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Traditional knowledge and medicinal use of *Chrysobalanus icaco* L. in the treatment of diabetes in southeastern Brazil

[Conocimiento tradicional y uso medicinal de *Chrysobalanus icaco* L. en el tratamiento de la diabetes al sureste de Brasil]

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Abstract: *Chrysobalanus icaco* L., "bajiru", occurs in the Brazilian coastal plain. Its fruits and leaves have been consumed by artisanal fishing communities. Therefore, this study aims to: investigate the ethnobotanical knowledge about the bajiru in the restingas, in Rio de Janeiro (Brazil); compare this knowledge with its potential registered in the literature; and expand the information related to the pharmacological potential for diabetes. The results showed that "bajiru" is still used in local medicine for the treatment of diabetes. Bibliographic studies show its effects on glucose metabolism. However, there is urgent concern about the conservation and maintenance of "bajiru" populations, the conservation plans for this species and the promotion of cultivation. Local experts highlighted their concern about the threat to this resource due to the loss of native vegetation and the predatory extraction of its native populations.

Keywords: Ethnomedicine; Artisanal fishermen; Atlantic Forest; Conservation; Diabetes

Resumen: *Chrysobalanus icaco* L., "bajiru", ocurre en la llanura costera brasileña. Sus frutos y hojas han sido consumidos por comunidades pesqueras artesanales. Por lo tanto, este estudio tiene como objetivos: investigar el conocimiento etnobotánico sobre el bajiru en las restingas, en Río de Janeiro (Brasil); comparar este conocimiento con su potencial registrado en la literatura; y ampliar la información relacionada con el potencial farmacológico para la diabetes. Los resultados mostraron que el "bajiru" sigue siendo usado en la medicina local para el tratamiento de la diabetes. Estudios bibliográficos muestran sus efectos sobre el metabolismo de la glucosa. Sin embargo, existe una preocupación urgente sobre la conservación y mantenimiento de las poblaciones de "bajiru", los planes de conservación de esta especie y el fomento del cultivo. Los expertos locales destacaron su preocupación por la amenaza sobre este recurso por la pérdida de vegetación nativa y la extracción depredadora de sus poblaciones nativas.

Palabras clave: Etnomedicina; Pescadores artesanales; Bosque Atlántico; Conservación; Diabetes

INTRODUCTION

Chrysobalanus icaco L. (Chrysobalanaceae) is a native but not endemic shrub species from Brazil and grows from Florida's tropical coast (United States of America, USA) to Southeast Brazil in the coastal vegetation as well as in northern South America, Central America, Mexico, and the west coast of Africa (Prance, 1972; Smith *et al*., 2004). In Brazil, it is known as "abajirú, abajurú, ajuru, abajerú, bajerú, bajirú, and guajurú" (Prance, 1972; Fonseca-Kruel & Peixoto, 2004; Coelho-Ferreira, 2009), especially in the restingas, sandy coastal plains of quaternary origin situated between the Atlantic Ocean and tropical rainforest (Marques *et al*., 2010). For the last two decades, this vegetation has been suffering strong anthropic pressures, which have led to the loss of large areas of native vegetation (Rocha *et al*., 2007) and local knowledge related to plant and cultural diversity. Although *C. icaco* is not yet on the List of Endangered Species of Flora of Brazil (JBRJ, 2024), it occurs in the Atlantic Forest biome in restinga areas (an environment associated with this biome), a biodiversity hotspot and one of the most endangered species in Brazil, with only 12.4% of its original area (Myers, 2000; SOS Mata Atlântica, 2018). In these areas, there is still local knowledge, such as that of artisanal fishermen, about the current and past use of ripe fruits of *C. icaco*, widely consumed by them *in natura*, as well as their use of the leaves to make anti-diabetic infusions (Fonseca-Kruel & Peixoto, 2004; Coelho-Ferreira, 2009; Carneiro *et al*., 2010; Lopes & Lobão, 2013).

A history of diabetes treatment is strongly related to natural products. The first-choice drug for diabetes mellitus Type 2 (DMT2) treatment is metformin; a biguanide derived from guanidine isolated from *Galega officinalis* L. (Bailey, 2017). In this context, medicinal plants can offer a potential source of alternative therapies for diabetes, especially when based on the traditional knowledge associated with species.

It is noteworthy that branches of this plant are still extracted in large quantities to be extensively marketed in fairs and markets in Rio de Janeiro (Silva & Peixoto, 2009). However, even though this species occurs along a large part of the long Brazilian coast (about 7,000 km), very few studies details ethnobotanical uses of *C. icaco* (Fonseca-Kruel & Peixoto, 2004; Lopes & Lobão, 2013). The fruits of *C. icaco* are rich in minerals such as chromium, selenium, calcium, and iron (Aguiar *et al*., 2011), and its leaves that are used in traditional medicine in Brazil have hypoglycemic properties (Presta & Pereira, 1987; Presta *et al*., 2007; Vargas *et al*., 2010; Paracampo *et al*., 2017; Paracampo *et al*., 2020). Some reports suggest its use in treating leukorrhea, bleeding, chronic diarrhea (Corrêa, 1984; Paulo *et al*., 2000), antimicrobial activity (Fernandes *et al*., 2003), and the leaf triterpenes' antitumor activity in leukemia cell lines (Fernandes *et al*., 2003). The fruits studied by Venancio *et al*. (2012), exhibited antioxidant activity in rats and reducing inflammation and DNA damage (Venancio, 2018). Two diterpenes were isolated from the roots of *C. icaco* collected in Central Africa, one of which showed *in vitro* inhibitory action on HIV-1 infected cells (Gustafson *et al*., 1991). In addition, proteomic characterization of the aqueous extract of *C. icaco* leaves confirmed the presence of enzymes involved in the glucose metabolic pathway (Pedrete *et al*., 2019).

In this context, this study aims to investigate the current ethnobotanical knowledge about "bajiru" in communities of artisanal fishermen on the Rio de Janeiro coast and to compare these with information from pharmacological studies that indicate this plant as antidiabetic. Our main aim was to investigate the relationship between the use of bajiru and diabetes treatment in Brazil. These results should be useful for conservation and sustainable management plans, demonstrating the importance of recognizing and valuing local knowledge in areas where this species occurs. Here, we report the results of a case study of the ethnobotanical knowledge of "bajiru" in a community of artisanal fishermen in southeastern Brazil.

MATERIALS AND METHODS

This study was conducted in Arraial do Cabo municipality (22°57′58″ and 42°01′40″), with a community of artisanal fishermen living in the vicinity of RM, on the southeast coast of Brazil. Restinga vegetation (sandy coastal plains of quaternary origin) is predominant in this area and is associated with the Atlantic Forest biome (Marques *et al*., 2015). This area has some climatic peculiarities, such as a rainfall rate of less than 900 mm per year, an average annual temperature of 24°C, and strong winds from the northeast quadrant (Coe *et al*., 2007; Araujo *et al*., 2009).

Artisanal fishermen have lived in this area for

over 150 years and have descended from European settlers, especially Portuguese and indigenous people (Britto, 1999). Until 1950, Arraial do Cabo was a small fishermen's village whose social identity and economic livelihoods were based on fishing (Prado, 2002). This area has been recognized for "trawl fishing." The Arraial do Cabo Marine Extractive Reserve (RESEX-Mar) is part of the recent environmental protection area of the State of Rio de Janeiro, Parque Estadual da Costa do Sol (responsibility of the State Environmental Institute–INEA, State Decree No. 42.929 of April 18, 2011). There are currently 1,600 artisanal fishermen families associated with RESEX-Mar, distributed in the fishing territories along with the RM and near the Araruama Lagoon (Barreto *et al*., 2015), whose predominant vegetation is restinga.

Ethnobotanical data collection

This study followed the International Society of Ethnobiology Code of Ethics (ISE Code 2006), and the research was supported by the signature and consent of the fishermen involved. The data analyzed here refer to the database of the project "Ethnobotany in the Center of Plant Diversity of Cabo Frio, Rio de Janeiro, Brazil," with data collected from artisanal fishers, from 2000 to 2011, currently registered with the larger Project: "Restinga de Massambaba: Vegetation, Flora, Propagation and Uses" in the National System of Genetic Heritage Management and Associated Traditional Knowledge (SISGEN) (no. A6B205D). Previous authorizations for botanical material collection and for access to traditional knowledge in Brazil are the National Council of Genetic Heritage (CGEN – No. 02000.01698/2006-18) and the Institute of State Environment (INEA - Nº 021/2010).

Ethnobotanical information was collected using the snowball technique (Bayley, 1994), seeking artisanal fishermen (residents for more than 20 years or born in the area) who had local knowledge about the use of plants. After this process, the selected collaborators actively participated in individual and semi-structured interviews sought to ask questions about the local use of "bajiru," current or past, as well as the parts used, perceptions related to the species, and the location of native populations of the species in the RM. Individually, free walks were carried out with specialists in the restinga vegetation to locate plant populations and collect botanical material that testified to local knowledge. The botanical material was then identified and deposited in the herbarium of the Botanical Garden of Rio de Janeiro (RB).

***Literature review of "bajiru"* (*Chrysobalanus icaco* L.)**

We searched Google Scholar, Science Direct, the CAPES database of theses and dissertations (CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, in English: Coordination for the Improvement of Higher Education Personnel; database of theses and dissertations in Brazil), PubMed, and Web of Science databases for the period between 2000 and 2020 (two decades). The queries used were: *Chrysobalanus icaco* AND diabetes, *Chrysobalanus icaco* AND ethnobotany, *Chrysobalanus icaco*, and ethnobotany AND diabetes (in both Portuguese and English). Information was sought on the ethnobotanical uses, contemporary uses, chemistry, and pharmacology of "bajiru" (*Chrysobalanus icaco* L.), aiming to carry out a search of the literature associated with these keywords and for articles on pharmacology supporting its traditional use as an antidiabetic.

A survey of botanical samples deposited in the herbarium of the Instituto de Pesquisas Jardim Botânico do Rio de Janeiro (RB) was conducted to obtain information on the occurrence of this species and its collection density in Brazil.

RESULTS

Ethnobotanical data

Interviews were conducted with 42 specialists and all the artisanal fishermen. Of these, 32 specialists recognized "bajiru" as an important resource of local traditional medicine, of past and present use, and they were unanimous about the importance of "bajiru" in the local treatment of diabetes. These specialists informed us that diabetes was a common disease in the region, especially until the construction of roads and access to medical resources in the municipality of Arraial do Cabo. They indicated that until 1960/70, this area was an arm of land in the sea, and a small artisanal fishing village was more isolated than other coastal cities. Thus, marriages took place between families of local fishermen, and the frequency of diabetes in the families of local fishermen was related by the following transcribed information: "...a*lmost*

every family has diabetes ... every other week, take a piece of bajiru leaf and cook it... and take it three times a day'.

Regarding the used part of "bajiru," the interviewees informed that the leaves are used in an decoction (the leaves are boiled and then the infusion is ingested) to treat diabetes. They often consumed plum-like "bajiru" fruits in natura when walking along with the restinga vegetation. They emphasized that there is no defined period for collecting leaves, as it is possible to collect them throughout the year, and the fruits are also available almost year-round. However, the current concern shown in the interviews (also unanimous) was related to the loss of vegetation due to the destruction of native vegetation in real estate projects. Some of those interviewed told us specific details about some native populations of the species that have suffered from predatory extraction once it became known that the leaves are sold in markets and fairs in the state of Rio de Janeiro.

***Literature review of "bajiru" (Chrysobalanus icaco* L.)**

Regarding the quantitative analysis of the literature on "bajiru," ethnobotany, and diabetes, the results were significantly different among the databases (Table No. 1), with the most effective combination "*Chrysobalanus icaco*" + "diabetes," showing more results than the others. Above all, what stands out is that among so many results, only three works directly address the antidiabetic evaluation of "bajiru," all demonstrating its effectiveness as an antidiabetic by different mechanisms. This highlights the need for more studies on this species since several ethnobotanical studies point to its use, but few pharmacological analyses support its use, emphasizing the lack of clinical studies.

According to the review of the most relevant studies on the traditional uses related to bajiru, in different regions and countries, the information also indicated that the fruits are the plant useful part associated with human food (consumed *in natura*), and the leaves for use medicinal, especially in the treatment of diabetes (Table No. 2).

Table No. 1
Quantitative results of the search of combined keywords in all databases consulted

Keywords / Database	Google Scholar	Science Direct	CAPES database	Pubmed	Web of Science
"*Chrysobalanus icaco*" + "diabetes"	405	15	30	4	6
"*Chrysobalanus icaco*" + "ethnobotany"	224	5	9	0	2
"*Chrysobalanus icaco*" + "*etnobotânica*"	128	1	9	0	0
"*Chrysobalanus icaco*" + "ethnobotany" + "diabetes"	110	2	3	0	0
"*Chrysobalanus icaco*" + "*etnobotânica*" + "diabetes"	54	1	3	0	0

Table No. 2
Vernacular names, traditional uses of *Chrysobalanus icaco* L. according to geographic localization

Vernacular names	Country	Location	Uses	References
	Colômbia	Palmarito, Cartagena	Fuel, construction	Mendoza *et al*., 2018
	Nigéria	Abia State	Food	Keswet & Abia, 2015
Abajeru	Brazil	Coastal regions	Food	Sousa, 1987
Abajeru	Nigeria	Lagos State	Food	Harrison, 2019
Ajiru	Brazil	Pará	Food	Rosa *et al*., 2007

Ajiru	Brazil	Ilha de Maiandeua, Pará	Food	Coelho-Ferreira & Jardim, 2005
Ajiru, ajiru-roxo, ajuru	Brazil	Pará	Food, medicinal	Carneiro *et al*., 2010
Ajuru, ajiru, ajuru-branco, cajuru, icaco, maçãzinha-da-praia	Brazil	Município de Maracanã, Pará	Medicinal	Jardim *et al*., 2005
Apuru	French Guiana	Coastal regions	Food, medicinal	Corrêa, 1984
Bajirú	Brazil	Arraial do Cabo, Rio de Janeiro, RJ	Food, medicinal	Fonseca-Kruel & Peixoto, 2004
Bihu, tawa	Nicarágua	Oriental Nicarágua	Food, medicinal	Coe & Anderson, 1996
Biup	Nicarágua	Rama settlements	Food, medicinal	Coe, 2008
Guaieru, guajeru	Brazil	-	Food	Albuquerque & Medeiros, 2014
Guajará	Brazil	Caripi; Marajó	Food	Bates, 1979
Guajiru	Brazil	Pernambuco	Food, medicinal	Silva & Andrade, 2005
Guajiru	Brazil	Ceará	Food, medicinal	Pinto *et al*., 2019
Guajiru	Brazil	Área de Proteção Ambiental de Tambaba, Paraíba	-	Brito et al., 2017
Guajirú	Brazil	Delta do Parnaíba	Food	Lemos & Pinho, 2020
Guajuru, abajeru, ajuru, apioba, goajuru, guabiru, ouajeru, guajuri, uajuru	Brazil	Coastal regions	Food, medicinal	Corrêa, 1984
Guajuru	Brazil	Município de Irituia, Pará	Food	Moraes *et al*., 2022
Guajuru	México	-	Food, medicinal	Corrêa, 1984
Hicaco	Haiti	Coastal regions	Food, medicinal	Von Martius, 1939

Iaco, guajerú, oajurú	Brazil	Coastal regions	Food	Hoehne, 1946
Icaco, guajerú	Brazil	-	Food, medicinal	Von Martius, 1939
Icaco	Colômbia	-	Food	Duke, 1970
Icaco	Cuba	-	Food, medicinal, ritualistic	Betancourt, 2011
Ipecak	Trindade and Tobago	-	Medicinal	Lans, 2006
Jicaco	México	Vera Cruz	Food	Moreno-Casasola & Paradowska, 2009
Jicaco, xicaco	México	Coastal regions	Food, medicinal	Corrêa, 1984
Jingimo, n'gmo	Angola	-	Food, medicinal	Corrêa, 1984
N'peudo, Ouaraye	Senegal	-	Food, medicinal	Corrêa, 1984
Uagiru	Brazil	Maranhão	Food	D`Abbeville, 2008
Uichup	Panamá	-	Food	Duke, 1975

As for the databases, Google Scholar stood out in the total number of results; however, it should be considered that its search is broader than the other databases. However, it is possible to better understand the relevance of the relationship between such data through this numerical analysis, mainly referring to research involving "bajiru" in association with diabetes.

Phytochemistry

Many compounds have been isolated from *C. icaco*. The main chemical components include in the leaves are flavonoids, phenolics acids (Barbosa *et al*., 2006; Castilho & Kaplan, 2011; da Silva *et al*. 2013; Venancio *et al*., 2016; White et al., 2016a; Bastos *et al*., 2017; Paracampo *et al*., 2017) and triterpenes (Fernandes *et al*., 2003; Vargas *et al*. 2010; Castilho & Kaplan, 2011; Ribeiro *et al*., 2020), whereas and in the fruits anthocyanins (Brito *et al*., 2007; Venancio *et al*., 2016; Venancio *et al*., 2017), phenolic acids and flavonoids (Venancio et al., 2016) have been described. A recent review on the chemistry and pharmacology of *C. icaco* (Onilude *et al*., 2021) describes the chemical profile of the species and its antidiabetic activity. However, the compounds account responsible for this activity are still under investigation, as well as their mechanisms of action.

Botanical samples collected from C. icaco in Brazil and deposited in collections

In a survey of botanical records of this species in Brazil, we found 119 botanical samples, with the most representative collections coming from the coast of Rio de Janeiro, followed in descending order by Bahia, Pará, and Espírito Santo (Figure No. 1). From this survey, it was possible to note the large range of vernacular names recorded on these samples: "abajeru, abajirú, abajuru, agiru, ajeru, ajiri, ajiru, bajurú, bajiru, guagiru, guajerú, guajiru-da-praia, guarú, guairu, and guarú".

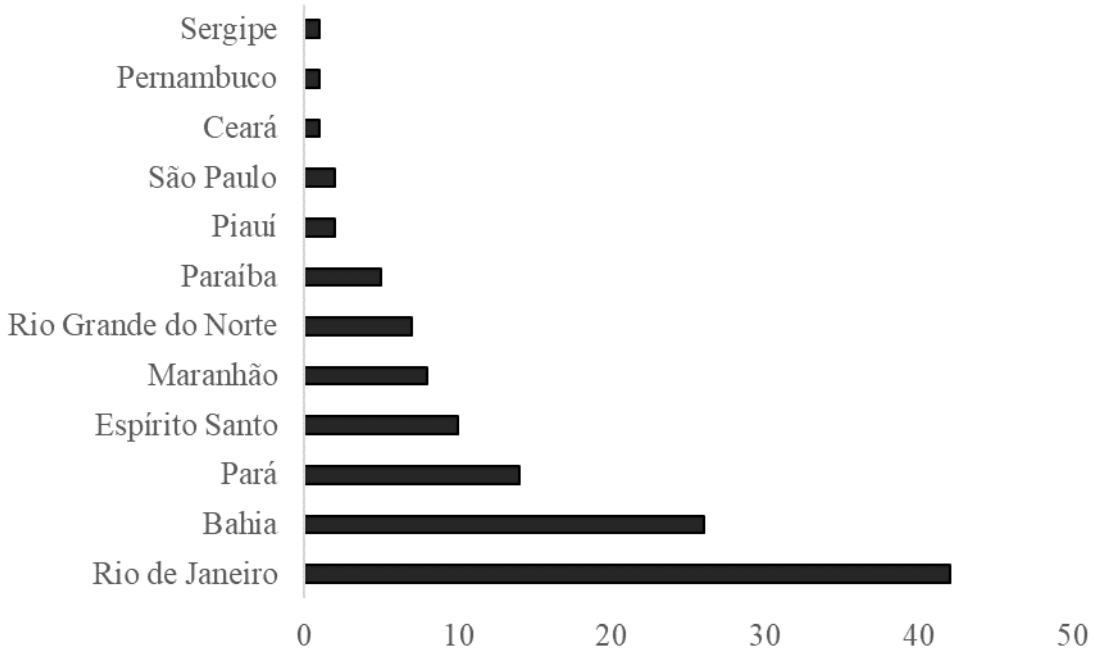

Figure No. 1
Number of samples (n=119) collected from *Chrysobalanus icaco* L. in Brazil and deposited in the Herbarium of the Botanical Garden of Rio de Janeiro (RB)

DISCUSSION

Different authors have studied restinga vegetation, with some studies on the potential of plant resources for this type of vegetation, such as Fonseca-Kruel & Peixoto (2004) on the coast of Rio de Janeiro (with fishermen from Arraial do Cabo) and Miranda & Hanazaki (2008) on the coast of São Paulo, with fishermen from Ilha do Cardoso.

Coastal vegetation in Brazil has been described for hundreds of years, with emphasis on the potential of its plant's resources, such as the potential of *C. icaco*, described in one of the oldest treatises on Brazilian food, the "Descriptive Treaty of Brazil de 1587" where described:

"***Abajeru is a tree like a carrasco, natural from where the sea spray arrives, so these trees only grow along the beaches, whose leaves are rough, and bear a small white flower. The fruit is of the same name as the shape and size of the plums here and is purple in color; it is eaten like plums but has a larger pit; the taste is sweet and tasty***" (Soares de Sousa, 1987).

In the same way, there are other naturalists from the 16th and 19th centuries who described this species and its food potential by comparing the color, texture, and flavor of the plum. D'Abbeville, in an original report from 1614, described the history of the Mission of the Capuchin Fathers on the Island of Maranhão and the surrounding lands, and highlighted the "uagiru", as a species that grows on the shores of beaches, and with fruit, the size of a large plum, red, edible, and pleasant on the palate (D'Abbeville, 2008). In 1863, Bates described on his journey between Caripi and Marajó the numerous thickets of "guajará", a shrub that produces a grape-like fruit (*C. icaco*) found on the sandy banks of rivers (Bates, 1979). Martius, in the 19th century, in the publication *Specimen Materiae medicae Vegetabilis Brasiliensis*, highlighted that *C. icaco* was one of the important wild, medicinal and useful plants in Brazil, whose indigenous Tupi name was 'guajerú' (von Martius 1939). Years later, Pio Correa, in 1909, corroborated this same information about the medicinal and food potential and described details of 'guajuru' whose root, bark, leaves and flowers are astringent, indicated against chronic diarrhea, gonorrhea, leucorrhea; and the fruit which is not only used by the people throughout its vast habitat, but the plant is also

cultivated; white-fleshed fruit , sweet and astringent, edible raw and its best use consists of making sweets, with an industry that has reached value, reaching the island of Cuba to export; in Mexico, fruits are common in coastal markets with famous "guajurú" sweet (Corrêa 1984). We emphasize that a classic publication by Pio Corrêa, *C. icaco* was already a species with potential use both in Brazil and in different areas of the Caribbean and coast of Africa, with description of historical and similar uses between these regions (Corrêa 1984).

However, this study emphasizes the importance of traditional local knowledge of restinga vegetation and the importance of gathering this information for use in biodiversity conservation actions. “Bajiru” in the RM is a potential medicinal resource and especially associated with a therapeutic target of worldwide relevance - diabetes. This result was also highlighted in studies carried out with fishing communities on the Brazilian coast, such as in Pará and Rio de Janeiro (Fonseca-Kruel & Peixoto, 2004; Coelho-Ferreira, 2009; Carneiro, 2010), as well as in studies on markets in the RJ (Silva & Peixoto, 2009) which point out the importance of “bajiru” in the treatment and management of diabetes. It is interesting to note that studies on the potential of this species are related to locations where they are abundant on the Brazilian coast, according to our survey of vouchers in the RB. Diabetes mellitus (DM) is a complex multifactorial disease characterized by increased blood glucose levels. This disorder affects more than 400 million people worldwide and has been identified as a cause of premature death (WHO, 2024). According to the IDF (2019), it is estimated that around 463 million people worldwide have diabetes. In this estimate, Brazil ranked fifth among the countries with the highest number of diabetics, with 16.8 million diagnosed and a projection of more than 20.3 million diagnosed by 2045 (IDF, 2019). In the state of Rio de Janeiro, the prevalence was 10.4% in the population aged 18 years and older (VigitelBrasil, 2021). Some antidiabetic mechanisms have been reported for plant metabolites in the literature, such as the alteration of glucose metabolism, hypolipidemic effects, pancreatic effects, and antioxidative effects, or they are directly associated with the treatment of diabetes complications and insulin-like effects (Chan *et al*., 2012; Saad *et al*., 2017; Shanak *et al*., 2019).

The antidiabetic activity associated with “bajiru” consumption has been studied. The results have shown that administration of large doses of the aqueous extract reduced fasting blood glucose similarly to metformin, accompanied by a reduction in body weight gain (Barbosa *et al*., 2013). Additionally, aqueous extract of “bajiru” leaves in lower concentrations can prevent fat storage or enhance fat utilization through the increase of locomotor activity, which reinforces its ability to maintain glucose homeostasis through the normalization of insulin sensitivity and glucose tolerance despite the high-fat diet intake (White *et al*., 2016b). A recent review on the chemistry and pharmacology of this plant species (Onilude *et al*., 2021) reveals that despite the importance of this medicinal plant, only two studies directly investigated the antidiabetic activity of *C. icaco* (Barbosa *et al*., 2013; Nayak *et al*., 2011), one of which reported the hypoglycemic activity of the fruit extract (Nayak *et al*., 2011), while other studies dealt with the anti-obesity effects of the plant extract (White *et al*., 2016a; White *et al*., 2016b; Portela de Sá *et al*., 2020), which can also have an impact on diabetes treatment since overweight and obesity are conditions known to increase the likelihood of diabetes (Najm & Lie, 2010). One study evaluated the acute and repeated dose 28-day oral toxicity of aqueous *Chrysobalanus icaco* leaf extract. Oral single-dose administration (2000 mg/kg) was considered to have low toxicity according to the class method recommended by the Organization for Economic Co-operation and Development (OECD), fitting into class 5 (LD_{50} greater than 2000 mg/kg), since no deaths or signs of toxicity were registered (Ribeiro *et al*., 2020). However, studies of repeated-dose toxicity (28 days) showed a reduction in the bodyweight of treated animals and an increase in hepatic enzymes alanine aminotransferase (ALT) and aspartate aminotransferase (AST), which led the authors to recommend that the population take care when using this species, especially for prolonged periods (Ribeiro *et al*., 2020).

The well-documented pharmacological potential of “bajiru” as an antidiabetic medicinal plant contrasts with the lack of studies on “bajiru” cultivation and management, associated with the risk of loss of areas in which the species grows naturally. It is not an ideal situation regarding conservation and availability for future use. This study showed that 100% of “bajiru” used citations refer to its medicinal

use for diabetes, which demonstrates the importance of such a plant for local communities as a form of treatment. Therefore, in addition to the risk to "bajiru" conservation, there is a risk of loss of traditional medicinal use by the populations of restinga areas. Since 1970/80, RM has been suffering from the rapid loss of vegetation cover over the years, especially due to the strong pressure of unsustainable tourism and real estate speculation (Rocha *et al*., 2007). This has changed, causing environmental and social collapse due to the loss of part of the vegetation cover and social/cultural activities. Such vegetation still has great potential for use by groups of humans living in its vicinity, especially as observed in the present study and others related to current health and food resources (Fonseca-Kruel & Peixoto, 2004; Santos *et al*., 2009, Fonseca-Kruel, 2011).

There was no direct relationship of this plant as a source of financial resource for the local population, as it is harvested only for different local uses, such as artisanal, fishing traps, and medicine, which does not result in a decrease in its diversity (Oliveira & Hanazaki, 2011). However, such activities have been carried out by people from other municipalities of Rio de Janeiro, who extract the leaves to sell in markets (e.g., Mercadão de Madureira) of the metropolitan region of Rio de Janeiro (Silva & Peixoto, 2009). Silva & Peixoto (2009), showed the additional problem of incorrect identification of *C. icaco*, which is sometimes substituted by leaves of other species, such as *Eugenia rotundifolia* Casar (currently named *E. astringens*) sold as "bajiru." This may result in difficulties related to the environmental monitoring of restinga resources since *E. astringens* has a wider distribution in RJ state and lower enforcement pressure.

CONCLUSIONS

In summary, this study shows the great potential for broader studies associating the traditional knowledge of "bajiru" medicinal use, cultivation, and management, as well as the importance of the conservation of the areas in which it occurs, to ensure its preservation as a potential source of broader medicinal use against diabetes. Should the use of "bajiru" increase commercially, greater plans for the conservation and possible cultivation of this species will be needed.

Popularly known by similar names, "bajiru, bajuru, abajeru, and ajiru", *C. icaco* is a valuable botanical source due to the use of its fruits as readily available food, especially its leaves in traditional medicine, as observed by the Arraial do Cabo artisanal fishermen, who use them to treat diabetes. Several scientific studies corroborate and validate the importance of bajiru as a hypoglycemic plant, and they also highlight other interesting bioactivities.

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