Journal of Ethnopharmacology 139 (2012) 155–163

ELSEVIER

Journal of Ethnopharmacology

journal homepage: www.elsevier.com/locate/jethpharm

Plants used as antidiabetics in popular medicine in Rio Grande do Sul, southern Brazil

M. Trojan-Rodrigues[a], T.L.S. Alves[a], G.L.G. Soares[a,b], M.R. Ritter[a,b,*]

[a] *Pós-Graduação em Botânica, Instituto de Biociências, Universidade Federal do Rio Grande do Sul. Av. Bento Gonçalves 9500, Prédio 43433, Campus do Vale, 91501-970, Porto Alegre, RS, Brazil*

[b] *Depto. de Botânica, Instituto de Biociências, Universidade Federal do Rio Grande do Sul. Av. Bento Gonçalves 9500, Prédio 43433, Campus do Vale, 91501-970, Porto Alegre, RS, Brazil*

ARTICLE INFO

Article history:
Received 27 July 2011
Received in revised form 24 October 2011
Accepted 26 October 2011
Available online 2 November 2011

Keywords:
Folk medicine
Ethnobotany
Diabetes mellitus
South Brazil

ABSTRACT

Ethnopharmacological relevance: Plants are widely as antidiabetics. The study of these plants is essential because many of them may have undesirable effects, such as acute or chronic toxicity; or their use may even delay or discourage the adoption of the proper and effective treatment.

Materials and methods: The present study surveyed the plant species that are popularly used to treat *diabetes mellitus* in the state of Rio Grande do Sul in southern Brazil. Sixteen ethnobotanical surveys performed in the state were consulted, and the species used to treat diabetes were listed. For species cited in at least two of the studies, scientific data related to antidiabetic activity were searched in the *ISI Knowledge* database. The scientific binomial of each species was used as keywords, and data found in review papers were also included.

Results: A total of 81 species in 42 families were mentioned; the most important families were Asteraceae and Myrtaceae. Twenty eight species were cited at least twice as being used to treat diabetes in the state. For 11 of these, no scientific data regarding antidiabetic activity could be located. The species most frequently mentioned for use with diabetes were *Syzygium cumini* (Myrtaceae) and *Bauhinia forficata* (Fabaceae), in 12 studies each, followed by *Sphagneticola trilobata* (Asteraceae), in six studies; and *Baccharis trimera* (Asteraceae), *Bidens pilosa* (Asteraceae), *Cynara scolymus* (Asteraceae), and *Leandra australis* (Melastomataceae) in four studies each. *Bauhinia forficata* and *Syzygium cumini* have been studied in more detail for antidiabetic activity.

Conclusions: A considerable number of plant species are traditionally used for the treatment of diabetes melitus in the Rio Grande do Sul State. The majority of those plants that have been studied for antidiabetic activity showed promising results, mainly for *Bauhinia forficata* and *Syzygium cumini*. However, for most of the plants mentioned, the studies are not sufficient to guarantee the efficacy and safety in the use of these plants in the treatment against diabetes.

1. Introduction

Diabetes mellitus is a metabolic disease that currently affects 250 million people around the world. Each year another 7 million people develop the disease (International Diabetes Federation, 2011), resulting in a chronic state of hyperglycemia. The condition is characterized by the body's inability to transform sugar into energy, causing hyperglycemia. Hyperglycemia can cause retinopathy, nephropathy, and cardiovascular damage (American Diabetes Association, 2007; Malviya et al., 2010).

WHO estimates that 30 million people had diabetes in 1985, and this number increased to 171 million people in 2000. In that year, an estimated 2.9 million people died of diabetes, representing 5.2% of all deaths, probably the fifth largest cause of mortality in the world (Roglic et al., 2005). It is estimated that in 2030, people with diabetes will number 366 million, most of them from developing countries, especially the among people from 45 to 64 years of age (Roglic, 2004).

Marles and Farnsworth (1995) listed 1200 species of plants that have been used to treat diabetes worldwide. They mostly belong to the families Fabaceae, Asteraceae, and Lamiaceae.

Among the main natural hypoglycemic products are carbohydrates, alkaloids, glycopeptides, terpenoids, flavonoids, and coumarins (Marles and Farnsworth, 1995; Negri, 2005; Cazarolli et al., 2008).

In Brazil, the use of plants as antidiabetics is very common, as reported by Volpato et al. (2002), Barbosa-Filho et al. (2005), Negri

* Corresponding author at: Programa de Pós-Graduação em Botânica, Instituto de Biociências, Universidade Federal do Rio Grande do Sul. Av. Bento Gonçalves 9500, Prédio 43433, Campus do Vale, 91501-970, Porto Alegre, RS, Brazil.
Tel.: +55 51 33087571.
E-mail address: mara.ritter@ufrgs.br (M.R. Ritter).

0378-8741
doi:10.1016/j.jep.2011.10.034

(2005), and Borges et al. (2008). In Rio Grande do Sul, several ethnobotanical studies established that the use of plants for metabolic disorders such as diabetes is common (Simões et al., 1986; Ceolin, 2009).

According to Witters (2001), in the Middle Ages, *Galega officinalis* L. (Fabaceae) was prescribed for polyuria, one of the most common symptoms of diabetes. The active principle in *Galega officinalis* is known as guanidine. Although guanidine this and some of its derivatives are overly toxic to treat diabetes, dimeric forms known as biguanides have been considered useful to treat the disease since the 1950s.

About 66% of the Brazilian population has no access to commercial medicines, which means that the use of plants is their only alternative for the treatment of their ills (Di Stasi, 2007). In this context, ethnobotanical studies that have the main objective to catalogue knowledge about medicinal plants and cultural aspects of communities can serve as the basis to list species to be studied as medicinal in order to validate the use, encourage the production of phytotherapeutics from these plants, or even the isolation and/or semi-synthesis of bioactive molecules (Elisabetsky and Coelho de Souza, 2007). The development of medicines by the production of synthetic or semi-synthetic bioactive molecules is based on the chemical diversity of plants (Phillipson, 2007).

This study surveyed the plant species mentioned for the treatment of diabetes in ethnobotanical surveys performed in Rio Grande do Sul, and evaluated the current status of scientific knowledge related to the antidiabetic activity of these plants.

2. Materials and methods

Sixteen ethnobotanical studies performed in Rio Grande do Sul were consulted: Simões et al. (1986); Kubo (1997); Garlet (2000); Marodin (2000); Possamai (2000); Garlet and Irgang (2001); Ritter et al. (2002); Hass (2003); Leitzke (2003); Martha (2003); Sebold (2003); Löwe (2004); Soares et al. (2004); Vendruscolo (2004); Barbosa (2005); Vendruscolo and Mentz (2006); Barros et al. (2007), and Ceolin (2009). The papers consist of articles, master's dissertations, and monographs contributed by researchers in the state, and were found in databases or in university libraries.

The plants used for the treatment of diabetes mentioned in these studies were selected by searching for terms such as "*diabete*", "*diabetes*" and "*lower the blood sugar*".

The popular names mentioned for these species, as they are given in the studies consulted, were compiled. For better understanding, the information concerning the plant parts used in preparations has been standardized. Terms related to preparation form such as infusion and decoction have been standardized as "tea", since these methods just differ in the extraction time and the temperature reached. The plants that were identified only to genus are listed separately, and were not considered in further analyses. The valid names of the species and the authors were confirmed using the databases Tropicos (2011) and The Plant List (2011). However, it was decided to retain the names given to the species as *Baccharis crispa*, *Baccharis trimera*, *Cynara scolymus* and *Eruca sativa* because the new combinations are not widely recognized currently yet. The botanical families were updated based on the APG III classification system (Stevens, 2011).

For species listed in two or more ethnobotanical studies, chemical data and data related to antidiabetic activity, found in studies in the database ISI Web of Knowledge (2010) were searched. In the search for these data, the scientific binomial of the plant was used as the descriptor.

3. Results and discussion

The ethnobotanical studies consulted mentioned 568 taxa with some medicinal usage, 84 of them used to treat diabetes. Among these, only three were not identified to species level, and were not counted in the final list. They are: *Eucalyptus* sp., Myrtaceae (Marodin, 2000); *Mentha* sp., Lamiaceae (Marodin, 2000); and *Origanum* aff. *vulgare*, Lamiaceae (Soares et al., 2004). The species of these genera are admittedly difficult to delimit, in addition to the occurrence of many hybrids.

The 81 species used for diabetes in the state of Rio Grande do Sul (Table 1) are members of 42 botanical families. Species of the families Asteraceae and Myrtaceae were most often mentioned, comprising, respectively 29% and 15% of the occurrences. The relatively high number of species of the families Asteraceae and Fabaceae agrees with the findings of Marles and Farnsworth (1995).

These two families include species of great abundance and biodiversity in Brazil (Giulietti et al., 2005) and plants of these families also have a highly developed secondary metabolism. A considerable fraction of antidiabetic compounds belonging to species of these families have been described and tested for diabetes and its complications (Marles and Farnsworth, 1995; Negri, 2005; Jung et al., 2006). There is a predominance of species belonging to the "tanniferous diagonal" which is a chemical group of families characterized by the production of large amounts of tannins (commonly gallic acid derivatives) and comprises the Cronquist's subclasses: Hammamelidade, Dillenidae and Rosidae (Dahlgren, 1980; Kubitzki and Gottlieb, 1984a). The species placed in this chemical group are often woody and tend to contain shikimate derivatives (Kubitzki and Gottlieb, 1984b). These compounds are also of great importance regarding antidiabetic activity known so far, because of their antioxidant properties (Negri, 2005). Several species of the family Myrtaceae are rich in tannins, flavonoids, and other phenolic derivatives. Among these classes, some compounds with antioxidant activity have been isolated.

The family Lamiaceae occupies a significant place in many ethnobotanical surveys, because of its aromatic characteristics and high phytochemical diversity, but did not have great significance in this study. Importantly, hypoglycemic activities attributed to flavonoids in the leaves of *Origanum majorana* L. and phenolic compounds from the leaves of *Hyssopus officinalis* L. have been found (Jung et al., 2006).

The species most frequently mentioned for use with diabetes were *Syzygium cumini* (Myrtaceae) and *Bauhinia forficata* (Fabaceae), in 12 studies each, followed by *Sphagneticola trilobata* (Asteraceae), in six studies; and *Baccharis trimera* (Asteraceae), *Bidens pilosa* (Asteraceae), *Cynara scolymus* (Asteraceae), and *Leandra australis* (Melastomataceae) in four studies each.

The monocots, although their metabolism has fewer secondary metabolites, contain many polysaccharides, which also show hypoglycemic activity (Von Poser, 2007). In *Saccharum officinarum*, e.g., the activity was found in the stems, where usually occurs the accumulation of polysaccharides (Takahashi et al., 1985).

The predominance of the use of teas agrees with the findings of surveys for medical use in general. The use of tea has a strong cultural appeal (Santayana et al., 2005). In the case of plants used for diabetes, this is particularly important because the antioxidants are commonly soluble in water. Furthermore, some reports described a combination of plants such as compound teas, elixirs, and also the use of the plant together with "chimarrão", a drink made with leaves of *Ilex paraguariensis* A. St. Hil., which is widely consumed in southern Brazil.

Popular names such as "insulin" and "vegetal insulin" were repeatedly mentioned, for four species of two different families: *Aspilia montevidensis* and *Sphagneticola trilobata* (Asteraceae); and

Table 1
Species used as antidiabetic mentioned in ethnobotanical surveys in Rio Grande do Sul, Brazil, distributed by family, indicating origin, popular names, used parts, preparation form and data related to the antidiabetic activity, found in scientific studies in the database ISI Web of Knowledge (2010).

Family	Species	Origin	Used part	Prepare form	References	Antidiabetic activity
Adoxaceae	*Sambucus australis* Cham. & Schltdl.	Native	Leaves; flowers	Tea	Garlet and Irgang (2001)	No anti diabetic related studies were found
			Leaves	Tea, compress	Leitzke (2003)	
Amaryllidaceae	*Allium sativum* L.	Exotic	Bulbil	Dye	Leitzke (2003)	–
Anacardiaceae	*Mangifera indica* L.	Exotic	–	–	Soares et al. (2004)	It has been reported that aqueous extract of leaves may have hypoglycemic activity in glucose-induced hyperglycemic rats (Aderibigbe et al., 2001); decreased of biodisponibility of glucose in vitro attributed to dietary fiber (Gourgue et al., 1992)
			Leaves	–	Vendruscolo and Mentz (2006)	
Apiaceae	*Petroselinum crispum* (Mill.) Nyman ex A.W. Hill	Exotic	Leaves	Tea, food	Marodin (2000)	
Aristolochiaceae	*Aristolochia triangularis* Cham.	Native	Leaves	–	Vendruscolo and Mentz (2006)	–
Asparagaceae	*Sanseviera zeylanica* Willd.	Exotic	Leaves	Tea	Marodin (2000)	–
Asteraceae	*Achillea millefolium* L.	Exotic	–	–	Soares et al. (2004)	–
Asteraceae	*Achyrocline satureioides* (Lam.) DC.	Native	Flowers	Tea (boiled with milk)	Marodin (2000)	Antihyperglycemic activity attributed to achyrofuran (Carney et al., 2002)
			Inflorescence	Tea, tea with eggnog, compound tea (with onion skin, orange and lemon drops), stuffy	Sebold (2003)	
Asteraceae	*Aspilia montevidensis* (Spreng.) O. Kuntze	Native	Inflorescence	Mal-me-quer (flower) + lard + beeswax – prepare a healing ointment for wounds which heal with difficulty. It would not work for those who have circulation problems	Ceolin (2009)	No anti diabetic related studies were found
Asteraceae	*Baccharis articulata* (Lam.) Pers.	Native	Leaves	Tea	Garlet and Irgang (2001)	Activity of crude extracts, dichloromethane, ethyl acetate and n-butanol fractions obtained from aerial parts (De Oliveira et al., 2003)
			Leaves	–	Barbosa (2005)	
			Leaves; roots	Tea	Kubo (1997)	
			Whole plant	Tea	Possamai, 2000	
Asteraceae	*Baccharis crispa* Spreng.	Native	Flowers; leaves	Tea	Ceolin (2009)	–
Asteraceae	*Baccharis gaudichaudiana* DC.	Native	Aerial parts	Tea	Garlet and Irgang (2001)	–
Asteraceae	*Baccharis trimera* (Less.) DC.	Native	Leaves	Elixir	Hass (2003)	Aqueous fraction reduced the glycemia (Oliveira et al., 2005)
			–	Tea	Leitzke (2003)	
			Aerial parts	Tea, dye	Marodin (2000)	
			Aerial parts	–	Simões et al. (1986)	
Asteraceae	*Bidens pilosa* L.	Native	Roots; aerial parts; flowers (inflorescence)	Tea, flower dust	Garlet and Irgang (2001)	Antihyperglycemic activity of the extract by simulation of secretion via pancreatic islets (Hsu et al., 2009); butanol fraction showed potential to prevent Th1-mediated diabetes but promoted Th2-mediated inflammation (Chang et al., 2004, 2005); water ethanol extracts reduced the hyperglycemia in mildly diabetic mice (Alarcon-Aguilar et al., 2002); The aqueous alcohol extract of the aerial parts showed hypoglicemic activity attributed to polyacetylenic glucosides (Ubillas et al., 2000)
			Whole plant	Tea, gargle	Leitzke (2003)	
			–	–	Löwe (2004)	
			Whole plant	–	Simões et al. (1986)	
			–	–	Soares et al. (2004)	
Asteraceae	*Cynara scolymus* L.	Exotic	Leaves	Tea	Kubo (1997)	No anti diabetic related studies were found
			Green fruits	Tea, food	Leitzke (2003)	
			Leaves	Tea	Possamai (2000)	
			–	–	Ritter et al. (2002)	
Asteraceae	*Galinsoga parviflora* Cav.	Native	Leaves; roots	Tea, poultice and gargle	Leitzke (2003)	–
Asteraceae	*Sonchus oleraceus* L.	Exotic	Leaves	Tea	Barros et al. (2007)	No anti diabetic related studies were found
			Leaves	–	Vendruscolo and Mentz (2006)	
Asteraceae	*Sphagneticola trilobata* (L.) Pruski	Native	Leaves	Tea	Barros et al. (2007)	It was reported that kaurenoic acids exhibit hypoglycemic effects (Bresciani et al., 2004)
			Leaves	Tea	Garlet and Irgang (2001)	
			Leaves	Tea	Marodin (2000)	
			Aerial parts	Tea	Martha (2003)	
			–	–	Soares et al. (2004)	
			Leaves	–	Vendruscolo and Mentz (2006)	

Table 1 (*Continued*)

Family	Species	Origin	Used part	Prepare form	References	Antidiabetic activity
Asteraceae	*Tagetes minuta* L.	Native	Stem; leaves; inflorescence	Tea	Kubo (1997)	–
Asteraceae	*Tanacetum vulgare* L.	Exotic	Aerial parts	Tea, alcoholic macerated of the aerial part	Garlet and Irgang (2001)	–
Asteraceae	*Taraxacum officinale* Webb	Exotic	Leaves	Tea	Garlet and Irgang (2001)	–
Boraginaceae	*Symphytum officinale* L.	Exotic	–	–	Ritter et al. (2002)	–
Brassicaceae	*Eruca sativa* Mill.	Exotic	Leaves	Food	Ceolin (2009)	–
Brassicaceae	*Lepidium aletes* J.F. Macbr.	Native	Stem; leaves; fruits	Tea	Kubo (1997)	–
Brassicaceae	*Lepidium bonariense* L.	Native	Leaves; aerial parts	Tea	Sebold (2003)	–
Celastraceae	*Maytenus ilicifolia* Mart. ex Reissek	Native	Leaves	Tea	Ceolin (2009)	–
Commelinaceae	*Tradescantia zebrina* Heynh.	Exotic	Inflorescence bracts; aerial parts	–	Vendruscolo and Mentz (2006)	–
Cucurbitaceae	*Sechium edule* (Jacq.) Sw.	Exotic	Leaves	Tea	Leitzke (2003)	No anti diabetic related studies were found
			Leaves	Tea, compound tea with cana-de-açúcar leaves and erva-cidreira	Sebold (2003)	
Equisetaceae	*Equisetum giganteum* L.	Native	Aerial parts	–	Vendruscolo and Mentz (2006)	–
Fabaceae	*Bauhinia forficata* Link	Native	Leaves; flowers	Tea	Garlet and Irgang (2001)	Antioxidant activity related to antidiabetic activity (Souza et al., 2009; Khalil et al., 2008); kaempferol-3-neohesperidoside showed mimetic effect like insulin (Cazarolli et al., 2009b); absence of antidiabetic activity (Volpato et al., 2008); antidiabetic effect attributed to kaempferitrin (Jorge et al., 2004); for review (Cechinel, 2009)
			Leaves	Elixir	Hass (2003)	
			Leaves	Tea, chimarrão, alcoholature diluted in water	Kubo (1997)	
			Bark; leaves; flowers	Tea	Leitzke (2003)	
			Leaves	Tea	Löwe (2004)	
			Leaves	Tea, dye	Marodin (2000)	
			Leaves	Tea	Possamai (2000)	
			–	–	Ritter et al. (2002)	
			Leaves; flowers	Tea	Sebold (2003)	
			Leaves	–	Simões et al. (1986)	
			–	–	Soares et al. (2004)	
			Leaves	–	Vendruscolo and Mentz (2006)	
Fabaceae	*Bauhinia microstachya* (Raddi) J.F. Macbr.	Native	Leaves	Tea, alcoholature, alcoholature for fomentation	Sebold (2003)	–
Fabaceae	*Bauhinia variegata* L.	Exotic	Leaves	Tea	Martha (2003)	–
Fabaceae	*Caesalpinia ferrea* Mart.	Native	Bark	Compound tea with guabiroba hull	Sebold (2003)	–
Fabaceae	*Gleditsia amorphoides* (Griseb.) Taub.	Native	Bast, pod	Syrup	Magalhães (1997)	–
Hydrangeaceae	*Hydrangea macrophylla* (Thunb.) Ser.	Exotic	Leaves	–	Vendruscolo and Mentz (2006)	–
Juglandaceae	*Carya illinoinensis* (Wangenh.) K. Koch	Exotic	Leaves	Tea, syrup	Garlet and Irgang (2001)	–
Lamiaceae	*Leonurus sibiricus* L.	Exotic	Stem; leaves	Tea	Kubo (1997)	–
Lamiaceae	*Origanum xapplii* Boros	Exotic	–	–	Soares et al. (2004)	–
Lamiaceae	*Salvia officinalis* L.	Exotic	–	Condiment, tea, gargle, "vinho-da-sálvia"	Leitzke (2003)	Hypoglycemic activity and metformin-like effect of essential oil from leaves (Lima et al., 2006); methanolic extract has hypoglycemic effect on diabetic animals (Eidi et al., 2005)
			Leaves; aerial parts	Tea, compound tea with guaco leaves and bergamota with brown sugar burned on charcoal, tea for mouthwash, alcoholature with wine, cigarette	Sebold (2003)	

Lauraceae	*Cinnamomum verum* J. Presl	Exotic	Bark	Tea	Leitzke (2003)	–
Lauraceae	*Persea americana* Mill.	Exotic	Seeds	Tea, chimarrão, alcoholature	Possamai (2000)	–
Loranthaceae	*Struthanthus vulgaris* Eichler	Exotic	Leaves	Tea	Possamai (2000)	–
Loranthaceae	*Tripodanthus acutifolius* (Ruiz & Pav.) Tiegh.	Native	Leaves; flowers	Tea	Leitzke (2003)	–
Malpighiaceae	*Bunchosia argentea* (Jacq.) DC.	Exotic	–	–	Soares et al. (2004)	–
Malvaceae	*Malvastrum coromandelianum* (L.) Garcke	Native	–	–	Soares et al. (2004)	–
Malvaceae	*Waltheria communis* A. St. -Hil.	Native	Leaves	–	Barbosa (2005)	–
Melastomataceae	*Leandra australis* (Cham.) Cogn.	Native	Leaves	Tea, chimarrão	Ceolin (2009)	No anti diabetic related studies were found
			Whole plant	Elixir	Hass (2003)	
			Aerial parts	Dye	Marodin (2000)	
			Leaves; flowers	Tea	Possamai (2000)	
Moraceae	*Morus alba* L.	Exotic	Leaves	–	Vendruscolo and Mentz (2006)	–
Moraceae	*Morus nigra* L.	Exotic	Leaves	–	Vendruscolo and Mentz (2006)	–
Myrtaceae	*Campomanesia guazumifolia* (Cambess.) O. Berg	Native	–	–	Soares et al. (2004)	–
Myrtaceae	*Campomanesia xanthocarpa* O. Berg	Native	Bark; leaves; roots	Tea	Possamai (2000)	–
		Native	Bark; leaves; fruits	Tea, juice, compound tea with pau-ferro bark	Sebold (2003)	–
		Native	–	"Three sete-capota branches plus three pitangueira branches and three goiabeira branches""	Soares et al. (2004)	–
Myrtaceae	*Eucalyptus globulus* Labill.	Exotic	Leaves	Elixir	Hass (2003)	–
		Exotic	Bark; leaves	Tea	Leitzke (2003)	–
		Exotic	Leaves	–	Simões et al. (1986)	–
Myrtaceae	*Eugenia involucrata* DC.	Native	Bark	Tea	Sebold (2003)	–
Myrtaceae	*Eugenia uniflora* DC.	Native	–	Tea, syrup, food	Leitzke (2003)	–
			Buds; leaves	Tea	Barros et al. (2007)	–
			Leaves	Tea	Garlet and Irgang (2001)	–
			Leaves	–	Simões et al. (1986)	–
Myrtaceae	*Psidium cattleianum* Sabine	Native	Leaves	–	Vendruscolo and Mentz (2006)	–
Myrtaceae	*Syzygium cumini* (L.) Skeels	Exotic	Seeds	Tea (in drops)	Ceolin (2009)	Hypoglycemic activity of ethanolic crude extract of leaves in diabetic rats (Schoenfelder et al., 2010); aqueous leaf extracts showed hypoglicemic activity in hyperglycemic patients (Bopp et al., 2009); hypoglicemic activity attributed to cuminoside from seeds (Farswan et al., 2009); hypoglycemic activity of mycaminose extracted from seed (Kumar et al., 2008); ethanolic extract of seeds showed hypoglicemic activity in rats (Singh and Gupta, 2007) absence of antihyperglycemic effect of tea and extracts prepared from leaves in normal rats, rats with streptozotocin-induced diabetes, normal volunteers and patients with diabetes (Teixeira and Fuchs, 2006); in vitro glucose uptake activity (Anandharajan et al., 2006); aqueous extract decreased the blood glucose in normal and diabetic rats (Rafiullah et al., 2006); dried bark extract showed antihyperglycemic and hypoglicemic activities (Villaseñor and Lamadrid, 2006); tea prepared from leaves of *S. cumini* do not showed hypoglycemic effect in patients with type 2 diabetes mellitus (Teixeira et al., 2006); extract do not reduced the glycemia in diabetic mice (Oliveira et al., 2005) the tea and extracts prepared from leaves are pharmacologically inert in diabetic patients (Teixeira et al., 2004); the treatment with tea prepared from leaves did not produce any antihyperglycemic effect in young volunteers neither the crude extract prepared from leaves in diabetic or non-diabetic rats (Teixeira et al., 2000); the tea concentration had none detectable antihyperglycemic effect either in normal or in diabetic rats (Teixeira et al., 1997)
			Leaves	Tea	Garlet and Irgang (2001)	
			Seeds	Elixir	Hass (2003)	
			Leaves	Tea	Kubo (1997)	
			Seeds	Tea, seed dust	Leitzke (2003)	
			–	–	Löwe (2004)	
			Leaves; seeds	Tea	Marodin (2000)	
			Leaves	Tea	Martha (2003)	
			Leaves; fruits	Tea	Possamai (2000)	
			Leaves	Tea	Sebold (2003)	
			–	–	Soares et al. (2004)	
			Floral button; seeds	–	Vendruscolo and Mentz (2006)	

Table 1 (*Continued*)

Family	Species	Origin	Used part	Prepare form	References	Antidiabetic activity
Myrtaceae	*Syzygium jambos* (L.) Alston	Exotic	Leaves	Tea	Sebold (2003)	Absence of antihyperglycemic effect from leaves in humans (Teixeira et al., 2000)
			–	–	Soares et al. (2004)	
Oxalidaceae	*Averrhoa carambola* L.	Exotic	Leaves; fruits	Tea	Possamai (2000)	Hypoglycemic activity attributed to apigenin-6-C-beta-L-fucopyranoside (Cazarolli et al., 2009a); hydro alcoholic extract showed active in the treatment of diabetes (Ferreira et al., 2008); dietary fibers are active in the absorption of glucose (Chau et al., 2004)
			Leaves	Tea	Sebold (2003)	
			–	–	Soares et al. (2004)	
Phyllanthaceae	*Phyllanthus niruri* L.	Native	Leaves	Tea	Barros et al. (2007)	Methanolic extract of aerial parts showed hypoglycemic activity in rats (Okoli et al., 2010)
			Leaves	Tea	Leitzke (2003)	
			Aerial parts; roots	–	Simões et al. (1986)	
Plantaginaceae	*Plantago australis* Lam.	Native	Leaves	Tea, chimarrão	Possamai (2000)	–
Poaceae	*Coix lacryma-jobi* L.	Exotic	Leaves	Tea	Ceolin (2009)	Absence of in vitro activity (Kotowaroo et al., 2006)
			Roots	Tea	Possamai (2000)	
Poaceae	*Saccharum officinarum* L.	Exotic	Leaves	Tea	Marodin (2000)	Stalks showed hypoglycemic activity in normal and alloxan-produced hyperglycemic mice (Takahashi et al., 1985)
			Leaves	Tea	Possamai (2000)	
Polygonaceae	*Muehlenbeckia sagittifolia* (Ortega) Meisn.	Native	Leaves	Tea, sitz baths	Garlet and Irgang (2001)	No anti diabetic related studies were found
			Leaves	Alcoholature, tea	Marodin (2000)	
			Aerial parts	–	Vendruscolo and Mentz (2006)	
Polypodiaceae	*Microgramma squamulosa* (Kaulf.) de la Sota	Native	Whole plant	Tea	Garlet and Irgang (2001)	–
Rosaceae	*Eriobotrya japonica* (Thunb.) Lindl.	Exotic	Root bark	Tea	Leitzke (2003)	–
Rosaceae	*Prunus persica* (L.) Batsch	Exotic	Fruits	Food	Leitzke (2003)	–
Rosaceae	*Rubus brasiliensis* Mart.	Native	Leaves	Tea	Kubo (1997)	No anti diabetic related studies were found
			Leaves; roots	Tea	Leitzke (2003)	
Rubiaceae	*Richardia brasiliensis* Gomes	Native	–	–	Soares et al. (2004)	–
Rutaceae	*Citrus aurantifolia* (Christm.) Swingle	Exotic	–	–	Soares et al. (2004)	–
Rutaceae	*Citrus aurantium* L.	Exotic	Seeds	Maceration, tea and food	Leitzke (2003)	Absence of hypoglicemic activity in diabetic rat model (Figueroa-Valverde et al., 2009); reestablishment of normal glucose levels by umbelliferone in streptozotocin-induced diabetic rats (Ramesh and Pugalendi, 2007a); normalization of circulatory and tissue levels of glucose by umbelliferone in diabetic rats (Ramesh and Pugalendi, 2007b)
			Leaves	Tea	Possamai (2000)	
			Leaves, fruits, fruit hulls, seeds, flowers	–	Vendruscolo and Mentz (2006)	
			Leaves, leaves without midrib, seeds, fruit hull	Tea, let it soaking in the water, compound tea with onion skin, lemon drops and marcela flowers	Sebold (2003)	
Salicaceae	*Casearia sylvestris* Sw.	Native	Leaves	Tea, bath, chimarrão	Possamai (2000)	–
Scrophulariaceae	*Stemodia verticillata* (Mill.) Hassl.	Native	Leaves	–	Vendruscolo and Mentz (2006)	–
Solanaceae	*Solanum paniculatum* L.	Native	Roots; leaves; fruits	Internal use	Simões et al. (1986)	–
Tropaeolaceae	*Tropaeolum pentaphyllum* Lam.	Native	Flowers	–	Ritter et al. (2002)	–
Urticaeae	*Urtica urens* L.	Exotic	Leaves	Salad	Leitzke (2003)	–
Verbenaceae	*Stachytarpheta cayennensis* (Rich.) Vahl	Native	Leaves; flowers	Elixir	Hass (2003)	Extracts of leaves showed significant blood glucose reductions (Adebajo et al., 2007)
			Aerial parts	Dye	Marodin (2000)	
Vitaceae	*Cissus sicyoides* L.	Exotic	Leaves	Tea	Barros et al. (2007)	–
Vitaceae	*Cissus verticillata* (L.) Nicolson & C.E. Jarvis	Native	Leaves	Tea	Possamai (2000)	No anti diabetic related studies were found
			–	–	Soares et al. (2004)	
Xanthorrhoeaceae	*Aloe arborescens* Mill.	Exotic	Leaves	Blend the leaves without the margins	Marodin (2000)	–
Zingiberaceae	*Alpinia zerumbet* (Pers.) B.L. Burtt & R.M. Sm.	Exotic	–	–	Soares et al. (2004)	–

Dashes (–) indicate plants which were not reviewed in *ISI Web of Knowledge.*

Cissus sicyoides and *Cissus verticillata* (Vitaceae). The adoption of names of medicaments for medicinal plants has been reported for some time, and indicates the occurrence of acculturation in the use of medicinal plants (Martins et al., 2005) This phenomenon is characterized by the abandonment of the traditional designation of one plant for another name that corresponds to a medicine used with the same therapeutic purpose (Di Stasi, 2007). In Rio Grande do Sul, Kubo (1997) and Marodin (2000) reported this phenomenon for several plants found in their work, emphasizing the term "insulin". One alarming consequence of this phenomenon is the replacement of the medicine by the plant. This substitution can cause intoxication, and if the plant is ineffective, delays the proper treatment of the disease, increasing the damage caused by the secondary effects of hyperglycemia. This substitution may occur because people must find a less expensive substitute for commercial medications, or even because of the belief that a natural product would cause less adverse effects than the medications that are usually prescribed.

For the species *Syzygium jambos* and *Coix lacryma-jobi*, the studies that were found reported a lack of antidiabetic potential (Teixeira et al., 2000; Kotowaroo et al., 2006). *Bauhinia forficata* and *Syzygium cumini* have been studied in more detail for antidiabetic activity. Notably, for the *Syzygium cumini*, the clinical studies that reported a lack of antidiabetic activity were carried out using leaves, the plant part used by the population (Teixeira et al., 1997, 2000, 2004, 2006; Oliveira et al., 2005; Teixeira and Fuchs, 2006). However, very promising studies in rats have reported antidiabetic activity of the fruits (Singh and Gupta, 2007; Kumar et al., 2008; Farswan et al., 2009).

According to Fröde and Medeiros (2008), there is no homogeneity in the way that the studies with potential antidiabetic plants are conducted, which complicates the interpretation of the results. This lack of standardization makes it difficult to validate the plant use, and may discourage further studies. However, the chances of finding an active compound in a plant traced from ethnobotanical information are a thousandfold higher than random chance in conventional techniques (Elisabetsky and Coelho de Souza, 2007). Just as a high level of agreement on the utility of a plant may suggest a higher probability of a therapeutic effect, facilitating the selection of species for studies on pharmacological activity (Friedman et al., 1986; Pinto et al., 2006), the findings in this study about the species most often mentioned for diabetes treatment may similarly serve this purpose.

In general, almost nothing is known about the specific mode of action of plants used to treat diabetes. However, most of these plants are rich in metabolites such as glycosides, alkaloids, terpenoids, and flavonoids. Within these classes, compounds with antidiabetic effects are often found (Malviya et al., 2010).

In summary, a considerable number of plant species are traditionally used for the treatment of diabetes melitus in the Rio Grande do Sul State. On other hand some of these plants have not been researched to confirm the antidiabetic activity. This fact highlights the importance of phytochemical and preclinical studies with these plants. Due to the large number of citations, *Bauhinia forficata* and *Syzygium cummini* deserve special attention for these studies. Furthermore, plants cited in this study appear to have a relatively similar chemical pattern, thus even the less-cited species appear to be a promising targets to screening for antidiabetic activity and antidiabetic drugs.

Acknowledgements

We are thankful to everybody who kindly took part in the surveys recording the ethnobotanical knowledge in the state of Rio Grande do Sul, Brazil. Our thanks also to Dr. Lilian Auller Mentz and Dr. Rumi Regina Kubo for their contributions to this paper, as well Raquel Ludke for the information about additional surveys. This research was carried out with financial support from the CAPES (Coordination for the Improvement of Higher Education Personnel – Brazil).

References

Adebajo, A.C., Olawode, E.O., Omobuwajo, O.R., Adesanya, S.A., Begrow, F., Elkhawad, A., Akanmu, M.A., Edrada, R., Proksch, P., Schimidt, T.J., Klaes, M., Verspohl, E.J., 2007. Hypoglycaemic constituents of *Stachytarpheta cayennensis* leaf. Planta Medica 73, 241–250.

Aderibigbe, A.O., Emudianughe, T.S., Lawal, B.A.S., 2001. Evaluation of the antidiabetic action of *Mangifera indica* in mice. Phytotherapy Research 15, 456–458.

Alarcon-Aguilar, F.J., Roman-Ramos, R., Flores-Saenz, J.L., Aguirre-Garcia, F., 2002. Investigation on the hypoglycaemic effects of extracts of four Mexican medicinal plants in normal and alloxan-diabetic mice. Phytotherapy Research 16, 383–386.

American Diabetes Association, 2007. Standards of medical care in diabetes. Diabetes Care 30, 4–41.

Anandharajan, R., Jaiganesh, S., Shankernarayanan, N.P., Viswakarma, R.A., Balakrishnan, A., 2006. In vitro glucose uptake activity of Aegles marmelos and Syzygium cumini by activation of Glut-4 PI3 kinase and PPARgamma in L6 myotubes. Phytomedicine 13 (6), 434–441.

Barbosa, J.F., 2005. Estudo etnobotânico das plantas de uso medicinal e místico utilizadas na comunidade quilombola de Nova Real, Bom Retiro do Sul, estado do Rio Grande do Sul. Monografia de Conclusão de Curso. Universidade do Vale do Rio dos Sinos, São Leopoldo.

Barbosa-Filho, J.M., Vasconcelos, T.H.C., Alencar, A.A., Batista, L.M., Oliveira, R.A.G., Guedes, D.N., Falcão, H.S., Moura, M.D., Diniz, M.F.F.M., Modesto-Filho, J., 2005. Plants and their active constituents from South, Central, and North America with hypoglycemic activity. Brazilian Journal of Pharmacognosy 15, 392–413.

Barros, F.M.C., Pereira, K.N., Zanetti, G.D., Heinzmann, B.M., 2007. Plantas de uso medicinal no município de São Luiz Gonzaga, RS, Brasil. Latin American Journal of Pharmacy 26, 652–662.

Bopp, A., De Bona, K.S., Bellé, L.P., Moresco, R.N., Moretto, M.B., 2009. *Syzygium cumini* inhibits adenosine deaminase activity and reduces glucose levels in hyperglycemic patients. Fundamental & Clinical Pharmacology 23, 501–507.

Borges, K.N., Bautista, H.P., Guilhera, S., 2008. Diabetes – utilização de plantas medicinais como forma opcional de tratamento. Revista Eletrônica da Faculdade de Farmácia 5, 12–20.

Bresciani, L.F.V., Yunes, R.A., Burger, C., De Oliveira, L.E., Bóf, K.L., Cechinel-Filho, V., 2004. Seasonal variation of kaurenoic acid, a hypoglycemic diterpene present in *Wedelia paludosa* (*Acmela brasiliensis*) (Asteraceae). Journal of Biosciences 59, 229–232.

Carney, J.R., Krenisky, J.M., Williamson, R.T., Luo, J., 2002. Achyrofuran, a new antihyperglycemic dibenzofuran from the South American medicinal plant *Achyrocline satureioides*. Journal of Natural Products 65, 203–205.

Cazarolli, L.H., Zanatta, L., Alberton, E.H., Figueiredo, M.S.R.B., Folador, P., Damazio, R.G., Pizzolatti, M.G., Silva, F.R.M.B., 2008. Flavonoids: cellular and molecular mechanism of action in glucose homeostasis. Mini-reviews. Medicinal Chemistry 8, 1032–1038.

Cazarolli, L.H., Folador, P., Moresco, H.H., Brighente, I.M.C., Pizzolatt, M.G., Mena Barreto Silva, F.R., 2009a. Mechanism of action of the stimulatory effect of apigenin-6-C-(2-O-alpha-L-rhamnopyranosyl) beta-L-fucopyranoside on C-14-glucose uptake. Chemico-Biological Interactions 179, 407–412.

Cazarolli, L.H., Folador, P., Pizzolatti, M.G., Mena Barreto Silva, F.R., 2009b. Signaling pathways of kaempferol-3-neohesperidoside in glycogen synthesis in rat soleus muscle. Biochimie 91, 843–849.

Cechinel, V., 2009. Chemical composition and biological potential of plants from the genus *Bauhinia*. Phytotherapy Research 23, 1347–1354.

Ceolin T., 2009. Conhecimento sobre plantas medicinais entre agricultores de base ecológica da Região Sul do Rio Grande do Sul. M.Sc. Thesis. Pelotas.

Chang, C.L.T., Kuo, H.K., Chang, S.L., Chiang, Y.M., Lee, T.H., Wu, W.M., Shyur, L.F., Yang, W.C., 2005. The distinct effects of a butanol fraction of *Bidens pilosa* plant extract on the development of Th1-mediated diabetes and Th2-mediated airway inflammation in mice. Journal of Biomedical Science 12, 79–89.

Chang, S.L., Chang, C.L.T., Chiang, Y.M., Hsieh, R.H., Tzeng, C.R., Wu, T.K., Sytwu, H.K., Shyur, L.F., Yang, W.C., 2004. Polyacetylenic compounds and butanol fraction from *Bidens pilosa* can modulate the differentiation of helper T cells and prevent autoimmune diabetes in non-obese diabetic mice. Planta Medica 70, 1045–1051.

Chau, C.F., Chen, C.H., Lin, C.Y., 2004. Insoluble fiber-rich fractions derived from *Averrhoa carambola*: hypoglycemic effects determined by in vitro methods. Food Science and Technology 37, 331–335.

Dahlgren, R.M.T., 1980. A revised system of classification of the angiosperms. Botany Journal of the Linnean Society 80, 91–124.

De Oliveira, S.Q., Dal-Pizzol, F., Gosmann, G., Guillaume, D., Moreira, J.C., Schenkel, E.P., 2003. Antioxidant activity of *Baccharis articulata* extracts: isolation of a new compound with antioxidant activity. Free Radical Research 37, 555–559.

Di Stasi, L.C., 2007. Plantas Medicinais – verdades e mentiras, 1st ed. Fundação Editora Unesp, São Paulo.

Eidi, M., Eidi, A., Zamanizadeh, H., 2005. Effect of *Salvia officinalis* L. leaves on serum glucose and insulin in healthy and streptozotocin-induced diabetic rats. Journal of Ethnopharmacology 100, 310–313.

Elisabetsky, E., Coelho de Souza, G.P., 2007. Etnofarmacologia como ferramenta na busca de substâncias ativas. In: Simões, C.M.O., Schenkel, E.P., Gosmann, G., Mello, J.P.P., Mentz, L.A., Petrovick, P.R. (Eds.), Farmacognosia: da planta ao medicamento. , 6th ed. Editora da Universidade/UFRGS/UFSC, Porto Alegre/Florianópolis, pp. 107–122.

Farswan, M., Mazumder, P.M., Parcha, V., Upaganlawar, A., 2009. Modulatory Effect of Syzygium cumini seeds and its isolated compound on biochemical parameters in diabetic rats. Pharmacognosy Magazine 5 (18), 127–133.

Ferreira, E.B., Fernandes, L.C., Galende, S.B., Cortez, D.A.G., Bazotte, R.B., 2008. Hypoglycemic effect of the hydroalcoholic extract of leaves of *Averrhoa carambola* L. (Oxalidaceae). Brazilian Journal of Pharmacognosy 18, 339–343.

Figueroa-Valverde, L., Diaz-Cedillo, F., Camacho-Luis, A., Ramos, M.L., 2009. Induced effects by *Ruta graveolens* L., Rutaceae, *Cnidoscolus chayamansa* McVaugh, Euphorbiaceae, and *Citrus aurantium* L., Rutaceae, on glucose, cholesterol and triacylglycerides levels in a diabetic rat model. Brazilian Journal of Pharmacognosy 19, 898–907.

Friedman, J., Yaniv, Z., Dafni, A., Palewitch, D., 1986. A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethnopharmacological field survey among bedouins in the Negev Desert, Israel. Journal of Ethnopharmacology 16, 275–287.

Fröde, T.S., Medeiros, Y.S., 2008. Animal models to test drugs with potential antidiabetic activity. Journal of Ethnopharmacology 115, 173–183.

Garlet, T.M.B., 2000. Levantamento das plantas medicinais utilizadas no município de Cruz Alta, RS, Brasil. M.Sc. Thesis. Universidade Federal do Rio Grande do Sul, Porto Alegre.

Garlet, T.M.B., Irgang, B., 2001. Plantas medicinais utilizadas na medicina popular por mulheres trabalhadoras rurais de Cruz Alta, Rio Grande do Sul, Brasil. Revista Brasileira de Plantas Medicinais 4, 9–18.

Giulietti, A.M., Harley, R.M., Queiroz, L.P., Wanderley, M.G.L., Van Den Berg, C., 2005. Biodiversity and conservation of plants in Brazil. Conservation Biology 19, 632–663.

Gourgue, C.M.P., Champ, M.M., Lozano, Y., Delort-Laval, J., 1992. Dietary fiber from mango byproducts – characterization and hypoglycemic effects determined by in vitro methods. Journal of Agricultural and Food Chemistry 40, 1864–1868.

Hass, A.P.S., 2003. Categorização tóxico-terapêutica da plantas medicinais usadas no município de Maquine – Rio Grande do Sul. Monografia de Conclusão de Curso. Universidade Federal do Rio Grande do Sul, Porto Alegre.

Hsu, Y.J., Lee, T.H., Chang, C.L.T., Huang, Y.T., Yang, W.C., 2009. Anti-hyperglycemic effects and mechanism of *Bidens pilosa* water extract. Journal of Ethnopharmacology 122, 379–383.

International Diabetes Federation, 2011. Unite for diabetes. Bruxelas. Available from: http://www.worlddiabetesday.org/the-campaign/unite-for-diabetes (accessed 13.03.11).

ISI Web of Knowledge, 2010. Thomson Reuters. Available from: http://www.isiwebofknowledge.com (accessed 13.03.01).

Jorge, A.P., Horst, H., De Sousa, E., Pizzolatti, M.G., Silva, F.R.M.B., 2004. Insulinomimetic effects of kaempferitrin on glycaemia and on 14 C-glucose uptake in rat soleus muscle. Chemico-Biological Interactions 149, 89–96.

Jung, M., Park, M., Lee, H.C., Kang, Y.H., Kang, E.S., Kim, S.K., 2006. Antidiabetic agents from medicinal plants. Current Medicinal Chemistry 13, 1203–1218.

Khalil, N.M., Pepato, M.T., Brunetti, I.L., 2008. Free radical scavenging profile and myeloperoxidase inhibition of extracts from antidiabetic plants: *Bauhinia forficata* and *Cissus sicyoides*. Biological Research 41, 165–171.

Kotowaroo, M.I., Mahomoodally, M.F., Gurib-Fakim, A., Subratty, A.H., 2006. Screening of traditional antidiabetic medicinal plants of mautitius for possible α-amylase inhibitory effects *in vitro*. Phytotherapy Research 20, 228–231.

Kubo, R., 1997. Levantamento das plantas de uso medicinal em Coronel Bicaco, RS. M.Sc. Thesis. Universidade Federal do Rio Grande do Sul, Porto Alegre.

Kubitzki, K., Gottlieb, O.R., 1984a. Phytochemical aspects of angiosperm origin and evolution. Acta Botanica Neerlandica 33 387, 457–468.

Kubitzki, K., Gottlieb, O.R., 1984b. Micromolecular patterns and the evolution and major classification of Angiosperms. Taxon 33, 375–391.

Kumar, A., Ilavarasan, R., Jayachandran, T., Decaraman, M., Aravindan, P., Padmanabhan, N., Krishnan, M.V., 2008. Anti-diabetic activity of *Syzygium cumini* and its isolated compound against streptozotocin-induced diabetic rats. Journal of Medicinal Plants Research 2, 246–249.

Leitzke, Z.C.S., 2003. Levantamento das plantas medicinais da comunidade Nossa Senhora da Conceição – Canguçu-RS. Trabalho de Conclusão do curso de Ciências Biológicas – Universidade Federal de Pelotas, Pelotas, RS.

Lima, C.F., Azevedo, M.F., Araujo, R., Fernandes-Ferreira, M., Pereira-Wilson, C., 2006. Metformin-like effect of *Salvia officinalis* (common sage): is it useful in diabetes prevention? British Journal of Nutrition 96, 326–333.

Löwe, T.R., 2004. Estudo etnobotânico em uma área rural do município de Três de Maio, RS. Trabalho de Conclusão do Curso de Ciências Biológicas, Instituto de Biologia, Universidade Federal de Pelotas, RS.

Magalhães, R.G., 1997. Plantas medicinais na região do Alto Uruguai-RS: conhecimentos de João Martins Fiúza, "Sarampião". M.Sc. Thesis. Universidade Federal do Rio Grande do Sul, Porto Alegre.

Malviya, N., Jain, S., Malviya, S., 2010. Antidiabetic potential of medicinal plants. Acta Poloniae Pharmaceutica 67, 113–118.

Marles, R., Farnsworth, N., 1995. Antidiabetic plants and their active constituents. Phytomedicine 2, 137–165.

Marodin, S.M., 2000. Plantas utilizadas como medicinais no município de Dom Pedro de Alcântara, Rio Grande do Sul. M.Sc. Thesis. Universidade Federal do Rio Grande do Sul, Porto Alegre.

Martha, E.M., 2003. O uso das plantas medicinais pela comunidade da associação dos agricultores construtores da Palma – assentamento 24 de Novembro. Trabalho de Conclusão do Curso de Ciências Biológicas, Instituto de Biologia, Universidade Federal de Pelotas, RS.

Martins, L.G.S., Senna-Valle, L., Pereira, N.A., 2005. Princípios ativos e atividades farmacológicas de 8 plantas popularmente conhecidas por nome de medicamentos comerciais. Revista Brasileira de Plantas Medicinais 7 (2), 73–76.

Negri, G., 2005. Diabetes melito: plantas e princípios ativos naturais hipoglicemiantes. Brazilian Journal of Pharmaceutical Sciences 41, 121–141.

Okoli, C.O., Ibiam, A.F., Ezike, A.C., Akah, P.A., Okoye, T.C., 2010. Evaluation of antidiabetic potentials of *Phyllanthus niruri* in alloxan diabetic rats. African Journal of Biotechnology 9, 248–259.

Oliveira, A.C.P., Endringer, D.C., Amorim, L.A.S., Das Graças, L., Brandão, M., Coelho, M.M., 2005. Effect of the extracts and fractions of *Baccharis trimera* and *Syzygium cumini* on glycaemia of diabetic and non-diabetic mice. Journal of Ethnopharmacology 102, 465–469.

Phillipson, J.D., 2007. Phytochemistry and pharmacology. Phytochemistry 68, 2960–2972.

Pinto, E.P.P., Amorozo, M.C.M., Furlan, A., 2006. Conhecimento popular sobre plantas medicinais em comunidades rurais de mata atlântica – Itacaré, BA, Brasil. Acta Botanica Brasilica 20, 751–762.

Possamai, R.M., 2000. Levantamento etnobotânico das plantas de uso medicinal em Mariana Pimentel, Rio Grande do Sul. M.Sc. Thesis. Universidade Federal do Rio Grande do Sul, Porto Alegre.

Rafiullah, M.R.M., Siddiqui, A.W., Mir, S.R., Ali, M., Pillai, K.K., Singh, S., 2006. Antidiabetic activity of some Indian medicinal plants. Pharmaceutical Biology 44, 95–99.

Ramesh, B., Pugalendi, K.V., 2007a. Influence of umbelliferone on glycoprotein components in diabetic rats. Toxicology Mechanisms and Methods 17, 153–159.

Ramesh, B., Pugalendi, K.V., 2007b. Influence of umbelliferone on membrane-bound ATPases in streptozotocin-induced diabetic rats. Pharmacological Reports 59, 339–348.

Ritter, M.R., Sobierajski, G.R., Schenkel, E.P., Mentz, L.A., 2002. Plantas usadas como medicinais no município de Ipê, RS, Brasil. Revista Brasileira de Farmacognosia 12, 51–62.

Roglic, G., 2004. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care 27, 10147–11053.

Roglic, G., Unwin, N., Bennett, P.H., Mathers, C., Tuomilehto, J., Nag, S., Connolly, V., King, H., 2005. The burden of mortality attributable to diabetes – realistic estimates for the year 2000. Diabetes Care 28, 2130–2135.

Schoenfelder, T., Warmlin, C.Z., Manfredini, M.S., Pavei, L.L., Réus, J.V., Tristão, T.C., Fernandes, M.S., Costa-Campos, L., 2010. Hypoglycemic and hypolipidemic effect of leaves from *Syzygium cumini* (L.) Skeels, Myrtaceae in diabetic rats. Brazilian Journal of Pharmacognosy 20, 222–227.

Sebold, D.F., 2003. Levantamento etnobotânico de plantas de uso medicinal no município de Campo Bom, Rio Grande do Sul, Brasil. M.Sc. Thesis. Universidade Federal do Rio Grande do Sul, Porto Alegre.

Simões, C.M.O., Mentz, L.A., Schenkel, E.L., Irgang, B.E., Stehmann, J.R., 1986. Plantas da medicina popular no Rio Grande do Sul, 5th ed. Editora da UFRGS, Porto Alegre.

Singh, N., Gupta, M., 2007. Effects of ethanolic extract of *Syzygium cumini* (L.) Skeels seed powder on pancreatic islets of alloxan diabetic rats. Indian Journal of Experimental Biology 45, 861–867.

Soares, E.L.C., Vendruscolo, G.S., Eisinger, S.M., Záchia, R.A., 2004. Estudo etnobotânico do uso dos recursos vegetais em São João do Polêsine, RS, Brasil, no período de outubro 1999 a junho de 2001. I – Origem e fluxo do conhecimento. Revista Brasileira de Plantas Medicinais 6, 69–95.

Souza, C.R.F., Georgetti, S.R., Salvador, M.J., Fonseca, M.J.V., Oliveira, W.P., 2009. Antioxidant activity and physical-chemical properties of spray and spouted bed dried extracts of *Bauhinia forficata*. Brazilian Journal of Pharmaceutical Sciences 46, 209–218.

Stevens, P.F., 2011. Angiosperm Phylogeny Website. Version 9, June 2008 [and more or less continuously updated since]. Available from: http://www.mobot.org/MOBOT/research/APweb/ (accessed in 10 abr. 2011).

Takahashi, M., Konno, C., Hikino, H., 1985. Antidiabetes drugs 10. Isolation and hypoglycemic activity of saccharans A, B, C, D, E and F glycans of *Saccharum officinarum* stalks. Planta Medica 51, 258–260.

Teixeira, C.C., Rava, C.A., Silva, P.M., Melchior, R., Argenta, R., Anselmi, F., Almeida, C.R.C., Fuchs, F.D., 2000. Absence of antihyperglycemis effect of jambolan in experimental and clinical models. Journal of Ethnopharmacology 71, 343–347.

Teixeira, C.C., Fuchs, F.D., 2006. The efficacy of herbal medicines in clinical models: the case of jambolan. Journal of Ethnopharmacology 108, 16–19.

Teixeira, C.C., Fuchs, F.D., Weinert, L.S., Esteves, J., 2006. The efficacy of folk medicines in the management of type 2 diabetes mellitus: results of a randomized controlled trial of *Syzygium cumini* (L.) Skeels. Journal of Clinical Pharmacy and Therapeutics 31, 1–5.

Teixeira, C.C., Pinto, L.P., Kessler, F.H.P., Knijnik, L., Pinto, C.P., Gastaldo, G.J., Fuchs, F.D., 1997. The effect of *Syzygium cumini* (L.) Skeels on post-prandial blood glucose levels in non-diabetic rats and rats with streptozotocin-induced diabetes mellitus. Journal of Ethnopharmacology 56, 209–213.

Teixeira, C.C., Weinert, L.S., Barbosa, D.C., Ricken, C., Esteves, J.F., Fucks, F.D., 2004. *Syzygium cumini* (L.) Skeels in the treatment of type 2 diabetes – results of a

randomized, double-blind, double-dummy, controlled trial. Diabetes Care 27, 3019–3020.
The Plant List, 2011. Version 1. Available from: http://www.theplantlist.org (accessed 18.03.11).
Tropicos, 2011. Missouri Botanical Garden (Mobot). Available from: http://www.tropicos.org (accessed 10 abr. 2011).
Ubillas, R.P., Mendez, C.D., Jolad, S.D., Luo, J., King, S.R., Carlson, T.J., Fort, D.M., 2000. Antihyperglycemic acetylenic glucosides from *Bidens pilosa*. Planta Medica 66, 82–83.
Vendruscolo, G.S., Mentz, L.A., 2006. Levantamento etnobotânico das plantas utilizadas como medicinais por moradores do bairro Ponta Grossa, Porto Alegre, Rio Grande do Sul, Brasil, Iheringia. Série Botânica 61, 83–103.
Vendruscolo, G.S., 2004. Estudo etnobotânico das plantas utilizadas como medicinais por moradores do bairro Ponta Grossa, Porto Alegre, Rio Grande do Sul. M.Sc. Thesis. Universidade Federal do Rio Grande do Sul, Porto Alegre.
Villaseñor, I.M., Lamadrid, M.R.A., 2006. Comparative anti-hyperglycemic potentials of medicinal plants. Journal of Ethnopharmacology 104, 129–131.
Volpato, G.P., Damasceno, D.C., Calderon, I.M.P., Rudge, M.V.C., 2002. Revisão de plantas brasileiras com comprovado efeito hipoglicemiante no controle do diabetes mellitus. Revista Brasileira de Plantas Medicinais 4, 35–45.
Volpato, G.P., Damasceno, D.C., Rudge, M.V.C., Padovani, C.R., Calderon, I.M., 2008. Effect of *Bauhinia forficata* aqueous extract on the maternal-fetal outcome and oxidative stress biomarkers of streptozotocin-induced diabetic rats. Journal of Ethnopharmacology 116, 131–137.
Von Poser, G.L., 2007. Polissacarídeos. In: Simões, C.M.O., Schenkel, E.P., Gosmann, G., Mello, J.P.P., Mentz, L.A., Petrovick, P.R. (Eds.), Farmacognosia: da planta ao medicamento. , 6th ed. Editora da Universidade/UFRGS/UFSC, Porto Alegre/Florianópolis, pp. 497–517.
Witters, L.A., 2001. The blooming of the French lilac. Journal of Clinical Investigation 108, 1105–1107.