadecatrienoic acid	29.19	309	97, 113, 119, 121, 137, 143, 148, 171(100), 177, 183	223	M2

Conventional farming. M1: **chapaichai** (*B. rapa* L. var. *chinesis* Tokyo Bekana), M2: **chinese mustard** (*B. juncea* (L.) Czernj. Cosson). Organic farming. M3: **chapaichai** (*B. rapa* L. var. *chinesis* Tokyo Bekana), M4: **chinese mustard** (*B. juncea* (L.) Czernj. Cosson), M5: **pak choi** (*B. rapa* L. var. *chinesis*).

PCA is a graphical tool that shows the inherent variability in the phenolic compound profile of five *Brassica* samples. This method explained 90.9% of the overall variance, where the first principal component (PC1) contributed 67.9% and the second principal component (PC2) contributed 23% (Fig. 5A). Furthermore, PLS-DA accounted for 84.1% of the total variance, with PC1 representing 67.7% and PC2 representing 16.4% (Fig. 5B). These complex evaluations are crucial for depicting the chemotype of *Brassica* and indicate that organic crops are a beneficial method to improve the nutraceutical worth of these greens.

Pearson's correlation analysis performed among the fifty-one phenolic compounds that were tentatively identified showed remarkable patterns of cooccurrence and chemical antagonism among the metabolites (Fig. 6). When analyzing the strength of Pearson's correlation coefficients, different sets of co-expression with strong relationships ($r > 0.85$) were found. Several subgroups with internal negative correlations (alternating red and blue block patterns) were also detected, indicating complex metabolic regulation in the accumulation of different phytochemicals.

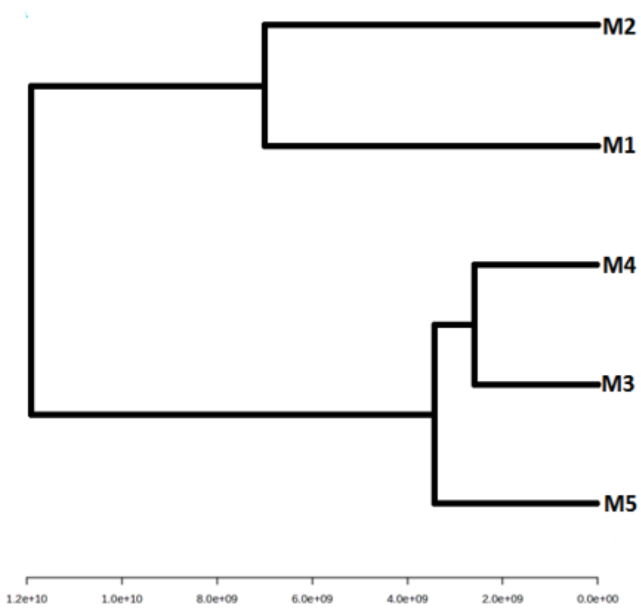

Figure 4. Ward's method dendrogram of *Brassica* samples.

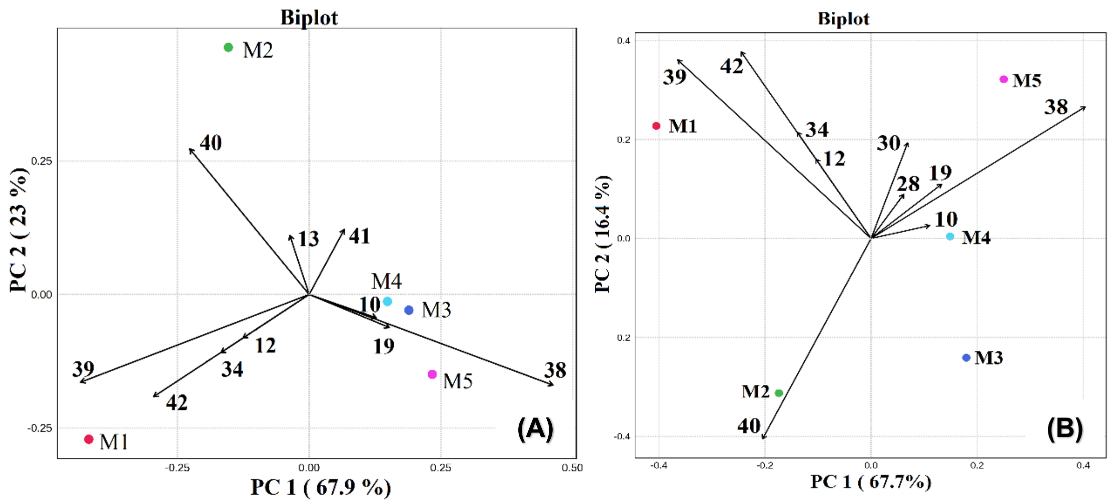

Figure 5. PCA analysis obtained from tentative bioactive compounds found in *Brassica* samples. A: biplot visualization tool, B: partial least squares discriminant analysis (PLS-DA) with biplot visualization tool.

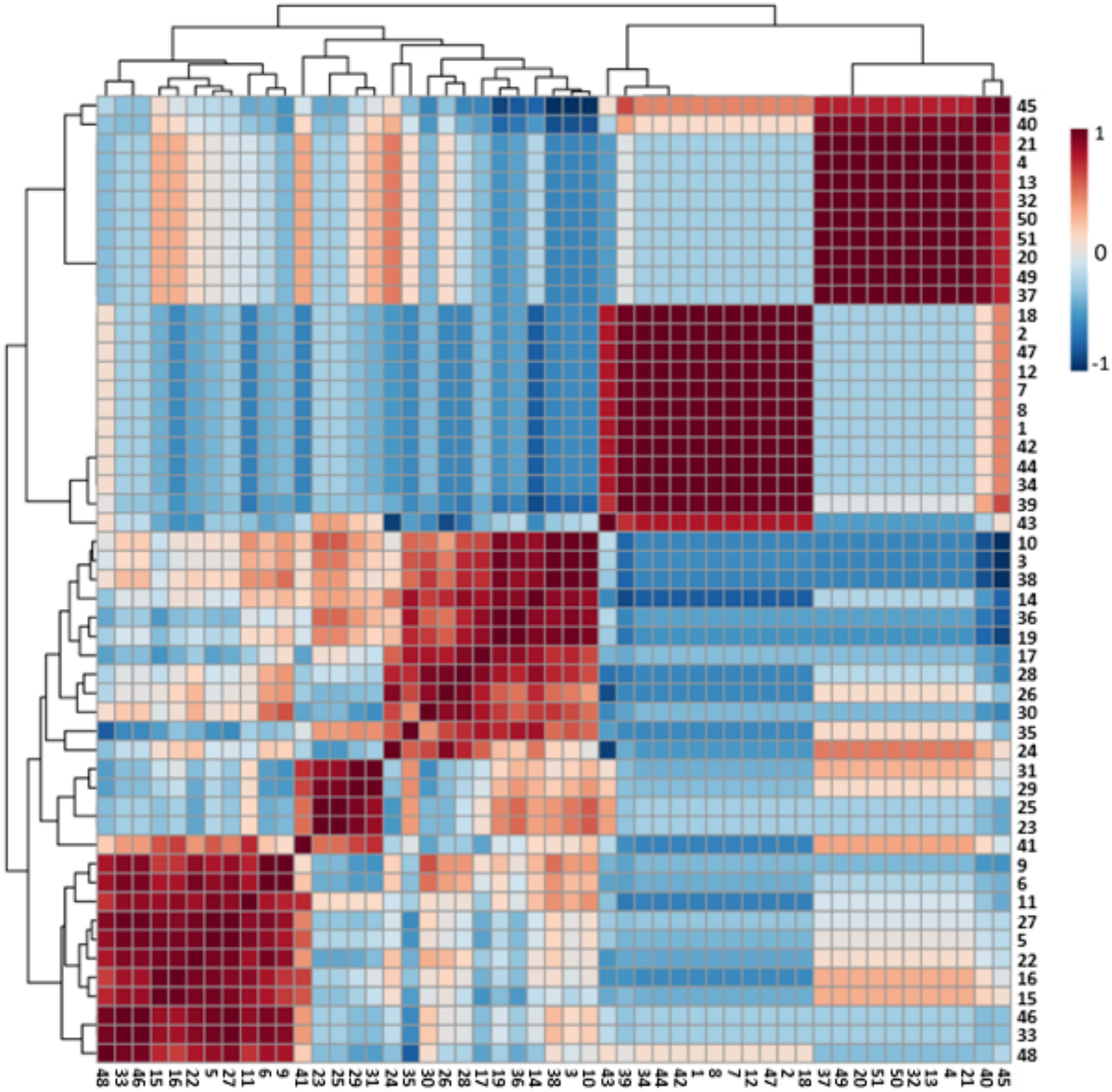

Figure 6. Correlation matrix obtained from the fifty-one compounds identified in the *Brassica* samples. Each square indicates the Pearson correlation coefficient of a pair of compounds, and the value of the correlation coefficient is represented by the intensity of the blue or red color, as indicated on the color scale.

Discussion

Ethnobotanical study

Local uses focus on ways of preparing various dishes and uses in cooking. In the first case, **chinese mustard** (*B. juncea*) is often used cooked in stir-fries and other Asian dishes. According to the information gathered, the seeds are also used to prepare mustard or eat their sprouts, but more in the domestic sphere of the Chinese community in Argentina, while in China they are also used for medicinal purposes (Zhang *et al*. 2023). In indigenous communities in India, it has been reported to be used to treat indigestion, fever, and headaches (Bushi *et al*. 2021). The traditional uses of mustard leaves are similar to those used locally in Argentina, which demonstrates how migrants recreate their cultural heritage in another country (Ladio & Albuquerque 2014). The fact that most uses remain the same in different contexts may also be due to the fact that this plant continues to be exclusive to the BCB and is only consumed by the local Chinese community. This species has been recorded for several years in urban areas and still remains invisible, along with its associated knowledge, to most of the urban population in Buenos Aires (Puentes 2024, Puentes *et al*. 2019).

Regarding the biological effects, studies have been carried out on its leaves, including new research linked to arthritis, Parkinson's disease, hypertension, among others (Rahman *et al*. 2024). In the case of **pak choi** (*B. rapa* L. var. *chinensis*), the situation in urban areas is different, as it is a widely marketed crop in the region (Hurrell *et al*. 2009, Puentes *et al*. 2019). Local uses do not differ from traditional uses in other Asian countries, as its use and preparation are similar. Among the most traditional food uses, it is noteworthy that in the East, the thicker-leaved varieties of **pak choi** are very popular for making salted pickles. In Argentina, the **pak choi** varieties commonly found in urban markets are **baby pak choi** and **bok choy**. In China, they have medicinal applications, one of which coincides with their studied biological activity, which is detoxification, while there are numerous academic references where multiple properties have been studied, as shown in Table 1. The crop known as **chapaichai** (or **Xiao bai cai** in Chinese) is a cultivar called Tokyo Bekana and is only sold in the Chinatown neighborhood of Belgrano. It is often described as headless Chinese cabbage and its uses are very similar to those of **pak choi**, with the only difference being its milder flavor. In terms of visibility, the same thing happens as with *B. juncea*: both its presence and associated knowledge remain hidden from most of the urban population because these plants are only consumed by the Chinese community in Buenos Aires. These three crops are grown throughout the year and are considered very profitable for producers because the part used is the leaves and they grow quickly. The crops presented are reproduced from seeds imported from China, as it is difficult to obtain them in Argentina, according to the producers interviewed. The seeds are imported each year to sow the crops, as if they are reproduced from seeds obtained from the same cultivated plant, the quality is not the same, mainly because they lose quality in the most important characteristics, such as the shape of the leaf or the taste of the plant. Plants that are exclusive to the BCB can be considered NUS, not because they are “forgotten” species, but because they are “underutilized” in relation to production volume, given that the destination of crops for commercialization and consumption is restricted to supermarkets in this immigrant sector. The analysis of the origin of fresh produce marketed by Chinese immigrants shows how previous surveys conducted from an urban ethnobotanical perspective are a useful tool for identifying NUS in urban areas (Hurrell *et al*. 2019). The survey of these crops contributes to the record of local agrodiversity, mainly through organic production methods, which generates new food alternatives and more sustainable agriculture in the study area. This can pave the way for an increase in the supply of food plants with great potential to improve the quality, resilience, and self-sufficiency of food production, as has been seen in other parts of the world (Padulosi *et al*. 2013, Ulian *et al*. 2020).

The cultivation of species (and their botanical varieties) increases the biocultural diversity (biological and cultural dimensions) of the region and constitutes a reservoir of knowledge in the multicultural urban context. Likewise, the relevance of migrant groups in urban and peri-urban contexts is highlighted, as they carry out crop production on a smaller scale than conventional farming and offer the Chinese community food plants linked to their traditions in their country of origin. In different parts of the world, organic agriculture is carried out by indigenous communities that supply urban markets and informal fairs (FAO 2025). This is extremely useful for studying the circulation of organically grown plants in urban areas, together with the associated botanical knowledge. Likewise, the organic model underpins food consumption diversity, which is beneficial for humans and broadens their dietary strategies. Analysis of samples obtained from the organic and conventional models shows that organic agriculture may provide more nutrients to crops produced using this model. These results encourage further comparative studies between plants produced using the organic and conventional models in order to evaluate significant differences in their chemical composition and thus contribute to academic studies of their nutritional properties for dissemination to the urban population. This information can be very useful for urban consumers when choosing plants linked to migrants from the Chinese community in the study area. Likewise, the study of urban botanical knowledge of these species should continue, evaluating how traditional and non-traditional knowledge interact and are part of this complex and dynamic knowledge in multicultural contexts.

Phytochemical analysis

The phytochemical compounds identified in *Brassica* species (Table 2) have a wide range of pharmacological activity. *B. rapa* samples contain anti-*Helicobacter pylori* activity, as well as increasing the anti-*H. pylori* IgG titer (Kim *et al*. 2016). Isorhamnetin, an *in vivo* metabolite derived from isorhamnetin 3,7-O-diglucoside present in the leaves of *B. juncea*, has shown remarkable antioxidant activity *in vitro*. This compound can reduce serum glucose and 5-(hydroxymethyl)furfural levels (Yokozawa *et al*. 2002). Also, it attenuates lipid peroxidation in blood, kidney, and liver, suggesting potential against oxidative stress. Isorhamnetin 3-O-glucoside exhibits remarkable hepatoprotective activity because the reduction of serum transaminase levels of mice with induced liver injury. The lack of glucose at the seventh position enhances its hepatoprotective properties compared to other compounds (Igarashi *et al.* 2008).

Derived from *B. juncea*, isorhamnetin 3-O-glucoside stimulates the activity of key metabolic components: alcohol oxidizing enzymes, the microsomal ethanol oxidation system and aldehyde dehydrogenase. This effect results in less accumulation of the toxic and carcinogenic agent acetaldehyde, therefore reducing the risk of cellular and organ damage (Hur *et al*. 2012). Additionally, this compound has been observed to promote the recovery of key enzymes in liver detoxification, such as glutathione S-transferase and epoxide hydrolase, which play a fundamental role in cell protection and the reduction of oxidative damage (Hur *et al*. 2007).

The dendrogram illustrates findings that imply variations in the characteristics of bioactive compounds (Fig. 4), which are heavily impacted by the method of cultivation (organic or conventional), even more than the identity of the species itself. Samples cultivated through organic practices (M3, M4, and M5) exhibited notable differences from those derived through conventional practices (M1 and M2). The presence of pesticides may modify and/or diminish the levels of bioactive compounds (Garcia *et al*. 2001, Wang *et al*. 2023).

Multivariate analysis through PCA and PLS-DA (Fig. 5) distinctly separated the metabolites linked to the two types of evaluated cultivation methods. In the case of PCA, it is revealed that organic samples M3 and M4 clustered closely together, largely driven by the intensity of compounds 10 and 19. Sample M5, while also classified as organic, occupied a more distinct position within this cluster, indicating some uniqueness in its chemical makeup. Conversely, the conventional samples M1 and M2 exhibited a noticeable separation and were tied to different metabolites, implying that the use of pesticides considerably alters the chemical profile when compared to organic crops (Park *et al*. 2025).

The PLS-DA evaluation confirmed these patterns and also underscored the significance of compounds 28 and 30, which are associated with organic samples M3 and M4. At the same time, metabolites with a higher total influence, like octadecenoic acids (compounds 38, 39, 40, and 42), are connected to reactions against biotic stress (microbial pathogens and/or herbivores) (Revol-Cavalier *et al*. 2024, Weiler 1997) as well as responses to abiotic stressors (ultraviolet radiation types B and C) (Conconi *et al*. 1996, Schaller 2001). These compounds played a pivotal role in the overall differentiation between clusters; however, compounds 10, 19, 28, and 30 surfaced as key indicators of organic crops. This is significant since these metabolites might correlate with traits specific to farming practices devoid of pesticides, promoting the buildup of secondary compounds that are associated with natural defense strategies or enhanced nutritional benefits (Briz-Cid *et al*. 2019).

Overall, the findings indicate that organic samples exhibit a distinct chemical composition when compared to conventional samples, and compounds 10, 19, 28, and 30 can be regarded as indicators of organic crops. The absence of pesticide exposure in organic agriculture encourages the production of secondary metabolites that are not produced at equivalent levels in conventional crops. Consequently, it is advised that future studies focus on these compounds, both to explore their biological functions more deeply and to utilize them as analytical methods for distinguishing between organic and conventional products.

Statistical analysis was performed using Pearson's correlation results in the multivariate dataset of candidate compounds (Fig. 6). Specifically, compounds 10, 19, 28, and 30 were found to be distinguished based on multivariate evaluation using PCA and PLS-DA. To this end, the study indicates that compound 10 is strongly positively correlated with compound 3 (r = 0.98652, $p = 1.32 \times 10^{-11}$), with compound 38 (r = 0.97468, $p = 7.76 \times 10^{-10}$), with compound 19 (r = 0.93268, $p = 4.03 \times 10^{-7}$), compound 36 (r = 0.88220, $p = 1.35 \times 10^{-5}$), and compound 14 (r = 0.85745, $p = 4.39 \times 10^{-5}$). Likewise, compound 19 is strongly positively correlated with compound 36 (r = 0.97825, $p = 2.91 \times 10^{-10}$), compound 3 (r = 0.97477, $p = 1.32 \times 10^{-11}$), compound 38 (r = 0.94462, $p = 7.76 \times 10^{-10}$), and compound 14 (r = 0.92884, $p = 5.73 \times 10^{-7}$). Furthermore, compound 28 is strongly positively correlated with compound 26 (r = 0.94394, $p = 1.26 \times 10^{-7}$), with compound 30 (r = 0.92336, $p = 9.15 \times 10^{-7}$), with compound 17 (r = 0.91032, $p = 2.46 \times 10^{-6}$), and compound 14 (r = 0.87249, $p = 2.21 \times 10^{-5}$). Finally, compound 30 is strongly positively correlated with compound 26 (r = 0.88011, $p = 1.51 \times 10^{-5}$) and with compound 17 (r = 0.80525, p = 0.00029).

Conclusion

The results obtained show that urban ethnobotany is key to understanding the interactions between migrant communities and plants grown in the peri-urban areas of cities. In this sense, migrant groups in the AMBA play a fundamental role in the study and characterization of urban botanical knowledge linked to the traditions of their country of origin. In turn, the orchards produced by migrants in urban contexts are consolidated as strategic spaces for the conservation of local agrobiodiversity, maintaining traditional crops and botanical varieties from other parts of the world with diverse uses and medicinal properties. The species studied in this work, such as **chinese mustard** and **chapaichai**, can be classified within the NUS category, given that their production is carried out on a small scale and their consumption is restricted to a specific sector of the population or local community. However, it cannot be ruled out that in the near future they may be incorporated into the general commercial circuit (outside Chinatown), as has happened with **pak choi**, which is sold in markets and greengrocers in the AMBA. In relation to the production systems analyzed, it is shown that the organic agriculture model represents a sustainable alternative to the conventional system. This model also contributes to improving crop quality by stimulating the synthesis of bioactive compounds and reducing the presence of contaminating residues. According to phytochemical analyses, crops obtained through organic practices have distinct chemical profiles, characterized by a higher presence of flavonoids such as kaempferol and isorhamnetin, which are associated with antioxidant, hepatoprotective, and antidiabetic properties. Consequently, this supports the hypothesis that the absence of pesticides favors the accumulation of beneficial secondary metabolites, which increases the nutritional value and functional potential of plants. Finally, the results of this work establish relevant background information for future ethnopharmacological and ethnobotanical research focused on interdisciplinary studies of species cultivated by migrant communities in urban contexts. In this vein, it is essential to continue conducting studies on new crops produced by migrants using agroecological or organic methods, in order to evaluate the properties of the plants and promote sustainable agri-food systems that encourage a more diverse and healthy diet for urban communities.

Declarations

List of abbreviations: LEBA - Laboratorio de Etnobotánica y Botánica Aplicada; AMBA - Área Metropolitana de Buenos Aires; UHPLC-MS/MS - Ultra-high performance liquid chromatography-tandem mass spectrometry; UHPLC-PDA - Ultra-high performance liquid chromatography-tandem mass spectrometry-photo diode array; PCA - Principal component analysis; PLS-DA - Partial Least Squares Discriminant Analysis; PC1 - First principal component; PC2 - Second principal component.

Ethics approval and consent to participate: Oral informed consent was obtained from all participants prior to data collection. The study adhered to the principles outlined in the Code of Ethics of the International Society of Ethnobiology (ISE 2006).

Consent for publication: Not applicable.

Availability of data and materials: The dataset analyzed during this study is available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests**.**

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Author contributions: JP conceived the work and carried out the ethnobotanical study, YKA-A, RDDGA, and MLG-Y carried out the phytochemical study and statistical analysis. JP and MLG-Y wrote the draft of the manuscript. All authors approved the final manuscript.

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