What’s in a name? Revisiting medicinal and religious plants at an Amazonian market

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Abstract

**Background:** In spite of an increasing number of ethnobotanical market surveys in the past decades, few studies compare changes in plant species trade over time. The open-air market Ver-o-Peso (VOP) in Belém, located near the mouth of the Amazon River in the state of Pará, Brazil, is known for its wide variety of medicinal plants. A survey of VOP was published in 1984, but it remains unknown to what extent its botanical composition changed over 34 years. Furthermore, in northern Brazil, little attention has been given to the origins of the vernacular names of these plants. Our aim is to give an up-to-date overview of the VOP medicinal plant market, concentrating on changes in species composition and vernacular names over time.

**Methods:** We collected medicinal plants and vernacular names at VOP in August 2018. We identified most plants at the Museo Paraense Emilio Goeldi Herbarium, where we also deposited vouchers and specimen labels. We compared our species composition data to the 1984 inventory by Van den Berg. Furthermore, we investigated the etymologies of the vernacular plant names.

**Results:** We recorded 155 plant specimens and 165 corresponding vernacular names, and collected 146 specimens from the medicinal and ritual stalls of VOP reporting 86 species formerly not recorded at this market. Vernacular names had mostly Portuguese roots, followed by Tupi and African ones. We found 30 species also documented in 1984, and vernacular names that overlapped between both surveys were used for the same botanical species or genus, indicating that vernacular names have changed little in the past decades. Lastly, we found 26 more introduced species sold at VOP compared to 1984.

**Conclusions:** Forest degradation and deforestation, prevalence of diseases, and methodological factors may play a role in the differences we found in our survey compared to 1984. Of the plants that did overlap between the two surveys, vernacular names of these plants were hardly different. Lastly, the lingual origins of the vernacular names in our survey and the origins of the plant species reflect the history of the intricate syncretism of medicinal plant practices of indigenous, Afro-Brazilian and European origins in Belém.

**Keywords:** Afro-Brazilian religion, Medicinal plants, Ritual plants, Market survey, Ethnobotany, Candomblé, Tupi, Brazil, Vernacular names, Ver-o-Peso, Amazonia
Background

Many people around the world rely on traditional healthcare systems involving medicinal plants, which are often sold at open-air markets [1–5]. This is also the case in Brazil, where a great variety of medicinal plants are still traded at open-air markets [6–8]. These markets are hosted and visited by Brazilians and tourists from various cultural backgrounds. This cultural diversity is reflected in the number of available plant species and their uses [9]. It is easy to establish which medicinal plants are popular in the region through market surveys, as markets give an overview of local demand [10].

There has been an increasing number of ethnobotanical market surveys in the past decades [11]. Although there are a number of studies that compare different markets to each other in terms of availability of plant species [12–14], few studies have repeated ethnobotanical surveys in markets that were already monitored decades before to examine changes in species composition [15, 16]. Likewise, few market surveys have included an analysis of vernacular names of medicinal species being sold [12, 17]. The availability of plant products at markets changes over time [16], indicating the importance of periodically conducting market surveys for a more complete picture of plant availability and to assess possible impacts of social and environmental factors [15, 18, 19]. Furthermore, the analysis of vernacular names associated with plant species can inform us more about people’s cultural and botanical history in the study area [17].

The famous open-air market Ver-o-Peso (VOP) is located in Belém, near the mouth of the Amazon River in the state of Pará, Brazil. This popular market functions as a source of medicinal plants for nearby smaller markets and is known for its wide variety of herbal medicine [20, 21]. In 1984, Van den Berg [1] published the only ethnobotanical survey of the VOP, listing the most common plants encountered in each section of the market (medicinal and ritual plants, handicrafts, vegetables and root crops, fruits, horticultural and ornamentals). This study provided an overview of the most popular species; however, this approach possibly underestimated the total medicinal species composition of the market. Furthermore, it remains unknown to what extent the botanical composition of this major Amazonian market has changed over the past 34 years.

The aim of this paper was to compile an up-to-date botanical overview of the VOP medicinal plant market, concentrating on species composition and vernacular names. Specifically, we wanted to know what plant species are sold at the medicinal stalls of VOP today and how these differed from those listed by Van den Berg [1]. We also compared the vernacular names for species in use today with those reported by Van den Berg [1]. Furthermore, we investigated whether the origin of currently marketed plant species and their attributed vernacular names reflected the cultural backgrounds of the VOP sellers. Our three hypotheses were as follows. First, we expected to find a higher and different medicinal species composition due to our methodological approach, which differed from that of previous studies [1, 15], and because the diversity of medicinal plants being offered for sale changes over time [16]. Availability of plant species changes from time period to time period, certain plants are conserved, new species are added, and other species are lost over time [16]. Second, we hypothesize that vernacular plant names would remain similar over time, as previously found in the Amazonian context [14, 22]. Thirdly, with their own language backgrounds, religious faiths, and practices, the VOP sellers are of mixed descent: indigenous, African, and European [23]. This mix of peoples is found throughout Brazil and influences the Brazilian Portuguese lexicon, including names of flora and fauna [24]. Afro-Brazilians of the Bahia state in northeastern Brazil, where a considerable number of enslaved Africans were forcefully brought to, sometimes use African-derived names for plants used in a medicinal and ritual context [25]. Also, many plant names in Surinam, a neighboring country to Brazil with a comparable history in the triangular trade involving the dislocation of western Africans, have African etymologies, influenced by the enslaved peoples that were forced to work there under brutal conditions [26, 27]. Therefore, following these examples, we hypothesized that the multicultural origins of the current population of north Brazil, including VOP sellers and consumers, would be reflected in the species’ origin and vernacular names [23, 28]. In the end, the outcome of this research contributes to the understanding of the present biocultural diversity of one of the largest and most diverse markets in South America.

Methods

Study area: Ver-o-Peso market

The VOP is situated on the bank of the river Pará, a tributary to the Amazon River, in the city of Belém (Figs. 1 and 2). It is a daily open market that caters to a large and varied public and offers several types of products, from fish to artisanal craftwork, which are offered for sale in separate areas [1, 23, 29]. We collected the medicinal plants at the VOP between the 7th and 25th of August of 2018 during ten mornings between 6:30 and 10:00 am. We checked the stalls for the freshest plants and bought a varying number of plants on each visit. Prior to buying the specimens, we introduced ourselves in Portuguese to the vendors, explained the framework of this research project, and highlighted that we were collecting medicinal
and ritual plant specimens for the Herbarium of the Museu Paraense Emílio Goeldi (MG). We followed the ISE Code of Ethics [30]. On the 25th of August, we counted 80 medicinal plant stalls and 50 ervaíras and ervaíros, female and male vendors respectively.

**Plant collection and identification**

We collected plants at the medicinal stands and at one artisanal stand known for its selection of dry fruits and seeds with medicinal applications. Popular plants that we could accurately identify on the spot, such as *Allium cepa* L. (onion) and *Ruta graveolens* L. (arruda), were not collected. We obtained oral informed consent from the vendors before buying the plants in the units in which they were sold. We documented vernacular names, date, price, and vendor’s names in a notebook. We asked for the vernacular names to be repeated several times for the correct notation. Following Albuquerque et al. [10], we made photographs of the specimens and close-up pictures of every plant in several angles, and we pressed the plants in a standard plant press to make herbarium vouchers. We either dried the specimens at home with a hairdryer, blowing hot air into a plastic bag opened at the end, in which the plant press was placed; or in the drying stove of the MG (TE-394/4, at 70 °C circulation and air renewal turned on). To disinfect our collections, we stored the dried plants in a freezer provided by the MG. After identification, we deposited all vouchers and specimen labels at the MG to become part of their collection and coded each plant according to the abbreviation of the first author: IPG.

We identified most plants by comparing them to herbarium vouchers at the MG and in the field during informal walks in nearby areas where these plants were presumably collected, such as at Ilha do Combu and the Parque Estadual do Utinga. Photographs of those specimens that we could not identify at the MG were compared to South American collections at the Herbarium of Naturalis Biodiversity Center (L) in Leiden, the Netherlands. We completed our identifications by consulting the Global Biodiversity Information Facility (GBIF) website [31], the online checklist of the Flora do Brasil 2020 [32], the Tropicos database [33], and literature on medicinal plants in Brazil [34, 35] and Suriname [36]. We identified seeds and barks by comparing their vernacular names with those mentioned in literature on
Brazilian useful plants [21, 35, 37–41], and comparing them with photographs in Google Images. We checked and updated the species scientific plant names by using The Plant List [42].

Data analysis
We organized the following information for each recorded specimen in an Excel sheet: family, genus, species and collection number, vernacular name, language, plant part sold, status in Brazil (native or introduced). We verified the spelling of the names, first with the help of the vendors in the market, and later by using Corriente [43], Navarro [44], DATAPLAMT [45], Dicionário ilustrado Tupi Guarani [46], and Michaelis Dicionário Brasileiro da Língua Portuguesa [47]. The Tupi and Portuguese dictionaries, along with the Online Etymology Dictionary [48], Corriente [43], Sebba and Corbacho [49], and Fernandes and Soares [50] were used to determine the etymology of the vernacular plant names. Names with Latin, Greek, Phoenician (in the case of Malaga), and Arabic etymologies were listed as Portuguese, as these words were implemented into Portuguese language prior to entering Brazilian Portuguese vocabulary [24, 51].

To check the phytogeographical distribution, its status in Brazil, and the origin of each plant species, we used the Tropical Plant Database [52], Missouri Botanical Garden Plant Finder [53], GBIF [31], PROTA4A [54], PROSEA [55], Van Andel et al. [56], the Flora do Brasil 2020 online checklist [32], the Flora of China [57], Kew Science Plants of the World online [58], the Catalogue of Life Annual Checklist [59], Tropicos [33], the Naturalis Bioportal [60], and Herbarium voucher labels at MG. To compare our results to the VOP ethnobotanical inventory in the 1980s, we updated the taxonomy of the plant species found at the medicinal and religious plant stalls by Van den Berg [1] and checked if they were native or introduced. Comparing detailed medicinal or ritual uses of plants between 1984 and 2018 was not part of our research aims.

Data sharing
This study was based on the participation of local specialist vendors. Although we compensated them financially by buying their plants, we also discussed our research results with them and followed up their request to provide them with a complete list of the common and scientific names of the identified plants, following Del Arco et al. [61]. We also included pictures of some pressed and dried vouchers, our contact information, and the MG location. We decided that this was the best option due to time constraints preventing us from organizing workshops or other benefit-sharing activities.

Results
Inventory of medicinal and ritual plants at the VOP in 2018
We recorded 155 plant specimens with in total 165 corresponding vernacular names and collected 146 specimens from the medicinal stalls of the VOP (Table 1). Most of the vernacular names had Portuguese roots (59%), followed by Tupi (28%) roots, while three names had unknown origins (2%) (Fig. 3). If a name had a double etymological root, they were classified in separate categories. We found names that had a combination of Tupi and Portuguese roots (9%) and African and Portuguese roots (2%). For example, *uxi-amarelo* (*Endopleura uchi* (Huber) Cuatrec.) is a combination of a Tupi plant (*uxi*) and the Portuguese term for yellow (*amarelo*). Likewise, *Tapete de Oxalá* (*Episcia cupreata* (Hook.) Hanst.) is a combination of an African term (the god Oxalá) and the Portuguese term for rug.

Most of our recorded specimens consisted of fresh plants, followed by woody stems or barks, and a few fruits, seeds, roots/rhizomes, and dried herbs (Table 2).

Of these, we identified 116 taxa to species level, 14 taxa to genus level, five to family level, and seven taxa...
| Family, scientific name/voucher number | Vernacular name/language | Part sold |
|----------------------------------------|--------------------------|-----------|
| *Acanthaceae*                          |                          |           |
| cf. *Blechum* sp./IPG20                | Amansa/P                 | Fresh aerial parts |
| *Justicia pectoralis* Jacq./IPG17, IPG44 | Abre caminho/P           | Fresh aerial parts |
| *Adoxaceae*                            |                          |           |
| *Sambucus canadensis* L./IPG24, IPG57  | Sabugueiro/P             |           |
| *Amaranthaceae*                        |                          |           |
| *Alternanthera brasiliana* (L.) Kuntze/IPG6, IPG78 | Chega até a mirim/P, Meracilha/P | Fresh aerial parts |
| *Pfaffia glomerata* (Spreng.) Pedersen/IPG33 | Corrente/P               | Fresh aerial parts |
| *Amaryllidiaceae*                      |                          |           |
| *Allium cepa* L./not collected         | Cebola/P                 | Bulb’s skin |
| *Anacardiaceae*                        |                          |           |
| *Anacardium* cf. *giganteum** Hancock ex Engl./IPG100 | Caju-i do mato/T + P     | Bark      |
| *Anacardium occidentale* L./IPG99      | Cajú/T                   | Bark      |
| *Antrocaryon amazonicum* (Ducke) B.L. Butt & A.W. Hill/IPG103 | Cedro/P                   | Bark      |
| *Schinus terebinthifolia* Raddi/IPG14  | Arceira/P                | Branches, fresh leaves, flowers |
| *Spondias* sp./IPG130                  | Taperebá/T, Cajá/T       | Bark      |
| *Anacardiaceae* sp. IPG94              | Anoera/T?                | Bark      |
| *Anacardiaceae* sp. IPG95              | Aroeira/P                | Bark      |
| *Annonaceae*                           |                          |           |
| *Annona montana* Macfad./IPG81         | Graviola/P               | Branches, fresh leaves |
| *Xylopia frutescens* Aubl./IPG155      | Ibiríba/T                | Dry fruit and seed |
| *Annonaceae* sp./IPG107                | Cipó urira/T             | Woody stem with T |
| *Apocynaceae*                          |                          |           |
| *Aspidosperma nitidum* Benth. ex Müll.Arg./IPG101 | Carapanauba/T           | Bark      |
| *Cascabela* cf. *thevetia* (L.) Lippold/IPG148 | Castanha da India/P, Munduruku/T, Chapeu de mato leão/P | Dry fruit and seed |
| *Himatanthus articulatus* (Vahl) Woodson/IPG129 | Sucuúba/T               | Bark      |
| *Araceae*                              |                          |           |
| *Dieffenbachia seguine* (Jacq.) Schott/IPG79 | Comigo-ninguém-pode/P   | Fresh aerial parts |
| *Araliaceae*                           |                          |           |
| *Polyscias scutellaria* (Burm.f) Fosberg/IPG73 | Cuia mansa/T + P         | Fresh aerial parts |
| *Arecaaceae*                           |                          |           |
| *Manicaria sacifera* Gaertn./IPG144    | Buçu/T                   | Fruit and seeds |
| *Sacatea exorrhiza* (Mart.) H.Wendl./IPG124 | Paxiúba/T               | Root      |
| *Asparagaceae*                         |                          |           |
| *Sansevieria cylindrica* Bojer ex Hook./not collected | Lança-de-São Jorge/P | Whole plant |
| *Sansevieria hyacinthoides* (L.) Druce/not collected | Espada-de-são Jorge/P | Whole plant |
| *Sansevieria trifasciata* Prain/not collected | Espada-de-Joana d’Arc/P | Whole plant |
| *Bignoniaceae*                         |                          |           |
| *Bignonia* cf. *nocutana* (Barb.Rodr.) L.G.Lohmann/IPG104 | Cipó curimbó/T           | Woody stem with bark |
| *Fridérica* cf. *chica* (Bonpl.) L.G.Lohmann/IPG77 | Pariri/T                 | Fresh aerial parts |
| *Mansoa alliacea* (Lam.) A.H.Gentry/IPG60 | Cipó de Alho/T + P      | Fresh aerial parts |
| *Newbouldia laevis* (P.Beaub.) Seem./IPG82 | Espinheira santa/P       | Dry leaves |
| Family/Ethnobotanical family | Scientific name | Voucher number | Vernacular name/language (language) | Part sold               |
|------------------------------|-----------------|----------------|-------------------------------------|-------------------------|
| Bixaceae                     | Bixa orellana L./IPG174 |               | Urucú/T                          | Fruit and seeds        |
| Boraginaceae                 | Cordia sp./IPG115 |               | Louro rosa/P                     | Wood with bark         |
| Burseraceae                  | Protium sp./IPG97 |               | Breu/P                        | Bark                   |
| Clusiaceae                   | Calophyllum brasiliense Cambess./IPG111 |       | Jacareuba/T                   | Bark                   |
|                             | Symphonia globulifera L.f./IPG92 |       | Anani/T                        | Bark                   |
| Commelinaceae                | Commelina erecta L./IPG31 |       | Vence-demanda/P                 | Fresh aerial parts     |
|                             | Tradescantia zebrina Bosse/IPG85 |       | Quebra-chibangá/P, Trapoeraba/T | Fresh aerial parts     |
| Compositae                   | Acemilla oleracea (L.) R.K.Jansen/IPG1 |       | Jambu/T                          | Fresh whole plant      |
|                             | Ayapana tripinervis (Vahl) R.M.King & H.Rob/IPG55 |       | Japana branca/T + P            | Fresh aerial parts     |
|                             | Bidens sp/IPG18 |               | Picão/P                      | Fresh whole plant      |
|                             | Mikania glomerata Spreng./IPG64, IPG75 |       | Sicuriju/T                    | Fresh aerial parts     |
|                             | Pectis elongata Kunth/IPG9 |       | Cominho/P                     | Fresh aerial parts     |
|                             | Sphagneticola triolobata (L.) Pruski/IPG16 |       | Desempata/P                   | Fresh aerial parts     |
|                             | Tagetes erecta L./IPG12 |       | Cravo/P                       | Fresh aerial parts     |
|                             | Unkia camphorata L./IPG51 |       | Trevo sáo João/P              | Fresh whole plant      |
| Convolvulaceae               | Cuscuta sp./IPG65 |               | Desatrapalha/P                | Fresh whole plant      |
| Costaceae                    | Costus spicatus (Jacq.) Sw./IPG59 |       | Canarana/P + T               | Fresh aerial parts     |
| Crassulaceae                 | Bryophyllum pinnatum (Lam.) Oken/IPG56 |       | Pirarucu/T                    | Fresh aerial parts     |
| Cucurbitaceae                | Cayaponia cf. rigida (Cogn.) Cogn./IPG63 |       | Quebra feitoço/P            | Fresh aerial parts     |
|                             | Luffa aperculata (L.) Cogn./IPG149 |       | Cabacinha/P                   | Dry fruit               |
|                             | Momordica charantia L/IPG15 |       | Melão-de-São Caetano/P        | Fresh aerial parts     |
| Dilleniaceae                 | Doloiocarpus dentatus (Aubl.) Standl/IPG105 |       | Cipó-de-fogo/P               | Woody stem with bark   |
| Dioscoreaceae                | Dioscorea sp/IPG176 |               | Batata-de-colar-osso/P        | Rhizome                |
| Euphorbiaceae                | Croton caucara Benth./IPG128 |       | Sacacá/T                     | Bark                   |
|                             | Croton sacaquinha Croizat/IPG5 |       | Angel-de-guarda/P, Corre atraz/P, Busca longe/P | Fresh aerial parts     |
|                             | Euphorbia tithymaloides L/IPG76 |       | Coramina/P                   | Fresh aerial parts     |
|                             | Jatropha curcas L/IPG47 |               | Pião branco/P                | Fresh aerial parts     |
|                             | Jatropha gossypiiolifolia L/IPG19 |       | Pião roxo/P                  | Fresh aerial parts     |
|                             | Jatropha podagrica Hook/IPG38 |       | Pião-paje/P + T            | Fresh aerial parts     |
| Family, scientific name/voucher number | Vernacular name/language | Part sold |
|----------------------------------------|--------------------------|-----------|
| Geraniaceae                            |                          |           |
| Pelargonium cf. graveolens L’Hér/not collected | Malva rosa/P             | Living plant |
| Gesneriaceae                           |                          |           |
| Episcia cupreata (Hook) Hanst./IPG40    | Tapete de Oxalá/P + A (Oxalá), Laço de amor/P | Fresh whole plant |
| Humiriaceae                            |                          |           |
| Endopleura uchi (Huber) Cuatrec./IPG134 | Uxi-amarelo/T + P        | Bark      |
| Humiria balsamifera Aubl./IPG117, IPG132 | Miri/T; Umiri/T         | Bark      |
| Lamiaceae                              |                          |           |
| Aeollanthus suaveolens Mart. ex Spreng./IPG11 | Catinga-de-mulata/T + P | Fresh whole plant |
| Ocimum americanum L/IPG7, IPG8         | Estorakue/P, Manjericão/P | Fresh aerial parts |
| Ocimum basilicum L/IPG62               | Manjericão roxo/P        | Fresh whole plant |
| Ocimum gratissimum L/IPG52             | Alfavaca/P               | Fresh aerial parts |
| Plectranthus amboinicus (Lour.) Spreng./IPG68 | Hortelã-de-Maranjão/P + T, Hortelã-de-folha-grande/P | Branch with fresh leaves |
| Pogostemon cablin (Blanco) Bent./IPG86 | Anica/P                  | Fresh aerial parts |
| Pogostemon heyneanus Bent./IPG58       | Oriza/P                  | Fresh aerial parts |
| Vitex agnus-castus L/IPG4              | Alecrim-de-Angola/P (alecrim) + A (Angola) | Fresh aerial parts |
| Lamiaceae sp. IPG61                    | Chama/P                  | Fresh aerial parts |
| Lauraceae                              |                          |           |
| Cinnamomum verum J.Presl/IPG120        | Canela/P                 | Woody stem with bark |
| Cinnamomum sp./IPG46                   | Canela/P                 | Fresh aerial parts |
| Lecythidaceae                          |                          |           |
| Couratari guianensis Aubl/IPG131       | Tauari/T                 | Bark      |
| Leguminosae                            |                          |           |
| Anadenanthera cf. peregrina (L) Speg./IPG121 | Paricá/T               | Bark      |
| Bauhinia cf. guianensis Aubl./IPG110   | Escada-de-Jabotí/P + T  | Woody stem with bark |
| Bauhinia monandra Kurz/IPG72           | Pata-de-vaca/P           | Fresh aerial parts |
| Bowdichia virgilioides Kunth/IPG172    | Sucupira/T               | Seeds     |
| Caesalpinia ferrea C.Mart./IPG158      | Jucá/T                   | Fruit     |
| Copaífera sp/IPG108                    | Copaíba/T                | Bark      |
| Dalbergia monetaria Lf./IPG135         | Verônica/P               | Woody stem with bark |
| Dipterx odarata (Aubl.) Willd./IPG152  | Cumaru/T                 | Seeds     |
| Hymenaea courbaril L/IPG112             | Jatobá/T                 | Bark      |
| Mimosa tenuiflora (Willd.) Poir./IPG114 | Jurema preta/T + P      | Bark      |
| Mimosa veracosa Benth./IPG113          | Jurema branca/T + P      | Bark      |
| cf. Ormosia sp./IPG98                  | Buiuçu/T                 | Bark      |
| Pentaclethra sp./IPG125                | Pracaxi/T                | Bark      |
| Senna hissuta (L) H.S.Inwivin & Barneby/IPG50 | Sombra-do-mundo/P, Afasta espirito/P | Fresh aerial parts |
| Vouacapoua americana Aubl./IPG89       | Acapú/T                  | Wood      |
| Leguminosae sp./IPG96                  | Barbatimão/T              | Bark      |
| Lythraceae                             |                          |           |
| Punica granatum L/IPG169               | Romã/P                   | Dry exocarp |
| Malvaceae                              |                          |           |
| Gossypium barbadense L/IPG42           | Algodão/P                | Fresh aerial parts |
Table 1 Medicinal plant species documented at VOP (Continued)

| Family, scientific name/voucher number | Vernacular name/language | Part sold |
|----------------------------------------|--------------------------|-----------|
| **Luehea sp./IPG90**                   | Açoita-cavalo/P          | Bark      |
| **Melastomataceae**                    |                          |           |
| *Miconia ciliata* (Rich.) DC./IPG26    | Canela-de-Velho/P        | Fresh aerial parts |
| **Meliaceae**                          |                          |           |
| *Carapa guianensis* Aubl/IPG93         | Andiroba/T               | Bark      |
| **Moraceae**                           |                          |           |
| *Brosimum acutifolium* Huber/IPG118    | Mururé/T                 | Bark      |
| *Dorstenia cayapia* subsp. *asaroides* (Hook.) C.C. Berg/IPG48 | Apuí/T | Fresh whole plant |
| *Morus nigra* L./IPG28                 | Amora/P                  | Branch with fresh leaves and fruits |
| **Olacaceae**                          |                          |           |
| *Psychopetalum olacoides* Benth./IPG116| Marapuarna/T             | Wood with bark |
| **Phyllanthaceae**                     |                          |           |
| *Phyllanthus amarus* Schumach. & Thonn./IPG22 | Quebra-pedra/P | Fresh whole plant |
| *Phyllanthus urinaria* L./IPG21        | Dinheiro-em-penca/P      | Fresh aerial parts |
| **Phytolaccaceae**                     |                          |           |
| *Petteria alliacea* L./IPG25, IPG179   | Mucuraca-á/T, Rinchão/P  | Fresh aerial parts; Dry whole plant |
| **Piperaceae**                         |                          |           |
| *Peperomia circinnata* Link/IPG64      | Carrapatinha/P           | Fresh aerial parts |
| *Piper callatum* Ruiz & Pav./IPG27     | Elixir-paregôrico/P      | Fresh aerial parts |
| *Piper peltatum* L./IPG70              | Malvarisco-de-folha-grande/P, Capeba/T | Fresh leaves |
| **Plantaginaceae**                     |                          |           |
| *Bacopa monnierioides* (Cham.) B.L.Rob./IPG84 | Trevo do mar/P | Fresh aerial parts |
| *Conobea scoparioioides* (Cham. & Schldl.) Benth./IPG32 | Pataqueira/P | Fresh aerial parts |
| *Scoparia dulcis* L./IPG13             | Vassourinha-de-igreja/P  | Fresh whole plant |
| **Poaceae**                            |                          |           |
| *Chrysopogon zizanioides* (L.) Roberty/IPG178 | Patchichuli/P | Dry roots |
| *Cymbopogon citratus* (DC.) Stapf/not collected | Capim-marinho/T + P | - |
| *Zea mays* L./IPG164                    | Milho/P                  | Stalk     |
| **Polygonaceae**                       |                          |           |
| *Antigonon leptopus* Hook. & Arn./IPG69| Agarradinho/P            | Whole plant with tubers |
| *Polygala spectabilis* DC./IPG36        | Camembeca/T              | Fresh whole plant |
| **Portulacaceae**                      |                          |           |
| *Portulaca pilosa* L./IPG23            | Amor crescido/P          | Fresh whole plant |
| **Rhizophoraceae**                     |                          |           |
| *Rhizophora mangle* L./IPG126          | Raíz-de-mangue/P         | Root      |
| **Rosaceae**                           |                          |           |
| cf. *Prunus* sp./IPG91                 | Ameixa/P                 | Bark      |
| **Rubiaceae**                          |                          |           |
| *Uncaria* sp./IPG133                    | Unha-de-gato/P           | Woody stem with bark |
| **Rutaceae**                           |                          |           |
| *Citrus x aurantium* L./IPG67          | Laranja-da-terra/P       | Branch with fresh leaves |
| *Ruta graveolens* L./not collected     | Arruda/P                 | Leaves in small plastic bags; Whole plant |

**Note:** The parts sold include both fresh and dry plant parts, as well as whole plants and roots.
remained unidentified. Species were spread over 59 families, the most diverse family at the market was Leguminosae (12% of the species), followed by Lamiaceae (7%), Compositae (6%), Euphorbiaceae (4%), Anacardiaceae, and Bignoniaceae (3%) (Table 3). We found 77 (66%) species native to Brazil and 39 (34%) previously introduced from Africa, Asia, Europe, and other Latin-American countries (see Additional file 1). We documented 11 species of African origin, 14 species of Asian origin, and three species of European origin. All African and almost all Asian species had a tropical distribution, except Allium cepa L. [54], Morus nigra L. [62], and

| Family, scientific name/voucher number | Vernacular name/language | Part sold |
|----------------------------------------|--------------------------|-----------|
| Sapindaceae                            |                          |           |
| *Paullinia cupana* Kunth/IPG154         | Guaraná/T                | Seeds     |
| Sapotaceae                             |                          |           |
| *Pradosia lactescens* (Veil.) Radlk./IPG102 | Casca doce/P        | Bark      |
| Selaginellaceae                        |                          |           |
| *Selaginella parkeri* (Hook. & Grev.) Spring/IPG49 | Samambaia/T           | Fresh whole plant |
| Simaroubaceae                          |                          |           |
| *Quassia amara* L./IPG41, IPG123       | Folha-da-quina/P, Pau-tenente/P | Fresh aerial parts; Wood with bark |
| Siparunaceae                           |                          |           |
| *Siparuna guianensis* Aubl/IPG88       | Capitiú/T, Negra-mina/P | Fresh aerial parts |
| Solanaceae                             |                          |           |
| *Capsicum annuum* L./IPG29             | Pimenta malagueta/P     | Fresh aerial parts |
| *Physalis angulata* L./IPG37           | Camapuú/T               | Fresh whole plant |
| Urticaceae                             |                          |           |
| *Cecropia obtusa* Trécul/IPG87         | Imbaúba branca/T + P    | Dry leaves |
| *Pellionia repens* (Lour.) Merr./IPG71 | Hei-de-vencer/P, Vence-batalha/P, Maria-fumaça/P | Fresh whole plant |
| Verbenaceae                            |                          |           |
| *Aloysia gratissima* (Gillies & Hook.) Tronc./IPG39 | Folha-de-alfazema/P | Fresh aerial parts |
| *Lippia alba* (Mill.) N.E.Britton & P.Wilson/IPG43, IPG66 | (Erva) cidreira/P | Fresh aerial parts |
| *Lippia thyrmoides* Mart. & Schauer/IPG30 | Manjeronra-de-Angola/P + A | Fresh aerial parts |
| Vitaceae                               |                          |           |
| *Cissus verticillata* (L.) Nicolson & C.E.Jarvis/IPG10, IPG34, IPG80 | Insulina/P, Cipó-de-puca/T, Quebra-barreira/P | Fresh aerial parts |
| Xanthorrhoeaceae                       |                          |           |
| *Aloe vera* (L.) Burm.f./not collected | Babosa/P                | Whole plant |
| Zingiberaceae                          |                          |           |
| *Alpinia zerumbet* (Pers.) B.L.Burtt & R.M.Sm./IPG45 | Vindicá/P | Fresh aerial parts |
| *Curcuma longa* L./not collected       | Mangarataia/T, Safrão/P, Açafria/P, Gengibre amarela/P | Rhizome |
| Unidentified                           |                          |           |
| Indet/IPG74                            | Chora-nos-meus-pés/P    | Fresh aerial parts |
| Indet/IPG83                            | Cabi/uncertain          | Fresh aerial parts |
| Indet/IPG106                           | Cipó-ferro/T + P        | Bark      |
| Indet/IPG109                           | Core/P                  | Bark      |
| Indet/IPG122                           | Pau-de-bota/P           | Woody stem with bark |
| Indet/IPG127                           | Raiz-do-sol/P           | Root      |
| Indet/IPG177                           | Cauan/T                 | Fresh tuber |

Fresh aerial parts include stem, leaves, flowers, and/or fruit
Indet species indetermined; languages: P Portuguese, T Tupi, A African
Punica granatum L. [63], which originated in the drier parts of southwestern Asia.

Comparison between current VOP medicinal plants and VOP in the 1980s

We compared our survey to Van den Berg’s medicinal and religious plant survey in 1984 [1]. Van den Berg [1] listed 39 (75%) native and 13 (25%) introduced species (Fig. 4). In our survey, we found 30 species (57%) that were also documented in 1984 [1] (Fig. 5). For these overlapping species, we documented three vernacular names not mentioned by Van den Berg [1]. Likewise, she documented four vernacular names that did not come up in our survey (Table 4). Overlapping vernacular names were used for the same botanical species or genus.

Discussion

Medicinal plants at the Ver-o-Peso

Our results give an up-to-date botanical inventory of the VOP, one of the largest open markets in South America, which is often quoted in ethnobotanical review studies [11, 14, 18]. Likewise, we were able to complement other medicinal plant market surveys in the area that differ in species composition and richness [8, 19, 20], providing a more accurate idea of the present diversity of medicinal plants in the area. Although subject of a previous ethnobotanical study [1], comparison with our intensive market inventory resulted in differing degrees of overlap in species assembly and nomenclature.

The differences in the species inventory we found compared to Van den Berg [1] may be caused by social or medical factors, such as the incidence of certain diseases for which our newly recorded plants are used for healing. For example, the prevalence of diabetes in Brazilian adults has increased since the 1980’s [64], and both Momordica charantia and Bauhinia species are employed to treat it in Brazil [6, 16]. Bauhinia species are also used to treat high cholesterol, kidney diseases, and high blood pressure [15, 16]. Although recovered by our survey, these plants were not documented before at the VOP, most likely due to their absence or lack of popularity during the time frame of the previous survey [1]. Furthermore, differences in plant inventory,
especially the higher proportion of introduced species in our study compared to Van den Berg’s 1960–1980’s study [1], may be influenced by environmental factors. Forest degradation and deforestation [65] caused by logging [66], cattle ranching [67], and fires [68] prompt a reduction in the availability of medicinal and native hardwood species, pushing a demand for introduced medicinal species to treat human diseases [19]. However, the most popular medicinal species in Belém listed by Shanley and Luz [19] partly overlap with our survey, but also partly with Van den Berg [1]. This implies that it is yet unknown what the impacts of deforestation are on the availability of medicinal plants at the VOP.

Van den Berg [1] initiated her market study in 1965, and it continued for two decades over a time span in which there was more intact rainforest habitat compared to the present [69]. However, our shorter study resulted in a more diverse medicinal plant species composition. We attribute this variation to our different methodological approaches due to our differing aims: while her aim was to document the most frequently occurring species, our aim was to find out the overall medicinal species diversity of the market. Because of these different approaches, a direct comparison of the species composition between studies remains problematic. However, this is inherent to studying ethnobotanical inventories over time and space [14, 15]. When comparing such historical ethnobotanical data, the only manner to overcome disparities in historical survey quality across studies is to clearly acknowledge differences in methodology. Our study highlights the importance of repeating market surveys, the necessity of establishing standard methodologies, and the exact documentation of the applied methodologies to ensure comparable results in future studies [10].

**Plant names preserved**

Of the species our survey shared with Van den Berg [1], the majority of vernacular names overlapped, indicating that there has been little change in names over three decades at the VOP. The small proportion that did not overlap could, again, be related to shifts in health perceptions and the occurrence of diseases over time. For example, in our study *Cissus verticillata* was called, among other names, *insulina*, which could be due to a higher occurrence of diabetes in Belém than at the time of Van den Berg’s study [1, 64]. However, such differences in associated names were minor. This is in line with our expectations, as plant names tend to present a remarkable continuity over time, even for centuries, as was previously found in Brazil [14] and neighboring Suriname [22]. For example, *Acmella oleracea* was named *jambu* in our survey, and we traced back this name to circa 375 years ago in the *Historia Naturalis Brasiliae* [14], where it was documented for the same species, in a slightly different spelling (*nhambi* and *nhambú*).

Substantial transformations in social and environmental factors are needed for plant names to change. Migration plays a large role, as migrants usually bring along their own language, plant uses, and cultural elements, including words for plants that may later be included in the dominant language [14, 17, 26]. In Tanzania, vernacular plant names at urban markets changed as a result of the migration from rural to urban centers of people with different cultural and lingual backgrounds [17]. Apparently, Belém’s cultural and linguistic context and its natural surroundings have not changed enough in the past decades to stimulate large shifts in vernacular plant names. Even though Belém is a large and expanding city, its surroundings are still inhabited by peoples

**Table 4** Differences in vernacular names found in the current study and in Van den Berg [1]

| Species              | Current vernacular names              | Vernacular names reported by Van den Berg [1]          |
|----------------------|---------------------------------------|-------------------------------------------------------|
| *Cissus verticillata*| Cipó de Puca, Insulina, Quebra barreira | Pucá                                                   |
| *Frideria cf. chica* | Pariri                                 | Pariri; Crajirú                                       |
| *Petiveria alliacea* | Mucuraca-ã; Rinchão                    | Mucura-caá; Guiné                                     |
| *Piper callosum*     | Elixir paregórico                      | Elixir paregórico; Óleo elétrico                       |
| *Bryophyllum pinnatum* | Pirarucu                               | Pirarucu; Folha-da-fortuna                            |
who have valued and traded in these herbal medicines in the past decades. Their ethnobotanical knowledge of medicinal plants, including vernacular names, is an essential element to their survival and a source of income. Thus, as people worked with these medicinal plants consistently over the past decades, and languages remained the same, it resulted in the preservation of these vernacular names.

Regarding presently recorded names of species, of which the species were not recorded previously at VOP, a broader analysis of names, involving ethnobotanical surveys in and around Pará, could further confirm or refute our results on long-term preservation of plant names in the area.

**Language origins**

The largest part of the vernacular plant names at this Amazonian market bore names of Portuguese origin. For example, the vernacular name *arruda* (*Ruta graveolens*) is of Portuguese origin, and the species is native to the Mediterranean region where it is embedded in the local plant pharmacopeia and also used against the “evil eye” [70]. We noticed this that several vendors at the VOP wore a sprig of *arruda* to protect against the “evil eye,” an interesting usage also commonly found in Bahia among Candomblé practitioners [25]. Bussmann et al. [13] also found that most plants sold at markets in Colombia, Bolivia, and Peru have mostly Spanish names. However, in northern Peru, Bussmann and Sharon [12] found that Spanish names were mainly used for introduced and coastal plant species whereas plants from the montane forests were often referred to by their indigenous name. In our case, there were relatively few plants of European origin at the VOP market and most plants with Portuguese vernacular names were native Brazilian species, such as, *Mansoa alliacea*, called *cipó de alho* (garlic vine).

The second largest group of vernacular names had a Tupi origin. Names like *caju, tapereba, buçu, sicuriju, jambu*, and *tauari* reflect an acquisition of indigenous words in the Brazilian lexicon for living organisms found in the natural world, also evidenced by the native and especially Amazonian plants that were sold at the market. Portuguese-speaking people have inhabited the Belém area since the seventeenth century, and their language gradually became the official language [71]. Nevertheless, Tupinambá indigenous people were still present around Belém during the turn of the twentieth century [72], and Tupi, Tupinambá, and *lingua geral* (a mix of Tupi and Portuguese which served as lingua franca in the region) were spoken in Pará up until the nineteenth or twentieth centuries [73], alongside various other spoken languages also belonging to the Tupi-Guarani language family [74]. This indicates that while the Portuguese-speaking peoples that inhabited the area mainly used Portuguese words to describe the natural world, they also relied upon indigenous Tupi names to some degree. This indigenous influence is not only reflected in the vernacular plant names at the VOP and the number of native species, but also in medicinal and religious plant uses. For example, the thin papery inner bark of *Couratari guianensis* (*tauari*), whose presence in Belém and surroundings was not previously documented, is used during Amazonian indigenous and Afro-Brazilian ceremonies as tobacco paper to roll ritual cigars [75]. We also found combinations of Tupi and Portuguese names, such as *pido-paje* (*Jatropha podagrica Hook.*) and *jur-emà preta* (*Mimosa tenuiflora* (Willd.) Poir.). These are prime examples of names shaped by cultural exchange among people from different cultural and linguistic backgrounds in the area.

We found a few vernacular names that had sub-Saharan African origins. Two of these directly refer to Africa: *alecrim-de-Angola* (*Vitex agnus-castus*), native to the Mediterranean region, and *manjerona-de-Angola* (*Lippia thymoides*), native to Brazil. The term Angola comes originally from Kimbundu, a Bantu language spoken in Angola, and it etymologically refers to a country of people from the Bantu linguistic group [76]. This word was used in the past by European traders to indicate the western coastline of Central Africa [77]. Although it is unclear when *alecrim-de-Angola* entered into Portuguese vocabulary, *V. agnus-castus* is used in Afro-Brazilian ceremonies in baths, as in the *Banho de São João* (bath of Saint John), an Afro-Brazilian ritual during the commemoration of St. John in Belém [9].

Further, the vernacular name *manjerona-de-Angola* has been documented before in Belém, but associated with *Origaniun majorana* L. instead of *Lippia thymoides* [9]. A closely related plant, *Lippia multiflora* Moldenke, is used as medicine and in rituals along the western coast of Africa [78, 79]. We suggest that *L. multiflora* was replaced in use by *L. thymoides* in Belém, and it is possibly used in Afro-Brazilian ceremonies.

The last vernacular name with an African etymology, *tapete de Oxalá* (rug of Oxalá in English, *Episcia cupreata*), is also used in other parts of Brazil for other plant species [25]. Oxalá is a Candomblé deity and has a West African etymology, but it is unknown when and how this name was introduced into the Brazilian Portuguese vocabulary [24], and therefore how and by whom *Episcia cupreata* was first associated with this deity.

Thus, contrary to our expectation, we found very few vernacular names of medicinal and ritual plants sold at the Ver-o-Peso with African-derived origins. Yet, many of the plants we documented at the VOP with Portuguese and Tupi vernacular names, including African and non-African species, are used in rituals and ceremonies
performed by followers of Afro-Brazilian religions, like Candomblé [1, 9, 25, 80, 81]. Other areas in Brazil, for instance in the northeast, where the Afro-Brazilian population is larger and may have experienced less difficulty in preserving Yoruba and Kikongo language elements, may exhibit other vernacular plant name patterns, including more African-derived plant names [25]. So, while we documented only a few plant names of African origin, several plants sold at the VOP were associated with ritual uses that were influenced by Afro-Brazilians. These findings may give us a glance into history: enslaved Africans who were brought to Brazil and arrived in the area of Belém, and later Afro-Brazilians faced more difficulties in retaining their language, possibly because they were in fewer numbers than Portuguese and Tupi-speaking peoples. However, they were clearly able to keep their knowledge on plant uses alive and to adjust their ceremonial and ritualistic customs to the new plants encountered in Brazil.

Conclusions
A great variety of medicinal plant species, mainly of Amazonian origin, is sold at the medicinal plant stalls of the VOP. Just 30 of the 126 plant species we encountered overlapped with Van den Berg’s earlier market survey [1], and we reported a larger number of species and vernacular names not previously recorded at VOP. Also, there was a greater number of introduced species than in 1984 (Van den Berg); however, if this is due to changed environmental factors or to differences in methodologies remains unclear. In the case of vernacular names, we found that vernacular names of plants did not change much in the last three decades. Furthermore, the diverse origin of vernacular plant names reflects how the need for words to describe natural phenomena in the colonized and foreign land impelled Portuguese-speaking peoples to use their own reference words to name native Brazilian plants, but not without taking up several Tupi plant names. Although we only found a few plants with African-derived names, African heritage was not that much embedded in terms of language, but in associated ceremonial uses. In summary, the species sold at the VOP and their vernacular names, as well as the uses associated with these species found in literature, attest to the fact that Belém harbors an intricate syncretism of ethnobotanical knowledge of indigenous, Afro-Brazilian and European origin.

Supplementary Information
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