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Medicinal plants and diabetes: An ethnopharmacological study in Brazilian Northeast

[Plantas medicinales y diabetes: un estudio etnofarmacológico en el noreste brasileño]

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Abstract: Despite access to conventional medical therapies, the use of complementary medicine is increasing in many communities. The present study aimed to evaluate the popular knowledge of medicinal plants used to treat diabetes and its co-morbidities, in four rural communities in the municipality of Vitória de Santo Antão, in the Brazilian State of Pernambuco. The relative importance of a particular medicinal plant was calculated based on the percentage of mentions (IR%). The similarity between the communities was quantified using the Sørensen index (Ss). Interviews were conducted with 141 patients, of these, 83 reported use of medicinal plants as an alternative treatment. Overall there were 186 mentions, covering 61 ethnospecies. In relation to IR%, *Mentha* × *villosa* presented the highest value. Knowing the factors that influence selection of medicinal plants sheds light on the mechanisms through which patterns of use develop and this may help to preserve this knowledge.

Keywords: Ethnopharmacology; Medicinal plants; Relative importance; Knowledge popular; Diabetes.

Resumen: A pesar del acceso a las terapias médicas convencionales, el uso de la medicina complementaria está aumentando en muchas comunidades. El presente estudio tuvo como objetivo evaluar el conocimiento popular de las plantas medicinales utilizadas para el tratamiento de la diabetes y sus comorbilidades, en cuatro comunidades rurales del municipio de Vitória de Santo Antão, en el estado brasileño de Pernambuco. La importancia relativa de una planta medicinal en particular se calculó en base al porcentaje de menciones (% de IR). La similitud entre las comunidades se cuantificó mediante el índice de Sørensen (Ss). Se realizaron entrevistas con 141 pacientes, de estos, 83 informaron el uso de plantas medicinales como tratamiento alternativo. En total hubo 186 menciones, cubriendo 61 etnoespecies. En relación al% de RI, Mentha × villosa presentó el valor más alto. Conocer los factores que influyen en la selección de plantas medicinales arroja luz sobre los mecanismos a través de los cuales se desarrollan los patrones de uso y esto puede ayudar a preservar este conocimiento.

Palabras clave: Etnofarmacología; Plantas medicinales; Importancia relativa; Conocimiento popular; Diabetes.

INTRODUCTION

Diabetes is a pathological condition caused by changes in metabolism and characterized by fasting hyperglycemia (Taika *et al*., 2018).

According to data from the International Diabetes Federation (IDF), it was estimated, in 2000, that 151 million adults were living with diabetes. By 2009, this figure had risen to 285 million. Recently, it was calculated that there has been a 9.3% increase in the numbers of adults aged between 20 and 79 years afflicted by this condition, to around 463 million individuals. This increase has been occasioned by intensive urbanization and the growth of a sedentary lifestyle and means that there is an urgent need for strategies to combat these growing trends (Cho *et al*., 2018).

The drug treatment adopted depends on the type of diabetes. For type 1 diabetes, insulin has always been necessary, since the discovery of the disease (Pinto & Oliveira, 2006; Oliveira *et al*., 2017a). Treatment for type 2 diabetes begins with diagnosis of the disease and involves recommendations regarding changes in lifestyle and prescription of an oral hypoglycemic drug, based on the patient's specific needs (Inzucchi *et al.*, 2012; Oliveira *et al*., 2017a).

Patients with diabetes and their caregivers often seek out alternative methods for controlling the disease that involve medicinal herbs, in the belief that these are less likely to produce side-effects than synthetic drugs (Surya *et al*., 2014; Kamau *et al*., 2016; Bhagour *et al*., 2016). Various studies have shown that secondary metabolites present in some plant species may facilitate the regenerative capacity of pancreatic β cells, the secretion of insulin and the process of insulin resistance (Bhagour *et al*., 2016).

One of the goals of ethnobotany is to conduct investigation into patterns of plant use by various communities around the world and into the reason certain species are chosen (Medeiros & Albuquerque, 2015). These patterns may occur for two reasons: diffusion and convergence. Diffusion of use of a particular plant comes from the process of transmission of knowledge regarding medicinal plants by way of teaching, imitation, and other forms of learning (Soldati, 2013; Medeiros & Albuquerque, 2015). In convergence, on the other hand, distinct communities use the same plants without any transfer of information between them having occurred (Medeiros & Albuquerque, 2015).

People do not select plants for use and incorporate them into their local pharmacopeia in a random manner. One of the most important features determining the choice of medicinal plant repertoire used by a community is the environment; the characteristics of each locality determine the species selected for use (Alencar *et al*., 2010).

Apart from the environment, other selection criteria may explain choices relating to the use of medicinal herbs, including effectiveness of treatment, availability, and organoleptic characteristics (Bennet & Husby, 2008).

It is thus important to examine all aspects that affect the health of those who use medicinal plants as an alternative and to explore the extent to which these are suitable for treatment of diabetes, thereby enabling evaluation of the ethnopharmacological knowledge of a cultural group in relation to the available flora (Leduc *et al*., 2006). These, along with other aspects, can be used to guide the provision of the most appropriate health services for each population.

The present study aimed to evaluate the popular knowledge of medicinal plants used to treat diabetes and its co-morbidities, in rural communities in the municipality of Vitória de Santo Antão, in the Brazilian State of Pernambuco, with a view to understanding how different communities in the same ecosystem build up their local pharmacopeia.

MATERIAL AND METHODS

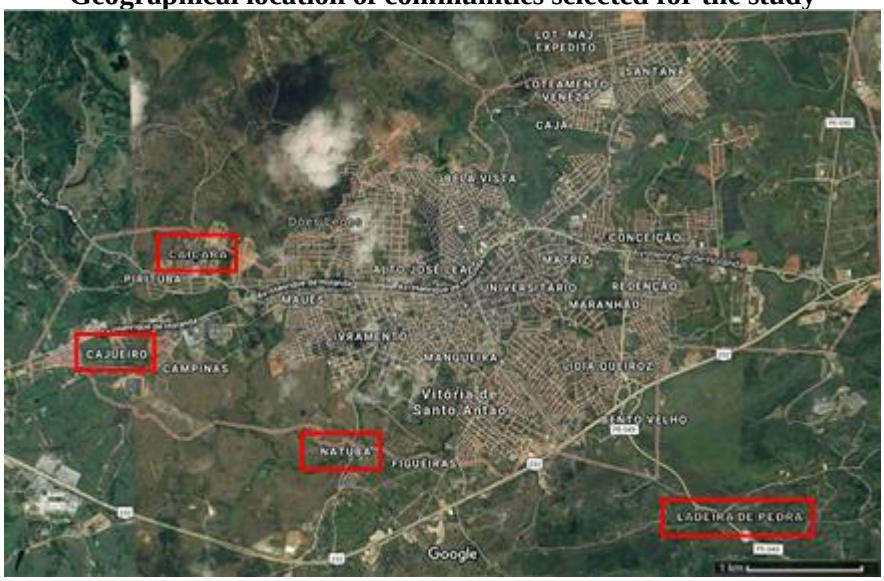
Study Area

The study was carried out in the rural zone of the municipality of Vitória de Santo Antão, located in the State of Pernambuco, which forms part of the Mata Pernambucana state mesoregion. The municipality lies 45 km west of the State capital, Recife, and has a predominantly tropical climate with preponderantly sub-perennial forest type vegetation, and patches of hypoxerophilic forest. Four communities with different demographic characteristics were selected from the rural parts of the municipality (Figure No. 1).

The Caiçara community covers a number of areas, including the main village, underprivileged housing developments and outlying farms. Because of the last of these, it is considered to be a rural community, even though, at 3.8 km to West of Vitória de Santo Antão town center, it is not that far from the main urban area. The community has a population of 1600 mostly low-income residents. Although there is one elementary school in the community, access to school is also facilitated by public school transport. The reach of the basic health

unit is restricted to the central parts of the community. Patients who live further afield, on ranches or farms, receive regular visits from health officers. As a result, some members of the community use medicinal plants as an alternative to conventional healthcare. The community health unit has a wall panel explaining the use of herbal medicines and an outreach project involving nutrition and physical exercise run by students from the Federal University of Pernambuco's Academic Center in Vitória.

Figure No. 1
Geographical location of communities selected for the study



Source: Google Maps Brazil (2018)

Situated 3.9 km southwest of the urban center of the municipality, Natuba is a typical rural community, with around 990 inhabitants, many of whom work on farms, because the area produces large quantities of fruit and vegetables. The community is well-organized politically, with a Natuba Small-Scale Farmers Association. This civil society organization has many accomplishments to its name, including gaining ownership of the land the farmers work, and bringing electricity and agricultural tools to the area (Barbosa Neto & Silva, 2012). It is the main supplier of vegetables for the warehouses of the State Food Supply Company – CEASA-Recife and its farms are watered by the hydrographic basin of the River Natuba (Brandão, 2013). The local basic health unit is well within reach of the population and health services are available at all hours. The village also has an elementary school accessible to local residents.

Cajueiro is a more urban community with around 2000 inhabitants. It is situated 4.8 km to the west of the town center, and covers the village, where there is a Basic Health Unit and a school, and easy access to public and private transport to schools in other parts of the municipality. The community's farms and ranches are located near the Pitú Bottling Plant, an alcoholic beverages factory which has a great impact on the economy of the city. Its population includes ex-farmers, with ample knowledge of the local flora, and is accustomed to discussion of the use of alternative medicine for the control of chronic diseases such as diabetes and hypertension, owing to the large numbers of university students involved in outreach projects at the local health center. The Health Unit holds weekly clinics and runs various events to raise awareness of healthcare issues.

Ladeira de Pedras has characteristics that differ somewhat from the other communities. The central part of the community lies 4.3 km east of the town center and has a mixed population, comprising a village near the PE-45 highway and more outlying farmlands, in addition to a settlement of landless rural workers. In view of this, there are no official data on the exact number of inhabitants in the community. The more remote residences lack access to health units or other healthcare facilities, as the roads are treacherous and may be impassable during the rainy

season. Subsistence, rather than commercial, farming is the main economic activity in the region. The health center serving this community is further away than that of the other communities, because of the vast extent of the territory, and is staffed by a Cuban physician from the More Doctors Program, who, in addition to providing conventional treatment, encourages the population to use herbal medicine. By way of contact with the culture of farmers arriving from other regions, the population has a considerable range of plant species for the treatment of various ailments.

These communities were selected on the basis of the distance between them and from the town center, the characteristics of each community, and ease of access.

Ethnopharmacological Data Collection and Legal Issues

The present study was approved by the Research Ethics Committee (CEP) of the Federal University of Pernambuco (number 2.006.671). The only criteria for including patients in the study were diagnosis of diabetes confirmed by the health clinic and age over 18 years. Each person involved in the research was asked to sign a Term of Free and Informed Consent (TCLE) regarding collection, use and publication of data.

First, a socioeconomic survey was conducted with the City Hall and the Department of Health to establish the number of patients with diabetes, as a way of determining the sample size. Prior to the interviews, the health center in each locality was visited to make the acquaintance of the nurses and community agents who work there and to obtain information on each community.

The semi-structured questionnaire used for the interviews was divided into parts, beginning with socioeconomic data and moving on to the patient's understanding of the disease, issues related to medical treatment, diet, and physical activity, and, finally, the use of alternative herbal remedies. The free list method (Albuquerque *et al*., 2010) was used to obtain data on whether a plant is recommended for treatment of diabetes or its complications, the part of the plant used, the manner of preparation, frequency of use, and, how knowledge of the species was acquired.

The interviews were accompanied by community workers who helped provide access to respondents, providing addresses and making interviewees feel more at ease and willing to talk about their disease and how they are treating it.

According to data provided by the municipal Department of Health, prior to the interviews (March 2017), 286 diabetic patients were registered in the e-SUS AB (diabetes and hypertension register) and being followed up by all the Basic Health Units in the municipality. Of these patients, 87 lived in the rural zone. In the communities covered by the present study, seven of those registered were in Natuba, eight in Ladeira de Pedras, 22 in Cajueiro and 11 in Caiçara. However, when data collection began, it was observed that the true situation in the communities diverged somewhat from the information registered. The field research therefore provided more accurate data than the official statistics because it enjoyed the support both of Community Health Workers and the local population, making it possible to reach a larger number of patients.

Data collection was carried out between March 2017 and May 2018 and involved interviews with 141 patients, 30 in Natuba, 20 in Ladeira de Pedra, 39 in Cajueiro and 52 in Caiçara, all with a confirmed diagnosis of diabetes and residing within the area covered by the local health centers. The interviews were conducted in the mornings, owing to the working hours of the community health workers and were carried out in all the areas covered by the communities' Basic Health Units.

Collection of Plant Material

During and after the interviews, botanical material was collected, labeled and stored in plastic bags for subsequent drying. Samples were collected primarily from plants kept in back yards or found near the residences of members of the community. For purposes of authorization and study, samples were registered on SisGen (the National System for the Management of Genetic Heritage and Associated Traditional Knowledge).

Samples were identified by the Pernambuco Institute of Agronomy (IPA), and the Professor Vasconcelos Herbarium, Federal Rural University of Pernambuco (PEUFR), and the Professor Geraldo Mariz Herbarium, Federal University of Pernambuco (UFP), although, in the case of some species, it was not possible to generate the registration number, owing to the lack of flowers or because they were purchased on the market by local people. In these cases, therefore, the scientific names presented were based on surveys in ethnobotanical or botanical studies, comparing the specimen with pictures in *Flora do Brasil* or in books, with the help of

specialists.

Data Analysis

The socioeconomic data were used to produce descriptive statistics and percentages on Microsoft Excel 2017 spreadsheets.

All species were classified as native or exotic, taking into consideration their origin and the phytogeographical domain of the species according to the List of Plant Species of Brazil inventory (Flora do Brasil, 2018). These classifications were used to establish whether the species selected were native or exotic and whether there were differences between communities.

The relative importance was calculated based on the percentage of mentions (IR%). This is an adapted version of the index proposed by Bennett & Prance (2000). Calculation of relative importance (IR) bore in mind the versatility of species, which may be used to treat various medical conditions relating to various body systems (Silva *et al*., 2008). However, this index provided no information on the degree of consensus among informants regarding the species. For this reason, a plant may have a high relative importance, even though it is cited by only one informant (Albuquerque, 2006) and the IR for the species was therefore adapted by multiplying it by the percentage of informants that mentioned it. This adjustment accounted for the fact that medicinal species of plant that are more widely shared are more promising candidates for bioprospecting studies.

The similarity between the communities was quantified using the Sørensen index (Ss), which can be used for both quantitative and qualitative comparison and is calculated using the following formula: $Ss = 2a/(2a + b + c)$, where "a" is the number of species found in community 1, "b" the number of species in community 2; and "c" the number of species common to both (Software Mata Nativa, 2018). Scores range from 0 to 1, with 1 representing the maximum similarity.

RESULTS

Socio-economic Data

Interviews were conducted with 141 patients with a confirmed diagnosis of diabetes and resident in the territory covered by the health centers of the four communities. Of these, 83 reported use of medicinal plants as an alternative treatment. The mean age of patients was 61.1 years (18-92 years) and most were women (77.3%) with a mean age of 59.6 years (31-92). The mean age for men was 66.5 years (18-92).

The level of schooling of most of those interviewed was elementary school unfinished (49.6%), followed by illiterate (33.3%). Only one individual had completed higher education.

The occupations most frequently cited by respondents were housewife (55%), farm worker (27.6%) and retired (19.2%).

It was not possible collect reliable information on economic status, since most respondents declined to report their monthly income.

Ethnobotanical Survey

Overall there were 186 mentions, covering 61 ethnospecies, belonging to 59 genera and 42 families of plants. Table 1 presents the common-or-garden names, the parts used, the forms of use, recommendations, place of origin, habit, and percentage Relative Importance (IR%) for species mentioned by members of the rural communities in the municipality of Vitória de Santo Antão-PE.

Table No. 1

A. Medicinal plants known or used in rural communities in the municipality of Vitória de Santo Antão - PE, for diabetes related purposes, with the respective characteristics, common-or-garden names, and B. recommendations and percentage Relative Importance (IR%)

Table No. 1A

Specie/ Family (Voucher)	Popular name	Parts used	Forms of use	Recommendations
Abelmoschus esculentos (L.) Moench/Malvaceae (IPA93828)	Quiabo	Fruit	Maceration	Lowering glucose; control of diabetes
Adiantum spp./Pteridaceae (-)	Avenca	Leaves	Decoction	Control of diabetes
Aechmea sp./Bromeliaceae (-)	Gravatá	Leaves	Maceration	Lowering glucose
Allium cepa L./ Alliaceae (-)	Cebola	Fruit	In natura	Control of diabetes

Aloe sp./Liliaceae (-)	Babosa	Leaves	In natura	Lowering glucose; control of diabetes
Anacardium occidentale L./ Anacardeaceae (IPA90585)	Caju	Fruit	In natura	Control of diabetes
Annona muricata L. Annonaceae (-)	Graviola	Leaves	Decoction	Control of diabetes
Baccharis trimera (Less.) DC./ Asteraceae (-)	Carqueja	Leaves	Infusion	Lowering glucose, control of diabetes
Bambusa vulgaris Schard. Ex. J.C. Wendl/ Bambusoideae (-)	Bambu	Bark	Decoction	Lowering glucose
Bauhinia cf. *monandra* Kurz/Leg. Caes. (IPA93827)	Pata de vaca	Leaves	Decoction, maceration, infusion	Lowering glucose, control of diabetes
Bowdichia virgilioides Kunth/ Fabaceae (-)	Sucupira	Bark	Decoction	Control of diabetes
Camellia sinensis (L.) Kuntze/ Theaceae (-)	Chá verde ou chá preto	Leaves	Infusion	Lowering glucose; feeling poorly
Cassia occidentalis L./ Caesalpinaseae (49615PEUFR)	Manjiroba	Pods	Decoction	Lowering glucose
Cinnamonum sp./Laureaceae (-)	Canela	Bark	Decoction, infusion	Lowering glucose, control of diabetes, feeling poorly
Cissus sicyoides L./Vitaceae (-)	Insulina	Leaves	Decoction, infusion, microwave	Lowering glucose, control of diabetes
Citrus sp./Rutaceae (-)	Limão	Fruit	In natura	Control of diabetes
Maranta divaricata Roscoe/ Marantaceae (-)	Cana de macaco	Leaves	Maceration	Control of diabetes
Coutarea hexandra (Jacq.) K. Schum./Rubiaceae (-)	Quina quina	Bark	Decoction	Control of diabetes
Crescentia cujete L./Bignoneaceae (-)	Coité	Leaves	Infusion	Control of diabetes, inflammation
Cymbopogon citratus (DC.) Stapf/ Poaceae (-)	Capim santo	Leaves	Infusion, decoction	'Nerves', difficulty sleeping, control of diabetes, lowering glucose, feeling poorly
Cynara scolymus L./Asteraceae (-)	Alcachofra	Leaves	Decoction	Control of diabetes, lowering glucose
Daphnopsis brasiliensis Mart./ Thymelaeacea (-)	Embira	Bark	Maceration	Control of diabetes
Didymopanax morototonii (Aubl.) Dcne. et Planch./Araliaceae (-)	Sambaquim	Bark	Infusion	Control of diabetes
Dysphania ambrosioides (L.) Mosyakin & Clemants/ Amaranthaceae (IPA93829)	Mastruz	Leaves	Inhalation	Headache
Egletes viscosa (L.) Less./ Asteraceae (-)	Marcela	Seeds	Decoction, infusion	Lowering glucose, control of diabetes
Eugenia uniflora L./Myrtaceae (IPA93832)	Pitanga	Bark seams	Maceration	Control of diabetes
Genipa americana L./Rubeacea (-)	Jenipapo	Fruit	In natura	Control of diabetes

Handroanthus impetiginosus impetiginosa (Mart. ex DC.)/ Bignoniaceae (UFP17536)	Pau d'arco roxo	Bark seams	Decoction	Control of diabetes
Illicium verum Hook f./ Magnoliaceae (-)	Anil estrelado	Flower	Infusion	Lowering glucose
Leonotis nepetifolia (L.) R. Br./ Lamiaceae (-)	Cordão de São Francisco	Fruit	Decoction	Control of diabetes
Lippia alba (Mill.) N.E.Br./ Verbenaceae (IPA93831)	Erva cidreira	Leaves	Decoction, infusion	Control of diabetes, 'nerves', feeling poorly
Machaerium hirtum (Vell) Stellfeld/ Fabaceae (-)	Chifre de bode	Bark, bark seams	Decoction	Control of diabetes
Malpighia emarginata DC/ Malpighiaceae (IPA93835)	Acerola	Fruit	Juice	Lowering glucose
Maranta divaricata Roscoe/ Zinziberaceae (-)	Cana de macaco	Leaves	Maceration	Control of diabetes
Matricaria chamomilla L./Astearaceae (-)	Camomila	Leaves	Infusion	'Nerves'
Cf. *Mentha* × *villosa* Huds. (-)	Hortelã miúda	Leaves	Decoction, infusion	Control of diabetes, lowering glucose, stomach problems, dizziness, a tingling sensation, feeling poorly, headache, 'nerves'
Momordica charantia L./ Curcubitaceae (IPA93825)	Melão de São Caetano	Leaves	Decoction, infusion	Lowering glucose
Morinda citrifolia L./Rubiceae (IPA93824)	Noni	Fruit	Juice	Lowering glucose, control of diabetes
Morus nigra L./Moraceae (IPA93822)	Amora	Fruit	Decoction, infusion	Control of diabetes, lowering glucose, excessive sweating
Musa spp./ Musaceae (-)	Banana verde	Fruit	In natura	Lowering glucose
Passiflora edulis Sims/ Passifloraceae (-)	Maracujá	Fruit, fruit peel	In natura, infusion	Lowering glucose, control of diabetes
Peperomia pellucida(L.) Kunth/ Piperaceae (-)	Língua de sapo	Leaves	Decoction, infusion	Lowering glucose, control of diabetes
Pimpinella anisium L./Apiaceae (-)	Erva doce	Leaves	Infusion	'Nerves'
Platycyamus regnellii (Benth)./ Fabaceae (-)	Pau pereira	Bark	Decoction	Lowering glucose
Plectranthus amboinicus (Lour.) Spreg./Lamiaceae (IPA93830)	Hortelã grande	Leaves	Infusion, decoction	Lowering glucose, headache, 'nerves'
Plectranthus barbatus Andrews/ Lamiaceae (IPA93827)	Boldo	Leaves	Infusion	Abdominal discomfort
Plectranthus barbatus Andrews/ Lamiaceae (IPA93827)	Sete dores	Leaves	Infusion	Control of diabetes
Psidium sp./Myrtaceae (-)	Araçá	Leaves	Infusion	Control of diabetes
Punica granatum L./Punicaceae (-)	Romã	Bark	Decoction	Lowering glucose
Quassia amara L./Simaraibaceae (-)	Pau tenente	Bark seams	Infusion	Lowering glucose
Rosmarinus officinalis L./Lamiaceae (-)	Alecrim	Leaves	Infusion, decoction	Lowering glucose, control of diabetes

Salvia officinalis L./Lamiaceae (-)	Salvia	Leaves	Decoction	Control of diabetes
Sambucus sp./Caprifoleaceae (-)	Sabugo	Leaves	Infusion	Lowering glucose
Solanum aethiopicum Radd./ Solanaceae (-)	Jiló	Fruit	In natura	Control of diabetes
Solanum melongena L./Solanaceae (-)	Berinjela	Fruit	Maceration, in natura	Lowering glucose, control of diabetes
Solanum paniculatum L./Solanaceae (IPA93834)	Jurubeba	Fruit	Maceration	Lowering glucose
Syagrus romanzoffiana/Arecaceae (-)	Coquinho amarelo	Fruit	Decoction	Lowering glucose
Syzygium jambolanum DC./ Myrtacea (-)	Azeitona roxa	Leave, bark, bark seams, fruit	Decoction, infusion, juice, in natura	Lowering glucose, control of diabetes
Tamarindus sp./Malvaceae (-)	Tamarindo	Fruit, bark, bark seams	Decoction, infusion, juice	Lowering glucose, control of diabetes
Turnera subulata Sm./Turneraceae (IPA93833)	Chanana	Flower	Infusion	Lowering glucose

Table No. 1B

Specie	Origin	Habit	General	Nat	Cai	Caj	Lad
Abelmoschus esculentos (L.) Moench	E	Her	0,013	-	0,02	-	0,03
Adiantum spp.	NI	Her	0,002	0,007	-	-	-
Aechmea sp.	NI	Her	0,002	0,007	-	-	-
Allium cepa L.	E	Her	0,002	0,007	-	-	-
Aloe sp.	N	Her	0,005	0,009	-	-	0,01
Anacardium occidentale L.	N	Arb	0,002	-	0,008	-	-
Annona muricata L.	E	Arb	0,004	0,01	-	-	-
Baccharis trimera (Less.) DC.	N	Shb	0,005	0,009	0,01	-	-
Bambusa vulgaris Schard. Ex. J.C. Wendl	E	Arb	0,002	0,007	-	-	-
Bauhinia cf. *monandra* Kurz	NI	Arb	0,03	0,009	0,03	0,02	-
Bowdichia virgilioides Kunth	N	Arb	0,002	-	-	-	0,008
Camellia sinensis (L.) Kuntze	E	Her	0,008	0,01	-	-	0,01
Cassia occidentalis L.	N	Shb	0,002	-	-	-	0,008
Cinnamonum sp.	N	Arb	0,01	-	0,03	0,01	-
Cissus sicyoides L.	N	Cre	0,03	0,009	0,03	0,08	0,03
Citrus sp.	E	Arb	0,002	0,007	-	-	-
Maranta divaricata Roscoe	N	Her	0,002	-	-	0,009	-
Coutarea hexandra (Jacq.) K. Schum.	N	Arb	0,006	-	-	0,01	0,008
Crescentia cujete L.	E	Arb	0,008	-	-	-	0,03
Cymbopogon citratus (DC.) Stapf	E	Her	0,14	0,05	0,11	0,03	0,05
Cynara scolymus L.	E	Her	0,008	0,01	-	0,01	-
Daphnopsis brasiliensis Mart.	N	Arb	0,002	0,007	-	-	-
Didymopanax morototonii (Aubl.) Dcne. et Planch.	N	Arb	0,002	-	-	-	0,008
Dysphania ambrosioides (L.) Mosyakin & Clemants	E	Her	0,002	-	-	0,009	-
Egletes viscosa (L.) Less.	N	Her	0,005	-	-	0,01	0,01
Eugenia uniflora L.	N	Shb	0,002	-	0,008	-	-

Genipa americana L.	N	Shb	0,002	-	0,008	-	-
Handroanthus impetiginosus (Mart. ex DC)	N	Arb	0,002	0,007	-	-	-
Illicium verum Hook f.	E	Her	0,002	-	0,008	-	-
Leonotis nepetifolia (L.) R. Br.	E	Shb	0,002	-	-	-	0,008
Lippia alba (Mill.) N.E.Br.	N	Her	0,03	0,04	0,04	0,05	-
Machaerium hirtum (Vell) Stellfeld	N	Arb	0,006	0,02	-	-	-
Malpighia emarginata DC	N	Arb	0,002	-	-	-	0,008
Maranta divaricata Roscoe	N	Her	0,002	-	-	0,009	-
Matricaria chamomilla L.	E	Her	0,002	0,007	-	-	-
Cf. *Mentha* × *villosa* Huds.	E	Her	0,14	0,03	0,39	0,14	-
Momordica charantia L.	E	Her	0,004	-	-	0,009	0,008
Morinda citrifolia L.	E	Arb	0,016	0,01	0,02	-	0,02
Morus nigra L.	NI	Arb	0,03	0,03	0,05	-	0,04
Musa spp.	NI	Her	0,004	0,007	-	-	0,008
Passiflora edulis Sims	N	Cre	0,005	-	0,01	-	0,01
Peperomia pellucida(L.) Kunth	N	Her	0,005	0,02	-	-	-
Pimpinella anisium L.	E	Her	0,002	0,007	-	-	-
Platycyamus regnellii (Benth).	N	Arv	0,002	-	-	0,009	-
Plectranthus amboinicus (Lour.) Spreg.	E	Her	0,02	0,01	0,02	0,04	0,02
Plectranthus barbatus Andrews	E	Her	0,002	0,007	-	-	-
Plectranthus barbatus Andrews	E	Her	0,002	-	-	-	0,008
Psidium sp.	NI	Arb	0,002	-	-	-	0,008
Punica granatum L.	E	Arb	0,002	-	-	0,009	-
Quassia amara L.	E	Arb	0,002	-	-	-	0,008
Rosmarinus officinalis L.	E	Her	0,005	0,009	0,01	-	-
Salvia officinalis L.	E	Her	0,002	-	-	-	0,008
Sambucus sp.	NI	Arb	0,002	-	-	0,009	-
Solanum aethiopicum Radd.	E	Shb	0,005	0,02	-	-	-
Solanum melongena L.	E	Her	0,013	0,04	-	-	-
Solanum paniculatum L.	N	Shb	0,002	-	-	-	0,008
Syagrus romanzoffiana	N	Her	0,002	-	-	-	0,008
Syzygium jambolanum DC.	E	Arb	0,10	0,08	0,05	0,13	0,16
Tamarindus sp.	NI	Arb	0,013	0,009	0,02	0,09	-
Turnera subulata Sm.	E	Her	0,002	0,007	-	-	-

Most individuals (60.2%) grew the medicinal plant they used on the premises of their own residence or had access to it on very nearby land. Some acquired it from third parties, be they neighbors or relatives living in other locations. Only 23.1% of those interviewed reported purchasing the plant material, the local open market being the main source.

Leaves, bark, bark seams, fruit, flowers, pods and seeds were all cited as parts used to prepare home remedies, with leaves being the part most commonly used (58%), followed by fruit (18.2%) and bark (12%).

Most respondents reported using the plant fresh (60.7%), 41.3% in a decoction and 36.5% in an infusion, these being the two methods of preparation most frequently reported.

The plant was reported as having been recommended for treatment of disease by neighbors or friends in 46.7% of those interviewed.

The plants were cited as being used to treat both diabetes and symptoms that they related to the disease, with the following being mentioned: control of diabetes, lowering glucose, ‘nerves’, excessive sweating, feeling poorly, abdominal discomfort, stomach problems, headache, inflammation,

dizziness, a tingling sensation, and difficulty sleeping. These recommendations were divided up by body system to calculate the Relative Importance (IR%).

It should be pointed out that, in the view of the population under study, the plants directly related to treatment of diabetes fell into two subclasses: 1) those recommended for "lowering glucose", after measurement with a glucometer or in laboratory tests revealed high blood sugar levels, the species most commonly cited for this purpose being *Syzygium jambolaum, Cissus sicyoides, Plectranthus ambroinicus, Morinda citrifolia* and *Morus nigra*; and 2) those recommended for "controlling diabetes", used when those interviewees experienced symptoms they understood to be related to the disease, such as fatigue, headache or numbness in the legs. The most common species cited in this context were *Syzygium jambolaum*, *Cissus sicyoides, Bauhinia* cf. *monandra*, *Morus nigra* and *Solanum melongena*.

Mentions involving control of diabetes included those citing use of the plant as a tranquilizer, since individuals under stress or suffering from 'nerves' may exhibit blood sugar level irregularities. The species most commonly mentioned in this context were *Cymbopogon citratus* (lemongrass) and *Lippia alba* (citronella).

Symptoms described by the local population as 'feeling poorly' included nausea and vomiting, with *L. alba* being the species most commonly cited in this regard. Other symptoms mentioned were excessive sweating, which may appear not to be related to diabetes, but is a consequence of diabetic neuropathy that affects most patients with type 2 diabetes. *Morus nigra* (mulberry) was the only species cited in this regard.

In relation to the desired effect of using medicinal plants, most (85.4%) mentioned feeling better after use. Few of those interviewed mentioned any adverse effects (8.4%), as Table No. 2 shows.

Table No. 2
Adverse effects of medicinal plants used to treat diabetes as observed by patients interviewed

Medicinal Plant	Adverse Effects
Star anise *(Illicium verum*) Cinnamon (Cinnamonum sp.)	Dry mouth and feeling unwell
Mulberry (Morus sp.)	Weakness in legs and tachycardia Blurred vision, dizziness and fainting
Camomile (*Egletes viscosa*)	Stomach pains
Tamarind (Tamarindus sp.) Possum grape (*Cissus sicyoides*)	Feeling unwell

Similarities between Communities

Only four ethnospecies were mentioned in all communities. These were: *Syzygium jambolaum* (Java plum); *Cymbopogon citratus* (lemongrass); *Plectranthus amboinicus* (mint) and *Cissus sicyoides* (possum grape).

Of the 30 respondents in the Natuba community, 20 mentioned use of medicinal plants for treatment and 32 ethnospecies were cited. The species with the highest IR% were *Syzygium jambolaum (0.08)* and *Cymbopogon citratus* (0.05) (Table No. 3).

In the Caiçara community, 52 individuals with diabetes volunteered to be interviewed. Of these only 24 reported use of plant species to help control diabetes, resulting in 19 ehtnospecies. *Mentha* × *villosa* (0.39) had the highest IR%.

In Cajueiro, 23 of the 39 individuals interviewed mentioned use of plants, citing 18 different ethnospecies in total, with *Mentha* × *villosa* (0.14) having the highest IR%, followed by *Syzygium jambolaum* (0.13).

In the Ladeira de Pedra community, 16 of the 20 individuals interviewed mentioned using medicinal plants to treat diabetes and its symptoms, citing 26 ethnospecies, with Syzygium jambolaum being the species with the highest IR%.

Evaluation of the similarity of composition of species between the areas studied was carried out using Sørensen's qualitative index, which is based on the absence or presence of species, with a similarity above 0.5 considered high (Camargo, 1999). The figures are shown in Table No. 3. The greatest similarity was found between the Cajueiro and Caiçara communities, these communities being those that presented the lowest mean number of mentions.

Table No. 3
Similarity between communities in the rural zone of the municipality of Vitória de Santo Antão –PE, Brazil, 2018, regarding knowledge of medicinal plants related to diabetes

Sørensen Index (S_s)					
Nat/ Cai	**Nat/ Caj**	**Nat/ Lad**	**Cai/ Caj**	**Cai/ Lad**	**Caj/ Lad**
0.47	0.36	0.31	0.48	0.31	0.27

Nat = Natuba; Cai = Caiçara; Caj = Cajueiro; Lad = Ladeira de Pedra.

DISCUSSION

The problem of under-reporting of ailments and diseases is a common one in all countries and studies show that this is caused by the everyday routine of patient care units, where record keeping is often considered a purely bureaucratic or unnecessary procedure by health professionals (Melo *et al.*, 2018). Registration and follow-up of people with diabetes was carried out, until 2013, using the Basic Care Arterial Hypertension and Diabetes Mellitus Management System (HiperDia) and thereafter e-SUS Basic Care (e-SUS AB). However, despite the growing availability of information systems for storage of national-level data, there is still no consistent mark-up system to enable the records of different systems to be conflated, which would greatly facilitate the updating of information (Abreu *et al*., 2017).

This made it difficult to plan our study and establish the sample size. We thus suggest that data gathering in Brazil take into consideration field observations, so as to build up a significantly large group, in view of the problem of under-reporting of the disease and official data not reflecting the true situation in communities. It was thus difficult to establish a number of interviewees appropriate to the reality of each region.

The greater percentage of female patients was also found in other studies and has been attributed to a variety of causes. The first is the actual predisposition of women to develop the disease. Rossaneis *et al*. (2016) also found a larger number of women with diabetes than men. The female population is more greatly predisposed to development of the disease owing to alterations in hormones caused, principally, by the menopause, and the accumulation of abdominal fat, which is one of the main factors determining development of the disease. A similar prevalence has been observed in previous studies, such as that of Freitas & Garcia (2012), in which the prevalence of diabetes among women was higher in all regions of Brazil.

Cotta *et al*. (2009), in a study carried out at Basic Health Units in the municipality of Teixeira, also found a larger number of women afflicted with diabetes, and the pattern is repeated in research by Batista *et al*. (2005) in the city of Belo Horizonte. This fact may also be related to women being more concerned with their own health and the greater accessibility to health services that this group enjoys, which is related to the larger number of programs targeting women compared to those targeting men.

Another factor noted by the community workers who accompanied the research is the low adherence of men to treatment and follow-up, leading to a scarcity of data on these patients. Corroborating this, the literature suggests that younger people and men are less likely to adhere to treatment for non-communicable chronic diseases (Krousel-Wood *et al*., 2009; Girotto *et al*., 2013).

The results regarding the parts of the plant used concurred with those of other ethnobotanical studies, which show that the leaves are mostly used for preparations, since these are easy to pick and help to identify the species, and their harvesting does not damage the plant, as harvesting of bark or roots tends to (Asase *et al*., 2005; Alves *et al*., 2008; Adeniyi *et al*., 2018).

Recommendations usually came from neighbors or friends, as the transmission of culture in the communities studied is heterogeneous and can be both horizontal and oblique. According to Soldati *et al*. (2015), the nature and frequency of transmission of knowledge are determined by environmental factors. Variable environments tend to encourage less conservative and more propagative forms of transmission than vertical transmission.

The lowest similarity value found was between the Cajueiro and Ladeira de Pedra communities, which are the furthest apart geographically. There are also different factors influencing these groups. Cajueiro has many

academics and health professionals working in the community, passing on more information and this increases the tendency to use certain kinds of medication. Ladeira de Pedra, apart from characteristics typical of a rural area, is also influenced by the diverse group of "landless rural workers", which means that there are people from all over Pernambuco looking for land to farm to feed their families.

Migrant groups tend to try to adapt their medical system to the plant species available in the new environment or develop strategies for obtaining the plants that they we were accustomed to use in their place of origin, by growing or gathering it, when the species occurs in both environments, or by importing it (Medeiros *et al*., 2012).

The greatest degree of similarity was between the Caiçara and Cajueiro communities, which are those with most similar territories and the closest both to each other and to the main urban center, leading to fewer ethnospecies being cited or used.

According to Vandebroek *et al*. (2004), social factors greatly affect the choice of species. For example, proximity to urban centers has a negative influence, because there is a greater supply of conventional medicine competing with local herbs, causing knowledge among the population to be forgotten or lost and dwindling use of such resources.

It was also observed that exotic species were used more in all the communities. This may be because of facility of access to the urban center and the cultural diversity of all the locations studied, which are influenced by the coming and going of residents, who bring different cultural and medical knowledge and building up each community's own pharmacopeia.

According to studies by Alencar *et al*. (2010), rural communities have a strong relationship with the natural resources existing locally, but exotic species from contact with other cultures are constantly being included in the medicinal repertoire of traditional communities. These exotic plants do not compete with local ones, but provide a more diverse range of treatments (Albuquerque, 2006).

Apart from this contact with diverse cultures, the widespread nature of diabetes facilitates the dissemination of knowledge of plants that can be used for treatment, thereby increasing the range of species deemed to be exotic that can be used by the population of each region.

CONCLUSION

Understanding of the biocultural mechanisms that drive plant use behavior involves various aspects relating to the environment in which each social group resides. Despite sharing the same biome, the communities studied were not similar in terms of the plant resources used to treat diabetes in traditional medicine. Various characteristics and the cultural diversity of the communities produce this variety of plants used to build up the pharmacopeia of each locality. Therefore, knowing the factors that influence selection of medicinal plants sheds light on the mechanisms through which patterns of use develop and this may help to preserve this knowledge and maintain the pharmacopeia of each community.

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