*IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS)*
*e-ISSN: 2278-3008, p-ISSN:2319-7676. Volume 9, Issue 4 Ver. V (Jul -Aug. 2014), PP 36-49*
*www.iosrjournals.org*

# Antidiabetic effect of potential Indian medicinal plants: A target specific in-vitro study

AparnaYagnambhatla[a],Gagandeep Kaur[b], Zehra Ali[b], Rajendra Yagnambhatla[a], Sunitha Galipelly[c], AshokKumarTiwari[b,], Sanjay K .Banerjee[b], Dattatray Manohar Akkewar[a]

[a]*Organic II Division , CSIR-Indian Institute of Chemical Technology, Hyderabad-500607, India*
[b]*Division of Medicinal Chemistry and Pharmacology, CSIR-Indian Institute of Chemical Technology, Hyderabad-500607, India*
[c]*Department of Botany, Phytochemistry Laboratory , Kakatiya University,Warangal-506001, India.*

***Abstract:*** *Thirty plant species were selected from the published literature as traditionally used by the indigenous people of the Telangana State for common human ailments. Antioxidants present in plants play an important role to protect the human body against damage by reactive oxygen species. In present studies methanolic extract of 30 plants were analyzed in a DPPH assay of free radical scavenging activity and some of the extracts were found to possess activity comparable to ascorbic acid. The plant extracts having higher antioxidant activity are Phyllanthus madaraspatensis, Bauhinia racemosa, Alkanna tinctoria, Ventilago maderaspatana (94.29, 88.13, 66.87 and 100 % inhibition, respectively and $IC_{50}$ values recorded were 5.48, 9.25, 20.15, 60.15µg/ml respectively, while the $IC_{50}$ value of standard compound (Ascorbic acid) is 20.9µg/ml. In present studies 23 plant methanlic extracts were assayed for α-glucosidase enzyme inhibition activity of which 5 plant extracts i.e., Jatropha gossypifolia (59.95), cocos nucifera flowers (63.78), Oroxylum indicum (93.24), Euphorbia hirta (62.56) and Cochlospermum gossypium (62.69%) noticed with higher % inhibition and comparable with acarbose. $IC_{50}$ values of all five plant extracts were recorded as 2.83, 3.42, 0.72,2.91 ,1.9 µg/ml respectively while standard $IC_{50}$ value is 0.69µg/ml for Acarbose. In present studies 30 higher % inhibition found were Jatropha gossypifolia (77.95%), Hiptage mandablota (82.16%), Alkanna tinctoria (86.32%), Euphorbia hirta (100%) and Pterocarpus marsupium (75.62%).$IC_{50}$ values of the plants recorded as Pterocarpus marsupium 55.81, Jatropa gossypifolia 50.23, Hiptage mandablota 20.76 and Euphorbia hirta 60.14 (µg/mL).Our data indicated that these plants could be potential natural sources for further drug development in diabetes.*

***Keywords:*** *Medicinal plants; Diabetes; Alfa-glucosidase enzyme inhibition; AGE inhibition; Antioxidant activity.*

## I. Introduction

Diabetes mellitus is a group of metabolic diseases in which a person has high blood sugar, either because the pancreas does not produce enough insulin, or because cells do not respond to the insulin that is produced. Diabetes mellitus is considered a major health concern, as its incidence is increasing at an alarming rate, and the high invalidating effects of its long-term complications affect macro- and microvasculature, heart, kidney, eye, and nerves. Increasing evidence indicates that hyperglycemia is the initiating cause of the tissue damage occurring in diabetes[2].Therefore, one therapeutic approach for treating diabetes is to control the hyperglycemia by reducing the absorption of glucose by inhibiting α- glucosidase. Enzyme alpha-glucosidase present in the epithelial mucosa of small intestine cleaves glycosidic bonds in complex carbohydrate to release absorbable monosaccharides. Inhibition of alpha-glucosidase in the digestive tract delay carbohydrate digestion and prolong overall carbohydrate digestion time, causing a reduction in the rate of glucose absorption and consequently blunting the postprandial blood glucose and insulin levels[4,5]. Thus alpha-glucosidase inhibitors may be an attractive therapeutic modality in type 2 diabetic patients. Reduction of advance glycation end products (AGEs) and oxidative stress in different tissues might be other appropriate approaches beside reduction of hyperlycemia. AGEs are formed in vivo through a non-enzymatic glycation of glucose and other reducing sugars with proteins via so-called Maillard reaction. Hyperglycemia and free radical formation are characteristics of diabetes which accelerate the formation of advanced glycation end products (AGEs) [5].AGEs may produce reactive oxygen species (ROS), bind to specific cell surface receptors, and form cross-links[1,3]. AGEs accumulate in the vessel wall, where they may perturb cell structure and function. AGEs have been implicated in both the microvascular and macrovascular complications of diabetes. AGEs may modify the extracellular matrix (ECM), modify the action of hormones, cytokines, and free radicals via engagement of cell surface receptors; and impact the function of intracellular protein. Oxidative stress in cells is

directly correlated with AGE formation.Many micro and macro complications of diabetes are related to oxidative stress. Low antioxidant level is associated with high AGE formation. Thus supplementation of plant based antioxidants may be useful to reduce the complications of diabetes.

Plant-based traditional medical systems continue to provide the primary health care to more than three quarters of the world's population. Indigenous herbal drugs widely used to treat diabetes and metabolic disorders. Plants continue to play an important role in the treatment of various diseases due to multiple beneficiary compositions having lesser or no side effect, and plant-based medicines can be used as an alternative approaches to treat diabetes. Traditional lifestyle, in which diet, exercise and possibly antioxidant and hypoglycemic medicines played an important role, may have masked people in pre-diabetic state in the past. As an evaluation of the benefit of the traditional medicine in relation to diabetes, we chose to study three types of activities in those plants used by the indigenous peoples of the South India for any symptoms associated with diabetes or its complications, on the premise that a particular species has a greater potential to treat diabetes if it can reduce more number of symptoms of diabetes or its complications.

Therefore the aim of our study was to evaluate the antidiabetic and antioxidant properties of 30 traditional plants of southern part of India. Our data indicated that out of 30 plants we screened, five of them have significant alfa-glucosidase inhibition properties, five of them have AGE inhibition properties and four of them have antioxidant properties.

## II. Materials and Methods

### 2.1. Reagents

1,1-diphenyl-2-picrylhydrazyl(DPPH), methanol, glucose, BSA (Bovine serum albumin), sodium phosphate buffer, ascorbic acid, ethanol, para-nitrophenyl-alpha-D-glucopyranoside, ascorbic acid.

### 2.2. Plant material

The plants were selected on the basis of their known medicinal activities in southern part of India. These plants were known to possess different type ethano medicinal properties. 30 medicinal plants were collected from Andhra Pradesh state and authenticated by Department of Botany, Kakatiya University Warangal. All plant species were collected in the month of October -November 2012.

### 2.3. Extraction procedure

Samples were air dried in shade before grinding to a particle size of 850 mm. Some of the thicker root samples and market produce were frozen and dried lyophilization before grinding. Extractions were performed in distilled methanol solvent using a Soxhlet apparatus. A fifty gm of each part's powder (leaf, stem or root) was extracted with 400 mL methanol by soxhlet percolation for 48 hrs. Extracts were collected and filtered twice using Whatman No.1 filter paper. The filtrates were then concentrated by rotary evaporation under reduced pressure at 40°C. Next the concentrates were poured into glass petri-dishes and put in the oven at 60° C for further drying and the resulting paste was stored in cold until further use.

### 2.4. Alfa-glucosidase inhibition assay.[20]

Intestinal alpha-glucosidase inhibition activity: 20µl of plant extracts (5mg/ml) was incubated with 50µl of crude intestinal alpha glucosidase for 5 minutes, and then 50µl of substrate 5mM para-nitrophenyl-alpha-D-glucopyranoside. Absorbance was measured at 405nm. Percentage enzyme inhibition was calculated. The formula is = Control- Sample/Control ×100.

### 2.5. Advanced glycation end product inhibition assay.[21]

For measurement of AGE, 40µl of the plant extract were added in 100µl of glucose and 60µl of BSA and made up the volume up to 200µl with sodium phosphate buffer in an eppendroph tube. Incubated the above solution for 12hrs at a temperature of 50°C in a water bath. The fluorescence was measured by using emissions at 440nm upon excitations at 370nm. (Munch et al., 1997).

### 2.6. DPPH radical scavenging activity Assay.[22]

The DPPH scavenging activity was determined by an assay modified from Khatua et al., 2012. DPPH solution was prepared at the concentration of 0.195 mg/ ml in methanol. To 150 µl of DPPH solution, 20 µl of plant extract (range 20 to 1000 µg/ml) was mixed and kept in the dark at room temperature for 60 minutes. After incubation, the absorbance was recorded at 517 nm. The results were compared with the control which contained 50µl of ethanol instead of plant extracts. The positive control used for this study was ascorbic acid. The antioxidant activity was expressed as percentage (%) inhibition =
{(absorbance control 517 nm – absorbance of samples 517nm)/ absorbance of the control 517nm} × 100.

**2.7. Statistics**

All samples were analyzed in triplicate. Data are presented as mean ± standard error mean (SEM). Differences were evaluated by one-way analysis of variance (ANOVA) test completed by a Bonferroni's multi comparison test. Differences were considered significant at $p < 0.01$. The concentration giving 50% inhibition ($IC_{50}$) was calculated by non-linear regression with the use of Graph pad Prism Version 5.0 for Windows (Graph Pad Software, San Diego, CA, USA) (www. graphpad.com) the dose–response curve was obtained by plotting the percentage inhibition versus concentration [37].

## III. Results

**3.1Alfa-glucosidase enzyme inhibition assay**

During screening of 23 promising Indian medicinal plants in search of potent glucosidase enzyme inhibitors, 23plant extracts were evaluated using Acarbose as standard for alfa-glucosidase enzyme inhibition assay. Among them five plant extracts exhibited significant inhibition in terms of $IC_{50}$ values up to 3.42µg/ml compared to Acarbose 0.69µg/ml (Table 2), (Fig. 1)

**3.2 Advance glycation end product inhibition assay**

In search of potent advance glycation end products inhibitors, 30 plant extracts were evaluated in a non-enzymatic assay. Amongst these 5 plants extracts exhibited significant inhibition above 75% and $IC_{50}$ values are given in Table 3 (Fig. 2)

**3.3.DPPH free radical scavenging assay**

All 30 plant extracts (Table-1) were evaluated for antioxidant activity. The extracts are able to reduce the stable radical DPPH to the yellow-coloured diphenylpicrylhydrazine. The scavenging effect of methanol extracts and standards with the DPPH radical is given in Table 4.Among them, four plants have shown comparable $IC_{50}$ values and it is significant to note that two of them are much more potent than ascorbic acid (Table 4).The reduction capability of DPPH radical is determined by the decrease in absorbance at 517 nm induced by antioxidants Ascorbic acid is used as standard compound (Fig. 3).

## IV. Discussion

Different alfa-glucosidase inhibitors such as Oleanolic acid and its semi synthetic derivatives[7],phenolic compound from aqueous extract of Myrtus communis[9] Oroxylin A, a flavone from hexane extract of Oroxylum indicum plant,[10]Nojirimycin and 1-deoxynojirimycin from Rosell (Hibiscus sabdariffa**)** and leaves of Morus bombysis[11] reported from plant sources,Acarbose- Glycolipids ,Miglitol – Glyset –Glycerol and Derivatives, Piperidines , Voglibose - Glycerol and Derivatives[8] are well-known and marketed. Present investigation revealed extracts of Jatropha gossypifolia bark,Cocoss nucifera flowers,Oroxylum indicum bark, Euphorbia hirta whole plant,Cochlospermum gossypium bark have exhibited remarkable activity. Therefore, based on bioassay guided information, further investigation is necessary in isolation,identification and characterization of bioactive principles.

AGEs inhibitors are phenolic compounds such as catechin, epicatechin and procyanidin B2 and phenol polymers from aqueous extract of cinnamon bark effectively scavenge reactive carbonyl species.[4] A terpenoid compound, Labdadiene dial from hexane extract of Alpinia zerumbet rhizomes[5] and a flavanol compound, mesquitol from methanolic extract of Dichrostachys cinera derived from plant sources. During our studies the extracts of Jatropha gossypifolia, Hiptage madablota, Bauhinia racemosa, Alkanna tinctoria,Euphorbia hirta, Oxalis carniculata have exhibited remarkable AGEs inhibition activity.

Well known and recognized dietary antioxidants are vitamin C, vitamin E, selenium, and carotenoids. However, recent studies have demonstrated that flavonoids found in fruits and vegetables may also act as antioxidants. Present investigation on antioxidant activity by DPPH inhibition assay, the extracts of Phyllanthus maderasipatensis, Bauhinia racemosa, Alkanna tinctoria and Ventilago maderaspatna have shown significant $IC_{50}$ values.

The reports on the preliminary phytochemical screening examination of Cochlospermum gossypium (bark), Jatropha gossypifolia (root), Bauhuni aracemosa (root) on antidiabetic activity are not available till date except Euphorbia hirta(whole plant). Euphorbia hirta has been examined earlier for the phytochemical constituents and found to possess tannins,saponins, flavonoids, steroids, cardiac glycosides and alkaloids.

Hencethere is a need for further investigation to isolate, identify and characterize the active compounds from those plants which showed good antidiabetic property.Amongst them Euphorbia hirta,Jatropha gossypifolia and Bauhinia racemosa with multiple biological functions are the most promising and of great interest for further investigation in development of new potent multifunctional inhibitors in management of diabetic therapy.

## V. Conclusions

Since it has been shown that the antioxidants,alfaglucosidase enzyme inhibitors, advance glycation end product inhibitors play important role and contribute to management of diabetes through different pathways, and plants being a treasury of source of various biologically active molecules.Our present studies concludes that it helped in identifying the promising plants with multiple biological functions which could be the potential source of unique bioactive therapeutic molecules for the management of hyperglycemia, diabetes and the related conditions warranting further investigation.

## Acknowledgements

The authors wish to gratefully acknowledge the Director CSIR-IICT, Hyderabad and Head, OrganicII Division,CSIR-IICT for their support. SKB is thankful to Department of Biotechnology (DBT) for providing Ramalingaswami Fellowship and CSIR for providing fund (SMiLE) for this work. We would also like to thank Professor and Head Botany Department Kakatiya University,Warangal (A.P) for identification and authentification of plants.

## References

[1]. Ahmad, M., Khan, M.A., Zafar, M., Arshad, M., Sultana, S., Abbasi, B.H., Siraj-Ud-Din.,2010. Use of chemotaxonomic markers for misidentified medicinal plants used in traditional medicines. Journal of Medicinal Plants Research 4, 1244-1252.
[2]. Ashok, B.K., Bhat, S.D., Ravishankar, B., 2012. Screening of intestinal transit time of Euphorbia fusiformisBuch.-Ham. ex D. Don in Swiss albino mice. Indian Journal of Natural Products and Resources 3, 547-550.
[3]. Baig I., 2003. Phytochemical Studies on Ferula Mongolica and Other Mongolian Medicinal Plants. PhD thesis, University of Karachi, Karachi, Pakistan. Available online at http://eprints.hec.gov.pk/662/1/438.htm [accessed 8th November, 2013].
[4]. Brownlee, M., 1995. Advanced protein glycosylation in diabetes and aging. Annu. Rev.Med. 46, 223–234.
[5]. Brownlee, M., Vlassara, H., Cerami, A., 1985. Nonenzymatic glycosylation products on collagen covalently trap low-density lipoprotein. Diabetes 34, 938–941.
[6]. Chowdhury, A.R., Rahmatullah, M., 2012. Ethnobotanical study of wound healing plants among the folk medicinal practitioners of several districts in Bangladesh. American-Eurasian Journal of Sustainable Agriculture 6, 371–377.
[7]. DebMandal, M., Mandal, S., 2011. Coconut (Cocosnucifera L.: Arecaceae): In health promotion and disease prevention. Asian Pacific Journal of Tropical Medicine 4, 241–247.
[8]. Fuentealba, D., Friguet, B., Silva, E., 2009. Advanced glycation endproducts induce photocrosslinking and oxidation of bovine lens proteins through type-I mechanism. Photochem. Photobiol. 85, 185–194.
[9]. Gul, A., Rahman, M.A., Hasnain, S.N., 2009. Role of fructose concentration on cataractogenesis in senile diabetic and non-diabetic patients. Graefes Arch. Clin. Exp. Ophthalmol. 247, 809–814.
[10]. Haus, J.M., Carrithers, J.A., Trappe, S.W., Trappe, T.A., 2007. Collagen, cross-linking, and advanced glycation end products in aging human skeletal muscle. Journal of Applied Physiology 103, 2068–2076.
[11]. Holman, R.R., Cull, C.A., Turner, R.C., 1999. A randomized double-blind trial of acarbose in type 2 diabetes shows improved glycemic control over 3 years (U.K. Prospective Diabetes Study 44). Diabetes Care 22, 960–964.
[12]. International Diabetes Federation Booklet. http://www.idf.org/files/docs/WDD-booklet-EN-final.pdf [accessed on 8th November, 2013] Kadavul, K. and Dixit. A.K. 2009. Ethnomedicinal studies of the woody species of Kalrayan&Shervarayan Hills, Eastern Ghats, Tamil Nadu. Indian Journal of Traditional Knowledge 8, 592-597.
[13]. Katekhaye, S.D., Nagmoti, D.M. 2013. α-Glucosidase and α-amylase inhibitory activities
[14]. ofPithecellobiumdulce bark and leaves. Phytopharmacology 4, 123-130.
[15]. Khatua, T.N., Padiya, R., Karnewar, S., Kuncha, M., Agawane, S.B., Kotamraju, S., Banerjee, S.K., 2012. Garlic provides protection to mice heart against isoproterenol-induced oxidative damage: role of nitric oxide. Nitric Oxide 27, 9–17.
[16]. Kim, K.Y., Nam, K.A., Kurihara, H., Kim, S.M., 2008. Potent alpha-glucosidase inhibitors purified from the red alga Grateloupiaelliptica. Phytochemistry 69, 2820–2825.
[17]. Kimura, A., Lee, J.-H., Lee, I.-S., Lee, H.-S., Park, K.-H., Chiba, S., Kim, D., 2004. Two potent competitive inhibitors discriminating alpha-glucosidase family I from family II. Carbohydrate Research 339, 1035–1040.
[18]. Kumar, S., Narwal, S., Kumar, V., Prakash, O., 2011. □-glucosidase inhibitors from plants: A natural approach to treat diabetes. Pharmacognosy Reviews 5, 19–29.
[19]. Lebovitz, H.E., 1997. alpha-Glucosidase inhibitors. Endocrinol. Metab. Clin. North Am. 26, 539–551.
[20]. Marta, K., Tomáš, Z., Petr, P., Pavel, Š., Martin, B., Jiřina, S., Květa, P., Rosemarie, K.-E., 2004. Advanced Glycation End-Products in Patients with Chronic Alcohol Misuse. Alcohol and Alcoholism 39, 316–320.
[21]. Murthy, E.N. 2012. Ethno medicinal plants used by gonds of Adilabad district, Andhra Pradesh, India. International Journal of Pharmacy and Life Sciences 3, 2034-2043.
[22]. Muthu, C., Ayyanar, M., Raja, N., Ignacimuthu, S., 2006. Medicinal plants used by traditional healers in Kancheepuram District of Tamil Nadu, India. Journal of Ethnobiology and Ethnomedicine 2, 43.
[23]. Negre-Salvayre, A., Salvayre, R., Augé, N., Pamplona, R., Portero-Otín, M., 2009. Hyperglycemia and glycation in diabetic complications. Antioxid. Redox Signal. 11, 3071–3109.
[24]. Nimachow, G., Rawat, J.S., Arunachalam, A., Dai, O. 2011. Ethno-medicines of Aka tribe, West Kameng district, Arunachal Pradesh (India). Science and Culture 77, 149-155.
[25]. Rajendar, K., Raju, D., Tirupathi M., Jaganmohan Reddy, K. 2010. Phytotherapeutical Methods Used by Traditional Healers of EturnagaramMandal, Warangal, Andhra Pradesh, India. Ethnobotanical Leaflets 14, 361-365.
[26]. Raju, V.S., Reddy, K.N. 2005. Ethnomedicine for dysentery and diarrhoea from Khammam district of Andhra Pradesh. Indian Journal of Traditional Knowledge 4, 443-447.
[27]. Rimando, A.M., Cuendet, M., Desmarchelier, C., Mehta, R.G., Pezzuto, J.M., Duke, S.O., 2002. Cancer chemopreventive and antioxidant activities of pterostilbene, a naturally occurring analogue of resveratrol. J. Agric. Food Chem. 50, 3453–3457.
[28]. Sabu, M.., Kuttan, R., 2002. Anti-diabetic activity of medicinal plants and its relationship with their antioxidant property. Journal of Ethnopharmacology 81, 155–160.

[29]. Schmidt, A.M., Hori, O., Brett, J., Yan, S.D., Wautier, J.L., Stern, D., 1994. Cellular receptors for advanced glycation end products. Implications for induction of oxidant stress and cellular dysfunction in the pathogenesis of vascular lesions. Arterioscler. Thromb. 14, 1521–1528.
[30]. Schmidt, A.M., Yan, S.D., Stern, D.M., 1995. The dark side of glucose. Nat. Med. 1, 1002–1004.
[31]. Shaikh, S., Nicholson, L.F.B., 2008. Advanced glycation end products induce in vitro cross-linking of alpha-synuclein and accelerate the process of intracellular inclusion body formation. Journal of Neuroscience Research 86, 2071–2082.
[32]. Simm, A., Wagner, J., Gursinsky, T., Nass, N., Friedrich, I., Schinzel, R., Czeslik, E., Silber, R.E., Scheubel, R.J., 2007. Advanced glycation endproducts: a biomarker for age as an outcome predictor after cardiac surgery? Exp. Gerontol. 42, 668–675.
[33]. Singh, R., Barden, A., Mori, T., Beilin, L., 2001. Advanced glycation end-products: a review. Diabetologia 44, 129–146.
[34]. Srikanth, V., Maczurek, A., Phan, T., Steele, M., Westcott, B., Juskiw, D., Münch, G., 2011. Advanced glycation endproducts and their receptor RAGE in Alzheimer's disease. Neurobiol. Aging 32, 763–777.
[35]. Srivastava, A., Patel, S.B, Mishra, R.K., Vashistha, R.K., Singh, A., Puskar, A.K. 2012. Ethnomedicinal importance of the Plants of Amarkantak region, Madhya Pradesh, India. International Journal of Medicinal and Aromatic Plants 2, 53-59.
[36]. Srivastava, R.C., Singh, R.K., Apatani Community, Mukherjee, T.K. 2010. Indigenous biodiversity of Apatani plateau: Learning on biocultural knowledge of Apatani tribe of Arunachal Pradesh for sustainable livelihoods. Indian Journal of Traditional Knowledge 9, 432-442.
[37]. Tan, K.C.B., Chow, W.-S., Lam, J.C.M., Lam, B., Bucala, R., Betteridge, J., Ip, M.S.M., 2006. Advanced glycation endproducts in nondiabetic patients with obstructive sleep apnea. Sleep 29, 329–333.
[38]. Ushakumari, J., Ramana, V.V., Reddy, K.J. 2012. Ethnomedicinal plants used for wounds and snake bites by tribals of Kinnerasani region, A.P., India. Journal of Pharmacognosy 3, 79-81.
[39]. Zimmerman, G.A., Meistrell, M., Bloom, O., Cockroft, K.M., Bianchi, M., Risucci, D., Broome, J., Farmer, P., Cerami, A., Vlassara, H., 1995. Neurotoxicity of advanced glycation endproducts during focal stroke and neuroprotective effects of aminoguanidine. Procedurals of National Academy of Sciences U S A 92, 3744–3748

Table :1 List of all plants along with their parts used and application in literatures

| **PLANT** | **FAMILY** | **PARTS AND USE** |
|---|---|---|
| Acalypha indica | Euphorbiaceae | Herb, Skin diseases |
| Adahatoda vasaka | Acantheceae | Leaf, Tuberclosis |
| Acacia chundra | Mimocaceae | Bark, asthma, Fever |
| Alkanna-tinctoria | Boranginaceae | Skin infections |
| Aegle marmelos | Rutaceae | Fruit pulp, Dysentry |
| Bauhinia racemosa | Caesalpinaceae | Bark, Dysentry |
| Bixa orellana | Bixaceae | Seed pulp, Dysentry |
| Clerodendrum serratum | Verbenaceae | Plant, Asthma, bronchitis |
| Cochlospermum-gossypium | Bixaceae | Stem, Gum Wounds |
| Chloroxylon-swietenia | Rutaceae | Bark, Shivering,Neck pain |
| Cocos nucifera | Aracaceae | Seeds, Burns, hair loss |
| Diplocyclus-palmatus | Cucurbitaceae | Leaf, Fever |
| Erythrina indica | Fabaceae | Bark, Wounds |
| Euphorbia hirta | Euphorbiaceae | Leaf juice, Scabies |
| Hybanthus vatsavaya | Violaceae | Whole plant, Urinary diseases |
| Hiptage mandablota | Malpighiaceae | Leaf, bark, Cough inflammation,skin disease |
| Jatropa gossypifolia | Euphorbiaceae | Bark paste, Dog bite |
| Lantana camara | Verbenaceae | Shrub Constipation, fever & stop bleeding |
| Nelumbo nucifera | Nyamphaceae | Seed, infertility |
| Michelia champaka | Mangolaceae | Flower oil, Rhumatism |
| Melia dubia | Meliaceae | Paste of berries, Leprosy |
| Oroxylum indicum | Bignonaceae | Bark, Rheumatism |

| | | |
|---|---|---|
| Oxalis corniculata | Oxalidaceae | Leaf juice, Dysentry |
| Phyllanthus maderaspatensis | Euphorbiaceae | Fruit powder, Teeth diseases |
| Pergularia-daemia | Asclepiadaceae | Leaf, Corneal opacity, gout, boils,blisters,wounds |
| Pterocarpus marsupium | Papilionaceae | Leaf, Diabetes, Labour pains |
| Smilax zeylanica | Smilaceae | Root, Venereal disorders |
| Ventilago maderaspatana | Ramnaceae | Root, Stomachache |
| Wrightia-tinctoria | Apocyanaceae | Leaf, Boils, blisters, fever |
| Zanthoxylum rhetsa | Rutaceae | Spines, applied on breast to relive pain |

Table:2 Alfa-glucosidase enzyme inhibition assay

| **Compound no.** | **Compound name** | **% inhibition** |
|---|---|---|
| 1 | Bixa orellana(L) | 26.65% |
| 2 | Pergularia daemia (w.p) | NA |
| 3 | Chloroxylon swietenia(L) | 51.72% |
| 4 | Jatropha gossypifolia | 59.95% |
| 5 | Oxalis corniculata(w.p) | 56.89% |
| 6 | Melia dubia(L) | 59.69% |
| 7 | Michelia champaka($L^{1)}$ | 61.28% |
| 8 | Smilax zeylanica(R ) | NA |
| 9 | Cocos nucifera (Fl) | 63.78% |
| 10 | Acacia chundra(B) | NA |

| | | |
|---|---|---|
| 11 | Aegle marmelos (R) | 52.55% |
| 12 | Hybanthus vastavaya(w.p) | 49.87% |
| 13 | Wrightia tinctoria (B) | 22.96% |
| 14 | Lantana camara(L) | 40.94% |
| 15 | Xanthoxylum rhetsa(B) | 56.38% |
| 16 | Bauhinia racemosa(R) | 35.52% |
| 17 | Aegle marmelos(L) | 30.61% |
| 18 | Oroxylum indicum(B) | 93.24% |
| 19 | Pterocarpus marsupium(B) | 31.63% |
| 20 | Ventilago madraspatana(B) | 56.25% |
| 21 | Euphorbia hirta(w.p) | 62.56% |
| 22 | Cochlospermum gossypium(B) | 62.69% |
| 23 | Alkanna tinctoria(R) | 55.74% |
| Acarbose | Standard compound | 93.97% |

**$IC_{50}$ value of α-glucosidase inhibitory assay**

| **Compund no.** | **Compund name** | **IC-50 (µg/mL)** |
|---|---|---|
| 4 | Jatropha gossypifolia (R) | 1.84 |
| 9 | Cocos nucifera (Fl) | 2.91 |
| 18 | Oroxylum indicum(B) | 0.723 |
| 21 | Euphorbia hirta(w.p) | 3.421 |
| 22 | Cochlospermum gossypium(B) | 2.83 |

| | | |
|---|---|---|
| Standard | Acarbose | 0.691 |

**Table 3:Advanced glycation end product assay**

| Compound no | Compound name | % inhibition |
|---|---|---|
| 1 | Pterocarpus marsupium(B) | 75.62664 |
| 2 | Adathoda vasaka(L) | 5.37339 |
| 3 | Xanthoxylum rhetsa(L) | 66.31328 |
| 4 | Bixa orinella(L) | 29.17909 |
| 5 | Jatropha gossypifolia (R ) | 77.95174 |
| 6 | Melia dubia(L) | NA |
| 7 | Phyllanthus maderasipatensis(B) | 43.73623 |
| 8 | Lantana camara(L) | 10.23355 |
| 9 | Chloroxylon swietenia(L) | NA |
| 10 | Hiptage mandabloata(B) | 82.16646 |
| 11 | Acalypha indica(w.p) | NA |
| 12 | Michelia,champaka (L) | 45.58439 |
| 13 | Aegle marmelos (R) | NA |
| 14 | Smilax zeylanica(R ) | 4.025506 |
| 15 | Clerodendrum serratum (B) | 47.06187 |
| 16 | Aegle marmelos(L) | 24.22821 |
| 17 | Bauhinia racemosa (R ) | 60.58218 |
| 18 | Michelia champak($L^1$) | 44.45683 |
| 19 | Alkanna tinctoria(R ) | 86.32157 |
| 20 | Erythrena indica (L) | NA |
| 21 | Oroxylum indicum(B) | NA |

| | | |
|---|---|---|
| 22 | Acacia chundra(B) | NA |
| 23 | Cocos nucifera (Fl) | NA |
| 24 | Hybanthus vastavaya(w.p) | NA |
| 25 | Nelumbo nucifera(S) | 25.33503 |
| 26 | Ventilago madrasipatana(B) | NA |
| 27 | Euphorbia hirta(w.p) | 100.2929 |
| 28 | Wrightia tinctoria (B) | 7.864382 |
| 29 | Colchospermum gossypium(B) | NA |
| 30 | Oxalis corniculata(w.p) | 63.1639 |

**$IC_{50}$ value of AGE**

| **Compund no.** | **Compund name** | **IC-50 (µg/mL)** |
|---|---|---|
| **1** | Pterocarpus marsupium(B) | 558.1149 |
| **5** | Jatropha gossypifolia (R ) | 502.3077 |
| **10** | Hiptage mandabloata(B) | 207.6042 |
| **27** | Euphorbia hirta(w.p) | 601.408 |

**Table 4: Antioxidant activity of all plant extract as assayed by DPPH inhibition assay**

| **Compound no** | **Compound name** | **% inhibition** |
|---|---|---|
| 1 | Pterocarpus marsupium(B) | 43.7596302 |
| 2 | Adathoda vasaka(L) | 9.86132512 |
| 3 | Xanthoxylum rhetsa(L) | 44.375963 |

| | | |
|---|---|---|
| 4 | Bixa orellena(L) | 43.4514638 |
| 5 | Jatropha gossypifolia (R ) | 47.1494607 |
| 6 | Melia dubia(L) | 38.0585516 |
| 7 | Phyllanthus maderasipatensis(B) | 94.2989214 |
| 8 | Lantana camara(L) | 19.8767334 |
| 9 | Chloroxylon swietenia(L) | 46.6872111 |
| 10 | Hiptage mandabloata(B) | 38.2126348 |
| 11 | Acalypha indica(w.p) | 20.8012327 |
| 12 | Michelia,champaka (L) | 39.2912173 |
| 13 | Aegle marmelos (R) | 38.366718 |
| 14 | Smilax zeylanica(R ) | 30.3543914 |
| 15 | Clerodendrum serratum (B) | 38.366718 |
| 16 | Aegle marmelos(L) | 29.7380586 |
| 17 | Bauhinia racemosa (R ) | 88.1355932 |
| 18 | Michelia champaka($L^1$) | 37.7503852 |
| 19 | Alkanna tinctoria(R ) | 66.8721109 |
| 20 | Erythrena indica (L) | 37.9044684 |
| 21 | Oroxylum indicum(B) | 37.1340524 |
| 22 | Acacia chundra(B) | 40.3697997 |
| 23 | Cocos nucifera (Fl) | 43.7596302 |
| 24 | Hybanthus vastavaya(w.p) | 33.4360555 |
| 25 | Nelumbo nucifera(S) | 35.9013867 |
| 26 | Ventilago madrasipatana(B) | 100 |
| 27 | Euphorbia hirta(w.p) | 38.5208012 |
| 28 | Wrightia tinctoria (B) | 40.8320493 |

| | | |
|---|---|---|
| 29 | Colchospermum gossypium(B) | 36.6718028 |
| 30 | Oxalis corniculata(w.p) | 39.2912173 |
| Standard compound | Ascorbic acid | 81.78 |

**$IC_{50}$ value of DPPH assay.**

| **Compund no.** | **Compund name** | **IC-50 (µg/mL)** |
|---|---|---|
| 7 | Phyllanthus maderasipatensis(B) | 5.48 |
| 17 | Bauhinia racemosa (R ) | 9.25 |
| 19 | Alkanna tinctoria(R ) | 20.15 |
| 26 | Ventilago madrasipatana(B) | 60.15 |
| Standard | Ascorbic acid | 20.9 |

Abbreviations: R, Roots; B, Stem bark; L, Leaves ; Fl, Flowers ; S. Seeds; w.p , whole plant

Fig. 1

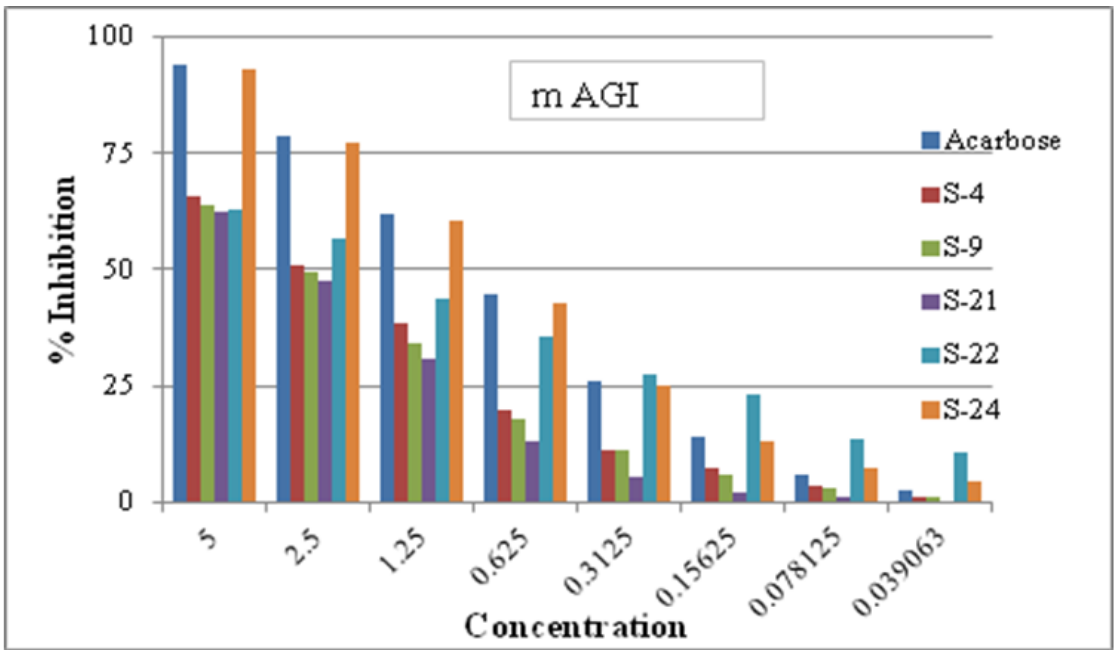


Fig. 2

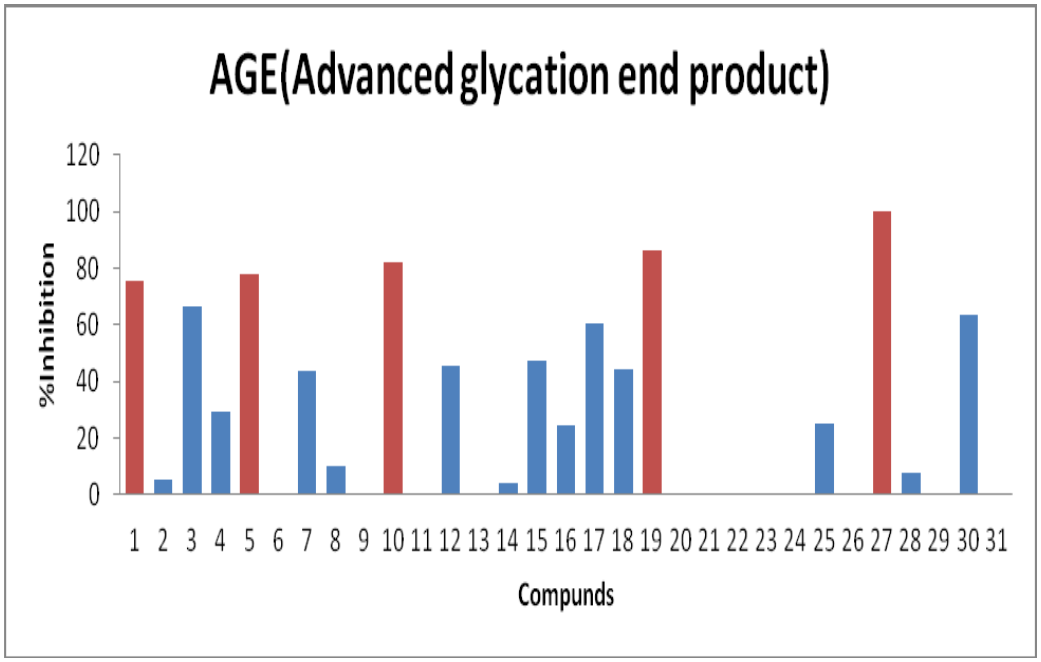
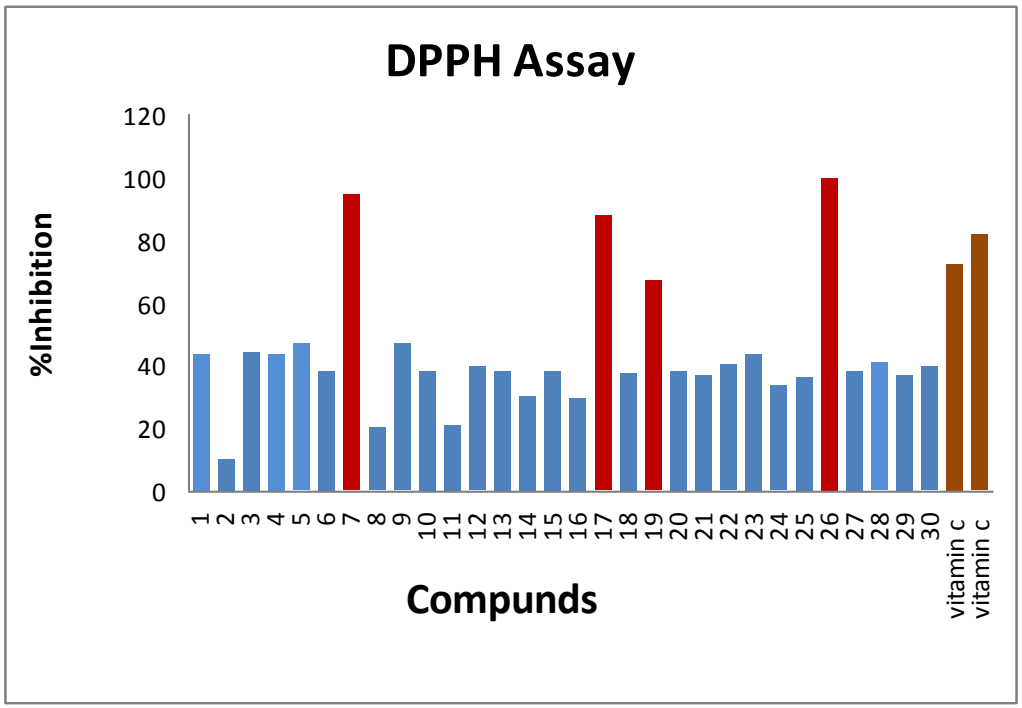



Fig. 3




**Legends**

1. The effects of 23 plant extracts on Alfa-glucosidase enzyme assay. The results were showed the % inhibition of Alfa-glucosidase enzyme.

2. The effects of 30 plant extracts on formation of advanced glycation end products (AGEs). The results were showed the % inhibition of AGE formation.

3. The effects of 30 plant extract on DPPH. The results were showed the % inhibition of oxidant activity.