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Research Article

IN VITRO ALPHA-GLUCOSIDASE INHIBITORY ACTIVITY OF EGYPTIAN PLANT EXTRACTS AS AN INDICATION FOR THEIR ANTIDIABETIC ACTIVITY

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ABSTRACT

Objective: Diabetes mellitus is a highly prevalent chronic disease in Egypt leading to high socioeconomic problems, especially in the cities due to the unhealthy life style. Although many drugs are available, they have many side effects. Furthermore, the body arouses resistance after a while for the drug so it should be changed every once in a while. Plants could be a good source for drugs. In Egypt, we have a rich flora which has not been subjected to systematic screening for antidiabetic activity.

Methods: The aim of this work was to screen 264 plant extracts for their *in vitro* α-glucosidase inhibitory activity. Those extracts which gave more than 70% inhibition were screened on different concentrations and their inhibitory concentrations giving 50% activity (IC_{50}) were calculated.

Results: Out of all the tested extracts, 63 gave more than or equal 70% inhibition on α-glucosidase at the tested concentration (25 ppm). After the calculation of the IC_{50} values, 10 extracts were chosen for further study having 5 ppm and less IC_{50}.

Conclusion: The most active plant extract is *Pinus roxburghii* Sarg. branches (IC_{50} is 2.47 ppm).

Keywords: Antidiabetic, Alpha-glucosidase, *In vitro*, Plant extracts, Bioassay, Egyptian.

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INTRODUCTION

Diabetes is a complex metabolic condition where the patient suffers a chronic increase in blood glucose concentration (hyperglycemia) since the body cannot properly utilize it [1-4].

Diabetes mellitus is a highly prevalent chronic disease in Egypt leading to high socioeconomic problems, especially in the cities due to the unhealthy life style. Although many drugs are available, they have many side effects. Furthermore, the body arouses resistance after a while for the drug so it should be changed every once in a while.

It is noteworthy that therapeutic pathways for type 2 diabetes mellitus are based on the following: Stimulation of insulin secretion, reducing the production of glucose from the liver, interfering with the metabolism and digestion of carbohydrates (our target), and optimizing insulin action [5].

Plants and natural products could represent an excellent source for drugs since they can provide new compounds which cannot be predicted by computational chemistry [6].

The α-glucosidase enzyme is responsible for changing oligo and disaccharides into monosaccharides. In case it is inhibited, the blood concentration of glucose decreases since only monosaccharides can be absorbed through intestinal mucosa [7] thus reducing the demand for insulin.

The aim of this work was to begin a series of diabetes-related *in vitro* screening program, studying the Egyptian flora. Since no systematic Egyptian large scale bio-study was done in that area before, we find it of great interest to undergo such a study.

The paper at hand, aimed to screen 264 plant extracts for their *in vitro* α-glucosidase inhibitory activity.

METHODS

Preparation of the plant extracts

Seventy five grams of dried plant powder were percolated in 450 ml 95% analytical grade methanol (ADWIC-Egypt) for 24 h in a stainless steel percolator. The percolate was vacuum dried using Büchi R-114 rotatory evaporator at 45°C. The distillate was used for re-percolation of the marc and the same procedure was adopted. The dried extract was kept in the dark at −20°C till its use [8].

Preparation of the stock solutions of plant extracts for bioassays

Ten mg of the dried methanol plant extract are dissolved in 500 µl dimethyl sulfoxide (stock solution A). Master plates for the extracts to achieve different concentrations are prepared as follows: 5 µl from the stock solution A + 195 µl buffer (stock B); 100 µl from the stock solution B + 100 µl buffer (stock C); 100 µl from the stock solution C + 100 µl buffer (stock D); and 100 µl from the stock solution C + 100 µl buffer (stock D).

α-glucosidase inhibitory activity

Briefly α-glucosidase (Sigma G5003-100UN-USA) of concentration 0.2 U/ml is prepared in phosphate buffer saline (0.2 M) (pH 6.8) (35.084 g Na_2HPO_4 [Loba Chemie-0597100500] + 13.872 g KH_2PO_4 [s.d.fine-Chem ltd. BOISAR 39608]L). 10 µl of sample at varying concentrations are mixed with 60 µl of 0.2 U/ml α-glucosidase and incubated for 20 min at 37°C in a 96 well plate. The 150 µl of 1.25 mM p-nitrophenyl α-D-glucopyranoside (p-NPG) (Sigma N1377-5g-USA) are added and incubated at 37°C for 20 min giving final concentrations of 0.2 to 25 ppm in the final volume. The reaction is terminated by the addition of 50 µl of 2 g/L sodium hydroxide (NaOH). α-glucosidase activity is determined spectrophotometrically at 405 nm by measuring the quantity of bright yellow p-nitrophenol released from the colorless p-NPG. The negative control has 10 µl of buffer solution in place of the test entity while acarbose is used as a positive control. For blank p-NPG with buffer solution is added instead of the enzyme [9,10].

Calculation of the result:

The percentage inhibition=(1−[average of sample absorbance/average of negative control absorbance])×100

RESULTS

Two hundred and sixty four plant extracts (25 ppm) were screened for their α-glucosidase inhibitory activity (Table 1).

Out of all the tested extracts, 63 gave more than or equal 70% inhibition on glucosidase at the tested concentration, where their IC_{50} values were calculated (Tables 2 and 3). IC_{50} of acarbose as a positive control is 45±2.7 ppm. By reviewing the results, the most active plant extract proved to be *Pinus roxburghii* Sarg. branches methanol extract (IC_{50} is 2.47 ppm).

DISCUSSION

The present study was designed for the purpose of screening a part of the Egyptian flora for their antidiabetic properties. Where a huge number of animals would be needed for the purpose, the resort to a simple *in vitro* method pointing out the plants which can be chosen as candidates for deeper *in vivo* studies is adopted. This paper is the beginning step in a much longer path so as to reach an effective antidiabetic drug from natural origin.

By reviewing our findings, several plant extracts showed significant results in blocking the α-glucosidase enzyme ability to break down starch, which, in turn, would decrease the blood glucose level.

Pinus roxburghii Sarg. being the most active plant was subjected to a literature survey. The survey showed that the bark alcohol extract has

Table 1: Screening of extracts on α-glucosidase inhibitory *in vitro* bioassay at 25 ppm

Genus species	Part	Activity on α-glucosidase (%)
Acacia ehrenbergiana Hayne	Fr	13
Acacia saligna (Labill.) H.L.Wendl.	L, Fl and Fr	1
	Br	100
Acalypha wilkesiana Mull. Arg. Cv. Hoffmanianum	L	99
Acer negundo L.	Bark	−24
Acer oblongum Wall. ex DC.	H	12
Achillea fragrantissima (Forssk) Sch	H	15
Achras sapota L.	L	100
Adenanthera pavonina L.	Bark	10
Aegilops ventricosa (Zhuk.) Chennav.	H	15
Aegle marmelos (L.) Corrêa	Inflorescence	16
Ageratum houstonianum Mill	Br	21
Albizia stipulata Boiv.	L, Br and Fl	16
Albizzia lebbeck (L.) Benth.	L	12
Alhagi graecorum Boiss.	H	3
Alkanna orientalis (L.) Boiss.	Br	43
Aloe arborescens Mill	Shoot system	16
Amaranthus graecizans L.	H	0
Anagallis arvensis L.	H	0
Anredera baselloides (HBK) Bail	L and Br	26
Aptenia cordifolia (L.f.) Schwant.	L	27
Arisarum vulgare v.vesligii	H	0
Artemisia judaica L.	H	0
Astragalus fruticosus Forssk.	H	0
Atriplex halimus L.	H	9
Atriplex portulacoides L.	H	11
Atriplex semibaccata R.Br.	H	21
Avena sterilis L.	H	0
Ballota kaiseri Tackh.	Br	0
Baugainvillea glabra Choisy	Bark	0
Bauhinia hookeri F.J.Muell.	L and Br	100
	L	100
*Bauhinia variega*ta (L.) Benth.	Fr with seeds	−15
	Bark	100
Beta vulgaris L.	Weed	30
Bombax malabaricum DC.	L	100
Bougainvillea spectabilis Willd.	L and Br	17
Brassaia actinophylla Endl.	L and Br	78
Brassica nigra L.	Weed	19
Brassica oleracea L.	Weed	23
Caesalpinia ferrae C.Mart.	L and Fl	3
Calligonum comosum L'Her.	Br	32
Calligonum polygonoides L.	H	99
Campsis radicans (L.) seem.ex Bur.	Br	33
Capsella bursa-pastoris (L.) Medik.	Weed	20
Caryota urens L.	Fr	100
Cassia Fistula L.	Br	100
Cassia renegra Wallich ex Benth.	Br	100
	L	26
Celosia argentea L.	Br, Fr and Bark	19
Chenopodium ficifolium Sm.	Weed	15
Chorisia insignis (A.St.-Hil.) Ravenna	Bark	99

(Contd...)

Table 1: ***(Continued)***

Genus species	Part	Activity on α-glucosidase (%)
Chrysophyllum oliviforme L.	Br	100
Cichorium endivia L.	Weed	16
Cissus rotundifolia (Forssk.) Vahl	L and Br	0
Citharexylon quadrangularis Jacq.	Br	0
	Bark and Wood	14
Citrullus colocynthis (L.) Schrad.	Fr	0
Citrus aurantiifolia (Christm.) Swingle	Shoot system	24
Cleome amblyocarpa Barr. and Murb.	L and Br	14
Cleome chrysantha Decne.	H	−30
Cleome droserifolia (Forssk.) Del.	Bark	−17
	H	10
Clerodendrum inermis L.	H with Fl	0
Clerodendrum splendenc G. Don.	Br	5
	L	27
Clivia miniata Regrl.	L	0
Coccoloba peltata Schott	L	39
Convolvulus arvensis L.	Weed	15
Cordia gharaf (Forssk.) Ehrenb.ex Asch.	L	2
	Br	2
	Bark	11
Cordia myxa L.	H	7
Cornopus niloticus (Delile) Spreng.	Weed	15
Cornulaca monacantha Delile	Bark	19
Cressa cretica L.	H	0
Cynanchum acutum L.	L and Fl	43
Dactyloctenium aegyptium (L.) Willd.	H	0
Datura stramonium L.	H with Fr	3
Dellina indica L.	Br	13
	H	68.70
Delonix regia (Boj. ex Hook.) Raf.	Fl	74
Dendrocalamus strictus (Roxb.) Nees	H with Fl	14
Derris robusta (Roxb. ex DC.) Benth.	L and Fl	89
	Br	87
Diplotaxis harra (Forssk.) Boiss.	H	11
Dombeya tiliaceae (Endl.) planch	Br	50
Encephalartos villosus Lem.	Male Cone	100
Ephedra alata Decne.	L	5
Ephedra aphylla Forsskål	H	100
Eriobotrya japonica (Thumb) Lindl.	Br	64
	L	59
Erodium cicutarium (L.) L'Hér. ex Aiton	H	52
Eruca sativa Mill.	Weed	32
Erythrina indica Lam.	Bark	37
	L and Br	0
Eucalyptus citriodora (Hook.) K.D. Hill and L.A.S.Johnson	H	100
Eucalyptus rostrata Schltdl.	Bark	95
Eugenia uniflora L.	L	97
Euphorbia cotinifolia L.	H	26
Euphorbia ingens E.Mey. ex Boiss.	Bark	37
Euphorbia peplis L.	Weed	45
Euphorbia pulcherrima Willd. Ex. Kolotzch.	L	23
Euphorbia retusa Forssk.	H	27
Feronia elephantum Corrêa	Bark	−23
Ficus afzelii G.Don	Bark	100
	L	75
	Br	56
Ficus bengalensis L.	Aerial Roots	67
	Fr	56
Ficus cyathistipula Warb.	L	11
Ficus decora Hort. Cv. Variegata	H	28
Ficus elastica Roxb. ex Hornem.	Bark	100
Ficus eriobotroydes (Ficus afzeliiG. Don.)	Br	22
	H	95
Ficus palmata Forssk. Sub. Sp. Virgata (Roxb.)	Br	24
Ficus platyphylla Delile	Br	25
	H	32
Ficus pyriformis L.	Shoot system	21
Ficus sperguana L.	Bark	100
	H	96
Flacourtia cataphracta Roxb. ex Willd.	L	−11
Halocnemum strobilaceum (Pall.) Bieb.	H	17

(Contd...)

Table 1: ***(Continued)***

Genus species	Part	Activity on α-glucosidase (%)
Harpephyllum caffrum Bernh. ex C.Krauss	Br	6
Harpullia cupanioides Roxb.	Bark	6
	Br	83
	L	0
	H	15
Heliotropium digynum (Forssk.) Aschers. ex C. Christ.	H	−6
Hippeastrum vittatum (L Her.)	Br	20
Hyphaene thebaica (L.) Mart.	Fl	2
	H	0
Iphiona scabra DC. ex Decne.	H	0
Jasminum primulinum Hemsl.	Br	18
	L	33
Juncus rigidus Desf.	H	0
Khaya dewi A.Juss.	L and Br	30
	L	0
Khaya senegalensis (Desr.) A.Juss.	L	66
	Br	83
	Bark	97
Koelreuteria elegans (seem.) A.C, Sm.(*Koelreuteria henryi* Dummer)	L	96
Koelreuteria paniculata Laxm.	Br	100
Lagerstroemia indica (L.) Pers.	Br	87
Lamium amplexicaule L.	Weed	23
Lantana camara L.	Br	0
Lasiurus hirsutus (Forssk.) Boiss.	L	20
*Launaea spinos*a (Forssk.) Sch.Bip.	H	−5
Leucaena glauca L. Benth	H with Fl and Fr	27
	L	32
Liomoniastrum monopetalum (L.) Boiss.	L, Br and Fl	8
	H	100
Lonicera japonica Thunb.	L and Br	23
Lotus tenuis Waldst. and Kit. ex Willd.	Weed	16
Synonyms *Lotus glaber* Mill.		
L. corniculatus subsp. *tenuifolius* L.		
Lycium europaeum L.	L and Br	31
Lycium shawii Roem and Schult.	H	10
Macadamia integrifolia Maiden and Betche	Br and L	26
Maclura pomifera (Raf.) Schneid.	Bark	0
Magnolia grandiflora L.	Bark	−15
	Fl	0
Malpighia glabra L.	L	0
Malvaviscus arboreas Cav.	H	21
*Mangifera indic*a L.	Br	96
Markhamia platycalyx (Baker) Sprague	Fl	16
Medicago polymorpha L.	Weed	17
Melaleuca ericifolia Sm.	L and Fl	50
	Br	55
Melia azedarach L.	Weed	0
Melilotus indicus (L.) All.	Weed	25
Mesembryanthemum nodiflorum L.	Weed	19
Montanoa bipinnatifida (Kunth) K.Koch	L	−26
	Br	2
Morettia philaena (Del.) DC	Br	2
Morus alba L.	L and Br	32
Morus nigra L.	Bark	99
Myoporum laetum G. Forst.	H	5
Nitraria retusa (Forssk.) Asch.	H	0
Ononis vaginalis Vahl	H	16
Oreopanax reticulatum Willd.	Fr	0
Panicum turgidum Forssk.	H	20
Parietaria judaica L.	L and Br	30
Parkinsonia aculeata L.	L	30
Paspalidium geminatum (Forssk.) Stapf.	H	0
Phlomis aurea Decne.	Shoot system	25
Phoenix dactylifera L.	Pulp	0
Pinus canariensis C.Sm.	Fr	100
	L	100
Pinus halepensis Mill.	Fr	75
	Br	37
	L	79
Pinus pinea L.	Br	100

(Contd...)

Table 1: ***(Continued)***

Genus species	Part	Activity on α-glucosidase (%)
	L	99
Pinus roxburghii Sarg.	Fr	30
	Br	99.50
	L	68
Pistacia chinensis Bunge	L and Fr	11
	L and Unripe Fruit	0
Pithecellobium dulce (Roxb.) Benth.	Fr	100
Plantago lagopus L.	H	0
Plumeria rubra L.	L, Br and Fr	15
Polyscias paniculata (DC.) Baker	Br	100
Psidium guajava L.	Br	99
	L	99
Pterospermum acerifolium (L.) Willd.	Br	17
Pulicaria incisa (Lam.) DC.	H with Fl	0
Putranjiva roxburghii Wallich	Br	47
	L	100
Pyracantha fortuneana (Maxim) H.L.Li (*Pyracantha creneto-serrata* Hance Rehd)	L	88
Pyrethrum santolinoides (Tanacetum santolinoides)	H	0
Pyrus communis L.	Shoot system	42
Ranunculus sceleratus L.	H	0
Reseda pruinosa Delile	H	9
Rumex dentatus L.	Weed	92
Sabal peregrina L.H. Bailey	L	9
Salsola kali L.	H	10
Sambucus nigra L.	Bark	0
Saraca cauliflora Bak.	L	91
Schefflera arboricola (Hayata) Kanehira	Shoot system	30
Senecio glaucus L. Synonyms *Senecio coronopifolius Desf*	Weed	23
Senna surattensis (Burm. f.) H. Irwin and Barneby	Br	98
Sesbania sesban (L.) Merr.	L and Br	−17
Shinopsis balansea Engl	Br	98
Silene rubella L.	Weed	19
Silybum marianum (L.) Gaertn.	Weed	23
Sonichus oleraceus L.	W	20
Spathodea nilotica Seem.	L and Br	19
	Fl	6
Spondias lutea L.	L	89
	Fr	100
	Br	100
Stachys aegyptiaca Pers.	H	0
Stellaria pallida (Dumort.) Piré	Weed	34
Sterculia foetida L.	L	51
	Br	100
Suaeda aegyptiaca (Hasselq.) Zohary	H	17
Suaeda pruinosa Lange	H	32
Suaeda vera Forssk. ex J.F.Gmel.	H	0
Swietenia macrophylla King	L	62
Swietenia mahagoni (L.) Jacq.	L	100
	Br	100
	Bark	42
Tecoma radicans (L.) Juss.	L and Br	14
Tecoma stans (L.) Juss. ex Kunth	H	21
	L	26
Terminalia angustifolia Blanco	Br	0
Terminalia arjuna (Roxb.) Wight and Arn.	Br	100
Terminalia bellirica (Gaertn.) Roxb.	Br	12
Teucrium polium L.	H	0
Tipuana tipu (Benth.) Kuntze	Bark	36
	L	0
	Fl	15
Trifolium resupinatum L.	Weed	23
Trigonella stellata Forssk.	H	0
Ulmus parvifolia Jacq.	L	50
Verbascum sinaiticum Benth.	Br	4
Verbena x hybrida Ross.	L	15
Vicia sativa L.	Weed	12
Woodfordia fruticose (L.) Kurz	Bark	4
Xanthium spinosum L.	H	0
Zilla spinosa (L.) Subsp. Parmata	Br	12
Zygophyllum album L.	L	20
Zygophyllum decumbens Delile.	Aerial part	12

H: Herb, Fr: Fruits, Fl: Flowers, L: Leaves, Br: Branches

Table 2: The percentage inhibition of extracts which gave≥70% at 25 ppm on α-glucosidase on different concentrations to be used in the calculation of the IC values

Genus species	Part	Activity on α-glucosidase (%)					
		25 ppm	12.5 ppm	6.3 ppm	3.1 ppm	1.6 ppm	0.8 ppm
Acacia saligna (Labill.) H.L. Wendl.	Br	99	86	66	37		
Acalypha wilkesiana Mull. Arg. Cv. Hoffmanianum	L	99	95	71	30		
Achras sapota L.	L	96	73	38	15		
Bauhinia hookeri F.J.Muell.	L and Br	90	88	73	34		
	Br	100	88	54	25		
Bauhinia variegata (L.) Benth.	Bark	71	71	59	54		
Bombax malabaricum DC.	Bark	97	78	48	24		
Brassaia actinophylla Endl.	L, Br	83	64	33	15		
Calligonum polygonoides L.	H	100	100	97	50		
Caryota urens L.	L	99	90	60	27		
Cassia Fistula L.	Bark	95	82	59	40		
*Cassia renegr*a Wallich ex Benth.	L	85	72	56	36		
Chorisia insignis (A.St.-Hil.) Ravenna	Bark	99	97	90	50		
Chrysophyllum oliviforme L.	Br	100	95	73	3		
Derris robusta (Roxb. ex DC.) Benth.	L and Fl	89	45	17	8		
	Br	88	82	79	46		
Encephalartos villosus Lem.	Male Cone	100	100	70	32		
Ephedra aphylla Forsskål	Herb	89	64	38	17		
Eucalyptus citriodora (Hook.) K.D. Hill *and L.A.S.Johnson*	Bark	84	52	28	20		
Eucalyptus rostrata Schltdl.	Bark	95	87	81	73		
*Eugenia uniflora*L.	L	97	95	85	43		
Ficus afzelii G.Don	Bark	98	99	99	67	36	16
	L	84	62	28	0		
Ficus elastica Roxb. ex Hornem.	Bark	100	96	87	40		
Ficus eriobotroydes (*Ficus afzelii*G. Don.)	Br and Fr	88	51	41	2		
Ficus sperguana L.	L	83	62	42	20		
	Bark	100	98	73	12		
*Harpullia cupanioides*Roxb.	Br	83	13	0			
	Fl	72	39	21	10		
Khaya senegalensis (Desr.) A.Juss.	Br	86	81	51	13		
	Bark	99	98	98	76	45	34
Koelreuteria elegans (seem.) A.C, Sm. (*Koelreuteria henryi Dummer)*	L	89	86	80	60		
Koelreuteria paniculata Laxm.	Br	93	67	29	0		
Lagerstroemia indica (L.) Pers.	L and Fl	96	90	77	44		
Liomoniastrum monopetalum (L.) Boiss.	Herb	100	76	41	11		
Mangifera indica L.	L	96	100	85	35		
Morus nigra L.	Bark	99	99	85	55		
Pinus canariensis C.Sm.	Fr	99	99	93	50		
	L	91	61	30	12		
Pinus halepensis Mill.	Fr	75	41	8	2		
	L	79	52	26	7		
Pinus pinea L.	Br	92	57	0	0		
	L	91	62	26	4		
Pinus roxburghii Sarg.	Br	92.00	97	91	67		
Pithecellobium dulce (Roxb.) Benth.	Bark	95	94	78	38		
*polyscias paniculat*a (DC.) Baker	Br	95	82	57	24		
Psidium guajava L.	Br	99	97	64	19		
	L	99	98	71	30		
Putranjiva roxburghii Wallich	L	87	54	37	11		
Pyracantha fortuneana (Maxim) *H.L.L.i (Pyracantha creneto-serrata (Hance Rehd)*	B	98	94	70	47		
Rumex dentatus L.	Weed	75	38	10	4		
Saraca cauliflora Bak.	L	99	97	70	32		
Senna surattensis (Burm. f.) H. Irwin and Barneby	Br	99	89	64	27		
Shinopsis balansea Engl	Bark	98	97	77	41		
Spondias lutea L.	L	89	82	64	62		
	Br	100	99	88	51		
	Fr	66	37	0			
Sterculia foetida L.	L	100	100	72	17		
	Br	100		89	50		
Swietenia mahagoni (L.) Jacq.	L	99	98	88	52		
	Br	100	100	100	65		
Terminalia arjuna (Roxb.) *Wight and Arn.*	Br	100	100	60	30		

H: Herb, Fr: Fruits, Fl: Flowers, L: Leaves, Br: Branches

Table 3: The calculated IC50 of the extracts which gave≥70% at 25 ppm

Plant name	Part	IC50
Acacia saligna (Labill.) H.L. Wendl.	Br	05.64±1.0
Acalypha wilkesiana Mull. Arg. Cv. *Hoffmanianum*	L	05.43±0.9
Achras sapota L.	L	09.17±1.7
Bauhinia hookeri F.J.Muell.	L and Br	06.20±1.6
	Br	06.26±0.9
*Bauhinia variegat*a (L.) Benth.	Bark	07.95±1.3
Bombax malabaricum DC.	Bark	07.80±1.7
Brassaia actinophylla Endl.	L, Br	11.07±1.9
Calligonum polygonoides L.	H	03.54±0.5
Caryota urens L.	L	11.63±2.1
*Cassia Fistula*L.	Bark	07.80±1.9
Cassia renegra Wallich ex Benth.	L	08.44±2.0
Chorisia insignis (A.St.-Hil.) Ravenna	Bark	02.97±0.8
Chrysophyllum oliviforme L.	Br	05.77±1.1
Derris robusta (Roxb. ex DC.) Benth.	L, fl	18.83±2.7
	Br	05.53±1.6
Encephalartos villosus Lem.	Male Cone	04.48±0.6
Ephedra aphylla Forsskål	H	10.66±1.2
Eucalyptus citriodora (Hook.) K.D. *Hill and L.A.S.Johnson*	Bark	12.41±2.1
Eucalyptus rostrata Schltdl.	Bark	03.20±0.1
Eugenia uniflora L.	L	04.36±0.8
Ficus afzelii G.Don	Bark	03.37±0.2
	L	13.23±1.1
Ficus elastica Roxb. ex Hornem.	Bark	03.99±0.1
Ficus eriobotroydes (Ficus afzelii G. Don.)	Br and Fr	13.18±1.4
Ficus sperguana L.	L	11.66±2.1
	Bark	05.17±1.1
Harpullia cupanioides Roxb.	Br	21.01±4.1
	Fl	15.50±2.1
Khaya senegalensis (Desr.) A.Juss.	Br	08.21±1.7
	Bark	03.03±0.4
Koelreuteria elegans (seem.) A.C, Sm. *(Koelreuteria henryi Dummer)*	L	03.96±0.3
Koelreuteria paniculata Laxm.	Br	11.18±2.0
Lagerstroemia indica (L.) Pers.	L and Fl	04.93±1.6
Liomoniastrum monopetalum (L.) Boiss.	H	08.09±2.1
Mangifera indica L.	L	04.66±0.5
Morus nigra L.	Bark	03.53±0.3
Pinus canariensis C.Sm.	Fr	04.37±0.7
	L	11.27±1.9
Pinus halepensis Mill.	Fr	17.00±3.1
	L	13.30±2.1
Pinus pinea L.	Br	13.63±1.9
	L	12.07±2.0
Pinus roxburghii Sarg.	Br	02.47±0.2
Pithecellobium dulce (Roxb.) Benth.	Bark	05.22±1.0
Polyscias paniculata (DC.) Baker	Br	07.42±1.2
Psidium guajava L.	Br	05.71±0.8
	L	04.99±0.2
Putranjiva roxburghii Wallich	L	11.97±2.1
Pyracantha fortuneana (Maxim) *H.L.L.i (Pyracantha creneto-serrata (Hance Rehd)*	Br	04.92±0.4
Rumex dentatus L.	Weed	17.60±2.4
Saraca cauliflora Bak.	L	05.29±0.8
Senna surattensis (Burm. f.) H. Irwin and Barneby	Br	06.43±0.1
Shinopsis balansea Engl	Bark	04.74±0.7
Spondias lutea L.	L	05.30±0.5
	Br	03.72±0.3
	Fr	18.03±3.0
Sterculia foetida L.	L	04.01±0.8
	Br	03.37±0.2
*Swietenia mahagon*i (L.) Jacq.	L	03.58±0.3
	Br	02.64±0.1
Terminalia arjuna (Roxb.) Wight and Arn.	Br	04.92±1.2

H: Herb, Fr: Fruits, Fl: Flowers, L: Leaves, Br: Branches

anti-inflammatory and analgesic effect [11], the wood oil of the plant possesses hepatoprotective activity, and the essential oil of the needles is antibacterial and antifungal [12]. The antidiabetic *in vivo* activity of the bark extract and its hypolipidemic property were studied, where it proved to have a hypoglycemic effect [13]. The fore-mentioned result conforms to our work on the branches of the same plant. It was also studied as a protective for gastric ulcers [14] and for its antibacterial activity [15].

CONCLUSION

After the calculation of the IC values, 10 extracts were chosen having 5 ppm and less IC_{50} which will be subjected to further extensive *in vivo* studies.

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AUTHORS CONTRIBUTIONS

Both authors contributed in the preparation of the extracts, the performance of the bioassay and the calculation of the IC_{50} values.

CONFLICTS OF INTERESTS

The authors have no conflicts of financial or personal interests with any other organizations or people.

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