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Use of the medicinal plant *Bauhinia forficata* Link. by carriers of type 2 diabetes mellitus: A study in the Brazilian amazon

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This study utilized a quantitative approach and obtained results from 33 questionnaires and ten (10) semi structured interviews of people with diabetes. The results obtained were as follows: Participants used hypoglycemic plant species (cow's paw, carqueja and eucalyptus) in the form of an infusion, mostly once a day; a large percentage of participants believed that some plant species have the ability to aid in reducing blood glucose. The collected data were analyzed using a Microsoft Excel 2007 worksheet and were summarized by descriptive statistical methods. Despite the small number of users of these plants, this study is valid; therefore, it adds information about the use of these plants in the control of diabetes. In addition, it is essential that health professionals know about the use of these plants, so that they can inform the public about the most commonly used preparations and the risks they may have in order for the use to provide the desired health benefits. The data demonstrated the use and efficacy of this medicinal plant for the treatment of type 2 diabetes mellitus. The results contribute information for ethnopharmacological screenings and the research direction regarding the use of medicinal plants for the treatment of type 2 diabetes mellitus.

Key words: Diabetes mellitus, phytotherapy, *Bauhinia forficata*, public health, Brazilian Amazon.

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disease with a global presence that occurs as a result of multiple factors; as a chronic condition, DM can cause unfavorable impacts on the quality of life of the individuals affected on families and on society (Ministry of health, Brazil, 2013). DM is a public health problem that affects 5.6% of the Brazilian adult population, and, to a large extent, DM is not diagnosed before its chronic manifestations have been established (Ministry of health, Brazil, 2013). According to the World Health Organization (WHO, 2011), it is one of the leading causes of mortality worldwide. DM occurs when insulin, a glucose-regulating

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hormone, is not produced or secreted correctly by the pancreas, not allowing the body to use it effectively.

Among individuals over 60 years old in developed and developing countries, such as Brazil, chronic noncommunicable diseases (NCDs), including diabetes, are one of the main causes of morbidity and mortality. These pathologies usually manifest more markedly in older individuals in the population and are closely associated with the loss of quality of life and autonomy. The chronic diseases not transmissible (DCNTs) with higher incidence and prevalence among this segment of the population are diseases of the circulatory system, diabetes, cancer and chronic respiratory diseases (Ministry of the Environment, Brazil, 2011).

Despite advances in science and medicine, many people with diabetes resort to natural treatments, mainly medicinal plants. The consumption of natural products is an important aspect of treatment because knowledge about them is common and cultural; therefore, these plants often represent the only therapeutic resource in many communities that have difficulty enjoying the benefits of modern medicine due to high cost, which is often associated with difficult access to the drugs that are the basis of their therapies (Ministry of the Environment, Brazil, 2016).

Brazil has the greatest biological diversity in the world and has rich flora, which arouses the interests of international scientific communities for the study, conservation and rational use of these resources. In the Brazilian Amazon, there are several tropical plants that provide raw material for the production of analgesics, tranquillizers, diuretics, laxatives, hypoglycemics, antibiotics, among others (Zaccaron et al., 2014). The use of medicinal plants is also valued by communities in several regions of Brazil (Amorozo, 2002; Ferreira et al., 2014; Cavalcante and Silva, 2014; Vásquez et al., 2014; Mendieta et al., 2015). This activity is associated with the richness of its sociobiodiversity since the country has the greatest genetic diversity of plants in the world, with more than 43,000 known species (Ministry of the Environment, Brazil, 2016), as well as sociocultural diversity derived from the colonial period (Carvalho et al., 2010).

Phytotherapy in Brazil appears to be a new health strategy, acting in a complementary way in the treatment of diabetes. At the time of diagnosis of type 2 diabetes mellitus (DM2), in addition to encouraging changes in lifestyle (health education, diet and physical activity), the doctor usually prescribes an oral antidiabetic agent. The choice of this drug is based on insulin resistance (RI) mechanisms, progressive β-cell failure, multiple metabolic disorders (dysglycemia, dyslipidemia and vascular inflammation) and micro- and macrovascular complications that accompany the natural history of DM2. Medicinal agents available for diabetes therapy include insulin, oral hypoglycemic agents (mainly biguanides and sulfonylureas), metiglinides, α-glycosidase inhibitors, glitazones, gliptins (DPP-4 inhibitors), mimetics, GLP-1 analogs, and SGLT2 inhibitors (Brazilian Diabetes Directives, 2017).

Phytotherapy is considered a medicine complementary useful in the treatment of various pathologies, including DM2. In this country, due to its geographical location and climatic diversity, It has a huge variety of natural resources that have been exploited since ancient times for the treatment of certain diseases, knowledge that has become widespread and perpetuated until today contributing to this type of Therapy is widely used in the population (Toloza-Zambrano et al., 2015).

Several plant species have been cited in the literature as adjuvants in the treatment of diabetes mellitus, acting both in the treatment of the disease itself and in the attenuation of its symptoms and possible consequences. Studies have been developed with the purpose of proving the effect of commonly used plant species only on the basis of empirical data (Cecílio et al., 2008).

The effects of the plant species that are the focus of the considerations of this manuscript have already been scientifically proven through clinical studies of the Medicines Center of the Ministry of Health in Brazil in 2011. The Fabaceae family member *Bauhinia forficata* Link of the *Bauhinia* genus, has proven hypoglycemic effects and is being used in various parts of the world to treat various diseases, mainly diabetes. The proven hypoglycemic activity of this plant is associated with the presence of the flavonoid kaempferitrin. This study cites 3 medicinal plants out of the 71 plants belonging to the National Relation of Medicinal Plants of Interest of the Single Health System.

The aim of this research is to carry out a survey considering the effects of variables such as gender, age group and schooling on the use of the medicinal *plant B. forficata* Link as a self-care resource for the control of diabetes mellitus type 2, as well as to analyze phytotherapy regarding its importance as a healthcare strategy in the health-disease process.

MATERIALS AND METHODS

Study area

This study respected the ethical observations that govern research involving human beings and was performed in accordance with Resolution 466/12 of the National Health Council (CNS) of Brazil. Through the Informed Consent Form (TCLE), participants were provided information about the study's objectives, assured anonymity and confidentiality with regard to the information provided and provided the freedom to consent and withdraw at any time during the research. Additionally, the research was approved by the Research Ethics Committee (CEP) of the Federal University of Roraima (UFRR) under the protocol Number of Opinion: 2,288,847 as of 09/21/2017 (PRPPG / UFRR) under registration number 1232017. The study also had previous authorizations with letters of agreement from the representatives of the districts of Nova Cidade and Raiar do Sol and the secretary of health from the Municipal Health Department of Boa Vista.

In the Brazilian Amazon, approximately 15 million people live in urban areas, according to data from the Brazilian Institute of

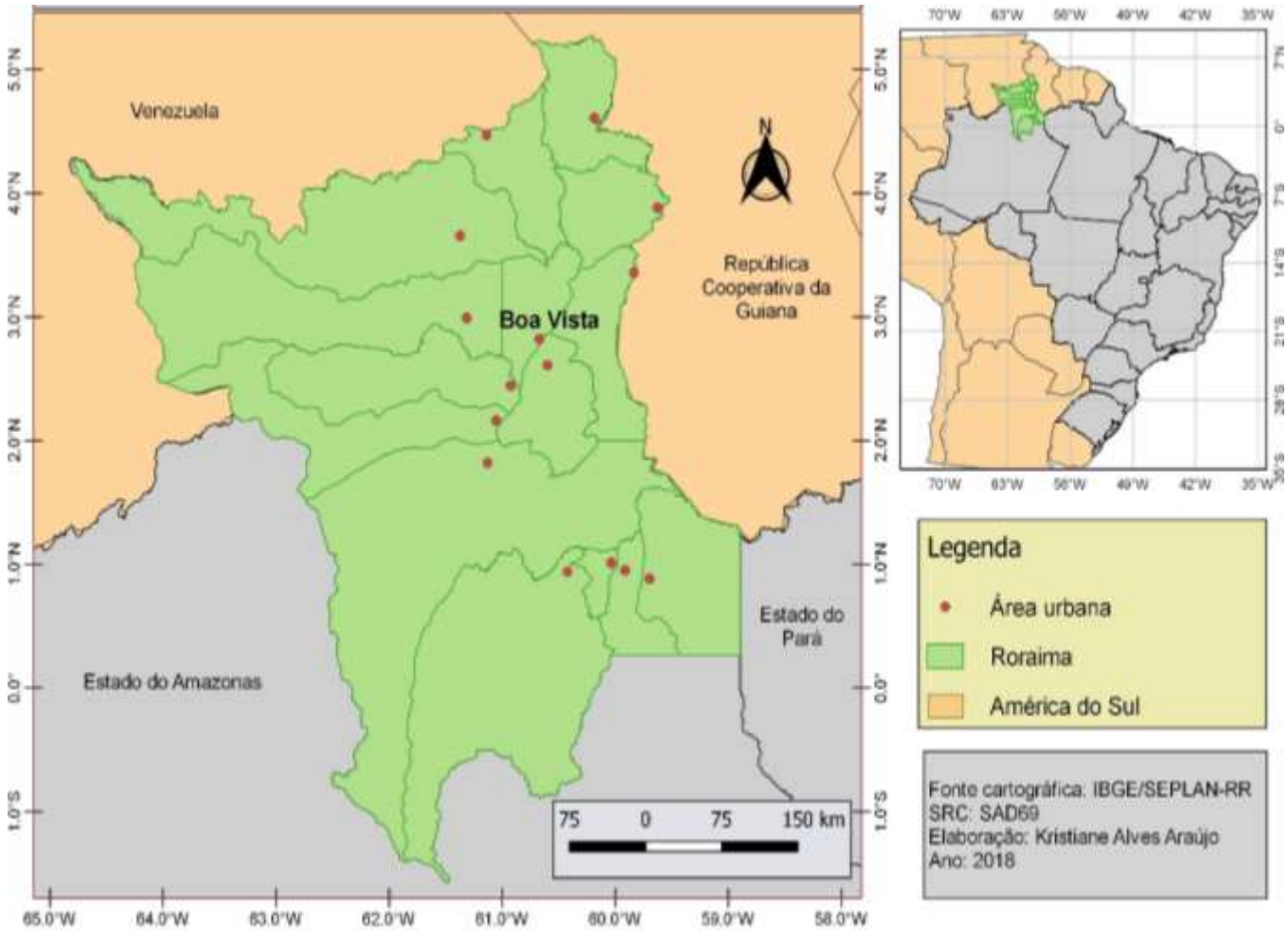

Figure 1. Map of Brazil with the State of Roraima and the municipality of Boa Vista.
Source:https://portugaldigital.com.br/wpcontent/uploads/2018/04/MapaBrasilFotoViajero.jpg

Geography and Statistics (IBGE, 2010). The State of Roraima was created by the Federal Constitution of 1988; it is located in the extreme north of Brazil and is, therefore, located within the Brazilian Amazon. The characteristics of its biome are well diversified and, thus, particularized from the rest of the Amazon Region. According to the IBGE (2010), the population of Roraima is composed of 450,479 people, distributed in fifteen municipalities, in an area of 224,303,187 km^2. The state has international borders with the Cooperative Republic of Guyana (East and Northeast), the Bolivarian Republic of Venezuela (North and Northwest), and national borders with the state of Amazonas (South and Southwest) and with the state of Pará (Southeast) (Figure 1).

The research field of the study is located in the municipality of Boa Vista (229,454 inhabitants), including the Nova Cidade and Raiar do Sol neighborhoods, located in the west of the capital, with 5,708 inhabitants and 5,863 inhabitants, respectively (IBGE, 2010). The population is quite heterogeneous, consisting of mostly Roraimenses, including Indians and descendants of the pioneers of the colonization of the State, but also Afrodescendants, southerners, northeasterners and northerners, in smaller numbers. This heterogeneity is important when analyzing the relationship between the use of medicinal plants and migration in the state of Roraima because many plants were brought from outside to the state, and to this day, their use remains a local health practice.

The city of Boa Vista, capital of the state of Roraima, is part of the subdivision Border of Integration of the western portion of the Amazon. Boa Vista has an equatorial climate with an average temperature of 27.4°C and typical vegetation of the savannah, and Boa Vista is located in the right bank of the Branco River, within the hydrographic basin of the same name. The Raiar do Sol neighborhood is located in the western part of the municipality of Boa Vista, near Paca Creek, and has the largest indigenous population in the city of Boa Vista, with 287 inhabitants, according to data from the Brazilian Institute of Geography (IBGE, 2010) and based on the criterion of self-declaration. The Nova Cidade neighborhood is also located in the western area of Boa Vista. The western zone is larger than all other zones put together (east, north and south) and is characterized as peripheral and encompasses the poorer districts in the city, presenting precarious health indicators.

Procedure for data collection and analysis

An initial visit was made to the research neighborhoods, mediated by representatives of the two neighborhoods and some community leaders, by whom the objectives and relevance of the research were presented in a general way; soon after, the residents were

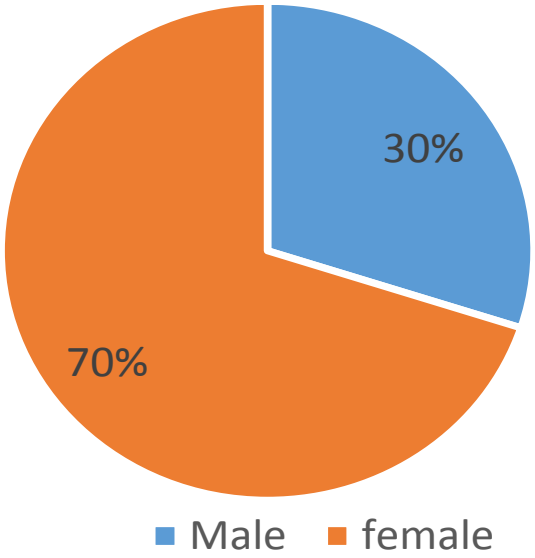

Figure 2. Self-declaration of gender cited by the research participants who were residents of the Nova Cidade and Raiar do Sol neighborhoods.

invited to participate. At that time, they were asked to authorize the monitoring and observation of their daily activities at home, at religious institutions and at work in health posts to be able to follow all the paths traveled by local residents in search of healthcare. Once the authorization was obtained, participant observation began, and the periods and activities were defined in agreement with the community leaders and members of the Family Health Strategy team. During the observation periods, the researchers' impressions were recorded in the form of notes in a field diary.

The choice of the places to include in the present research was motivated by several situations, including (a) the region was already studied by the researcher during her masters and doctorate; and (b) contacts had already been established with community leaders and with some former residents of the two neighborhoods. First, a questionnaire to characterize the sociodemographic characteristics of the study population was provided to all those involved, and interviews were conducted. The responses were recorded through the use of a tape recorder. The elaborated script used the technique of a semi structured interview and contained 20 questions.

Data were collected between September 2017 and February 2018. Snowball-type nonprobabilistic sampling was defined as the technique used to obtain a sample of forty-three (n = 43) local residents with type 2 diabetes mellitus. Concerning the data collection, the main instruments used were the semi-structured interviews of ten (n = 10) participants recognized as having local knowledge about medicinal plants in the studied districts. The interviews were performed with the help of a questionnaire, which included, in a semistructured way, open and closed questions. The remaining thirty-three (n = 33) participants were administered questionnaires on the use and knowledge of the plant referred to as leg of the cow.

The inclusion criteria were as follows: (1) Individuals who declared themselves as having type 2 diabetes mellitus (DM), regardless of diagnosis time, or who had close relatives, such as spouses, fathers, mothers, children or siblings, who had the disease, since this would facilitate the contact and follow-up of the study; (2) Moradores of the neighborhoods New City or Raiar of the Sun who made use of medicinal plants hypoglicemiantes. The sample consisted of 43 individuals who used or had a close relative who used the medicinal plant *B. forficata* Link for the complementary treatment of diabetes.

The medicinal plants reported in this research were some of the most prevalent scientific names reported in the literature, considering the popular name associated with the use of the plants as a hypoglycemic agent. The data were plotted and analyzed using a statistical program based on the distributions of means and proportions, and comparisons between means were performed by Student's t-tests and comparison between proportions were performed by the chi-square (χ^2) test.

Guided tours (Albuquerque, 2010) were carried out around the residences of the participants, usually in backyards and in free fairs in the city of Boa Vista, Roraima, Brazil. The plants cited in the interviews were photographed, collected or bought at markets during the guided tours and at subsequent visits. Some domesticated plants already known and obtained through purchase were identified based on specialized literature (Lorenzi and Matos, 2008; Souza and Lorenzi, 2012). The spelling of the scientific names was checked using the Tropics database, available at http://www.tropicos.org. The listing of the taxa followed the APG III guidelines (2009). The diseases/symptoms cited by informants were categorized according to the International Statistical Classification of Diseases and health-related problems (ICD-10 2008).

For the interpretation of the data, the independent variables were as follows: Age, gender and schooling. The data collected were analyzed by descriptive statistical methods, such as tables, graphs and percentages. Descriptive analyses were performed resulting in mean values and standard deviations. The comparison between sample means was performed by Student's t test. The chi-square test was used to compare proportions. The estimation of risk quantification was performed using the odds ratio and 95% confidence interval (Newcombe-Wilson method). The statistical program used was SPSS: Statistical Package for the Social Sciences (IBM SPSS Statistics Version 24), setting the level of significance at 5% for the rejection of the null hypothesis.

RESULTS AND DISCUSSION

Regarding socioeconomic and demographic characteristics, the data analyses were performed based on the data collected among 43 participants with an average age of 52 years (standard deviation 10.43 years) and an age range of 40 years to 70 years. Of the sample, 30% were males and 70% were females; the results of this study were similar to those reported in other ethnobotanical studies (Silva et al., 2017; Viu et al., 2016; Defani et al., 2012; Kankara et al., 2018) (Figure 2).

The female predominance found in this study in Boa Vista can be justified by the greater availability of women to respond to the questionnaire and greater responsibility for the care of the family.

The higher number of female subjects was similar to the findings of investigations performed by other researchers, as referenced by Dahmer et al. (2015). What was observed in the informal conversations and interviews during the research was that, most of the time, the women made it clear that they were the ones who take care of the family; because they have a greater responsibility for their children and husband, they need to know more about the use of medicinal plants, including

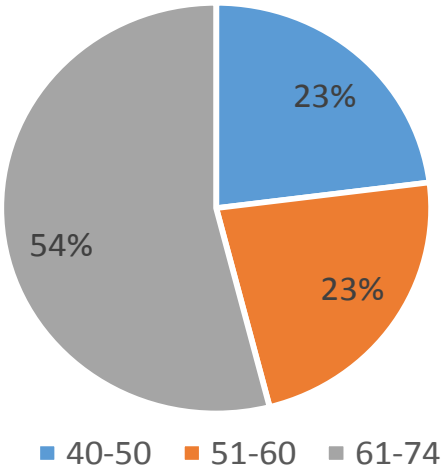

Figure 3. Age categories cited by the research participants who were residents of the Nova Cidade and Raiar do Sol neighborhoods.

the plant species, which are bought or cultivated, and their therapeutic indications.

In this study, we observed that the majority of the participants were female (70%), which was similar to the results of studies by Prado and Jacopetti (2009) and by Miranzi et al. (2008). What can justify this information is that the majority of the population of the municipality of Boa Vista, where the study was conducted, is composed of women. This proves the veracity of the data from the Brazilian Institute of Geography and Statistics (IBGE, 2010), which verified that in 2017, approximately 52.03% of the resident population was female. This finding is explained by the differences in life expectancy between genders, a very prominent phenomenon in Brazil, known as feminization of old age, which shows that women live on average eight years longer than men (Lima, 2011).

According to the Institute of Applied Research (IPEA, 2014), along with population aging, there is a disproportionate increase in the proportion of the female gender, reaching up to 55% of the world's elderly population. In Brazil, the percentage of elderly women was 55.9%, while the male portion consisted of only 44.1%. Another relevant factor is that men are more resistant to participating in activities that are not related to work (Beltrame, 2008; Dahmer et al., 2015).

The age of the respondents varied greatly, but the majority (54%) of the sample was composed of people aged over 60 years (Figure 3). A similar population was studied in other studies (Miranzi et al., 2008, Prado and Jacopetti, 2009, Rego, 2011). Similar results were also found in a study by Dahmer et al. (2015), in which the subjects of the research were over 60 years of age. These data are compatible with the information from the World Health Organization, which showed that DM occurs at any age but is diagnosed at a higher incidence after the age of 40. This state of affairs makes the research more relevant since the adult and elderly populations can develop microvascular complications, such as cardiovascular, cerebrovascular and peripheral diseases, and microvascular diseases, such as retinopathy and neuropathy (World, 2009).

According to Oliveira (2016), one of the trends observed in several ethnobotanical studies is that women have greater knowledge about medicinal species and men have greater knowledge about species related to wood use, such as energy generation and construction. This difference is understandable because of the division of labor between the genders, where men and women accumulate different experiences, which are reflected by different levels of local knowledge (Voeks, 2007; Cecilia et al., 2018). Another tendency observed is that older people have a greater knowledge than younger ones since young people are believed to be less affected by external factors (Quinlan and Quinlan, 2007).

Moraes (2011), mentioned that cultural wealth in the Amazon is an important element in the composition of the social identity of this region and because it is dynamic, it presents constant changes. Urbanization and globalization processes bring about several transformations and changes in values, contributing to cultural changes, often resulting in losses and changes in important traditional elements and knowledge.

According to Brazilian Institute of Geography and Statistics (IBGE 2010), the illiterate population (15 years and over) according to the Roraima Federation Unit includes 30,672 illiterate inhabitants, corresponding to the socioeconomic index (illiteracy rate) of 10.28% of the total population of Roraima.

Regarding education in relation to male and female, there were illiterate participants (15 and 10%, respectively), participants with elementary education only (25 and 30%, respectively), participants with high school education (50 and 50%, respectively), and participants with higher education (10 and 10%, respectively). Defani et al. (2011) also noted that participants with diabetes had low levels of education. Salvi (2016) found similar results related to the relationship between education and diabetes.

The educational level of the sample consisted of an average of 28% who completed Grades 1 to 4 and only 50% who had completed high school; the remaining 22% correspond to participants who were illiterate, who did not complete high school and who completed a higher education (Figure 4). In Brazil, many studies show the low level of education of individuals with arterial hypertension and diabetes mellitus (REGO, 2011). In the study by Dos Santos et al. (2013), 25.6% of the sample had completed high school. This finding reflects the different conditions of access to education in previous decades, where going to school was a privilege of a small portion of the population (Beltrame, 2008; Dahmer et al., 2015).

Factors such as a low level of education, a significant prevalence of African and indigenous individuals, and a

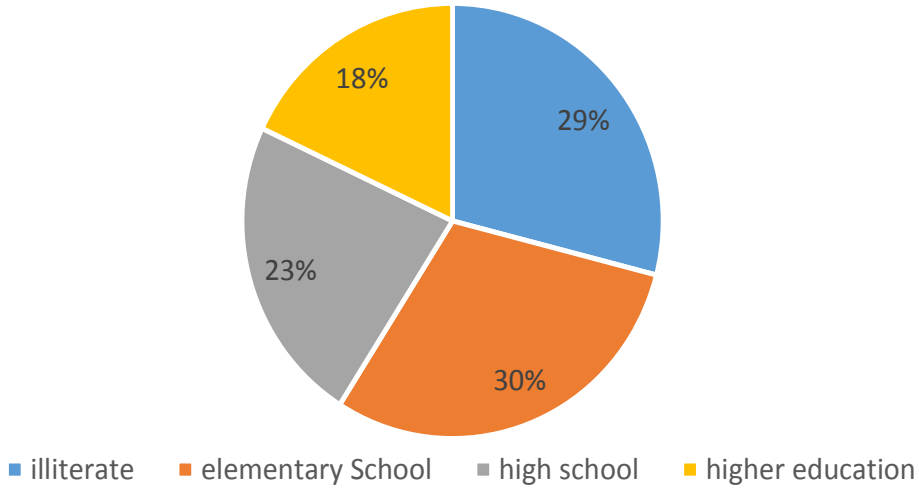

Figure 4. Educational level of the research participants who were residents of the Nova Cidade and Raiar do Sol neighborhoods.

Table 1. Plants with hypoglycemic effects that are on the RENISUS list and were used by the research participants.

Common name	Scientific name	Part used	Number of quotes
Cow leg	*Bauhinia fortificata Link*	Fruit / leaf	27
Eucalyptus	*Eucalyptus globulus* Labill	leaf	19
Carcharas	*Baccharis trimera* Less	leaf	10

Source: Questionnaire Data Appropriate to Research Participants (2018).

high prevalence of obesity and elderly individuals, are directly associated with the large increase in the prevalence of diabetes mellitus (DM) in Brazil, and similar factors were found in the research conducted in Roraima. In addition, small differences were observed in the prevalence of DM among the different regions, but these differences were considered insignificant when differences in sociodemographic factors and nutritional status were taken into account (Iser et al., 2014).

The research findings also showed an important relationship between educational level and the use of medicinal plants, with these variables being inversely proportional. According to the results of the sample studied in the Nova Cidade and Raiar do Sol neighborhoods, the lower the educational level, the greater the use of hypoglycemic medicinal plants.

Regarding the use of medicinal plants for glycemic control in individuals with DM2, of the 43 individuals surveyed, 100% used or had relatives who used medicinal plants as adjuvant treatment for diabetes and reported that they were able to control their glycemic levels and the side effects of medications with the use of medicinal plants to support drug treatment; the data are comparable to the results of a study conducted by Pinto (2008). Diabetic patients using plants cited 22 types of plant species belonging to different families that they believe have some type of antidiabetic property, and many believe in their effects in terms of complications or increased glycemia. In this study, only the plant species that are in the National Relation of Medicinal Plants of Interest to the Unified Health System (RENISUS), for a total of 3 plants was considered.

Table 1 shows the hypoglycemic plants mentioned by the interviewees. The chi-square test showed that the difference between the age groups of the participants was generally statistically significant ($\chi^2 = 19.33$, gl = 7, $p < 0.01$) and that even when the analysis was performed after separating the participants by gender, the results were significant ($\chi^2 = 6.30$, gl = 6, $p < 0.05$). The interviewees could cite up to three plants for a better analysis of the data, and the most cited plant in the present study was *B. forficata* Link (Paw-cow), which was similar to the results of the study conducted by Dos Santos (2013) in Pernambuco, Brazil. The finding also corresponds to a study by Salvi (2016) conducted in Rio Grande do Sul, Brazil on the perception of individuals with diabetes mellitus regarding the use of *B. forficata* Link (Fabaceae).

Out of 129 responses of a total of 43 respondents, 27 individuals cited *B. forficata* Link (cow's foot), which corresponds to 23% of responses. The second most cited plant was *Eucalyptus globulus* (eucalyptus), with 19

responses, corresponding to 14%; the third plant species cited was *Baccharis trimera* (carqueja), with 10 responses, corresponding to 08%.

Corroborating the results of Lino (2004), who studied the efficacy of *B. forficata* L. (cow's foot) for reducing hyperglycemia and suggested the validity of the clinical use of the plant for the treatment of type 2 DM, the present research, carried out in two neighborhoods, Boa Vista/RR, confirms the use reported by study participants.

The type of plants used by the population to treat ailments exhibits important differences because of geographical and ethnic variants. However, it was observed that several plants cited in this survey were also cited by authors in similar works, such as the plants known as cow's paw, carqueja and insulin (Defani et al., 2011, 2012). These results are consistent with the fact that insulin-dependent pancreatic beta-cells have been shown to inhibit insulin resistance in the pancreas (Buchan et al., 2010). Corroborating the findings of Defani et al., (2011, 2012), this research also found medicinal plants used for the treatment of diabetes with similar effects similar to those of the following plant species: Cow's paw, eucalyptus and carqueja.

The knowledge and use of the native medicinal plant *B. forficata* Link (cow's paw) reported by most of the individuals participating in this research has been supported by scientific studies that prove the efficacy of this plant in several experimental models (Marques et al., 2013). In this sense, the effects of *B. forficata* Link especially related to hypoglycemic effect, are reported in the literature, proving and justifying the use of these species in folk medicine (Silva et al., 2016). Some studies state that carbohydrate metabolism improved when diabetic rats were treated with a *B. forficata* Link decoction. This finding shows that the plant, when administered, can reduce glycemia, triglycerides and total blood cholesterol (Negri, 2005).

The other hypoglycemic medicinal plant cited by the participants was eucalyptus (n = 19), which presented the second largest number of responses for the treatment of diabetes. In one study, eucalyptus (*Eucalyptus globulus*) was given as decoction in mice, and a reduction in the level of hyperglycemia was observed (Swanston et al., 1990). Experiments have demonstrated the anti-hyperglycemic activity of eucalyptus, which is associated with stimulation of insulin secretion, representing an additional option for the treatment of diabetes and demonstrates potential for the discovery of new active compounds for the treatment of diabetes (Salvi, 2016).

Carqueja presented the third largest number of responses (n = 10) for its use for the treatment of diabetes in this research in the neighborhoods of Nova Cidade and Raiar do Sol. A study of the aqueous fraction of *B. trimera* Less. demonstrated a potential antidiabetic activity, with a reduction in glycemia. In another study, crude extracts of carcharine (*B. trimera* Less.) and Jambolão (*Syzygium cumini*) were used in diabetic and and nondiabetic mice, and the use of a single dose of *B. trimera* Less. was shown to be most effective in the treatment of hypercholesterolemia.

Given the interviewees' responses, it can be seen in this research carried out in the Nova Cidade and Raiar do Sol neighborhoods that the responses corroborate with the population of Brazil (2013); the epidemiological, social and economic analysis of a growing population that is affected by DM shows the need to develop public health policies that act by reducing the difficulties faced by patients and their families to obtain adequate treatment, thus guaranteeing an improvement in their quality of life (Ministry of health, Brazil, 2013). These hypoglycemic plants referred to by the participants are an important complementary health resource for the treatment of diabetics.

Regarding the general characteristics of obtaining and using the hypoglycemic herbs, 90% of the participants make use of teas by infusion, while 10% utilize via maceration or by other forms of preparation. Statistical analysis showed that the difference between the way the interviewees used the medicinal plants in the community was significant ($\chi^2 = 25.12$, gl = 11, $p < 0.001$), presenting some divergent points when the analysis was performed by gender.

Compared with the data collected by Defani et al. (2011, 2012), data from the present study also indicated that the majority of respondents were users of tea by infusion or decoction. The results found in this study are also in agreement with the results reported by Salvi (2016), suggesting that, from a scientific and pharmacological point of view (Anvisa, 2010), the preparation of medicinal plants by decoction or infusion is the most correct form of use.

Research data indicate that most people with diabetes use the plants as follows: twice a day (42%), once a day (38%), three times a day (15%) and sporadically when they remember or have a will (5%) as shown in Figure 5. According to Kalluf (2008), this finding shows the disorientation of the population in regard to the consumption of medicinal plants since the therapeutic dosage, the frequency of consumption and the time of administration for obtaining treatment results are particular to each medicinal plant and consequently of its bioactive components, which, like allopathic medicines, need a correct period of use to have therapeutic effects. In the study conducted in Boa Vista / RR, it was found that residents of Nova and Raiar do Sol had little knowledge regarding storage, conditioning and other parts of the plants that could be used.

During the survey, some people reported having no fixed schedule for consuming the teas, nor did they show any concern about frequency or dosage; the majority (90%) also reported never having had any negative symptoms due to the use of the medicinal plant Pata De Vaca.

Regarding obtaining the medicinal plants, 38% of the patients collected the plants in their own backyards; 32%

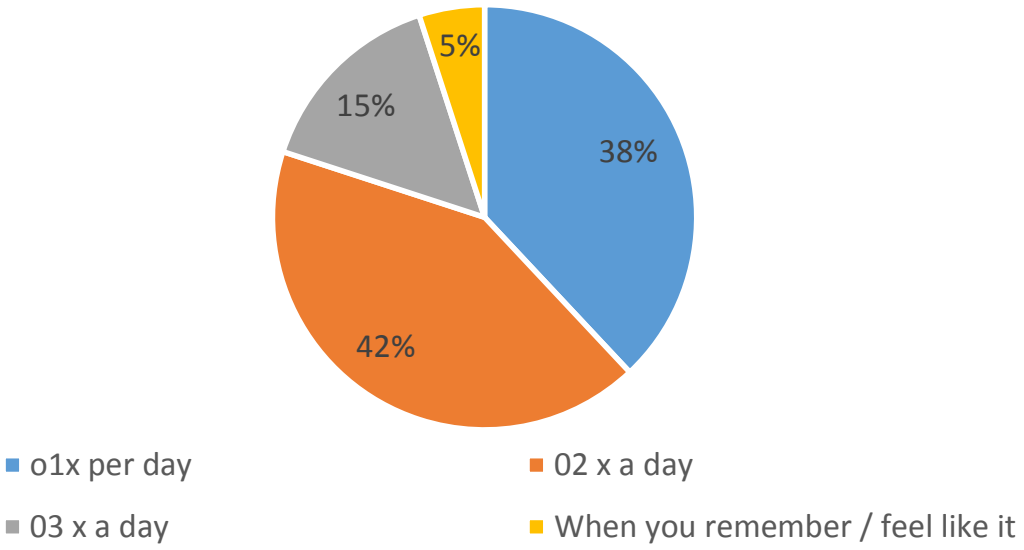

Figure 5. Number of times per day the participants make use of the medicinal plant cow's paw (Posology) cited by the research participants.

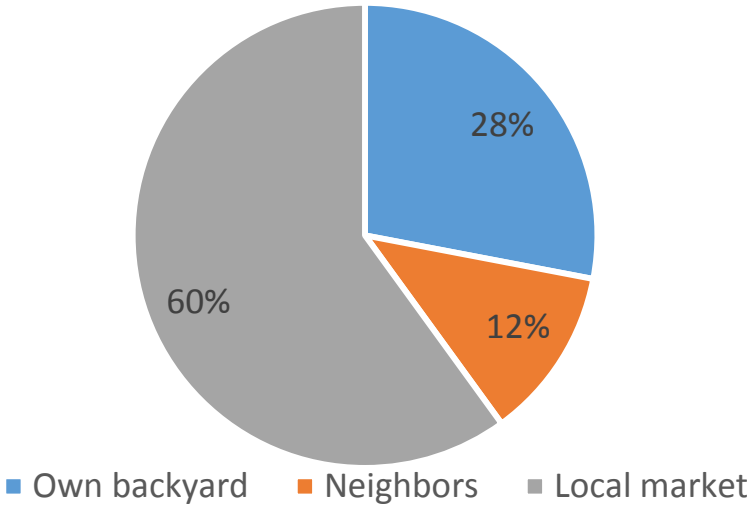

Figure 6. Obtaining the medicinal plant *B. forficata* Link (cow's foot).

32% indicated that they acquired them in local commerce (pharmacies, grocers, supermarkets and natural products stores), 18% obtained them from neighbors and 12% collected them in the field (Figure 6). The data of the present study are in agreement with those presented by Pilla et al., (2006), who reported the backyard of houses as the most cited place by individuals as a source of obtaining plant species.

The interviewees use the most diverse parts of the plants in the preparations of the home remedies. Considering the parts used, the following results were obtained: 70% used the leaves; 10% used the stem bark; 10% used the fruits, 08% used the seeds and 2% used the roots, as shown in Figure 7; these findings are similar to those found by Borges et al. (2008), who demonstrated the preference of the interviewees for the leaves. The chi-square test showed that the difference between the responses of the residents of the studied districts on the most-used parts of the plants was quite significant (χ^2 = 29.26, gl = 9, p <0.001).

As for the quantity used, the majority (69%) used one to seven plant units, and the others used a handful, as it is popularly said. Calabria et al. (2008) observed that the doses employed do not have standardized measures. The results of Borges et al., (2008) and Calabria et al. (2008) corroborate the findings of this research in peripheral

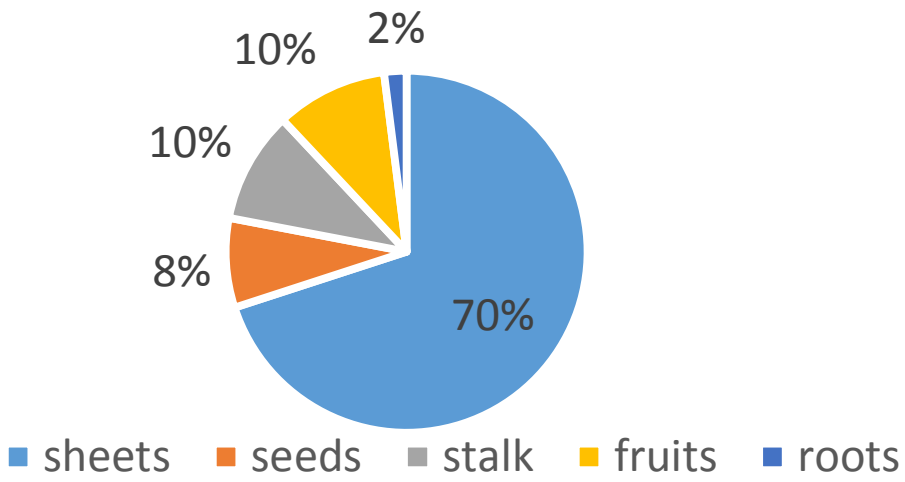

Figure 7. Parts of the medicinal plant cow's paw used by the residents.

neighborhoods in Boa Vista (2018). Regarding the characterization of the effects of the hypoglycemic plant species, *B. forficata* Link the majority of the research participants believe that cow's paw, eucalyptus and carqueja lower glucose (60%) or ease complications from diabetes (40%). Similar observations were made by Defani et al. (2011, 2012) and in the work of Del (2016).

The data analyzed in this research in Boa Vista, Roraima, Amazonia Brasileira on the knowledge of the possible side effects of the use of the plant leg of the cow revealed the following results: 90% of the interviewees did not know any contraindication of the medicinal plant used, and 10% believe that there may be some type of risk in the consumption of these plants; however, they have never asked any health professional about the possible risks that these plants may present. In a study with residents of Lima Duarte (MG), respondents stated that they use plants whenever they need them, also claiming that hypoglycemic plants do not harm their health (Salv, 2016).

Many plants have a hypoglycemic effect, attributed to several mechanisms of action; however, some plants may be toxic. The great diversity of chemical classes indicates that a variety of mechanisms of action must be involved in reducing the level of blood glucose. Some of these substances may have therapeutic potential, while others may produce hypoglycemia as a side effect due to their toxicity, especially hepatotoxicity. The search for natural plants or compounds with antidiabetic activity may supply the need for new active compounds and may possibly be more accessible to the population.

The most common effects caused by the use of the medicinal plant paw (Figure 8) reported by the participants in the Boa Vista, RR study were the improvement of diabetes complications(49%), the decrease in glucose (20%), other (21%), and no effect related to hypoglycemia (10%). The study by Defani et al. (2012) showed that most of the interviewees cited improvement in diabetes or a decrease in blood glucose, with the rest of the interviewees mentioning that they felt well or did not notice changes.

Conclusion

The data collected and analyzed in the present research allowed us to conclude that the majority of the population interviewed in this study and with a medical diagnosis of type 2 diabetes mellitus in the city of Boa Vista (RR) is adept at the use of hypoglycemic medicinal plants. More pharmacological and clinical studies are needed, in addition to the local knowledge and training of health professionals, to prove the effects of the plants used by the diabetic population, thus providing the desired health benefits to the patients. The results of this work may contribute to stimulating research in the search for new active compounds for the treatment of diabetes mellitus, but for this to happen, greater investments are needed for scientific studies in this area to prove the efficacy of these species as hypoglycemic agents since a large number of uses was demonstrated by the local residents in the Nova Cidade and Raiar do Sol neighborhoods in Boa Vista, RR. In this sense, we can guide some complementary therapies, including phytotherapy with the use of medicinal plants that are effective for glycemic control. Medicinal plants cannot act as the only form of medication but should act as an adjunct in the treatment of DM. The beneficial effects could be perceived in the two districts studied. The group under analysis demonstrated knowledge regarding phytotherapy as well as the hypoglycemic potential of some plant species. There was no significant difference regarding the effects perceived by the individuals in the research. According to the perception of the participants regarding the effects of

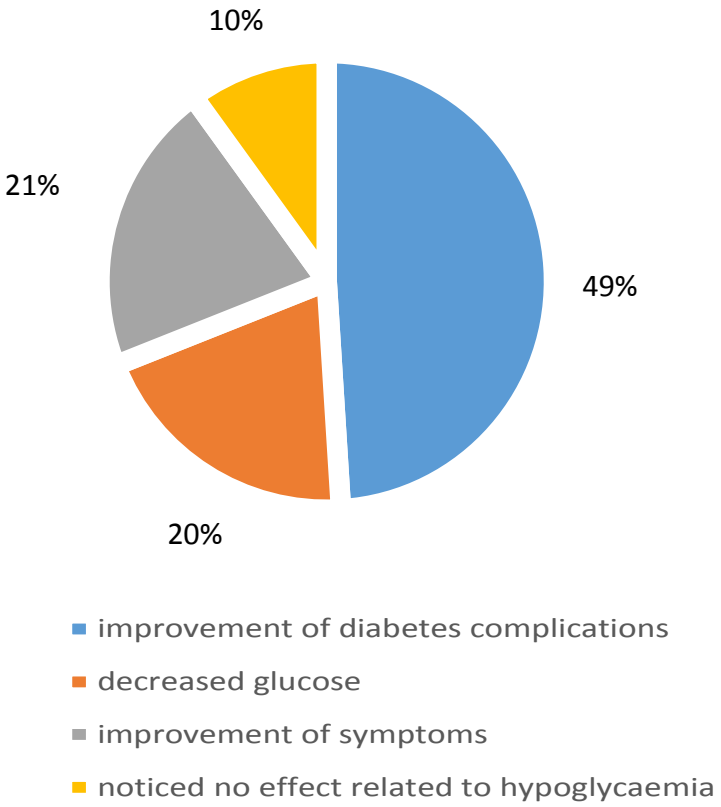

Figure 8. Effects of the medicinal plant paw mentioned by the inhabitants.

herbal medicine as an aid in the control of glycemic index, the use of medicinal plants associated with conventional allopathy is an effective alternative for the treatment of individuals with type 2 diabetes mellitus. Among other effects mentioned by the interviewees, the regular use of medicinal plants resulted in improvements in fatigue and increased willingness to carry out day-to-day activities.

It is suggested that studies of medicinal plants have promise, especially those of the plant researched in this study *B. forficata* Link, which has shown promising potential as an aid in the treatment of diabetes. Studies that analyze its use in the community, as well as its effects, dosage and ideal frequency of use are necessary to observe hypoglycemic effects.

In this study, some problems were identified regarding the use of plants, such as inadequate preparation, origin and improper storage, which could compromise quality, functional properties and health benefits. The practice of using hypoglycemic medicinal plants is common among the population in the neighborhoods of Cidade Nova and Raiar do Sol to treat diabetes, but in most cases, there is no guidance regarding the indication, preparation or use of these plants from health professionals who have had training or courses on medicinal plants.

CONFLICT OF INTERESTS

The authors did not declare any conflict of interests.

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