

**Use of *Bauhinia forficata* Link infusion in the treatment of diabetes *mellitus***  
**Utilização da infusão de *Bauhinia forficata* Link no tratamento do diabetes *mellitus***  
**Uso de la infusión de *Bauhinia forficata* Link en el tratamiento de la diabetes *mellitus***

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**Abstract**

Diabetes *mellitus* is a chronic disease that affects millions of people around the world. One of the medicinal plants used by the Brazilian population in the treatment of diabetes *mellitus* is *Bauhinia forficata* Link. The objective of this work was to conduct a review of clinical case studies in order to analyze the hypoglycemic effect of *B. forficata* infusion in diabetic and pre-diabetic individuals. A direct search for articles of clinical cases was carried out in the databases LILACS, PubMed, SciELO, and Scopus. Were searched works in Spanish, English and Portuguese, published in the last 10 years and that only used the infusion of leaves of the plant species in the treatment of mens and womens, over the age of 18, with pre-diabetes or diabetes *mellitus*. Were used the keywords "*Bauhinia forficata*" and "diabetes", and the boolean operator "AND". Five studies were found, of which three of them presented positive results in relation to the use of *B. forficata* infusion as an effective hypoglycemic agent in diabetic and pre-diabetic individuals, while two studies did not present positive results. It was concluded that the infusion of *B. forficata* is able to assist in the treatment of diabetes *mellitus*, despite the need for more scientific evidence on the subject.

**Keywords:** Chronic disease; Hypoglycemic; Medicinal plants.

### Resumo

O diabetes *mellitus* é uma doença crônica que afeta milhões de pessoas em todo o mundo. Uma das plantas medicinais utilizadas pela população brasileira no tratamento do diabetes *mellitus* é a *Bauhinia forficata* Link. O objetivo deste trabalho foi realizar uma revisão de estudos de casos clínicos a fim de analisar o efeito hipoglicemiante da infusão de *B. forficata* em indivíduos diabéticos e pré-diabéticos. Foi realizada uma busca direta por artigos de casos clínicos nas bases de dados LILACS, PubMed, SciELO e Scopus. Foram pesquisados trabalhos em espanhol, inglês ou português, publicados nos últimos 10 anos e que utilizassem apenas a infusão das folhas da espécie vegetal no tratamento de homens e mulheres, acima de 18 anos de idade, com pré-diabetes ou diabetes *mellitus*. Foram utilizadas as palavras-chave "*Bauhinia forficata*" e "diabetes", e o operador *booleano* "AND". Foram encontrados cinco estudos, dos quais três apresentaram resultados positivos em relação ao uso da infusão de *B. forficata* como agente hipoglicemiante eficaz em diabéticos e pré-diabéticos, enquanto dois estudos não apresentaram resultados positivos. Concluiu-se que a infusão de *B. forficata* é capaz de auxiliar no tratamento do diabetes *mellitus*, apesar da necessidade de mais evidências científicas sobre o assunto.

**Palavras-chave:** Doença crônica; Hipoglicemia; Plantas medicinais.

### Resumen

La diabetes *mellitus* es una enfermedad crónica que afecta a millones de personas en todo el mundo. Una de las plantas medicinales utilizadas por la población brasileña en el tratamiento de la diabetes *mellitus* es *Bauhinia forficata* Link. El objetivo de este trabajo fue realizar una revisión de estudios de casos clínicos con el fin de analizar el efecto hipoglucemiante de la infusión de *B. forficata* en individuos diabéticos y prediabéticos. Se realizó una búsqueda directa de artículos de casos clínicos en las bases de datos LILACS, PubMed, SciELO y Scopus. Se buscaron trabajos en español, inglés o portugués, publicados en los últimos 10 años y utilizando únicamente la infusión de hojas de plantas en el tratamiento de hombres y mujeres, mayores de 18 años, con prediabetes o diabetes *mellitus*. Se utilizaron las palabras clave "*Bauhinia forficata*" y "diabetes" y el operador *booleano* "AND". Se encontraron cinco estudios, de los cuales tres presentaron resultados positivos en relación al uso de la infusión de *B. forficata* como agente hipoglucemiante eficaz en diabéticos y prediabéticos, mientras que dos estudios no presentaron resultados positivos. Se concluyó que la infusión de *B.*

*forficata* es capaz de ayudar en el tratamiento de la diabetes *mellitus*, a pesar de la necesidad de más evidencia científica sobre el tema.

**Palabras clave:** Enfermedad crónica; Hipoglucemia; Plantas medicinales.

## 1. Introduction

Diabetes *mellitus* (DM) consists of a chronic non-transmissible disease characterized by excess glucose in the blood, due to deficient production of insulin by the pancreas or resistance to its action on tissues (Sociedade Brasileira de Diabetes, 2019).

This metabolic disorder reaches epidemic proportions. It is estimated that approximately 463 million people worldwide have DM (International Diabetes Federation, 2019). Persistent hyperglycemia caused by this disease can be associated with cardiac complications, increased morbidity, reduced quality of life and increased mortality rate (Insel et al., 2015).

According to the Sociedade Brasileira de Diabetes (2019) the current classification of DM is based on its etiology, classified as: type 1 diabetes *mellitus* (DM 1), type 2 diabetes *mellitus* (DM 2), and gestational diabetes *mellitus* (GDM).

DM 1 is an autoimmune, polygenic disease, resulting from the destruction of pancreatic beta cells, causing complete deficiency of insulin synthesis (Chiang, Kirkman, Laffel & Peters, 2014; Insel et al., 2015) and corresponds to 5-10% of all cases of DM. It is most often diagnosed in children and adolescents, although less common in adults. It is estimated that more than 16,8 million of Brazilians have diabetes *mellitus* (International Diabetes Federation, 2019).

DM 2 is a disease of multifactorial etiology, with a family inheritance not yet completely clarified and generally linked to behavioral factors. Most diagnoses of DM 2 are made in individuals over 40 years old, corresponding to 90 to 95% of all DM cases (American Diabetes Association, 2020; Skyler et al., 2017).

Gestational diabetes *mellitus* (GDM) is usually diagnosed in women who are in the second or third trimester of pregnancy, and can be associated with both insulin resistance and beta-pancreatic cell dysfunction, which can cause risks for both the mother and the fetus. The disease can be transient or can persist after child-birth, being an important risk factor for the future development of DMII (Hu et al., 2013).

Inadequate eating habits, overweight and physical inactivity are considered the main risk factors for the development of DM 2. Unlike DM 1, patients with DM 2 are not

dependent on exogenous insulin and can use it, if necessary, for glycemic control (De-Fronzo, 2009).

The treatment of DM consists of a change in lifestyle, requiring healthy eating habits and maintenance of regular physical activity, in addition to therapeutic methods, such as the use of drugs and insulin therapy. It is also necessary that the patient with the disease to regularly analyze his blood glucose levels (International Diabetes Federation, 2019).

The use of plant species has been widely studied for the treatment of many pathologies, including diabetes *mellitus*, and can be a positive alternative, due to the fact that it has a lower cost than synthetic drugs (Santos, Nunes & Martins, 2012).

The World Health Organization (WHO) has been playing an important role in encouraging studies related to the safety, efficacy and quality of plant drugs, aiming at the normalization of phytotherapy in health services (World Health Organization, 2013).

In Brazil, stand out the National Policy for Medicinal Plants and Herbal Medicines and the National Program for Medicinal Plants and Herbal Medicines within the Unified Health System (SUS), with objectives of ensuring safe access and rational use of medicinal and herbal medicines (Brasil, 2008).

In 2009, the Brazilian Ministry of Health published the National List of Medicinal Plants of Interest to SUS (RENISUS) to direct scientific research with 71 plant species of pharmacological potential (Ministério da Saúde, 2009). Among the plants with antidiabetic properties, there is *Bauhinia forficata* Link, popularly known as “Pata-de-vaca”, due to the characteristic aspect of its leaves (Marques *et al.*, 2013).

The leaves of this species are often used in the form of infusion by rural populations. This use has been widely reported in the literature, as verified by Trojan-Rodrigues, Alves, Soares and Ritter (2012), in an analysis of ethnobotanical studies, in which *B. forficata* stood out among the plants popularly mentioned to treat DM in the State of Rio Grande do Sul (Brazil). In addition, this species is among the medicinal plants widely commercialized in the Brazil (Franco, Caetano, Caetano & Dragunski, 2011).

Due to the popular consumption of this herbal medicine, to many studies have been developed with the purpose of proving the pharmacological properties of the species, particularly of leaves, aiming to make them useful, from the therapeutic point of view, as a new therapeutic option for the treatment of diabetes *mellitus*. Therefore, this article performed a review of clinical case studies in order to analyze the hypoglycemic potential of *B. forficata* infusion in diabetic and pre-diabetic individuals.

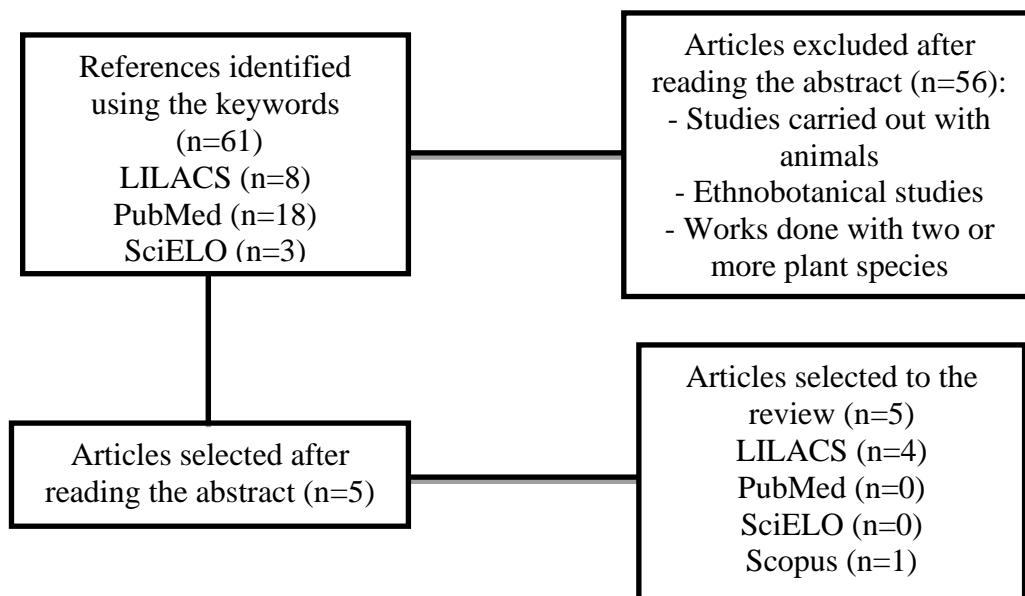
## 2. Methodology

A direct search for articles of clinical cases on the topic of interest was carried out from March to July of 2020 in the database of Literatura Latino-americana e do Caribe em Ciências da Saúde (LILACS), PubMed, Scientific Electronic Library Online (SciELO) and Scopus. Were included to the analyses studies with only pre-diabetic or diabetic people over the age of 18. Were included also works only in Spanish, English and Portuguese, published in the last 10 years and that only used the infusion of leaves of the plant species in the intervention for male and female sex. Were used the keywords "*Bauhinia forficata*" and "diabetes", and the *boolean* operator "AND".

The choice for studies using infusion was due to the fact that it is, in general, a form of easy access and preparation by the Brazilian population, in addition to preserving the characteristics of the plant as close to the natural one.

Studies carried out with animals, review articles, ethnobotanical studies, and works done with two or more plant species with therapeutic activity in the treatment of diabetes were excluded from this study. The (Figure 1) shows the flowchart for the selection of articles.

**Figure 1:** Flowchart of article selection.



Source: From the authors.

### 3. Results and Discussion

Currently, the increase in the prevalence of diabetes in the population has been increasing, therefore, the use of medicinal plants has stood out in this area, with a large investment in studies for the characterization of chemical substances derived from plant species in order to investigate the mechanisms of action of these compounds in comparison with synthetic drugs (Odeyemi & Bradley, 2018).

In the search using only the keyword "*Bauhinia forficata*" 188 articles were found, 19 in the LILACS database, 43 in PubMed, 26 in SciELO and 100 in Scopus. However, using the keywords "*Bauhinia forficata*" and "diabetes" the result was 61 articles, among which five of them were selected for the present study. Four articles were found at LILACS in Portuguese and one at Scopus in Spanish. The (Table 1) presents the main results found in the selected studies, as well as the methodology used. Among the articles included it was possible to observe that the average age of all the patients studied was 64,89 years, being most of the population studied womens, representing 59,44% of the individuals, while the mens patients presented 40,56%.

All patients had DM 2 or pre-diabetes. It was also observed that in all studies, patients were instructed to take the infusion of *B. forficata* for a certain period, according to the methodology of each study.

**Table 1.** Summary of the analyzed articles.

Author	Type of study / Objective	Sample (n)	Sex: Male / Female	Age (Years)	Methodology	Results
(Moraes, Rempel, Périco & Strohschoen, 2010).	Clinical case study: Evaluate the glycemic profile of users of basic health units with diabetes <i>mellitus</i> (type 2) who used the infusion of <i>B. forficata</i> leaves (Group 1) and compare it with DM 2 patients who did not use any type of infusion (Group 2).	Total: 20 individuals Group 1: 10 individuals Group 2: 10 individuals	Total: 9 Male / 11 Female Group 1: 6 Male / 4 Female Group 2: 3 Male / 7 Female	Total: 56 – 84 Group 1: 66,6 (± 2,57) Group 2: 72,1 (± 2,20)	Biweekly assessment of fasting blood glucose from the two groups studied by the Human Gene Therapy (HGT) method, for 75 days. The study did not describe in its methodology the dosage and frequency of infusion administration that Group 1 was instructed to use.	Group 1 had a significant decrease in the glycemic profile, while group 2 did not have a significant change in the glycemic profile, which indicates the efficiency of consumption of leaf infusion in the treatment of DM 2.

(Zaccaron, Rempel, Strohschoen, Bosco & Moreschi, 2014).	Clinical case study: Evaluate blood glucose levels, blood pressure and anthropometry of DM 2 patients who used <i>B. forficata</i> infusion (Test Group) and DM 2 patients who did not use (Control Group).	Total: 42 individuals Test Group: 20 individuals Control Group: 22 individuals	Total: 20 Male 22 Female Test Group: 9 Male 11 Female Control Group: 12 Male 10 Female	Total: 37-77 Test Group: 57,67 Average Control Group: 59,27 Average	Evaluation at the beginning and at the end of the experiment of anthropometric measurements (Weight, Height, Body Mass Index (BMI), Waist Circumference and Hip Circumference). Biweekly evaluation of blood pressure and fasting blood glucose by hemoglucotest of the two groups studied for 180 days. The Test Group was instructed to use a dessert spoon of chopped <i>B. forficata</i> leaves for a medium-sized full cup and prepare an infusion for three minutes, and consume it three times a day, once on an empty stomach, and twice before main meals.	There was a significant decrease in the values of hemoglucotest in the test group, compared to the values of the first and second analysis. Other analyzes did not show significant results. This result demonstrated that the infusion of <i>B. forficata</i> can be used as an adjuvant in the treatment of DM 2.
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Clinical case study:  
Investigate the hypoglycemic potential of the medicinal plant *B. forficata* by assessing glycated hemoglobin levels and testing capillary glycemia in individuals with diabetes *mellitus* (type 2).

(Pozzobon *et al.*, 2014).

Total: 49 individuals	Total: 19 Male 30 Female	Total: 65,51 (± 8,38)
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Four data analyses were performed for the study. In the first, all individuals were submitted to anthropometric assessment (weight, height, BMI and waist circumference) and glycemic assessment, using the capillary glycemia test (HGT) and glycated hemoglobin (A1C). In the second one, the previous evaluations were repeated and the patients received the infusion of *B. forficata* to start consumption. The patients were instructed to prepare an infusion of three minutes using a medium-sized cup of water with the quantity referring to a dessert spoon of chopped leaves of *B. forficata* and consuming three cups of this infusion daily, one being fasting, and twice before main meals. In the third analysis, 45 days after the introduction of the infusion, the user's HGT and A1C tests were reassessed. After five months of study, in the fourth and last analyse, anthropometric and glycemic data from all users were again measured.

Through Pearson's correlation, it was observed that there was a weak, positive and non-significant correlation between the values of A1C and BMI in the individuals evaluated in analyzes 1, 2 and 4. In the other analyzes, anthropometric and glycemic of HGT and A1C there was no significant differences before and after consuming the infusion. In this study, it was not possible to notice the hypoglycemic effect of *B. forficata* infusion in diabetic individuals.

<p>(Toloza-Zambrano, Avello &amp; Fernández, 2015).</p>	<p>Clinical case study:                  Determine the content of rutin and trigonelline in the aqueous and infused extracts of the leaves of <i>B. forficata</i> subsp. <i>pruinosa</i>, and then evaluate the effect caused by the infusion of 0,15% of the leaves on fasting blood glucose and glycated hemoglobin (HbA1c) levels in diabetic and pre-diabetic volunteers.</p>	<p>Total:                  15 individuals</p>	<p>Total:                  11 Male                  4 Female</p>	<p>Total:                  58                  (± 8)</p>	<p>The content of rutin (R) and trigonelline (T) was determined in the infusions of 0,15% and 1,0% of the lyophilized aqueous extract of the leaves of <i>B. Forficata</i> subsp. <i>pruinosa</i>, using the HPLC system. Subsequently, three data collections were carried out over three months, in which anthropometric (Weight, Height and BMI) and fasting blood glucose assessments of the individuals studied were performed. The analysis of HbA1c was performed only in the first and last data collection of the study. The patients were instructed to prepare an infusion using a teaspoon of the crushed leaves to one liter of heated water, wait for 15 minutes and then filter. During the three months, patients were instructed to consume one cup (250 ml) of this infusion three times a day, after meals.</p>	<p>The determined content of rutin (R) and trigonelline (T) in the 0,15% Infusion was: 2,80 µgR/mL and 2,87 µgT/mL; in the 1,0% infusion it was: 12,48 µgR/mL and 16,24 µgT/mL; and in the Infusion 0,1% of the lyophilized aqueous extract was: 5.70 µgR/mL and 8.14 µgT/mL. The results of the HbA1c analyzes showed a significant reduction, while the results of fasting blood glucose did not show a significant reduction. There was no evidence of a correlation between anthropometric data and glycemic values among the patients studied. The study considers that the use of <i>B. forficata</i> subsp. <i>pruinosa</i> can be effective in the complementary treatment of DM 2 and pre-diabetes.</p>
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(Heller, Bosco, Rempel & Moreira, 2013)	Clinical case study: Evaluate the anthropometry, blood pressure and fasting glucose levels in individuals who used <i>B. forficata</i> infusion (Group 1) and individuals who did not use the plant (Group 2).	Total: 54 individuals	Total: 40 Male 14 Female	Total: 64 (Average)	Two data collections were made, one before and one after the use of the plant. Anthropometry (weight, height, BMI), systolic blood pressure, diastolic blood pressure and fasting blood glucose (HGT) were assessed in both collections. The patients were instructed to prepare an infusion of three minutes using a medium-sized cup of water with the quantity referring to a dessert spoon of chopped leaves of <i>B. forficata</i> and consuming three cups of this infusion daily, one being fasting, and twice before main meals	In group 1 (Test), a significant reduction in diastolic blood pressure was observed. In group 2 (Control) there was no significant difference in any analyzed variable. In the comparison between the groups, there was a significant difference in the variables weight and BMI. The other variables analyzed did not show significant differences. The study suggests that the infusion of <i>B. forficata</i> is associated with a decrease in blood pressure, BMI and body weight, however, it has shown no evidence regarding its use as a hypoglycemic agent.
		Group 1: 31 individuals Group 2: 23 individuals	Group 1: Not measured in the study Grupo 2: Not measured in the study	Group 1: 65,6 (± 8,6) Group 2: 65,4 (± 8,4)		

Source: From the authors.

Analyzing the results of all studies, it was observed that only three studies obtained positive results in relation to the use of *B. forficata* infusion as an effective hypoglycemic agent in the treatment of DM. The other studies that did not show positive results in their results, highlighted that although the studied patients were monitored regularly, it could not be said that they consumed the infusion according to the recommendation established by the researchers, which may have been a factor that affected the results of research.

The studies conducted by Moraes *et al.* (2010); Zaccaron *et al.* (2014); and Toloza-Zambrano *et al.* (2015) presented positive results regarding the use of the infusion, which corroborates the study by Mariángel *et al.* (2019), which demonstrated a significant reduction in glycated hemoglobin values in diabetic individuals after ingesting the *B. forficata* infusion for a period of three months. These results are also in line with previous studies by Sixel & Pecinalli (2005), which also demonstrated the hypoglycemic effect of this plant in diabetic individuals who ingested the infusion of *B. forficata* for a period of 45 days.

However in the study conducted by Moraes *et al.* (2010), some gaps were identified, such as the fact that the researchers did not report in the methodology the frequency of consumption and the concentration of the infusion that patients were advised to follow, and this may have interfered with the final result.

In experimental studies with animals *in vivo*, such as Curcio *et al.* (2012), who investigated the effect of aqueous extract of *B. forficata* in diabetic mice and the study by Cunha *et al.* (2010) who demonstrated the effect of dry extract of *B. forficata* in hyperglycemic rats, it was possible to observe that in both studies they presented positive results in relation to the use of *B. forficata* as a potential glyceemic reducing agent.

Some authors suggest that this therapeutic effect of the medicinal plant is attributed to phytochemical compounds present in its aerial part, such as phytosterols, flavonoids, polyalcohols and alkaloids (Miyake, Akisue & Akisue, 1986). Among these compounds, rutin and trigonelline stand out (Sharma, Ali, Ali, Sahni & Baboota, 2013; Kappel *et al.*, 2013; Zhou & Zhou, 2012)

Studies have shown that rutin has a hypoglycemic effect due to the fact that its metabolites interfere in the formation processes of advanced glycation final products (AGEs) (Pashikanti, Alba, Boissonneault & Laurean, 2010), in addition to inhibiting the activity of disaccharides (maltose) and increasing insulin release, exercising a protective effect on pancreatic beta cells (Fontana-Pereira *et al.*, 2011).

Researchers concluded that the trigonelline compound has hypoglycemic activity because it works by inhibiting the mechanisms of intestinal glycosidase and insulin release, in addition to delaying gastric emptying and glucose absorption, inhibiting the facilitated transport of glucose in the cells of the intestinal epithelium (Shane-McWhorter, 2001).

It is possible to observe that both rutin and trigonelline have mechanisms of action similar to alpha glycosidase inhibiting drugs, such as acarbose and miglitol, which act by delaying intestinal digestion and absorption of carbohydrates, consequently reducing post-prandial blood glucose levels (American Diabetes Association, 2020).

In 2019 Brazil was ranked fifth among the countries with the highest number of diabetic people, with 16,8 million cases among adult individuals (20-79 years old) (International Diabetes Federation, 2019). National data on diabetes *mellitus* in Brazil estimates the prevalence of the disease at 7.4% of the population (Ministério da Saúde / Secretaria de Vigilância em Saúde, 2020, April).

Considering that diabetes is associated with possible complications such as renal failure, lower limb amputation, blindness, cardiovascular disease, among others, it can be observed that diabetes is a disease that generates high social and financial costs for the patient and the health system (International Diabetes Federation, 2019). Studies have estimated that DM caused 12,0% of total hospitalizations not related to pregnancies, and up to 15,4% of hospital costs in the Brazilian Unified Health System (SUS) in the period from 2008 to 2010 (Rosa, Nita, Rached, Donato & Rahal, 2014). For this reason, the use of *Bauhinia forficata* would be a sustainable and economically viable alternative for the health system, since the plant is already cataloged in the National List of Medicinal Plants of Interest to SUS (RENISUS) as a medicinal plant with antidiabetic properties (Marques *et al.*, 2013).

It is important to report that many individuals use medicinal plants initially in search of clinical improvement, however, when there is no therapeutic efficacy coming from the plants, it is extremely important to look for physicians and pharmacists to better investigate the clinical condition (Fabro, Ramos, Israel & Souza, 2020). In addition, the practice of using medicinal plants in the treatment of diseases is improved over the years and passed on from generation to generation (Moraes *et al.*, 2020).

Therefore, it is possible to verify that although there are few studies that use the infusion of *B. forficata* in humans, there is evidence that the use of the infusion of *Bauhinia forficata* can be promising for the treatment of diabetes *mellitus*.

The study has some limitations, which interfere with the conclusion about the effectiveness of using *B.forficata* infusion in the treatment of DM. These limitations consist

mainly of the reduced number of studies that use the method of preparation of infusion, and the methodology often simple or without much consistency.

#### 4. Final Considerations

This review demonstrated that the infusion of *B. forficata* has the potential to act as a support in the treatment of diabetes *mellitus*, since there are studies that present evidence regarding its hypoglycemic action, in addition to having a promising role for the phytotherapy industry, since it is a low-cost natural medicine, easily accessible by the Brazilian population.

However, it is possible to realize that further research using the plant infusion in diabetic and hyperglycemic humans are needed. This is reflected in the low number of studies available for analysis, even when using reputable scientific article indexing bases.

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