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Native foods from Brazilian biodiversity as a source of bioactive compounds

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ABSTRACT

The interest in South American native plant species has been growing in recent years due to their health benefits. Brazil is one of the world's mega-diverse locations with over 40,000 different plant species representing 20% of the world's flora. The country was visited in the 19th century by European travelers and naturalists, who described the use of native plant species as food. In this study, data on 67 species was recovered from historical documents and bibliographies. Several of the recorded species show potential as functional food in laboratory studies. Other species are unknown or not yet submitted to any study, in order to verify their health benefits.

1. Introduction

There are several vegetable species that have been claimed as an important sources of bioactive substances, and efforts to evaluate their potential against chronic diseases have been made in several parts of the world (Cardellina, 2002; Dembitsky et al., 2011; Devalaraja, Jain, & Yadav, 2011; Sant'Ana, 2011). Tropical ecosystems are particularly rich in such plants, where they are consumed by the producers, sold in national or international markets or used for industrial processing. The interest in South American native species has been growing in recent years: the potential of yacon (*Smallanthus sonchifolius* (Poepp. & Endl.) H. Rob.) to reduce the risk of diabetes, maca (*Lepidium meyenii* Walp.) as an effective revitalizing and invigorating food, vitamin C-rich extracts of camu-camu (*Myrciaria dubia* (Kunth) McVaugh) and anthocyanins of purple corn (*Zea mays* L.) and açaí (*Euterpe oleraceae* Mart.), for example, have been evaluated in several studies (Desmarchelier, 2010).

Brazil is one of the world's mega-diverse countries with over 40,000 different plant species representing 20% of the world's flora. However, the Brazilian vegetable richness is not optimally utilized, which can be partially explained by the history of the country. Brazil was discovered by the Portuguese in 1500. The first information about the uses of native plants was collected by the Jesuit priests, who had direct contact with the Amerindians at the beginning of colonization. The Jesuits repeatedly attracted the attention of the Portuguese in their reports on the utility of Brazilian plants. However, the colonial Portuguese project did not have an interest in evaluating the potential of native products. On the contrary, the Portuguese have made efforts to acclimatize plants, introduced from other continents (Leite, 1996; Nepomuceno, 2008). By the mid-sixteenth century, for example, Brazil witnessed the successful cultivation of cinnamon from Ceylon, pepper from Malabar, ginger from China, coconuts from Malaysia, mangos from Southeast Asia, jackfruit from India and cacao from Middle America (Ferrão, 2004; Voeks, 2004).

In 19th century, dozens of European travelers and scientists (botanists, mineralogists, zoologists, doctors, named naturalists) arrived into Brazil with an interest in studying the natural resources and assessing their potential utility. Some of them documented their observations about the various aspects of Brazilian life, including the use of native species as remedies and food. At that time, Brazilian Southwestern ecosystems were still preserved and native species were widely used by the population for different purposes (Brandão, Grael, & Fagg, 2011). Their contributions for the knowledge of the Brazilian botanical resources are incalculable: hundreds of new species were discovered, and innumerable new genera were described, based on the material they collected. In the last years, our research group has been concentrated in recovering data and images of useful native plant species recorded by the naturalists. The information recovered from herbaria, documents and historical bibliography is deposited in Brazilian and European Institutions. In a previous study, for example, we showed data on native medicinal species used in 19th century in Minas Gerais, and discussed the necessity to improve laboratory studies with them, to verify their potential use as medicine (Brandão, Cosenza, Grael, Netto, & Monte-Mór, 2009; Brandão et al., 2008). In this present study, we describe information on the use of native plant foods.

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2. Material and methods

2.1. Historical literature survey

This paper is an extension of a previous study on medicinal plants (Brandão et al., 2008). The study was based on data recovery on the use of native plant foods recorded in diaries of sixteen European travelers and naturalists (translated to Portuguese) who traveled throughout Minas Gerais and the surrounding areas in the 19th century. The naturalists included Austrians (Pohl, 1976), Germans (Burmeister, 1958; Freyress, 1982; Langsdorff (Silva, 1997); Martius (Spix & Martius, 1981); Wied-Neuwied, 1989), English (Bunbury, 1981; Burton, 1976, 1977; Gardner, 1975; Luccock, 1975; Mawe, 1978), French (Castelnau, 1949; D'Orbigny, 1976; Saint-Hilaire, 1975a, 1975b, 1975c, 1975d) and Swiss (Tschudi, 1980). Detailed uses of some species were obtained from the following books written specifically about Brazilian plants: *Plantes Usuelles des Brasiliens* (Saint-Hilaire, 1824a), *Histoire des plantes les plus remarcables du Brésil et du Paraguay* (Saint-Hilaire, 1824b), *Flora Brasiliae Meridionalis* (Saint-Hilaire, 1825–1833) and *Systema Materiae Medicae Vegetabilis Brasiliensis* (Martius, 1843).

Confirmation of the species as native of Brazil was performed using the website http://floradobrasil.jbrj.gov.br/2010/. The names of plants cited by von Martius were verified at www.florabrasiliensis.cria.org.br. The English names for each species, genus and families were updated using data from the Missouri Botanical Garden's website (www.mobot.org) and International Plant Names Index (www.ipni.org). Traditional uses described in the bibliography (in Portuguese) were compared with those given in the original books (in Latin and French) and translated into English. Data on recent laboratory studies were obtained from PubMed and Scopus.

2.2. Organization of data

All data obtained in this study are described in Table 1. The species were grouped by their families, scientific and vernacular names, uses in 19th century and results of recent laboratory studies. Similar species with the same traditional use were grouped together, such as *Annona crassiflora* Mart. and *A. glabra* L., *Xylopia sericea* A. St.-Hil. and *X. aromatica* (Lam.) Mart., *Syagrus botryophora* (Mart.) Mart. and *S. flexuosa* (Mart.) Becc., *Lecythis pisonis* Cambess. and *L. lurida* (Miers) S.A. Mori and species of *Oxalis*. Species whose only occurrence (and not the use) was mentioned by the naturalists were not included in Table 1; they are *Astrocaryum campestre* Mart. (tucum-do-campo), *Spilanthes brasiliensis* Spreng. (jambu), *Begonia* spp., *Cereus jamacaru* D.C. (mandacaru), *Periandra mediterranea* (Vell.) Taub. (alcaçuz), *Ximenia americana* L. (ameixa-da-terra), *Sideroxylon obtusifolium* (Roem. & Schult.) T.D. Penn. (quixabeira) and *Solanum paniculatum* L. (juripeba). Species used as tea (*Ilex paraguariensis* A. St.-Hil, *Lippia pseudo-thea* and *Stachytarpheta jamaiscensis* (L.) Vahl.) were also considered and included in Table 1. The species *Myrtus quiruiri* (quiruiri, Myrtaceae), registered by D'Orbgni and Saint-Hilaire, was not found in any botanic database and was also not included in table.

3. Results

Table 1 shows a total of 67 native food species, registered by the sixteen studied naturalists, and their uses in the 19th century. The species are distributed in 32 families, and those with greater number of species were Arecaceae (12 species), Myrtaceae (8), Annonaceae (5), Malvaceae and Oxalidaceae (4), Anacardiaceae (3), Euphorbiaceae, Sapindaceae and Verbenaceae (2). All the other families were represented by only one species.

The species most mentioned in the bibliography was *Manihot esculenta* Crantz (cassava), and its use as food was described by 15 (94%) of the 16 studied naturalists. Other species mentioned by more than half of the naturalists were *Anacardium occidentalis* L. (cajueiro, 12, 75%), *Myrciaria cauliflora* (Mart.) O. Berg (jabuticaba, 11, 68.7%), *Araucaria angustifolia* (Bertol.) Kuntze (pinheiro brasileiro), *Bixa orellana* L. (urucum) and *Psidium guayava* L. (goiabeira) (10, 62.5%), *Genipa americana* L. (genipapo) (9, 56%), *Mauritia vinifera* Mart. (buriti), *Attalea oleifera* Barb. Rodr., *Euterpe edulis* Mart. and *L. pisonis* Cambess. (8, 50%). All the other species were mentioned by a maximum of seven naturalists (Table 1).

From the total of mentioned plants, 28 (47%) were consumed by the Brazilians as fruits *in natura* (Table 1). Eight species were used to prepare juices (*Hancornia speciosa* Gomes, *Caladium striatipes* (Kunth & C.D. Bouché) Schott, *Mauritia armata* Mart., *M. vinifera* Mart., *Psidium guajava* L., *P. guineense* Sw., *P. rufum* DC. and *Syagyrus schizophylla* Mart. Glassman) or used as dye, spices or flavors (*B. orellana* L., *Caryocar brasiliense* A. St-Hil., *Drymis brasiliensis* Miers, *Hymenaea* spp., *Ocotea odorifera* (Vell.) Rohwer, *Pimenta pseudocaryophyllus* (Gomes) Landrum, *Xylopia aromatica* (Lam.) Mart. and *X. sericea* A. St-Hil.). Seven species were used to prepare alcoholic drinks (*C. striatipes* (Kunth & C.D. Bouché) Schott, *H. speciosa* Gomes, *M. armata* Mart., *M. vinifera* Mart., *P. guajava* L., *P. guineense* Sw. and *Syagrus schizophylla* (Mart.) Glassman), seven to prepare candies (*A. oleifera* Barb. Rodr., *Eugenia uniflora* L., *Guazuma ulmifolia* Lam., *H. speciosa* Gomes, *M. armata* Mart., *M. vinifera* Mart., *P. guajava* L.) and three were used in teas (*I. paraguariensis* A. St-Hil., *L. pseudo-thea* Schauer and *S. jamaicensis* (L.) Vahl.). Some species the nuts were used (*A. occidentale* L., *A. angustifolia* (Bertol.) Kuntze, *Acrocomia aculeata* (Jacq.) Lodd. ex Mart., *L. pisonis* Cambess.), oils (*Acrocomia aculeata* (Jacq.) Lodd. ex Mart., *A. oleifera* Barb. Rodr., *Copernicia prunifera* (Mill.) H.E. Moore, *C. brasiliense* A. St-Hil.) and palms (*Acrocomia aculeata* (Jacq.) Lodd. ex Mart., *E. edulis* Mart. and *S. botryophora* (Mart.) Mart.) were also reported.

Table 1 also shows information on recent laboratory studies performed on each species. From the total of registered species, 47 (60%) have already been submitted to a study confirming their health benefits. The anti-oxidative property was the most studied as demonstrated for 23 (34.2%) of the total of species from Table 1. Eight species (11.9%) showed antitumor, anti-mutagenic or anticancer activities. In addition, six species had anti-diabetic activity, five had anti-inflammatory and cardioprotective properties, and two showed antiglycation activity and usefulness in treating hypovitaminosis. Other species were confirmed as having laxative, hepatoprotective and hypolipidemic properties. The species that was submitted to the highest number of studies was *T. cacao* L., which seeds showed anticancer (Jourdain, Tenca, Deguercy, Troplin, & Poelman, 2006; Ohno, Sakamoto, Ishizuka, & Fujita, 2009), antidiabetic (Ruzaidi, Amin, Nawalyah, Hamid, & Faizul, 2005), anti-inflammatory (Kim et al., 2010), antioxidant (Crozier et al., 2011; Sakagami et al., 2008; Sarmadi, Ismail, & Hamid, 2011; Spadafranca, Martinez, Sirini, & Testolin, 2010), cardioprotective (Allen, Carson, Kwik-Uribe, Evans, & Erdman, 2008; Balzer et al., 2008; Berry, Davison, Coates, Buckley, & Howe, 2010; Buijsse, Feskens, Kok, & Kromhout, 2006; Fisher, Hughes, Gerhard-Herman, & Hollenberg, 2003; Grassi et al., 2008; Heiss, Dejam, & Kleinbongard, 2003; Jia et al., 2010; Rein, Paglieroni, & Wun, 2000; Wang-Polagruto et al., 2006) (data not show in Table 1).

The bibliography relates that 13 species were already cultivated in Minas Gerais at that time (*Ananas comosus* (L.) Merr., *Arachis hypogaea* L., *A. angustifolia* (Bertol.) Kuntze, *B. orellana* L., *Convolvulus edulis* Thunb., *Eugenia uniflora* L., *E. edulis* Mart., *I. paraguariensis* A. St-Hil., *Manihot esculenta* Crantz, *M. cauliflora* (Mart.) O. Berg, *Passiflora* spp., *P. guajava* L. and *Theobroma cacao* L.), and four of these species (*A. comosus* (L.) Merr., *M. esculenta* Crantz, *M. cauliflora* (Mart.) O. Berg and *T. cacao* L.) were already commercialized.

4. Discussion

Bioactive substances present in plants have become popular as complementary or alternative therapeutic agents to manage and/or

Table 1
Native species used as food in the nineteenth century in Minas Gerais and surroundings and results of recent laboratory studies.

Family and species	Vernacular names	Naturalists	use	Results of studies
Anacardiaceae				
Anacardium occidentale L.	Caju, acaju, cajueiro, cashew nut	Bunbury, Burmeister, Burton, Castelnau, Gardner, Luccock, Pohl, Spix & Martius, St.-Hilaire, Tschudi, Wied-Neuwied	Intoxicating liquor, brandy, wine (fermented fruit), refreshments and a kind of beer; fruits; peduncle edible fruit flavor, bittersweet; roasted chestnuts; stem acids	Antidiabetic (Tedong et al., 2010), antioxidant (Barreto, Souza, Azeredo, & Mercadante, 2007; Morais et al., 2010; Rufino, Fernandes, Alves, & Brito, 2009; Rufino et al., 2010), antitumoral (Lograd o et al., 2010)
Anacardium humile A. St.-Hil.	Cajuzinho-do-campo, caju-rasteiro	Burton, Gardner, Langsdorff, Spix & Martius	Use of fruits	Antiulcer (Ferreira et al., 2007, 2010)
Spondias tuberosa Arruda	Imbuzeiro, umbuzeiro, imbu	Burton, Spix & Martius, St.-Hilaire, Wied-Neuwied	Description of "imbuzada" (fruit juice with milk and sugar); fruit taste with very pleasant aroma	Antioxidant (Genovese, Pinto, De Souza, & Lajolo, 2008; Gonçalves, Lajolo, & Genovese, 2010; Rufino et al., 2009, 2010)
Annonaceae				
Annona crassiflora Mart., *Annona glabra* L.	Araticum, araticu	Burmeister, Burton, Langsdorff, St.-Hilaire, Wied-Neuwied	Use of fruits	Anticancer (Cochrane, Nair, Melnick, Resek, & Ramachandran, 2008), antimutagenic (Vilar, Ferreira, Ferri, Guillo, & Chen Chen, 2008), antioxidant (Genovese et al., 2008; Gonçalves et al., 2010; Roesler, Catharino, Malta, Eberlin, & Pastore, 2007; Roesler et al., 2006; Roesler, Malta, et al., 2007)
Rollinia sylvatica (A. St.-Hil.) Mart.	Araticu-do-mato, anones, corossols	St.-Hilaire	Use of fruits	anticancer (Mikolajczak et al., 1990)
Xylopia aromatica (Lam.) Mart., *X. sericea* A. St.-Hil.;	Embira, pindaíba, ibira, pimenteira do sertão, pimenteira da terra	Martius, St.-Hilaire,	Fruits as spice	None
Apocynaceae				
Hancornia speciosa Gomes	Mangaba, mangabeira	Burton, Castelnau, Gardner, Langsdorff, Spix & Martius, St.-Hilaire, Tschudi	Tasty fruit, sweet, eaten raw, such as jams or sweets; juice made with fruit	Antioxidant (Rufino et al., 2009, 2010)
Aquifoliaceae				
Ilex paraguariensis A. St.-Hil.	Mate, erva-do-Paraguai, erva, erva-mate, congonha, árvore-do-mate, árvore-da-congonha	Burton, Castelnau, Martius, Spix & Martius, St.-Hilaire	Drink: Infusion preparation of yerba mate (drunk without sugar)	Antidiabetic (Oliveira et al., 2008), antioxidant (Leonard et al., 2010; Matsumoto et al., 2009; Vieira et al., 2010), cardioprotective (Mosimann, Wilhelm-Filho, & Silva, 2006), hepatoprotective (Heck & Mejia, 2007; Martins et al., 2009)
Araceae				
Caladium striatipes (Kunth & C.D. Bouché) Schott	Banana-do-brejo	St.-Hilaire	Juicy fruit with a sweet aroma and pleasant taste (do not eat or suck up because the spike has a sour taste)	None
Araucariaceae				
Araucaria angustifolia (Bertol.) Kuntze	Pinheiro-brasileiro, araucária, pinheiro-do-Brasil, pinheiro-do-Paraná	Bunbury, Burmeister, Burton, Castelnau, Gardner, Langsdorff, Pohl, St.-Hilaire, Tschudi, Wied-Neuwied	Consumption of pinion nuts; almonds were sold.	None
Arecaceae				
Acrocomia aculeata (Jacq.) Lodd. ex Mart.	Macaúba, palmeira-macaúba, coco-de-catarro, mucajá	Burmeister, Castelnau, D'Orbigny, Langsdorff, Spix & Martius, St.-Hilaire, Tschudi	Consumption of nuts; use as palm and olive oil made from fruit; use oil for soap and bows and spindles.	Antihypovitaminosis A (Ramos, Siqueira, Isomura, Barbosa, & Arruda, 2007)
Attalea oleifera Barb. Rodr.	Indaiá, palmeira-indaiá, indajá, ouricuri	Burmeister, Burton, Castelnau, D'Orbigny, Pohl, Spix & Martius, St.-Hilaire, Tschudi	Fruits crushed and added to water produce "milk pleasant"; fruits used in jams; use of coconuts for oil extraction.	None
Copernicia prunifera (Mill.) H.E. Moore	Palmeira-carnaúba, carnaúba, carnaubeira, carnaíba	Burton, Langsdorff, Spix & Martius	Resin edible and the leaves used to feed livestock, the pulp of green fruit, boiled to remove its astringent taste was considered good and healthy, especially when eaten with milk. The mature coconut was eaten raw. Oil used for the preparation of butter. Coconuts boiled and eaten with milk.	Antioxidant (Rufino et al., 2010)
Euterpe edulis Mart.	Açaí, palmito	Bunbury, Burmeister, Burton, Castelnau, Gardner, Spix & Martius, St.-Hilaire, Wied-Neuwied	Drink boiled extract of the fruit. Consistence similar to chocolate, sweet taste. "Cauim" (made with coconuts). Consumption as palm.	Antioxidant (Borges et al., 2011)
Mauritia armata Mart.	Buriti-mirim, buriti-anã	Burton, Castelnau	Candy made with pulp from the peel and core from the albuminous substance, and brown sugar. Drink: sweet juice extracted from the trunk and wine.	None

Table 1 (*continued*)

Family and species	Vernacular names	Naturalists	use	Results of studies
Mauritia vinifera Mart.,	Buriti, murici, palmeira-buriti, bority, bruti, muricky	Burton, Castelnau, Gardner, Langsdorff, Pohl, Spix & Martius, St.-Hilaire, Tschudi	Sweet ("saieta") made with fruit pulp and sugar, which was marketed. Another sweet was made with the "marrow" of the trunk. One type of emulsion was made from the pulp sweetened with sugar. The juice (beverage) removed from the trunk, had similar taste to sweet wine, described as intoxicating.	Antioxidant (Barreto, Benassi, & Mercadante, 2009; Rosso & Mercadante, 2007), cardioprotective (Manhães, 2007), vitamin A activity (Ambrósio, Campos, & Faro, 2006; Mariath, Lima, & Santos, 1989)
Oenocarpus bacaba Mart.	Bacaba, palmeira-de-vinho	Castelnau	"Milk" prepared from crushed almonds with water	Antioxidant (Finco & Silva, 2009)
Syagrus botryophora (Mart.) Mart.; *Syagrus flexuosa* (Mart.) Becc	Patioba, palmeira pati, Palmito do campo	Burmeister, Castelnau, D'Orbigny, Spix & Martius, Tschudi	Use as palm	None
Syagrus coronata (Mart.) Becc.	Palmeira aricuri, palmeira alicuri, ouricuri	Burton, D'Orbigny, Spix & Martius, Wied-Neuwied	Starch similar to "tapioca" made from the young stem used in the preparation of bread. Sweet fruits (not healthy).	None
Syagrus schizophylla (Mart.) Glassman	Palmeira-ariri	Burton, D'Orbigny, Spix & Martius	Preparation of medicinal juice.	None
Bixaceae				
Bixa orellana L.	Urucu, urucum	Burton, Castelnau, D'Orbigny, Langsdorff, Pohl, Spix & Martius, St.-Hilaire, Tschudi, Wied-Neuwied	Use as dye; raw seeds used as seasoning or for industrial purposes.	Anticancer (Reddy, Alexander-Lindo, & Nair, 2005; Tibodeau, Isham, & Bible, 2010), antiglycant (Gutierrez, Baez, Cortez, & Cárdenas, 2011), antioxidant (Lima & Bragagnolo, 2011; Muntha, Reddy, Lindo, & Muraleedharan, 2005; Oboh, Akomolafe, Adefegha, & Adetuyi, 2011), hypoglycemic (Russell, Morrison, & Ragoobirsingh, 2005; Russell, Omoruyi, Pascoe, & Morrison, 2008)
Bromeliaceae				
Ananas comosus (L.) Merr.	Ananás, abacaxi, abacaxizeiro, ananás-do-campo	Bunbury, Castelnau, D'Orbigny, Spix & Martius, St.-Hilaire, Tschudi, Wied-Neuwied	Cultivation and marketing. Drink: Cauí = alcohol (fermentation of pineapple)	Antioxidant (Mhatre, Tilak-Jain, De, & Devasagayam, 2009), antitumoral (Báez et al., 2007; Kulpreet, Prasad, George, & Shukla, 2009; Neetu et al., 2008), cardioprotective (Kahlon & Smith, 2007)
Cannaceae				
Canna glauca L.	Imbiri, andurinha	Spix & Martius, St.-Hilaire	Fruits	None
Caryocaraceae				
Caryocar brasiliense A. St.-Hil.	Pequi, piqui, pequizeiro	Burton, Castelnau, Langsdorff, Pohl, St.-Hilaire, Tschudi	Fruit edible raw or as a seasoning for industrial purposes; farinaceous pulp and oily	Antioxidant (Ascari, Takahashi, & Boaventura, 2010; Miranda et al., 2009; Roesler, Malta, et al., 2007)
Clusiaceae				
Garcinia gardneriana (Planch. & Triana) Zappi	Bacupari, bacopari	St.-Hilaire	Edible fruit	None
Convolvulaceae				
Convolvulus edulis Thunb.	Batata-doce	Burton, Spix & Martius, St.-Hilaire	Collective farming in the woods by the Indians	Antioxidant (Steed & Truong, 2008; Terahara et al., 2009)
Euphorbiaceae				
Manihot esculenta Crantz	Aipim, aipi, mandioca-doce, mandioca-mansa, mandioca, macaxeira	Agassiz & Agassiz, Bunbury, Burmeister, Burton, Castelnau, D'Orbigny, Freyress, Gardner, Langsdorff, Luccock, Pohl, Spix & Martius, St.-Hilaire, Wied-Neuwied	Cultivation and marketing. Consumer cooked in water or roasted over coals or under ashes. Drinks: "Cauí" or "beer" or "abatitu", alcohol (fermentation root); species of beers. Consumption as toasted flour or not: distinction of two types (coarse and fine), used to thicken broths and preparation of tapioca. Flour used as a substitute for bread (wheat). Cassava-soft distinction of "mad".	Antioxidant (Rahmat, Kumar, Fong, Endrini, & Sani, 2004; Sreeramulu & Raghunath, 2010)
Maprounea brasiliensis A. St.-Hil.	Marmeleiro-do-campo	Martius, St.-Hilaire	Use as a dye	None
Fabaceae-				
Arachis hypogaea L.	Amendoim, mandubi, mundubi, manobi	Burton, St.-Hilaire	Cultivation	Anticancer (Awad, Chan, Downie, & Fink, 2000; Huang et al., 2010), antiinflammatory (Djoko, Robin, Shee, & Liu, 2007), antioxidant (Rehman, 2003; Yen & Duh, 1995;) cardioprotective (Ghadimi, Kimiagar, Abadi, Mirzazadeh, & Harrison, 2010), weight maintenance (Mattes & Dreher, 2010)

(*continued on next page*)

Table 1 (*continued*)

Family and species	Vernacular names	Naturalists	use	Results of studies
Hymenaea spp.	Jatobá, jetahy, jatahy, jetaí, jataí-uva, jetaíba, abati-timbahy, jataí	Burton, Gardner, Langsdorff, Martius, Spix & Martius, St.-Hilaire, Tschudi	Fruits. Flour made from the seeds. Uses: raw, as a spice and for industrial purposes; deer ate the flowers.	Antiinflammatory (Jayaprakasam, Alexander-Lindo, DeWitt, & Nair, 2007; Takagi et al., 2002), antioxidant (Jayaprakasam et al., 2007)
Inga spp.	Ingá	Burton, St.-Hilaire, Wied-Neuwied	Fruits	None
Lauraceae				
Ocotea odorifera (Vell.) Rohwer	Sassafrás, canela sassafrás	Burmeister, Denis, Spix & Martius	Flavoring	None
Lecythidaceae				
Lecythis pisonis Cambess. ou *L. lurida* (Miers) S.A. Mori	Sapucaia	Agassiz & Agassiz, Burmeister, Burton, Castelnau, D'Orbigny, Spix & Martius, St.-Hilaire, Wied-Neuwied	Nuts or walnuts, consumed by Indians. Trade almonds. Drink: "beer" alcoholic beverage from fermented fruit.	None
Malpighiaceae				
Byrsonima spp.	Murici, guiné	St.-Hilaire	Fruits	Antidiabetic (Perez-Gutierrez, Ramirez, Gomez, & Bautista, 2010), antioxidant (Rufino et al., 2010)
Malvaceae				
Abutilon esculentum A. St-Hil.	Benção-de-Deus	Bunbury, St.-Hilaire	The flower buds are cooked.	None
Guazuma ulmifolia Lam.	Mutamba, mutombo, motamba, matomba	Burton, Spix & Martius, St.-Hilaire	Fruits emollient, jelly and saccharin; resin is used to refine sugar	None
Sterculia apetala (Jacq.) H. Karst.	Chichá	St.-Hilaire	seeds eaten, a pleasant taste.	None
Theobroma cacao L.	Cacaueiro, cacau	Agassiz & Agassiz, D'Orbigny, Pohl, Spix & Martius, Wied-Neuwied.	Article export to Europe	Several studies confirmed anticancer, antidiabetic, antiinflammatory, antioxidant and cardioprotective activities
Melastomataceae				
Mouriri pusa Gardn.	Pusá, puçá	Burton, Castelnau	Fruits	Antioxidant (Rufino et al., 2010)
Moraceae				
Brossimum sp.	Borulé	St.-Hilaire	Fruits	None
Myrtaceae				
Eugenia dysenterica DC.	Cagaiteira, cagaita, murta-cagaiteira	Burton, Castelnau, D'Orbigny, Spix & Martius, St.-Hilaire	Fruits	Antioxidant (Genovese et al., 2008; Roesler, Malta, et al., 2007), laxative (Lima et al., 2010)
Eugenia uniflora L.	Pitangueira, pitanga	Bunbury, D'Orbigny, St.-Hilaire, Wied-Neuwied	Raw fruits and used for making sweets	Antioxidant (Velázquez, Tournier, Buschiazzo, Saavedra, & Schinella, 2003)
Myrciaria cauliflora (Mart.) O. Berg	Jabuticaba, jabuticabeira, jaboticabeira	Burmeister, Burton, Castelnau, Gardner, Langsdorff, Luccock, Pohl, Spix & Martius, St.-Hilaire, Tschudi, Wied-Neuwied	Commerce of fruits	Antioxidant (Reynertson et al., 2006)
Pimenta pseudocaryophyllus (Gomes) Landrum	Craveiro-da-terra, falso-craveiro, cravo-da-terra	Martius, Spix & Martius	Flavoring	None
Psidium cattleyanum Sabine	Guabiroba, gabiroba	Burton, Langsdorff, Spix & Martius, St.-Hilaire, Tschudi	Flavorful fruit. Intoxicating beverages, wine and beer.	None
Psidium guajava L.	Goiabeira, guaiaba, goiaba, guava	Bunbury, Burmeister, Burton, Castelnau, D'Orbigny, Langsdorff, Pohl, Spix & Martius, St.-Hilaire, Wied-Neuwied	Fruits. Guava. Juice and jelly. Preserved. "Guava bush"	Antidiabetic (Owen, Martineau, Caves, Haddad, & Matainaho, 2008), antiglycant (Hsieh et al., 2005)
Psidium guineense Sw., *Psidium rufum* DC.	Araçá, araçazeiro	Burton, Castelnau, Langsdorff, Luccock, St.-Hilaire, Wied-Neuwied	Fruits. Drink: juice made from the root "palatable"	Antioxidant (Genovese et al., 2008; Gonçalves et al., 2010; Jimenez-Escrig, Pulido, & Saura-Calixto, 2001)
Orchidaceae				
Vanilla planifolia Andrews	Baunilha, Vaynilla	Burton, Pohl, Wied-Neuwied	Prepare the vanilla. The pods keep the smell for months, aromatic.	None
Oxalidaceae				
Oxalis cordata A. St.-Hil.; *O. hirsutissima* Mart. & Zucc.; *O. fulva* A. St.-Hil; *O. repens* Thunb.	Azedinha, frero, trevo	Martius, St.-Hilaire	Household leaves acidic	Cardioprotective (Abhilash et al., 2011)
Passifloraceae				
Passiflora spp.	Maracujá, flor-da-paixão, Maracujá-do-estralo	Bunbury, Burton, Langsdorff, Luccock, Spix & Martius, Wied-Neuwied	Use of fruits	Digestive disorders (Yapo & Koffi, 2008)
Rhamnaceae				
Ziziphus joazeiro Mart.	Juazeiro, juá	Burton, D'Orbigny, Langsdorff, Spix & Martius	Use of fruits	None
Rubiaceae				
Genipa americana L.	Genipapo, jenipapo, jenipapeiro	Burton, Castelnau, DOrbigny, Denis, Langsdorff, Pohl, Spix & Martius, St.-Hilaire, Wied-Neuwied	Use of fruits; dye. Drink: "cauí" alcoholic beverage fermented fruit	Antitumoral (Conceição, Rossi, Oliveira, Tasker, & Lafond, 2011)

Table 1 (*continued*)

Family and species	Vernacular names	Naturalists	use	Results of studies
Sapindaceae				
Allophylus edulis (A. St-Hil., Cabess. & A. Juss.) Radlk.	Fruta-de-parão	St-Hiliare	Use of fruits	Antioxidant (Schmeda-Hirschmann, Feresin, Tapia, Hilgert, & Theoduloz, 2005)
Sapindus esculentus A. St.-Hil.	Pitombeira, pitomba	Burton, St.-Hilaire	Use of fruits	None
Solanaceae				
Solanum lycocarpum A. St.-Hil.	Lobeira, fruta-do-lobo, árvore-da-batata	Burmeister, Burton, Langsdorff, St.-Hilaire, Von Tschudi	Fruit unpalatable; food of the maned wolf.	Antidiabetic (Farina, Moysés, Bazzolli, & Bissoli, 2010; Perez, Franca, Daldegan, & Duarte, 2006; Yoshikawa et al., 2007), antiinflamatory (Vieira et al., 2003)
Verbenaceae				
Lippia pseudo-thea Schauer	Camará, capitão-do-mato, chá de frade, chá-de-pedestre	Burton, Martius, St-Hilaire	Aromatic tea	None
Stachytarpheta jamaicensis (L.) Vahl	Gervão, jarbão, urgevão, orgibão	St-Hilaire	Tea	Antiinflamatory (Sulaiman et al., 2009), antioxidant (Alvarez, Leiro, Rodríguez, & Orallo, 2004), Cardioprotective (Ikewuchi, Okaraonye, & Ogbonnaya, 2009)
Violaceae				
Rinorea laevigata (Sol. ex Ging.)	Lobolobo	St.-Hilaire	Cooked leaves	None
Winteraceae				
Drymis brasiliensis Miers	Casca-d'anta	St-Hilaire	Spice	Antiinflamatory (Lago et al., 2010)

treat chronic diseases (Samir, Shalini, & Hariom, 2011). The growing interest for products derived from tropical plants (herbs, food supplements and dyes) have gained much attention in the international arena and this fact is very important for countries like Brazil, rich in biodiversity and local cultural traditions (Nepstad et al., 2009; Newman & Cragg, 2007; Nogueira, Cerqueira, & Soares, 2010). However, intensive transformations of Brazilian ecosystems since the discovery of the country in 1500 have caused severe genetic and cultural erosion of native species of Brazil. The intense miscegenation of cultures over the last centuries has also popularized the use of several exotic and imported vegetable species as remedies and foods (Brandão, Acúrcio, Montemor, & Marlière, 2006; Luna & Klein, 2010; Pilla & Amorozo, 2009). As a consequence, the original Amerindian menu was replaced by foreign alternatives, and Brazilian's eating habits today are based, almost exclusively, on species from other continents (Cascudo, 1967; Lima, 1999).

In this study, we retrieved data on Brazilian native plant food species that were used in the Brazilian Southwest State of Minas Gerais in the19th century from the bibliographies of sixteen European naturalists. The State (whose area is approximately that of France) exhibited remarkable ecological diversity because four of Brazil's six main biomes (Atlantic Forest in the east, the Cerrado in the west, Caatinga in the north, and the Araucaria Forests in the south) exist there. At that time, 45% of the territory was covered by forests and there were extensive unexplored savannas. There was also yet an interaction between the native Amerindians and the inhabitants of the agricultural areas. Consequently, hundreds of native useful plant species were available.

Sixty-seven native plant species (or genera) used as food were recorded by the naturalists, as shown in Table 1. *Manihot esculenta* (manioc, cassava) was the most frequently cited species, and its use by the Amerindians was already documented by the Portuguese, soon after the discovery of Brazil (Ferrão, 2004). In the 19th century, *M. esculenta* was planted and processed into flour, which became a very significant component (with maize, rice, beans and corn) in the food composition of the population. In 1820, there were already 130 producers of cassava in São Paulo, and it is widely cultivated today throughout the country (Luna & Klein, 2010). Other frequently mentioned species were *A. occidentalis* (cajueiro), *M. cauliflora* (jabuticaba), *A. angustifolia* (pinheiro brasileiro), *B. orellana* (urucum) and *Psidium guayava* L. (goiabeira). Besides cassava, all these plants are cultivated and widely used by the Minas Gerais's population today.

The health benefits from the recorded species were confirmed by several studies. From the 67 plants, 47 (60%) have been subjected to laboratory studies, confirming their health benefits and potential as functional food. The most studied species was *T. cacao* (cacao), known to be rich in polyphenols, which are reported to reduce the risk of carcinomas and other degenerative processes. Scavenging for reactive oxygen species is considered to be the major mechanism of the anti-mutagenic effects of polyphenols and their health benefits (Ohno et al., 2009). Another recorded species rich in polyphenols is the mate tree, *I. paraguariensis*. The leaves are rich in caffeoyl derivates, such as dicaffeoylquinic and chlorogenic acids. The French naturalist A. de Saint-Hilaire (1779–1853) was responsible for the first description of the use of mate, which infusion was used by Amerindians before the arrival of the Europeans to continent. Mate beverages are currently widely consumed as infusions in Argentina, Paraguay, Uruguay and Southern Brazil. Oral administration of mate tea in rat models of hypercholesterolemia resulted in a significant reduction in serum levels of cholesterol (30% reduction) (Oliveira et al., 2008). Beneficial effects, as antioxidative, were also observed in young women (Matsumoto et al., 2009). The results of all studies supports that the ingestion of mate tea might provide important health benefits and its use could be stimulated as functional food in other parts of Brazil and the world.

Tropical ecosystems are very rich in edible fruits and several of them were registered by the naturalists, especially by Saint-Hilaire, which he named “wild fruits” (Saint-Hilaire, 1824a, 1824b): *Sapindus esculentus* (pitomba), *Annona* spp. (araticum), *Psidium* spp. (araçá and goiaba), *Byrsonima* spp. (murici), *Spondias tuberosa* (umbu), *M. vinifera* (buriti), *H. speciosa* (mangaba), *Eugenia dysenterica* (cagaiteira), *Psidium cattleyanum* (gabiroba), *Hymenaea* spp. (jatobá) and many species of *Inga* (inga). Several species, especially from savannas (cerrado) have recently gained acceptance and technology, and some of them are marketed in Brazil in the form of juices, sweets, ice cream and candies. Studies have shown that these fruits have different bioactive substances that can act alone or together on various pathophysiological targets of chronic diseases, such as anti-diabetic, anti-obese, anti-cancer, anti-oxidant and anti-inflammatory (Table 1) (Bicas et al., 2011; Cardoso, Martino, Moreira, Ribeiro, & Sant'Ana,

2011; Clerici & Carvalho-Silva, 2011; Clerici et al., 2011; Souza, Fernandes, Alves, Freitas, & Naves, 2011; Vidigal, Minin, Carvalho, Milagres, & Gonçalves, 2011). Anti-cancer activities were observed for acetogenins from *A. crassiflora* (Vilar et al., 2008). The possibility of introducing such products in the form of nutraceuticals and food supplements could improve their use and include them in international markets (Saklani & Kutty, 2008). However, one factor that prevents the use of these species is the lack of detailed agronomic studies, which could increase productivity and contribute to its market availability.

Tropical fruits also contain higher amounts of fiber, defined as plant cell wall remnants that are resistant to hydrolysis by human alimentary enzymes, as that found in *Passiflora* fruits (Yapo & Koffi, 2008). Dietary fiber may be protective against cardiovascular diseases, diabetes, obesity, colon cancer and other diverticular diseases. Half of the species from Table 1 (47%) were used *in natura* in 19th century and to stimulate the consumption of these fruits in the original form, or transforming these pulps in integral products, may represent an alternative source of fiber, contributing to the reduction of the prevalence of those diseases. Fruits of *Eugenia dysenterica* (cagaiteira) are particularly rich in fiber and their excessive consummation has strong laxative activity. This activity is due also to the presence of a peptide and its use for the treatment of chronic constipation and irritable bowel syndrome has been evaluated (Lima et al., 2010).

Plants have been used as home remedies for the treatment of diabetes in developing countries where the cost of the conventional medicines represents a burden to the population. Five species from Table 1 have shown activities in the treatment diabetes, such as *P. guajava* (goiabeira): its extract significantly decreased blood glucose levels and the accumulation of fat droplets in liver tissues (Owen et al., 2008). The fruits of *Byrsonima crassifolia* (murici), *A. occidentalis* (caju), *I. paraguariensis* (mate) and *Solanum lycocarpum* (lobeira) also showed anti-diabetic activity (Table 1). Different classes of antidiabetic substances were identified in these species: polyphenols and flavonoids, for example, were responsible for the activity observed by *I. paraguariensis* (Matsumoto et al., 2009), *P. guajava* (Owen et al., 2008) and *T. cacao* (Balzer et al., 2008); for *A. occidentalis* and *S. lycocarpum* this activity was correlated to anacardic acids and steroidal alkaloids, respectively (Tedong et al., 2010; Yoshikawa et al., 2007). Recent research has indicated that fruits local to India, such as *Garcinia indica* Choisy, possess antidiabetic activity (Devalaraja et al., 2011) indicating the potential of the Brazilian *G. gardneriana* (bacupari) to treat this disease.

Natural colors have been used in food preparation since the ancient times. These products have raised a growing economic interest due their potential use in the food and cosmetic industries and to prohibition on the use of specific synthetic color additives. The use of the seeds of *B. orellana* as a colorant by the Amerindians was described in the earliest times of discovery of Brazil. This plant is rich in several derivatives of carotenoids, such as bixin and norbixin. Bixin is the second most natural colorant used in the food and cosmetic industry (Mercadante, Steck, & Pfander, 1997). This substance binds to protein and reduces cholesterol, triacylglycerols, and blood glucose levels (Gutierrez et al., 2011; Reddy et al., 2005). Anticancer activity was observed for carotenoids from *B. orellana* (Tibodeau et al., 2010). Spices and flavors have been also used by the Amerindians (Ferrão, 1993) and some of them such as *X. aromatica* and *X. sericea*, *Pimenta pseudocaryophyllus* and *Drimys brasiliensis* were recorded in 19th century. Despite the ancient use and commercial interest, very few studies have been done so far with these plants (Table 1).

Brazil is rich in palms that were first described by the German naturalist Karl von Martius (1794–1868) (Martius, 1853). Eleven different species of palms were found and used in Minas Gerais in the 19th century, as shown in Table 1. These species are still used as nuts or to prepare drinks and candies. Few studies have been performed to date with these plants but all of them demonstrated antioxidative activity (Barreto et al., 2009; Borges et al., 2011; Coimbra & Jorge, 2011; Finco & Silva, 2009; Ramos et al., 2007; Rosso & Mercadante, 2007; Rufino et al., 2010). Polyphenols were responsible for cardioprotective activity of *M. vinifera* (Manhães, 2007).

A study recently performed by Brazilian governmental Agencies (2008–2009) revealed that, in all geographic areas and economic classes, there was an excessive amount of sugar and processed food (high in saturated fat and sodium) in the diet and an insufficient intake of fruits and vegetables (IBGE, 2010). This result is more worrying when we consider that these changes are occurring also in areas of Amazon region, where the forest remains useful and traditional use of native species are, in part, preserved (Major, Clement, & DiTommaso, 2005; WinklerPrins & de Oliveira, 2010). Changes in eating habits have been observed throughout time and in various societies. Cavender (2006) and Moerman (1996), for example, have shown the consequences of changes occurring with the consumption of food species by the American Native Indian in last centuries. Bennett and Prance (2000) reported that 216 plants employed as medicine in northern South America are native from other continents and that 88 of these were originally introduced as food plants. In Europe, Łuczaj (2010) showed a strong variation on the use of green vegetables in Poland since the 19th century, which led the population to different eating habits. In contrast, other studies have shown the resilience of some species used by migrant populations living in Europe (Ceuterick, Vandebroek, & Pieroni, 2011; Pieroni, Muenzc, Akbulut, Can Bas, & Durmus, 2005; Pieroni & Quave, 2005). The recovery of old habits is an important strategy for promoting health but, despite the elevated number of options, few incentives for the consumption of native species is provided by the Brazilian Governmental Agencies. The Food Guide (Brasil, 2005), for example, recommends only the use of *Manihot esculenta* (cassava), *Ananas sativus* (pineapple) and the fruits of *P. guajava* (goiabeira) and *Myrtus cauliflora* (jabuticaba) as native species. The inclusion of others native food plants is necessary not only to increase the number of choices but also to promote better use of the plants.

Some species from Table 1 have little or no use today, as verified in recent bibliographies on the use of plants (Dias & Laureano, 2009; Macedo, 1992; Silva-Júnior, 2005; Silva-Júnior & Pereira, 2009). Examples are banana-do-brejo (*Calladium striatipes*), imbiri (*Canna glauca*), marmeleiro do campo (*Maprounea brasiliensis*), benção de Deus (*Abutilon sculentum*), Pusá (*Mouriri pusa*), Borulé (*Brosimum* sp.), Azedinha (*Oxalis* spp.) or fruta-de parão (*Allophylus edulis*). Vernacular names of other native food plants such as abajeru, amaitim, azamboa, guti and ubaia can also be found in historical bibliographies, but without any additional information or botanical identification. The Traditional Medicine Division of the WHO recognizes the importance of plant species used by the Amerindian for improves health, and recommends that their efficacies should be evaluated through pharmacological and toxicological studies (WHO, 2002). They also recommend the consumption of at least 400 g of fruits and vegetables on a daily basis (excluding potatoes and starchy tubers). The present study shows that several Brazilian vegetable food species have a long tradition of use that is confirmed by the historical record. However, only a few of which have been investigated in detail but all studies which have been conducted to date have in each case confirmed their health benefits. In addition, 27 species from Table 1 (39%) have not been subjected to any laboratory evaluation to verify their health potential and other effects. We argue that the plant species already used on the past in Brazil must be better considered and submitted urgently to laboratory studies for verify their potential as source of bioactive compounds. We also points to an urgent need for agronomic studies, as well as studies on their ecology and conservation.

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