



Plants and their active constituents from South, Central, and North America with hypoglycemic activity

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ABSTRACT: There has been marked interest in recent years in the use of plants for the treatment of diabetes. Plants have been found in many countries which have been indicated as having hypoglycemic activity. The present work is an up-to-date review with 178 references of crude plant extracts and chemically defined molecules with hypoglycemic activity from South, Central and North America. The review refers to 224 plants with their families, parts used and type of extract, organism tested and activity. It also includes 40 compounds isolated from those plants. Some aspects of recent research with natural products from plants directed to the treatment of diabetes are discussed.

Keywords: Diabetes, hypoglycemic activity, medicinal plants, natural products.

INTRODUCTION

Diabetes is a disease in which the body does not produce insulin or use it properly. Insulin is a hormone needed to convert sugar, starch and other food into energy needed for daily life. The cause of diabetes continues to be a mystery, although both genetic and environmental factors such as obesity and lack of exercise appear to play a part.

Worldwide 177 million people suffer from diabetes. This figure is likely to more than double by 2030 (See Table 1). The greater part of the increase is likely to occur in developing countries, which can least afford it.

The annual number of deaths in 2000 caused by diabetes mellitus in Latin America and the Caribbean has been estimated as 339035. This represents a loss of 757096 years of productive life among persons younger than 65 years (Barceló et al 2003). Diabetes is the third leading cause of death in the United States after heart disease and cancer (Accessed from http://www.medicinenet.com/Diabetes_Mellitus/article.htm in 01/21/2004).

Plants have always been an important source of drugs and many of the currently available drugs have been derived directly or indirectly from them. Ethnobotanical reports indicate about 1200 plants in the world with anti-diabetic potential (Alarcon-Aguilara et al 2002c), of which more than three hundred have been reported in the literature (Perez et al 1984; Almeida et al 1986; Bailey et al 1989; Handa et al 1989; Ivorra et al 1989; Oliveira et al 1989; Rahman et al 1989; Marles et al 1995; Ernest 1997; Pereira 1997; Perez et al 1998b; Volpato et

al 2002; Grover et al 2002), referring to a large variety of identified chemical substances (Ivorra et al 1989; Rahman et al 1989; Marles et al 1995; Perez et al 1998b; Lamba et al 2000). The discovery of the widely used hypoglycemic drug, metformin (*N,N*-dimethylguanylguanidine) came from the traditional approach through the use of *Galega officinalis* (Grover et al 2002).

In a previous paper this research group has reviewed crude plant extracts and chemically defined molecules with potential antitumor activity for mammary (Moura et al 2001), cervical (Moura et al, 2002) and ovarian neoplasias (Silva et al 2003), as inhibitors of HMG CoA reductase (Gonçalves et al, 2000), central analgesic activity (Almeida et al, 2001), employed in prevention of osteoporosis (Pereira et al, 2002), for the treatment of Parkinson's disease (Morais, 2004) and antileishmanial activity (Rocha et al, 2005).

The present work reviews the literature on plants and plant-derived compounds from South, Central, and North America with hypoglycemic activity. Those plants which are used in the indigenous system of medicine have not been included, except for those whose hypoglycemic activity has been scientifically established.

The search was carried out on Chemical Abstracts, Biological Abstracts, Web of Sciences, LILACS (Latin American and Caribbean literature in Health Sciences) and the data bank of The University of Illinois in Chicago – NAPRALERT (Acronym for Natural Products ALERT), updated to December 2003, using hypoglycemic activity plus anti-diabetic as search terms. The references found in the search were consulted.

The search for data from different sources led

Table 1. Total of people with diabetes in some countries of South, Central and North America. (Accessed from <http://www.int/ncd/dia/databases4.htm> on 01/21/2004)

Country	2000	2030
South America		
Argentina	1426152	2457044
Bolivia	206824	554527
Brazil	4553003	11305516
Chile	494932	1047405
Colombia	883401	2410362
Paraguay	102237	324326
Peru	754087	1960957
Central America		
Cuba	479612	875643
Jamaica	80631	197573
Mexico	2178507	6130209
Panama	59220	153308
Trinidad	60259	124780
North America		
Canada	2006107	3542974
USA	17701942	30312264
World	176525312	370023002

to the elaboration of a list of natural products, evaluated specifically for hypoglycemic effect, of several plants and plant-derived compounds, used as anti-diabetic remedies from South, Central and North America (Tables 2-4). It should be noted that most of the references cited are not first hand observations, but compilations copied from other sources. The original references should be consulted for details on the models or mechanism based bioassays used for testing plant extracts and pure compounds for hypoglycemic activity.

Plants and plant-derived compounds with hypoglycemic activity

In the Americas many plants are used popularly to control diabetes mellitus. This has caused an increase in the number of experimental and clinical investigations directed toward the validation of the anti-diabetic properties, which have been empirically attributed to these remedies.

In Brazil, around 200 plants are used empirically to control diabetes mellitus. Of these, fifty two have been experimentally studied and hypoglycaemic activity detected in most of them (See Table 2). *Bauhinia forficata* known popularly as “pata-de-vaca” (cows hoof) is the most studied species. Some studies confirm the activity and others do not. This controversy may be related to the model employed in the experiments. More recently, Pepato et al. (2002) analysed the effects of a leaf decoction as a drinking-water substitute for about 1 month on streptozotocin-diabetes (STZ-diabetes) in male Wistar rats. The STZ-diabetic rats treated with the decoction showed a significant reduction in serum and urinary

glucose as compared with the STZ-diabetic control, no difference being seen between decoction-treated and -untreated non-diabetic rats.

In Venezuela, the aqueous extract of *B. megalandra* has been used for diabetes mellitus. It was shown to inhibit intestinal glucose absorption in a concentration-dependent way and additive to phlorizine (Gonzalez-Mujica et al., 2003). In addition, the Chilean species *B. candicans* also used for diabetes, presented a significant decrease of glycaemia in alloxan diabetic rats (Lemus et al., 1999).

Phyllanthus sellowianus is a plant used in folk medicine in Argentina as a hypoglycemic and diuretic agent. The aqueous and butanolic extract of this plant, administered at a dose of 200 mg/kg p.o., caused a significant reduction in blood glucose concentration after 6 and 9 h in mice, similar to that observed with glibenclamide (10 mg/kg) which was used as a reference, while the dichloromethane extract of the same plant was ineffective (Hnatyszyn et al., 2002).

Aproximately 150 plants are used in traditional folk medicine in the treatment of diabetes in Mexico (Alarcon-Aguilar et al., 1998). However, only a small number of them have been studied scientifically. The plants most extensively studied are “nopal” *Opuntia streptacantha*, “tronadora” *Tecoma stans*, “Guarumbo” *Cecropia obtusifolia* and “Matarique” *Psacalium decompositum*, (see Table 3). The aqueous extract of the latter species significantly reduced blood glucose in a dose-dependent manner in normal mice after intraperitoneal administration ($P < 0.05$) (Alarcon-Aguilar et al., 2000).

A menu which includes common culinary herbs and spices with hypoglycemic activity for the control

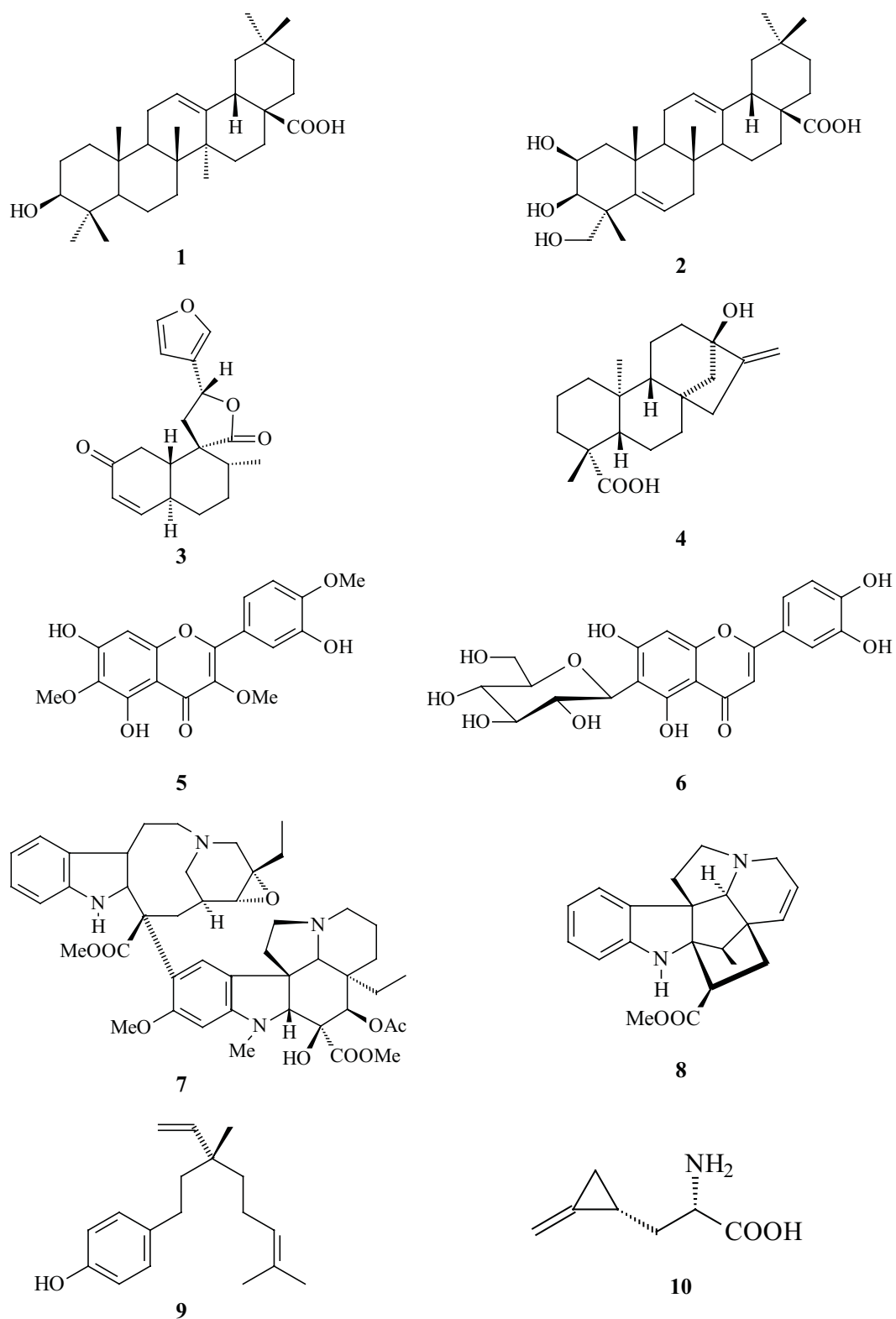


Figure 1. Representative examples of compounds with hypoglycemic activity.

and prevention of diabetes mellitus was utilized by Broadhurst et al. (2000). To evaluate the possible effects on insulin function, 49 herb, spice, and medicinal plant extracts were tested in the insulin-dependent utilization of glucose using the rat epididymal adipocyte assay. "Cinnamon" *Cinnamomum cassia* was the most bioactive product followed by witch hazel *Hamamelis virginiana*, green and black teas *Camellia sinensis*, allspice *Pimenta officinalis*, bay leaves *Laurus nobilis*, nutmeg *Myristica fragans*, and cloves *Syzgium aromaticum* (see Table 4).

A survey of the literature has shown that a large variety of compounds obtained from several plants of South, Central and North America were found to possess hypoglycemic action. For instance, the triterpenes oleanolic acid (**1**) and bassic acid (**2**) from *Bouvardia terniflora* (Perez et al., 1998) and *Bumelia sartorum* (Naik et al., 1991) respectively lowered blood sugar in test animals. Similarly the diterpenes *trans*-dehydrocrotonin (**3**) from *Croton cajucara* (Farias et al., 1997) and steviol (**4**) from *Stevia rebaudiana* (Ishii; Bracht, 1985) exhibited similar activity. Certain flavonoids *eg.* 5,7,3-trihydroxy-3,6,4'-trimethoxyflavone (**5**) from *Brickellia veronicaefolia* (Perez et al., 2000a) and the glycoside isoorientin (**6**) from *Cecropia obtusifolia* (Andrade-Cetto et al., 2001) also showed hypoglycaemic effects. A number of alkaloids isolated from *Vinca rosea* (*Catharanthus rosea*) with antitumor activity (Svoboda et al., 1964) were submitted for assay for hypoglycemic effects. The results indicated that catharantine, leurosine (**7**), lochnerine, tetrahydroalstonine, vindoline and vindolinine (**8**) produce varying degrees of blood-sugar reduction. For *Otholobium pubescens* this property was attributed to a phenolic compound bakuchiol (**9**). The amino acid hypoglycine A (**10**) isolated from *Blighia sapida* was particularly effective against diabetes (Kean, 1975; Mills et al., 1987) (Figure 1). The great variety of chemical classes indicate that a variety of mechanisms of action are involved in reduction of the glucose level in blood.

The information recorded in Tables 2-4, has been assembled by continent (South, Central and North America), with the name of the country, plant in alphabetical order, scientific name, family, part used, organism tested, activity and reference. This study has enumerated 224 plants and 40 compounds for which hypoglycemic activity has been reported, as a result of pharmacological studies carried out in various research centers in Argentina, Brazil, Canada, Chile Colombia, Cuba, Jamaica, Mexico, Panama, Paraguay, Peru, Puerto Rico Trinidad and the USA. The ten principal families in which such activity has been reported are Fabaceae (25), Asteraceae (25), Myrtaceae (11), Labiatae (10), Cucurbitaceae (8), Solanaceae (7), Anacardiaceae (6), Euphorbiaceae (6), Rubiaceae (6), and Liliaceae (5).

CONCLUSION

This literature review adds more data to that previously published, since there are many plants in South, Central and North America, which present hypoglycemic effects.

The number of plants described in the literature as having hypoglycemic activity is more or less the same in the three continents. Among the 224 plants studied 73 (33%) are found in South America, 77 (34%) in Central America and 74 (33%) in North America. The countries in each continent with the largest contribution are: Brazil with 52 (23%) of the plants studied, Mexico with 54 (24%) and the USA with 70 (31%). None of the plants with hypoglycemic activity was found in all three continents. The following species stood out for the number of citations reported in the scientific literature in each continent: *Bauhinia forficata* with 8 citations (Brazil), *Opuntia streptacantha* with 5 citations (Mexico) and, *Avena sativa* (USA) with 3 citations.

Of an estimated 250.000 higher plants, less than 1% have been screened pharmacologically and very few in regard to diabetes mellitus. Therefore, it is prudent to look for options in herbal medicine for diabetes mainly in developing countries because it is a pathological condition associated with high morbidity, mortality and economic impact. None of the plants used in traditional medicine, should be used until safety studies have been completed.

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Table 2. Plant and plant-derived compounds with hypoglycemic activity from South America.

Place and Plant	Family	Part used	Organism tested	Activity	Reference
Argentina					
<i>Bauhinia candicans</i>	Fabaceae	Aqueous extract of the leaves	Dogs	Active	Gallo, 1941
<i>Morus insignis</i>	Moraceae	Aqueous extract of the leaves	Rats	Inactive	Basnet, 1993
		Butanol extract of the leaves	Rats	Active	Basnet, 1993
<i>Phyllanthus sellowianus</i>	Euphorbiaceae	Aqueous extract of the bark	Rats	Active	Gonalons et al., 1926
		Aqueous extract of the stem bark	Rats	Active	Hnatyszyn et al., 1997
		Aqueous and butanol extract of the stem bark	Mice	Active	Hnatyszyn et al., 2002
		Dichloromethane extract of the stem bark	Mice	Inactive	Hnatyszyn et al., 2002
<i>Smallanthus sonchifolius</i>	Asteraceae	Aqueous extract of the leaves	Rats	Active	Aybar et al., 2001
Brazil					
<i>Allium cepa</i>	Liliaceae	Bulb powder	Humans	Active	Oliveira; Saiko, 1989
<i>Anacardium occidentale</i>	Anacardiaceae	Tincture of the bark	Humans	Active	Arduino; Soares 1951; Oliveira; Saito, 1989
<i>Amona muricata</i>	Annonaceae	Tincture of the bark	Rats	Active	De Aguiar; Lins, 1958
		Part used and type of extract not stated	Mice	Active	Neves et al., 2002
<i>Averrhoa carambola</i>	Oxalidaceae	Ethanol extract of the leaves	Rats	Inactive	Provasi et al., 2001
		Aqueous extract of the leaves	Rats	Inactive	Damascono et al., 2002 ^a
<i>Baccharis trimera</i>	Asteraceae	Aqueous extract of the aerial parts	Humans	Active	Oliveira; Saito, 1989
<i>Bauhinia forficata</i>	Fabaceae	Aqueous extract of the leaves	Humans	Active	Juliant, 1931
		Aqueous extract of the leaves	Humans	Inactive	Oliveira; Saito, 1989
		Aqueous extract of the leaves	Humans	Inactive	Russo et al., 1990
		Aqueous extract of the leaves	Rats	Active	Pepato et al., 2002
		Ethanol extract of the leaves	Rats	Inactive	Almeida; Agra, 1986
		Aqueous extract of the leaves	Rats	Inactive	Volpato et al., 1999
		Butanol extract of the leaves	Rats	Inactive	Silva et al., 2002
		Kaempferol-3,7-O-dirhamnoside	Rats	Active	Sousa et al., 2002a

<i>Bauhinia unguiculata</i>	Fabaceae	Aqueous extract of the leaves	Rats	Active	Vale et al., 2001
<i>Bidens pilosa</i>	Asteraceae	Aqueous and methanol extract of the aerial parts	<i>In vitro</i> α -glucosidase	Inactive	Carvalho et al., 2002
<i>Bowditchia virgiloides</i>	Fabaceae	Aqueous extract of the bark	Humans	Active	Oliveira; Saito, 1989
<i>Brosimum acutifolium</i>	Moraceae	Ethanol extract of the bark	Rats	Inactive	Manrique et al., 2002
<i>Bumelia sartorum</i>	Sapotaceae	Ethanol extract of the stem bark	Rats	Active	Almeida et al., 1985
<i>Caesalpinia ferrea</i>	Fabaceae	Basic acid	Rats	Active	Naik et al., 1990
<i>Canavalia ensiformis</i>	Fabaceae	Ethanol extract of the stems	Rats	Inactive	Almeida; Agra, 1986
		Aqueous extract of the bark	Humans	Active	Oliveira; Saito, 1989
		Canatoxin	Rats	Active	Ribeiro da Silva et al., 1986
					Ribeiro-da-Silva et al., 1990
					Ribeiro-da-Silva; Prado, 1993
<i>Chrysobalanus icaco</i>	Chrysobalanaceae	Protein	Mice	Active	Oliveira et al., 1999
<i>Citrullus vulgaris</i>	Cucurbitaceae	Aqueous extract of the leaves	Mice	Active	Presta; Pereira, 1987
<i>Cissus sicyoides</i>	Vitaceae	Pulp of the fruits	Humans	Active	Araújo, 1999
		Leaves - Type of extract not stated	Rats	Active	Mori, 2001
		Aqueous extract of the leaves	Rats	Active	Belframe et al., 2001
<i>Cissus verticillata</i>	Vitaceae				Pepato et al., 2003
<i>Citrus spp</i>	Rutaceae	Aqueous extract of the leaves	Rats	Active	Barbosa et al., 2002
<i>Coffea arabica</i>	Rubiaceae	Soluber fiber pectin	Rats	Active	Derivi et al., 1987
		Seed powder	Mice	Active	Sampaio, 1979
		β -Sitosterol	Mice	Active	Sampaio, 1979
<i>Croton cajucara</i>	Euphorbiaceae	Part used and type of extract not stated	Rats	Active	Cardoso et al., 2002
		<i>Trans</i> -dehydrocrotonin	Rats	Active	Farias et al., 1997
<i>Cymbopogon citratus</i>	Poaceae	Aqueous extract of the leaves	Rats	Inactive	Souza et al., 1986
<i>Dalbergia subynosa</i>	Fabaceae	Part used and type of extract not stated	Guinea pigs	Active	Cardoso et al., 2002
<i>Echinodorus macrophyllus</i>	Alismataceae	Ethanol extract of the leaves	Rats	Active	Camargo et al., 2002
<i>Epidendrum nonseii</i>	Orchidaceae	Aqueous extract	Rats	Active	Novaes et al., 2001
<i>Eugenia jambolana</i>	Myrtaceae	Ethanol extract of the seeds	Humans	Active	Oliveira; Saito, 1989
		Aqueous extract of the leaves	Rats	Inactive	Pepato et al., 2001
		Aqueous extract of the leaves	Rats	Inactive	Damasceno et al., 2002a
<i>Glechoha hederacea</i>	Labiatae	Sapogenin	Rats	Inactive	Damasceno et al., 2002b
<i>Gymnema sylvestre</i>	Asclepiadaceae	Ethanol extract of the leaves	Humans	Active	Oliveira; Saito, 1989
		Leaves powder	Rats	Inactive	Galletto et al., 2003

<i>Licania rigida</i>	Chrysobalanaceae	Aqueous extract of the leaves and stems	Rats	Inactive	Almeida; Agra, 1986				
<i>Mangifera indica</i>	Anacardiaceae	Aqueous extract of the leaves	Rats	Inactive	Teixeira et al., 1998				
<i>Marrubium vulgare</i>	Labiatae	Aqueous extract of the leaves	Humans	Inactive	Teixeira et al., 1998				
<i>Myrcia sphaerocarpha</i>	Myrtaceae	Aqueous extract	Rats	Active	Novaes et al., 2001				
<i>Myrcia uniflora</i>	Myrtaceae	Aqueous extract of the leaves	Humans	Active	Oliveira; Saito, 1989				
<i>Nasturtium officinale</i>	Cruciferae	Aqueous extract of the leaves	Humans	Inactive	Russo et al., 1990				
<i>Periandra mediterranea</i>	Fabaceae	Aqueous extract of the entire plant	Rats	Active	Pepato et al., 1993				
<i>Phrygilanthus acutifolius</i>	Loranthaceae	Aqueous extract of the roots	Humans	Active	Oliveira; Saito, 1989				
<i>Phyllanthus niruri</i>	Euphorbiaceae	Aqueous extract of the leaves	Rats	Active	Gomez et al., 2000				
<i>Polymnia sonchifolia</i>	Asteraceae	Ethanol extract of the aerial parts	Humans	Active	Oliveira; Saito, 1989				
<i>Punica granatum</i>	Punicaceae	Ethanol extract of the leaves	Mice	Active	Longhi et al., 2003				
<i>Rhedia gardneriana</i>	Cyperaceae	Ethanol extract of the fruits	Mice	Active	Pereira, 1997				
<i>Ricinus communis</i>	Euphorbiaceae	Aqueous extract	Rats	Inactive	Novaes et al., 2001				
<i>Rubus imperialis</i>	Rosaceae	Aqueous extract of the leaves	Humans	Active	Oliveira; Saito, 1989				
<i>Rudgea viburnioides</i>	Rubiaceae	Aqueous extract	Rats	Active	Novaes et al., 2001				
<i>Salvia officinalis</i>	Labiatae	Methanol extract of the roots	Rats	Active	Kanegusuku et al., 2002				
<i>Solanum lycocarpum</i>	Solanaceae	Ethanol extract of the leaves	Rats	Inactive	Silveira et al., 2001				
<i>Stevia rebaudiana</i>	Asteraceae	Aqueous extract of the leaves	Humans	Active	Oliveira; Saito, 1989				
<i>Syzygium cumini</i>	Myrtaceae	Starch from the unripe fruits powder	Mice	Inactive	Oliveira et al., 2003				
<i>Syzygium jambos</i>	Myrtaceae	Aqueous extract of the aerial parts	Human	Active	Alvares et al., 1981				
<i>Syzygium malaccense</i>	Myrtaceae	Aqueous extract of the leaves	Rats	Inactive	Oliveira; Saito, 1989				
<i>Talauma ovata</i>	Magnoliaceae	Steviol and isoesteviol	Rats	Inactive	Von Schmeling, 1977				
<i>Vatairea macrocarpa</i>	Fabaceae	Aqueous extract of the bark	Rats	Active	Ishii; Bracht, 1985				
<i>Vitex megapotamica</i>	Verbenaceae	Aqueous extract of the leaves	Humans	Inactive	Miron et al., 2002				
<i>Wedelia paludosa</i>	Asteraceae	Aqueous extract of the leaves	Humans	Inactive	Teixeira et al., 2000				
		Part used and type of extract not stated	Mice	Active	Teixeira, 1990				
		Ethanol extract of the leaves	Rats	Inactive	Neves et al., 2002				
		Aqueous extract of the bark	Rats	Inactive	Morato, 1989				
		Ethanol extract of the leaves	Rats	Active	Reis et al., 2002				
		Aqueous extract	Rats	Active	Sousa et al., 2002b				
			Rats	Active	Novaes et al., 2001				

Chile									
<i>Bauhinia candicans</i>	Fabaceae		Aqueous extract of the leaves	Rats	Active	Lemus et al., 1999			
<i>Galega officinalis</i>	Fabaceae		Aqueous extract of the leaves	Rats	Active	Lemus et al., 1999			
<i>Geranium core-core</i>	Geraniaceae		Ethanol extract of the whole plant	Rat	Active	Rodriguez et al., 1994			
<i>Lupinus hillii</i>	Fabaceae		Part used and type of extract not stated	Humans	Equivocal	Diaz et al., 1990			
<i>Morus alba</i>	Moraceae		Aqueous extract of the leaves	Rats	Active	Lemus et al., 1999			
<i>Oxalis rosea</i>	Oxalidaceae		Ethanol extract of the whole plant	Rats	Inactive	Rodriguez et al., 1994			
<i>Plantago major</i>	Plantaginaceae		Ethanol extract of the whole plant	Rats	Inactive	Rodriguez et al., 1994			
<i>Rubus ulmifolius</i>	Rosaceae		Aqueous extract of the leaves	Rats	Active	Lemus et al., 1999			
Colombia									
<i>Curatella americana</i>	Anacardiaceae		Chloroform extract of the bark	Rats	Active	Ospina et al., 1995			
Paraguay									
<i>Eugenia uniflora</i>	Myrtaceae		Aqueous extract of the leaves	Mice	Active	Matsumura et al., 2000			
<i>Hexachlamys edulis</i>	Myrtaceae		Aqueous extract of the leaves and stems	Monkeys Rats	Inactive Active	Ferro et al., 1988 Rodriguez et al., 1992			
<i>Stevia rebaudiana</i>	Asteraceae		Aqueous extract of the leaves	Humans	Active	Oviedo et al., 1970			
Peru									
<i>Aloe vera</i>	Liliaceae		Juice of the leaves	Rats	Active	Valencia et al., 1994			
<i>Cyclanthera pedata</i>	Cucurbitaceae		Aqueous extract of the leaves	Rats	Active	Valencia et al., 1994			
<i>Gentianella thyrsoides</i>	Gentianaceae		Aqueous extract of the roots and stems	Rats	Active	Tomas et al., 1999			
<i>Otholobium pubescens</i>	Fabaceae		Dichloromethane extract of the roots and stems	Rats	Active	Tomas et al., 1999			
Venezuela									
<i>Bauhinia megalandra</i>	Fabaceae		Methanol extract of the roots and stems	Rats	Equivocal	Tomas et al., 1999			
	Fabaceae		Bakuchiol	Rats	Active	Krenisky et al., 1999			
	Fabaceae		Aqueous extract of the leaves	Rats	Active	Gonzalez-Mujica et al., 2003			

Table 3. Plant and plant-derived compounds with hypoglycemic activity from Central America.

Place and Plant	Family	Part used	Organism tested	Activity	Reference
Cuba					
<i>Bidens alba</i>	Asteraceae	Ethanol extract of the leaves	Rats	Inactive	Guerra, 2001
<i>Bougainvillea spectabilis</i>	Nyctaginaceae	Ethanol extract of the leaves	Rats	Inactive	Salvado et al., 1997
<i>Ocimum sanctum</i>	Labiatae	Ethanol extract of the leaves	Rats	Active	Deas-Rodriguez et al., 1988; 1997
<i>Pectiveria alliacea</i>	Phytolacaceae	Ethanol extract of the leaves	Mice	Active	Lores et al., 1990
		Ethanol extract of the roots	Mice	Inactive	Lores et al., 1990
		Ethanol extract of the stems	Mice	Active	Lores et al., 1990
<i>Phyllanthus embira</i>	Euphorbiaceae	Aqueous extract of the leaves	Humans	Inactive	Rojo-Dominguez et al., 2002
		Aqueous ext. of the leaves	Mice	Active	Cuellar; Estevez, 1980
		Fagasterol	Mice	Active	Cuellar; Estevez, 1980
Jamaica					
<i>Anacardium occidentale</i>	Anacardiaceae	Aqueous extract of the bark	Dogs	Weak activity	Morrison et al., 1982
<i>Bixa orellana</i>	Bixaceae	Chloroform extract of the seeds	Dogs	Active	Morrison et al., 1985
		Aqueous ext. of the seeds	Dogs	Active	Morrison et al., 1982
<i>Blighia sapida</i>	Sapindaceae	Arrilus powder	Humans	Active	Kean, 1975
		Fruits powder	Humans	Active	Jelliffe; Stuart, 1954
		Hypoglycine A	Rats	Active	Bressler, 1976
					Kean, 1975
					Mills et al., 1987
<i>Cannabis sativa</i>	Canabaceae	Aqueous extract of the resin	Dogs	Weak activity	Morrison et al., 1982
<i>Capsicum frutescens</i>	Solanaceae	Aqueous extract of the seeds	Dogs	Active	Morrison et al., 1982
<i>Cassia alata</i>	Fabaceae	Aqueous extract of the leaves	Dogs	Active	Morrison et al., 1982
<i>Catharanthus roseus</i>	Apocynaceae	Aqueous extract of the leaves	Dogs	Active	Morrison et al., 1982
<i>Cocos nucifera</i>	Arecaceae	Aqueous extract of the shell	Dogs	Weak activity	Morrison et al., 1982
<i>Colocasia esculenta</i>	Araceae	Ethanol extract of the tuber	Rats	Active	Grindley et al., 2002
<i>Dioscorea cayenensis</i>	Dioscoreaceae	Ethanol extract of the tuber	Rats	Weak activity	Grindley et al., 2002
<i>Mikania micrantha</i>	Asteraceae	Aqueous extract of the aerial parts	Dogs	Weak activity	Morrison et al., 1982
<i>Momordica charantia</i>	Cucurbitaceae	Aqueous extract of the fruits	Dogs	Weak activity	Morrison et al., 1982
<i>Spondias dulcis</i>	Anacardiaceae	Aqueous extract of the fruits	Dogs	Weak activity	Morrison et al., 1982
<i>Symphytum officinale</i>	Boraginaceae	Aqueous extract of the leaves	Dogs	Weak activity	Morrison et al., 1982
Mexico					
<i>Acourtia thurberi</i>	Asteraceae	Aqueous extract of the roots	Rats and rabbits	Active	Alarcon-Aguilar et al., 1997
<i>Acrocomia mexicana</i>	Palmae	Aqueous extract of the roots	Rats	Active	Perez et al., 1984
		Coyolose	Mice	Active	Perez et al., 1997
<i>Agarista mexicana</i>	Ericaceae	Chloroform extract of the bark	Mice and rats	Active	Perez et al., 1996
<i>Aloe vera</i>	Liliaceae	Juice of the stems	Rabbits	Active	Roman-Ramon et al., 1991

<i>Arachis hypogaea</i>	Fabaceae	Seeds powder	Humans	Inactive	Frati-Mumari et al., 1991						
<i>Argemone mexicana</i>	Papaveraceae	Aqueous extract of the flowers	Dogs	Inactive	Meckes-Lozoya et al., 1986						
<i>Bidens leucantha</i>	Asteraceae	Aqueous extract of entire plant	Mice	Active	Perez et al., 1984						
<i>Bidens pilosa</i>	Asteraceae	Aqueous extract of entire plant	Mice	Active	Perez et al., 1984						
<i>Bouvardia teniflora</i>	Rubiaceae	Chloroform extract of the stems	Mice	Active	Perez et al., 1998a						
		Oleanolic acid	Mice	Active	Perez et al., 1998a						
		Ursolic acid	Mice	Active	Perez et al., 1998a						
<i>Brickellia veronicaefolia</i>	Asteraceae	5,7,3'-trihydroxy-3,6,4'-trimethoxyflavone	Mice	Active	Perez et al., 2000a						
<i>Cacalia decomposita</i>	Asteraceae	Aqueous extract of the roots	Mice	Active	Perez et al., 1984						
<i>Calamintha macrostema</i>	Labiatae	Aqueous extract of the roots	Mice	Active	Perez et al., 1984						
<i>Capraria biflora</i>	Strophulariaceae	Aqueous extract of the leaves	Mice	Active	Perez et al., 1984						
<i>Cecropia obtusifolia</i>	Cecropiaceae	Aqueous extract of the leaves	Mice	Active	Mellado et al., 1984						
		Aqueous extract of the leaves	Rabbits	Weak activity	Roman-Ramos et al., 1991						
		Aqueous extract of the leaves	Mice	Active	Perez et al., 1984						
		Aqueous and butanol extract of the leaves	Rats	Active	Andrade-Cet; Wiedenfel, 2001						
<i>Cirsium pascuarensense</i>	Asteraceae	Chlorogenic acid	Rats	Active	Andrade-Cet; Wiedenfel, 2001						
		Isoortentim	Rats	Active	Andrade-Cet; Wiedenfel, 2001						
		Hexane extract of the leaves	Mice	Active	Perez et al., 2001						
		Chloroform and methanol extract of the leaves	Mice	Inactive	Perez et al., 2001						
<i>Coutarea latiflora</i>	Rubiaceae	Part used and type of extract not stated	Rabbits	Inactive	Guerra, 1947						
<i>Cucurbita ficifolia</i>	Cucurbitaceae	Aqueous ext. of the leaves	Mice	Active	Perez et al., 1984						
		Juice of the fruits	Rabbits	Active	Roman-Ramos et al., 1991						
		Juice of the fruits	Mice	Active	Alarcon-Aguilar et al., 2002a						
		Juice of the fruits	Humans	Active	Acosta-Paino et al., 2001						
<i>Equisetum myriochaetum</i>	Equisetaceae	Aqueous extract of the aerial parts	Humans	Active	Revilla et al., 2002						
		Aqueous and butanol extract of the aerial parts	Rats	Active	Andrade-Cetto et al., 2000						
		Kaempferol-3-O-sophoroside-4'-O- β -D-glucoside	Rats	Active	Andrade-Cetto et al., 2000						
<i>Eriobotrya japonica</i>	Rosaceae	Aqueous extract of the leaves	Rabbits	Weak activity	Roman-Ramos et al., 1991						
<i>Eucalyptus globulus</i>	Myrtaceae	Aqueous extract of the leaves	Mice	Active	Perez et al., 1984						
<i>Euphorbia prostata</i>	Euphorbiaceae	Aqueous extract of the entire plant	Rabbits	Active	Alarcon-Aguilar et al., 1998						

<i>Eysenhardtia polystachya</i>	Lotodiaceae	Aqueous extract of the entire plant	Mice	Activa	Perez et al., 1984
<i>Gnaphalium semitriplexicaule</i>	Asteraceae	Aqueous extract of the flowers	Dogs	Weak activity	Meckes-Lozoya et al., 1986
<i>Guazuma ulmifolia</i>	Sterculiaceae	Aqueous extract of the leaves	Rabbits	Active	Alarcon-Aguilar et al., 1998
<i>Ibervillea sonorae</i>	Cucurbitaceae	Aqueous extract of the roots	Mice and rats	Active	Alarcon-Aguilar et al., 2002b
<i>Lepechinia caulescens</i>	Lamiaceae	Aqueous and methanol extract of the aerial parts	Mice	Active	Roman-Ramos et al., 1991
		Hexane, methylene chloride, methanol and aqueous ext of the flowers	Mice	Inactive	Roman-Ramos et al., 2001
<i>Loeselia mexicana</i>	Polemoniaceae	Aqueous ext of the leaves	Rabbits	Active	Alarcon-Aguilar et al., 1998
		Aqueous extract of the entire plant	Mice	Active	Perez et al., 1984
<i>Musa sapientum</i>	Musaceae	Aqueous ext of the leaves	Rabbits	Active	Alarcon-Aguilar et al., 1998
<i>Opuntia ficus-indica</i>	Cactaceae	Leaves powder	Humans	Active	Frati-Munari et al., 1991
<i>Opuntia</i> sp	Cactaceae	Stem powder	Humans	Inactive	Frati-Munari et al., 1987
<i>Opuntia streptacantha</i>	Cactaceae	Aqueous extract of the aerial parts	Humans	Active	Frati-Munari et al., 1989
		Stem powder	Humans	Inactive	Frati-Munari et al., 1990
		Juice of the stems	Rabbits	Active	Roman-Ramos et al., 1991
		Sap powder of the stems	Dogs	Active	Ibanez-Camacho et al., 1983
		Leaves powder	Rats	Active	Ibanez-Camacho et al., 1979
<i>Oryza sativa</i>	Poaceae	Seed powder	Humans	Inactive	Frati-Munari et al., 1991
<i>Parmantiera edulis</i>	Bignoniaceae	Aqueous ext. of the roots	Mice	Inactive	Perez et al., 1984
		Lactucin-8- <i>O</i> -methylacrylate	Rats	Active	Perez et al., 2000b
<i>Phaseolus vulgaris</i>	Fabaceae	Aqueous extract of the pods	Rabbits	Weak activity	Roman-Ramos et al., 1991
<i>Plantago psyllium</i>	Plantaginaceae	Mucilage	Humans	Active	Frati-Munari et al., 1985
<i>Psacalium decompositum</i>	Asteraceae	Chromatographic fraction of the roots	Mice	Active	Alarcon-Aguilar et al., 2000
		Aqueous extract of the roots	Rats and rabbits	Active	Alarcon-Aguilar et al., 1997
		Aqueous extract of the roots	Mice	Active	Alarcon-Aguilar et al., 2000
		Hexane extract of the roots	Mice	Inactive	Alarcon-Aguilar et al., 2000
		Cacalol, cacalone and maturin	Mice	Inactive	Alarcon-Aguilar et al., 2000
<i>Psacalium peltatum</i>	Asteraceae	Aqueous ext. of the roots	Rats and rabbits	Active	Alarcon-Aguilar et al., 1997
		Aqueous ext. of the roots	Rabbits	Active	Roman-Ramos et al., 1991
<i>Psittacanthus calyculatus</i>	Loranthaceae	Aqueous extract of the flowers	Mice	Active	Perez et al., 1984
<i>Rhizophora mangle</i>	Rizophoraceae	Aqueous extract of the leaves	Rabbits	Active	Alarcon-Aguilar et al., 1998
<i>Salpianthus arenarius</i>	Nyctaginaceae	Aqueous extract of the flowers	Mice	Active	Perez et al., 1984

<i>Salpianthus macrodontus</i>	Nyctaginaceae	Leaves and stems - Type of extract not stated	Rabbits	Weak activity	Roman-Ramos et al., 1991
<i>Sambucus mexicana</i>	Caprifoliaceae	Aqueous extract of the flowers	Dogs	Inactive	Meckes-Lozoya et al., 1986
<i>Solanum tuberosum</i>	Solanaceae	Tuber powder	Humans	Inactive	Frati-Munari et al., 1991
<i>Solanum verbascifolium</i>	Solanaceae	Aqueous extract of the leaves and stems	Rabbits	Active	Roman-Ramos et al., 1991
<i>Tecoma stans</i>	Bignoniaceae	Aqueous extract of the leaves and stems	Rabbits	Weak activity	Roman-Ramos et al., 1991
		Aqueous extract of the leaves	Rats	Active	Aguilar et al., 1993
		Part used and type of extract not stated	Rabbits	Inactive	Guerra, 1946
		Aqueous extract of the entire plant	Mice	Active	Perez et al., 1984
<i>Teucrium cubense</i>	Lamiaceae	Aqueous extract of the leaves and stems	Rabbits	Weak activity	Roman-Ramos et al., 1991
<i>Tournefortia hirsutissima</i>	Boraginaceae	Aqueous extract of the leaves	Rabbits	Active	Alarcon-Aguilar et al., 1998
<i>Trigonella foenum-graecum</i>	Fabaceae	Aqueous extract of the leaves	Rabbits	Active	Alarcon-Aguilar et al., 1998
<i>Turnera diffusa</i>	Turneraceae	Aqueous extract of the leaves	Mice	Active	Perez et al., 1984
		Aqueous extract of the leaves	Rabbits	Active	Alarcon-Aguilar et al., 1998
<i>Valeriana officinalis</i>	Valerianaceae	Aqueous extract of the roots	Mice	Active	Perez et al., 1984
<i>Valeriana edulis</i> ssp. <i>procera</i>	Valerianaceae	Aqueous extract of the roots	Mice	Active	Perez et al., 1984
<i>Verbesina crocata</i>	Asteraceae	Aqueous extract of the flowers	Mice	Active	Perez et al., 1984
<i>Verbesina persicifolia</i>	Asteraceae	Aqueous extract of the leaves	Mice	Active	Perez et al., 1984
<i>Zea mays</i>	Poaceae	Chloroform extract of the bark	Mice and rats	Active	Perez et al., 1996
		Seed powder	Humans	Inactive	Frati-Munari et al., 1991
Panama					
<i>Cajanus cajan</i>	Fabaceae	Aqueous extract of the leaves	Rats	Active	Avellar et al., 1991
<i>Cassia fistula</i>	Fabaceae	Aqueous extract of the leaves	Rats	Active	Avellar et al., 1991
<i>Neurolaena lobata</i>	Asteraceae	Ethanol extract of the leaves	Mice	Active	Gupta et al., 1984
<i>Momordica charantia</i>	Cucurbitaceae	Aqueous extract of the vine	Rabbits	Active	Rivera, 1942
		Alkaloid fraction	Rabbits	Inactive	Rivera, 1942
Trinidad					
<i>Momordica charantia</i>	Cucurbitaceae	Aqueous extract of the leaves, flowers and stems	Mice	Active	Bailey et al., 1985

Table 4. Plant and plant-derived compounds with hypoglycemic activity from North America.

Place and Plant	Family	Part used	Organism tested	Activity	Reference
Canada					
<i>Avena sativa</i>	Poaceae	Gum powder	Humans	Active	Braaten et al., 1991
<i>Fatsia horrida</i>	Araliaceae	Aqueous extract of the rootbark	Rabbits	Active	Large et al., 1938
<i>Panax quinquefolius</i>	Araliaceae	Saponin fraction of the roots	Rats	Weak activity	Martinez et al., 1984
		Aqueous extract of the roots	Humans	Active	Vuksan et al., 2000
		Ginsenoside	Humans	Inactive	Sievenpiper et al., 2003
		Aqueous extract	Rats and dogs	Active	Fortier, 1949
<i>Rhus typhina</i>	Anacardiaceae				
USA					
<i>Abutilon theophrasti</i>	Malvaceae	Seeds powder in ration	Rats	Active	Dugan et al., 1990a
<i>Allium sativum</i>	Liliaceae	Bulb powder in ration	Rats	Inactive	Chi et al., 1982
		Part used and type of extract	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
		not stated			
<i>Aloe vera</i>	Liliaceae	Leaves powder	Rats	Inactive	Herlihy et al., 1998
<i>Anethum graveolens</i>	Umbelliferae	Part used and type of extract	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
		not stated			
<i>Apium graveolens</i>	Umbelliferae	Part used and type of extract	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
		not stated			
<i>Arachis hypogaea</i>	Fabaceae	Part used and type of extract	<i>In vitro</i> cells	Week activity	Broadhurst et al., 2000
		not stated			
<i>Astragalus membranaceus</i>	Fabaceae	Part used and type of extract	<i>In vitro</i> cells	Week activity	Broadhurst et al., 2000
		not stated			
<i>Atriplex halimus</i>	Chenopodiaceae	Part used and type of extract	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
		not stated			
<i>Avena sativa</i>	Poaceae	Brun powder	Pigs	Active	Knudsen et al., 1995
		Brun powder	Humans	Active	Hopewell et al., 1993
		Part used and type of extract	<i>In vitro</i> cells	Weak activity	Broadhurst et al., 2000
		not stated			
<i>Brassica nigra</i>	Cruciferae	Part used and type of extract	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
		not stated			
<i>Brassica oleraceae</i>	Brassicaceae	Ethanol extract of the aerial parts	Rats	Active	Dubin et al., 1928
		Part used and type of extract	<i>In vitro</i> cells	Active	Broadhurst et al., 2000
		not stated			
<i>Camellia sinensis</i>	Theaceae	Leaves - Smoking	Humans	Inactive	Podolsky et al., 1971
<i>Cannabis sativa</i>	Cannabaceae	Part used and type of extract	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
<i>Capsicum annuum</i>	Solanaceae	not stated			

<i>Carica papaya</i>	Caricaceae	Fruits powder	Rabbits	Inactive	Bischoff et al., 1929
<i>Carya ilinoensis</i>	Juglandaceae	Part used and type of extract not stated	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
<i>Chimaphila umbellata</i>	Pyrolaceae	Buthanol extract of the leaves	Rats	Inactive	Williams et al., 1959
<i>Cinchona</i> sp.	Rubiaceae	Cystine	Rats	Inactive	Williams et al., 1959
<i>Cinnamomum cassia</i>	Lauraceae	Indole-3-acetic acid	Rats	Inactive	Williams et al., 1959
<i>Cinnamomum verum</i>	Lauraceae	Quinine	Humans	Inactive	Taylor et al., 1988
<i>Coffea arabica</i>	Rubiaceae	Part used and type of extract not stated	<i>In vitro</i> cells	Active	Broadhurst et al., 2000
<i>Curcuma longa</i>	Zingiberaceae	Part used and type of extract not stated	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
<i>Echinaceae purpurea</i>	Asteraceae	Caffeine	Humans	Active	Kerr et al., 1993
<i>Elettaria cardamomum</i>	Zingiberaceae	Part used and type of extract not stated	<i>In vitro</i> cells	Week activity	Broadhurst et al., 2000
<i>Eleutherococcus senticosus</i>	Araliaceae	Part used and type of extract not stated	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
<i>Eupatorium urticaefolium</i>	Asteraceae	Part used and type of extract not stated	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
<i>Fatsia horrida</i>	Araliaceae	Fluid extract of the aerial parts	Dogs	Inactive	Cartland et al., 1931
<i>Ginkgo biloba</i>	Ginkgoaceae	Aqueous extract of the bark	Humans	Active	Smith, 1983
<i>Grifolia frondosa</i>	Basidiomycete	Aqueous extract	Rats	Inactive	Williams et al., 1959
<i>Glycyne max</i>	Fabaceae	Aqueous extract	Humans	Active	Kudolo, 2001
<i>Gossypium herbaceum</i>	Malvaceae	Polysaccharide caplets	Humans	Active	Konno et al., 2002
<i>Gymnema sylvestre</i>	Asclepiadaceae	Part used and type of extract not stated	<i>In vitro</i> cells	Week activity	Broadhurst et al., 2000
<i>Hamamelis virginiana</i>	Hamamelidaceae	Pulp powder of the seeds	Ewes	Active	Menaull, 1923
		Part used and type of extract not stated	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
		Part used and type of extract not stated	<i>In vitro</i> cells	Active	Broadhurst et al., 2000

<i>Humulus lupulus</i>	Cannabaceae	Colupulone	Mice	Active	Manning et al., 1994
<i>Ipomoea hederaceae</i>	Convolvulaceae	Seeds powder	Rats	Active	Dugan et al., 1990
<i>Ipomoea lacunosa</i>	Convolvulaceae	Seeds powder	Rats	Active	Dugan et al., 1990
<i>Laurus nobilis</i>	Lauraceae	Part used and type of extract not stated	<i>In vitro</i> cells	Active	Broadhurst et al., 2000
<i>Linum usitatissimum</i>	Linaceae	Part used and type of extract not stated	<i>In vitro</i> cells	Week activity	Broadhurst et al., 2000
<i>Lupinus sp</i>	Fabaceae	Aqueous extract of the seeds	Humans	Inactive	Tsiodras et al., 1999
<i>Medicago sativa</i>	Fabaceae	Aqueous extract of the entire plant	Rats	Inactive	Williams et al., 1959
<i>Momordica charantia</i>	Cucurbitaceae	Fraction peptide MC-6	Rats	Active	Nag, 2000
		Fraction peptide MC-6.1	Rats	Active	Nag, 2000
		Fraction peptide MC-6.2	Rats	Active	Nag, 2000
		Fraction peptide MC-6.3	Rats	Active	Nag, 2000
<i>Morus indica</i>	Moraceae	Aqueous extract of the leaves	Humans	Active	Andallu et al., 2001
<i>Myristica fragans</i>	Myristicaceae	Part used and type of extract not stated	<i>In vitro</i> cells	Active	Broadhurst et al., 2000
<i>Nepeta cataria</i>	Labiatae	Part used and type of extract not stated	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
<i>Ocimum basilicum</i>	Labiatae	Part used and type of extract not stated	<i>In vitro</i> cells	Active	Broadhurst et al., 2000
<i>Ocimum sanctum</i>	Labiatae	Aqueous extr. of the entire plant	Organism not stated	Active	Luthy; Martinez 1964
<i>Origanum vulgare</i>	Labiatae	Part used and type of extract not stated	<i>In vitro</i> cells	Active	Broadhurst et al., 2000
<i>Panax ginseng</i>	Araliaceae	Part used and type of extract not stated	<i>In vitro</i> cells	Week activity	Broadhurst et al., 2000
<i>Panax quinquefolius</i>	Araliaceae	Saponin fraction of the roots	Rats	Weak activity	Martinez et al., 1984
		Part used and type of extract not stated	<i>In vitro</i> cells	Weak activity	Broadhurst et al., 2000
<i>Petroselinum crispum</i>	Umbelliferae	Part used and type of extract not stated	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
<i>Pimenta officinalis</i>	Myrtaceae	Part used and type of extract not stated	<i>In vitro</i> cells	Active	Broadhurst et al., 2000
<i>Pimpinella anisum</i>	Umbelliferae	Part used and type of extract not stated	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
<i>Piper nigrum</i>	Piperaceae	Part used and type of extract not stated	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000

<i>Plantago ovata</i>	Plantaginaceae	Seed husks in ration	Mice	Inactive	Watters et al., 1989
<i>Prunus dulcis</i>	Rosaceae	Part used and type of extract	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
<i>Rosmarinus officinalis</i>	Labiatae	Part used and type of extract	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
<i>Salvia officinalis</i>	Labiatae	Part used and type of extract	<i>In vitro</i> cells	Week activity	Broadhurst et al., 2000
<i>Solanum nigrum</i>	Solanaceae	not stated			
<i>Stevia rebaudiana</i>	Asteraceae	Seeds powder	Rats	Active	Dugan et al., 1990a
		Leaves - Type of extract not stated	Dogs	Inactive	White jr et al., 1994
<i>Syzigium aromaticum</i>	Myrtaceae	Part used and type of extract	<i>In vitro</i> cells	Active	Broadhurst et al., 2000
<i>Tecoma stans</i>	Bignoniaceae	Aqueous extract	Mice	Inactive	Nash, 1958
<i>Tillandsia usneoides</i>	Bromeliaceae	Aqueous extract of the entire plant	Mice	Active	Keller et al., 1981
		3-Hydroxy-3-methyl-glutaric acid	Mice	Active	Witherup; McLaughlin, 1995
		Succinic acid	Mice	Inactive	Witherup; McLaughlin, 1995
		4',5,7-Trihydroxy-3',5',6'-tetramethoxy-7-O-β-D-glucoside	Mice	Inactive	Witherup; McLaughlin, 1995
<i>Vaccinium corymbosum</i>	Ericaceae	Ethanol extract of the leaves	Dogs	Inactive	Allen, 1927
<i>Vaccinium myrtillus</i>	Ericaceae	Ethanol ext. of the leaves	Dogs	Inactive	Allen, 1927
<i>Vaccinium pennsylvanicum</i>	Ericaceae	Aqueous extrac of the leaves	Dogs	Inactive	Allen, 1927
<i>Vanilla planifolia</i>	Orchidaceae	Part used and type of extract	<i>In vitro</i> cells	Week activity	Broadhurst et al., 2000
		not stated			
<i>Vinca rosea</i>	Apocynaceae	Ajmalicine	Rats	Inactive	Svoboda et al., 1964
		Catharantine	Rats	Questionable	Svoboda et al., 1964
		Leurosine	Rats	Moderated act.	Svoboda et al., 1964
		Lochnerine	Rats	Slight activity	Svoboda et al., 1964
		Perivine	Rats	Inactive	Svoboda et al., 1964
		Sitsirikine	Rats	Inactive	Svoboda et al., 1964
		Tetrahydroalstonine	Rats	Questionable	Svoboda et al., 1964
		Vincathicine	Rats	Inactive	Svoboda et al., 1964
		Vindoline	Rats	Slight activity	Svoboda et al., 1964
		Vindolinine	Rats	Moderated act.	Svoboda et al., 1964
<i>Withania somnifera</i>	Solanaceae	Part used and type of extract	<i>In vitro</i> cells	Inactive	Broadhurst et al., 2000
		not stated			
<i>Xanthium strumarium</i>	Asteraceae	Ethanol extract of the entire plant	Rabbits	Active	Turner et al., 1974
<i>Zingiber officinale</i>	Zingiberaceae	Part used and type of extract	<i>In vitro</i> cells	Week activity	Broadhurst et al., 2000
		not stated			

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