URBAN AGRICULTURE AND FOOD SOVEREIGNTY IN LATIN AMERICA: EXAMPLES OF NUTRITIOUS DIETS

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ABSTRACT
This article addresses the issue of food and spices grown and traded in Latin America, mostly in food gardens that are inside cities and metropolitan areas. The research question is: how can nutritious foods be available for consumers? Results from a series of projects about the useful flora consumed in nine countries of the New World, at the beginning of European colonisation and in modern times, using old manuscripts as secondary research source and semi-structured interviews of urban gardeners, farmers, traders, and consumers, as a primary source, have shown that native fresh fruits and vegetables are the option for Latin Americans. A total of 1,724 testimonies were gathered for two decades, from a percentage of 56.34 urban gardeners and farmers, from Cuba and Mexico to Southern Argentina and Chile, giving us a good number of food options that might improve family diets all over the world. Further promotion of urban agriculture and training on food and spice conservation techniques might boost the availability of nutritious diets for all.
Keywords: nutrition, urban agriculture, food sovereignty, sustainable cities, Latin America.

1 INTRODUCTION

For over twenty years we have been investigating flora consumption in Latin America. Research was initiated in Brazil, in 1998, and has been continued in several Spanish speaking countries, totalling nine so far (see Table 1). The project was first developed in the Portuguese Tropical Institute and later (2015) continued in the University of Lisbon. The main research objective was to assess the weight of native American useful flora consumed or applied as herbal remedy, in relation to exotic plants introduced later. From the New World we further investigated the Old World, namely Asia (2013–2015) and Africa (2017–2019). Methodology used testimonies of food plants growth in front and backyards in Latin American cities (1998 onwards). Trade of nutritious flora was also added to the research after 2004, in Mexico and Peru, followed by Brazil over gain.

Current contribution will only focus food plants and spices that are part of Latin American peoples' diets, as it would be impossible to summarise all findings in one single paper. As Henseleit [1] wrote, it is a controversial discussion whether consumers are taking care of environmental issues when buying food. Under the assumption that the survival of plant species mentioned in early colonisation manuscripts provided a fair indicator of environmental sustainability of both native and exotic flora introduced in the Americas, a secondary objective became the assessment of the survival of vegetable species, collected from the wild and cultivated through times.

The research question for this contribution is: How can nutritious foods be available for consumers? In fact, both Brazil that has 210,867,954 inhabitants, and Mexico, with 130,759,074, have a high percentage of urban population, respectively 84% and 78% [2]. As the majority of Latin Americans are urbanites, the option for this project was to target the urban realm, because some residents grow food, spices, and medicinal plants, in order to improve household nutrition and health, as previous research found [3].

Poverty reduction in the Americas has been an issue for the United Nations, as far as the Millennium Development Goals are concerned. Good governance and effective institutions


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Table 1: Surveys conducted in Latin America [17].

Cities and countries	Semi-structured interviews (n)	Urban gardeners and farmers (%)	Mission years
1. Belém, Brazil	570	97.3	1998, 2005
2. Presidente Prudente, Brazil	280	100	1999
3. Recife, Brazil	50	6.0	2019, 2020
4. S. Luís, Brazil	100	90.0	2010
5. Santarém do Pará, Brazil	50	64.0	2006, 2007
6. Santiago Metropolis, Chile	132	84.1	2002, 2003, 2005
7. Iquique, Chile	75	64.0	2012
8. Central Mexican Metropolis	100	42.0	2004, 2006
9. Lima, Peru	34	0.0	2004
10. Piura, Peru	40	0.0	2016
11. Habana, Cuba	50	94.0	2009
12. San José, Costa Rica	43	69.7	2010
13. Rio Cuarto, Argentina	100	80.0	2011
14. Colonia del Sacramento, Uruguay	50	48.0	2011
15. Panamá City, Panama	50	6.0	2017
Total or average	**1,724**	**56.34**	**–**

are crucial to sustain the trend in success examples, as recent literature suggests [4]. This aspect provides justification to further investigate the availability of nutritious plant species so as to offer national governments evidence of ways to better explore their own food environments. Facts and figures about the methodology used in this project will be presented next, followed by the results and the conclusions.

2 METHODOLOGY AND MATERIALS

The project started with surveys to urban agriculture practitioners in Belem, Amazonia, and Presidente Prudente, S. Paulo State, in Brazil, and continued three years later in Santiago, the capital of Chile. After 2004, food, medicinal plant traders and wild herb collectors were also targeted, vis a vis the great importance of herbal remedies for urban gardeners, registered in both countries. In the last decade the methodology evolved from primary data gathering into a twofold methodological approach:

(1) Archival investigation about food plant species, spices, and medicinal flora existent from the 16th to the 17th centuries, in Portuguese and Spanish speaking countries, the so-called first globalisation [5]. Manuscripts written by local Indians [6]; by travellers and settlers [7], [8]; and by Catholic priests [9]–[15] were selected using recent publications, historical archives, and libraries. This phase allowed us to examine secondary data about peasantries in the initial colonisation years, landscape descriptions of the geographical locations under scrutiny, as well as all flora uses reported.
(2) Fifteen surveys were conducted in cities, metropolitan areas, and rural settings located in alluvial islands of the Brazilian Amazon Basin, using face-to-face semi-structured interviews, an ongoing process. Table 1 summarises fieldwork done from 1998 to 2020

in Latin America, providing data about the number of testimonies, the percentage of gardeners and farmers interviewed, and the scientific missions accomplished per year.

The methodological process was continued with the botanical identification of flora mentioned in the first globalisation manuscripts and the primary data gathered during the interviewing phase, so as to compare their uses in modernity and in early colonisation years, to finalise with the evaluation of useful flora evolution through times. This research process used the Missouri Botanical Garden database, available online [16], and allowed to assess which species had vulnerable status or whether flora existent in the 16th and 17th centuries had been depredated (see Figs 1 and 2).

Figure 1: Corn from Argentina.

Figure 2: Quinoa, from Iquique, Chile.

3 RESULTS AND DISCUSSION

A total of 672 different plant species have been recorded through fieldwork conducted along two decades, about two thirds of which were native American flora. Therefore, a good array of nutritious food plants is available in home-gardens and peri-urban farms, in informal and formal trading posts, widely diverse and usually accessible to the Latin American urbanites. Food species were not the only aim of the project, as said, and thus spices and medicinal plants are part of the research. Earlier contributions had herbal remedies as the primary concern because they constitute the majority of the flora gathered [17], [18]. Current paper will only focus food and spices cultivated and traded in the New World, as the main research objective was to assess the weight of native American useful flora consumed in relation to exotic plants introduced later.

Results show that nutritious native and exotic flora mentioned in 16th and 17th century manuscripts did not disappear from local peoples' diets, even though food plants such as rice, potatoes and corn dominate as staples in the nine investigated countries (see Table 2). As to the bread, it is usually baked with wheat. Potatoes and corn (Fig. 1) are, by the way, American food species such as pumpkins, beans, sweet potatoes (*Ipomoea batatas*), amaranth or Inca wheat, cassava, and quinoa (Fig. 2). Inca wheat (*Amaranthus caudatus*) was mentioned by Garcilaso de la Vega [6], and beans by the Jesuits Jose de Anchieta, Cardim and, again by the Spanish Vega [6], [9], [12].

By country, the record was that potatoes and corn are basic food in Peru and in Chile; in Peru, yacón (*Polymnia sonchifolia*), a tuberous root is consumed to lower sugar levels, recommended to diabetes patients [19]. Cassava was a preference in Brazilian Amazonia,

Table 2: Food plants and spices usually consumed in Latin America, in the beginning of European colonisation and nowadays. *(Source: Author's surveys and [16].)*

Vernacular names	**Scientific names**	**Countries**	**Manuscripts (year)**
1. Amaranth, Inca wheat	*Amaranthus caudatus* L. AMARANTHACEAE	Ar, Br, CR, Ch, Me, Pe	Vega (1609)
2. Apium	*Appium graveolens* L., *A. sellowianum* H. Wolff., *A. leptophyllum* (Pers.) F. Muell. ex. Benth. APIACEAE	Br, Ar, Ur	Cardim (1625)
3. Apple	*Malus domestica* (Suckow) Borkh. ROSACEAE	All	Vega (1609), Vieira (1638), Oviedo (1526)
4. Avocado	*Persea americana* Mill. LAURACEAE	All	Oviedo (1526), Vega (1609), Arriaga (1621)
5. Banana	*Musa paradisiaca* L. MUSACEAE	All	Acosta (1590), Cardim (1625), Oviedo (1526), Vega (1609)
6. Beans	*Phaseolus vulgaris* L. FABACEAE	All	Anchieta (1610), Cardim (1625), Vega (1609).
7. Caja	*Spondias mombim* L. ANACARDIACEAE	Br	Cristovão de Lisboa (1627)
8. Cara	*Dioscorea dodecaneura* Vell DIOSCOREACEAE	Br	Anchieta (1610), Cardim (1625)
9. Carrot	*Daucus carota* L. APIACEAE	Br, Pa, Pe, Ar	Oviedo (1526)
10. Cashew	*Anacardium occidentale* L. ANACARDIACEAE	Br, Cu, CR, Pa	Anchieta (1610), Cardim (1625), C. Lisboa (1627)
11. Cassava	*Manihot esculenta* Crantz EUPHORBIACEAE	Br, CR, Cu, Pa, Pe	Caminha (1500), Oviedo (1526), Anchieta (1610), Cardim (1625), Acosta (1590), C. Lisboa (1627),Vieira (1652)
12. Chicory	*Eryngium foetidum* L. APIACEAE	Br, CR, Cu, Pa, Pe	Oviedo (1526), Vega (1609), Cardim (1625)
13. Chilli pepper	*Capsicum annuum* L. SOLANACEAE	All	Oviedo (1526), Vega (1609), Acosta (1590), Anchieta (1610), Arriaga (1621)
14. Cocoa	*Theobroma cacao* L. MALVACEAE	All	Acosta (1590), Vieira (1652)
15. Coconut	*Cocos nucifera* L. ARECACEAE	Br, Cu, CR, Me, Pa, Pe	Oviedo (1526), Acosta (1590), Anchieta (1610),Cardim (1625)

Table 2: Continued.

Vernacular names	Scientific names	Countries	Manuscripts (year)
16. Coriander	*Coriandrum sativum* L. APIACEAE	Ar, Ch, Br, Pa	Anchieta (1610), Cardim (1625), Vega (1609)
17. Corn	*Zea mays* L. POACEAE	All	Oviedo (1526), Acosta (1590), Anchieta (1610), Cardim (1625), Vega (1609), Arriaga (1621), Ovalle (1646), Ruiz de Montoya (1639), Vieira (1654)
18. Ginger	*Zingiber officinale* Roscoe ZINGIBERACEAE	All	Acosta (1590), Anchieta (1610), Vieira (1675)
19. Guava	*Psidium guajava* L. MYRTACEAE	Br, Ch, Me, Pa, Cu, CR	Oviedo (1526), Vega (1609), Vieira (1654)
20. Laurel	*Laurus nobilis* L. LAURACEAE	All	Oviedo (1526), Vieira (1645)
21. Lemon, Lime, Citron	*Citus limon* (L.) Osbeck, *C. aurantifolia* (Christm.) Swingle, *C. medica* L. RUTACEAE	All	Oviedo (1526), Vega (1609), Anchieta (1610), Cardim (1625)
22. Lentils	*Lens culinaris Medik* FABACEAE	Br, Ch	Anchieta (1610), Viera (1694; 1655, 1670–1675)
23. Oranges (sweet and sour)	*Citrus sinensis* (L.) Osbeck, *C. aurantium* L. RUTACEAE	All	Oviedo (1526), Vega (1609), Anchieta (1610), Cardim (1625), Acosta (1590)
24. Papaya	*Carica papaya* L. CARICACEAE	Br, Ch, Pa	Oviedo (1526)
25. Parsley	*Petroselinum crispum* (Mill.) Fuss. APIACEAE	All	Anchieta (1610)
26. Passionfruit	*Passiflora edulis* Sims PASSIFLORACEAE	Ar, Ch, Cu, Me, Br, CR	Cardim (1625), Lisboa (1627)
27. Peach	*Prunus persica* (L.) Batsch. ROSACEAE	Ar, Ch, Pa, Pe	Oviedo (1526), Vega (1609)
28. Peanuts	*Arachis hypogaea* L. FABACEAE	All	Vega (1609), Cristovão de Lisboa (1627)
29. Physalis, Camapu	*Physalis* sp. SOLANACEAE	Br, Pe	Anchieta (1610)
30. Pineapple	*Ananas comosus* (L.) Merr. BROMELIACEAE	Br, Ch, Pa, Pe	Oviedo (1526), Vega (1609), Anchieta (1610), Cardim (1625), Lisboa (1627)

Table 2: Continued.

Vernacular names	Scientific names	Countries	Manuscripts (year)
31. Pomegranate	*Punica granatum* L. LYTHRACEAE	All	Oviedo (1526), Vega (1609), Vieira (1651)
32. Potato	*Solanum tuberosum* L. SOLANACEAE	All	Oviedo (1526), Vega (1609), Anchieta (1610), Arriaga (1621)
33. Pumpkin	*Cucurbita moschata* Duchesne, *C. pepo* L. CUCURBITACEAE	Br, Me, Pa, Pe	Oviedo (1526), Vega (1609), Anchieta (1610), Cardim (1625), Anchieta (1610)
34. Quinoa	*Chenopodium quinoa* Willd. AMARANTHACEAE	Ar, Ch, Pe	Acosta (1590), Vega (1609), Arriaga (1621)
35. Rice	Oryza sativa L. POACEAE	All	Caminha (1500), Anchieta (1610), Vega (1609)
36. Soursop	*Annona muricata* L. ANNONACEAE	Br, Pe, Pa	Oviedo (1526), Vega (1609), Vieira (1672)
37. Sugar cane	*Saccharum officinarum* L. POACEAE	All	Anchieta (1610), Vieira (1649–1667)
38. Tuna and Nopal	*Opuntia* sp. CACTACEAE	Me	Acosta (1590)
39. Wheat	*Triticum* sp. POACEAE	All	Caminha (1500), Vieira (1642–1699)
40. Wine, Grapes	*Vitis vinifera* L. VITACEAE	All	Caminha (1500), Oviedo (1526), Vega (1609), Vieira (1633), Anchieta (1610), Arriaga (1621), Cardim (1625)

Note: Ar = Argentina; Br = Brazil; CR = Costa Rica; Ch = Chile; Cu = Cuba; Me = Mexico; Pa = Panama; Pe = Peru; Ur = Uruguay.

where the iron and calcium rich leaf is cooked for several hours and eaten in stews and duck dishes. However, rice and beans are the most common staples consumed everywhere else in the country; pumpkins, beans and corn are grown together in Mexico and in Costa Rica. In this last country as in Panama, meaning in Central America, chayote (*Sechium edule*), otoi (*Xanthosoma sagittifolium*), or *Dioscorea* gender staples and vegetables are local preferences.

Horticulture species such as anti-anaemic watercress (*Nasturtium officinale*), European anti-inflammatory Appium (*A. graveolens),* the native species *(leptophyllum, sellowianum*), as well as basil leaf (*Ocimum basilicum*), were introduced by the Spaniards and Italian migrants during colonisation years and are widely consumed in Argentina and Uruguay, together with new Asian crops such as soybeans (*Glycine max*). The same innovative process can be applied to fruit crops, such as antioxidant noni (*Morinda citrifolia*) gardened and available in Havana plots and urban farms, as well as in S. Luis backyards (Fig. 3), in Brazil [17], [18]. However, in Mexico native tunas and the nopal cactus, as well as exotic species

(*Opuntia ficus-indica*) are ingested together in fish or meat dishes, to control blood sugar levels in diabetic consumers [18].

Of course the preferences usually go to native American fruits like the highly caloric and vitamin-rich avocado (980 calories per fruit); anti-ageing and mood enhancer cocoa; vitamin C rich acerola cherries (*Malpighia emarginata*); assai palm fruits (*Euterpe oleracea*), which juice is more nutritious than milk (Fig. 4); Physalis (vitamins A and C); guavas (vitamins A, B and C); soursops (complex B and C); diuretic pineapples; digestive papayas (vitamins A, B, C and D); the Chilean cherimoya (*Annona cherimola*); as well as the sedative passion fruit [18]. It's important to emphasize that most of these fruits come from selected tropical plants with small space requirements. That's the case of papaya (4 × 2.5 m), guavas (6 × 5 m), soursops (7 × 7 m). Exotic fruit trees like banana are also choices for urban gardeners (3 × 2 m), limes (7 × 7 m) and pomegranates (2 × 2 m), for similar reasons [20].

Figure 3: Noni from S. Luis, Brazil.

Figure 4: Assai from Belem, Brazil.

Urban agriculture is the growth of food species within the urban tissue or in peri-urban areas. More and more, food sovereignty is dependent on front- and backyard production, because both the 2019 corona pandemic outbreak and the recent increase in fuel prices (2022), due to conflicts spiralling almost everywhere in the world, and most particularly in Eastern Europe, turned food prices higher due to scarcity of cereals, fertilisers, and pesticides. Chemicals are, by the way, usually not used in urban agriculture, as the production is mostly organic. That tendency was already evident in 1998, in Belem, Brazil, where 52.3% of the urban gardeners interviewed used no fertilization, at all; only about 8.5% used chemicals; the remainder utilized fruit seeds (Assai), leftovers from the kitchens, and weeds from pots and home gardens, as well as chicken manure to fertilize their food gardens [18].

Fruit culture dominated in Brazil and in Chile, ranging from 95% in Belem to 65.5% in Santiago, whereas most of the trees produced nutraceutical fruits, such as guavas, acerola cherries, papayas, and in Santiago, Chile, most particularly avocados. Avocados were also found in Mexico, in Cuba and Costa Rica capitals, in biodiverse food gardens, where medicinal species rivalled with all sorts of citrus trees [18]. Coconuts grew in Recife and in Belem, Brazil, as well as other quite diverse type of *Palmae*, most endemic like *Bactris gasipaes* (Pupunha). Exotic trees imported from far away former Portuguese colonies were trees like *Mangifera indica* (mangoes, from India) and *Eugenia malaccensis* (Jambos, from Malaca, Malaysia).

Native nuts such as cashew, peanuts, and Brazil nuts (*Bertholletia excelsa*), are consumed everywhere in Latin America. Unlike the previous examples, cashew and Brazil nut trees have wider space requirements. Even so, cashew trees were abundant in S. Luis, Brazil. From

the early colonisation years, all citrus trees were introduced by the Portuguese and Spaniards, as Fernandez de Oviedo (1526) and the Inca Garcilaso de la Vega (1609) wrote, even though the so popular *Bixa orellana* fruit, which paste covered the Indian skin [7], is now a nearly forgotten plant species. Exception is Belem, where the small tree is cultivated in ten home-gardens investigated in 1998 (nearly 3%); the fruit was consumed as spice. The useful flora listed in old manuscripts doesn't possess a vulnerable conservation status [16].

Local vegetables like *Eryngium foetidum* (Chicory) and *Spilanthes oleracea* have an elective role in Amazon Brazilian diets, but the first one is also common in Central America (Panama and Costa Rica). The *Hibiscus sabdariffa* (vinagreira) is used to make healthy rice dishes in S. Luis, Brazil. Native chicory is a bitter herb mentioned both by Oviedo and Vega, a recognised medicinal species (see Fig. 5); it has anti-anaemic, anti-flu, anti-fever, and anti-diarrhoeal properties [12], [21]. As to jambu (*Spilanthes oleracea*) it is very rich in iron and vitamin C, also possessing healing effects. *Talinum triangulare* is an African *Portulacaeae*, one of the many plants brought to the Americas by the Portuguese; anti-anaemic, mineral rich (calcium, iron and phosphorous), with high protein content, the leaf is usually added to soups and bean dishes, in Brazil.

Figure 5: Native chicory from Panama City, Panama.

Figure 6: Stevia from Rio Cuarto, Argentina.

Chillies, onions, coriander, and parsley were adamant in all Brazilian cities researched, from Amazonia to the S. Paulo state city of Presidente Prudente. In this last interior town, investigated back in 1999, cassava was the main staple grown by the less wealthy gardeners that used the municipal Feed Prudente Programme [22]. As to Chile, in Santiago laurel was the most sought-after spice, because the leaf was also consumed in anti-flatulence teas. However, exotic species like ginger were bought in markets and supermarkets, as no evidence was found that urban gardeners interviewed in Latin America had interest in growing the rhizome in their front or backyards.

Urban agriculture is an environmentally sustainable activity among the surveyed food growers, even those who had to intensively irrigate their plot, as was the case with dry Iquique city in northern Chile [23]. In this case study, the urban gardeners cultivated their food and medicinal herbs using organic fertilization (43,8%), in special mulching with leaves and leftovers (13.3% of the gardeners), rabbit manure (2.7%), horse, goat and chicken manure (2.7% again). Other quite advisable ways to fertilize the soil were compost tanks, and avocado outer skin usage. Compost tanks were provided by La Pintana municipality researched back in 2002 and 2003, in Santiago, but in Iquique, there was no such program available, in 2012. Only three of the 75 interviewed in Iquique used chemical fertilizers.

Coming back to food species available in food gardens or peri-urban farms, native American sweeteners like stevia (*Stevia boliviensis,* in Fig. 6) are cultivated in Argentina. It replaces sugarcane in several households, particularly in case of diabetes diseases. As to spices, the preference goes to chilli peppers mostly everywhere in Latin America, another native plant species recorded in old manuscripts (see Table 2). In Brazil and in Mexico, chillies are kept in vinegar to make a hotter mixture ready to be cooked in traditional dishes. In the last city researched, Recife, in Brazil, the usage is to preserve chillies in sugarcane distilled cachaça [24].

That doesn't mean Latin Americans reject Old World spices, such as coriander, laurel, ginger, already mentioned, and oregano, or *Piper nigrum*, which therapeutic value has wide recognition. Training opportunities on spice and food species conservation are needed to build the skills of urban gardeners and the urbanites in general, in order to improve food environments in Latin America. The secondary objective of this paper, meaning, the assessment of the survival of vegetable species, collected from the wild and cultivated through times, was done while recognizing that plants mentioned in old manuscripts are still grown in food gardens today.

4 CONCLUSIONS

Food growth in cities can effectively contribute for the improvement in food security of the urban citizens. It is an advisable solution to tackle climate change as it works in physical resilience of urban realms and in behavioural changes among urbanites [25]. Staple foods like rice and wheat and drinks, like water and wine, were carried in the Portuguese caravels, as it is mentioned in the letter of Pero Vaz de Caminha, the chronicles writer who accompanied Pedro Alvares Cabral, during his first voyage to Brazil, officially considered as the discovery of the land of *Caesalpinia echinata*, so-called Brazil-wood tree [7], [24]. They are obviously some of the most consumed food species all over Brazil, as are local flora namely corn (*Zea mays*) and potatoes (*Solanum tuberosum*), but also in the Spanish-speaking countries of the Americas. Local staples as cassava, chayote, otoi (*Xanthosoma sagittifolium,* Fig. 7), and cará (*Dioscorea dodecaneura*), one of several *Dioscorea* gender species are also available in contemporaneity as they were in the 16th century [24].

Figure 7: Otoi from Panama City, shaded by other native species.

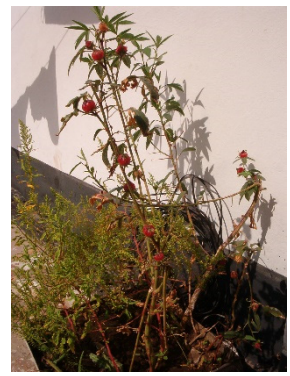

Figure 8: Vinagreira from S. Luis.

Exotic fruits and spices are eagerly sought after, yet native vitamin and mineral-rich species are preferred and cropped in urban gardens and farms. Latin America constitutes a

good example of option for nutritious daily food consumption, because the natural diversity of local flora has invited peoples from all latitudes to grow, trade and buy fresh fruits and vegetables through times, leading to positive consumer behaviour. Further promotion of individual and community food gardening (see Fig. 8) will improve the availability of nutritious vegetables and fruits that might ameliorate the daily diet of the less wealthy households. Current climate change situation, added to the 2019 pandemic outbreak, generated problems that require the development of innovative solutions, such as urban agriculture, to create more liveable urban areas. As seen in Tables 1 and 2, when practised with wise use of local resources, such as water and soil, without the application of chemical pesticides and fertilisers, food growth in the cities becomes a solution for nutrition sufficiency and environmental sustainability, without endangering our common future.

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