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Review Article

Anti-diabetic Plants used in Sudanese Folk Medicine and their Phytochemical Constituents: A Review

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A B S T R A C T

Diabetes is a chronic metabolic disease that affected 451 million people worldwide on 2017. According to W.HO. The global health care expenditure on diabetic people was estimated to be 850 billion $ on 2017. Many medicinal plants have proven to be a good alternative to chemical medications. In this work 24 medicinal plants from different families used traditionally in Sudanese folk medicine for treatment of diabetes are reviewed based on scientific evidence. Their taxonomy, part used, life form, sources of collection, distribution, phytochemical screening and pharmacological activities have been identified.
It is reported that the most abundant plant families were found to be Caesalpiniaceae, followed by Asteraceae and Euphorbiaceae and then Anacardiaceae. 45 % were found to be herbs and 63 % of them were wild not cultivated. Phytochemical components of these plants were reviewed. Their anti-diabetic activities were reported in alloxinized and streptozotocin diabetic rats and in normoglycemic ones. LD_{50} of these plants was determined. Medicinal plants in this review article showed a confirmed anti-diabetic activity and have been assessed for their safety which proposes them as herbal medications for treatment of diabetes.

Keywords: Ethno Pharmacology, Phytochemical Screening, Hypoglycemic, Medicinal Plants

Introduction

In 2011, Sudan split into two countries with one third of the country being proclaimed a new country named "Republic of South Sudan" leaving behind the remaining area retaining the older name "The Republic of Sudan".[1] The diversity of climates in Sudan results in a rich variety of flora species corresponding to the wide range of ecological habitats and vegetation zones. Thus the intersection of cultures and the unique geographical position of Sudan potentiate research in many fields, the most important of which is research in the field of medicinal and aromatic plants. The flora of Sudan consists of 3137 documented species of flowering plants belonging to 170 families and 1280 genera. It is estimated that 15% of these plants are endemic to Sudan.[2]

Medicinal plants and their derivatives represent an integral part of life in Sudan and communities in different regions of Sudan use traditional medicine for the treatment of various ailments.

Diabetes mellitus, is a complex disorder characterized

by hyperglycemia resulting from malfunction in insulin secretion and/or insulin action, is the most common serious metabolic disease in the world.[3] The number of people with diabetes has arisen from 108 million in 1980 to 451 million in.[4] Many indigenous medicinal plants have been reported by various authors to have hypoglycemic effects. Some of these hypoglycemic medicinal plants have been shown to significantly reduce blood glucose concentration in normal and diabetic animals. Informed knowledge of the effects of medicinal plants as well as their safety is necessary to understand their appropriate medical applications. Reviews of medicinal plants studies provide platforms for multidisciplinary information about their beneficial activities.[5]

The present work is designed to collect data about the mostly used hypoglycemic plants among Sudanese communities, in order to provide knowledge about their taxonomical properties, distribution, phytochemical components, anti-diabetic effects and safety studies. This effort may highlight the most promising hypoglycemic plants in this field.

Materials and Method

The current review was done by collecting data on 24 medicinal plants native to Sudan, which have been reported to possess potential hypoglycemic activity. This was carried out by reviewing various research papers, review papers, short communications and published books. The sources of data were initially gathered from the major scientific databases such as science web of Knowledge, Science Direct, Pubmed and Google. The data were tabulated according to plant species names and families (Both arranged alphabetically), vernacular names of plant species used locally in Sudan. The plant part used traditionally for treatment of diabetes is also recorded, in addition to life form of the tree, sources of collection and distribution [6;7;8;9]. The hypoglycemic activities for each species were summarized and the references were cited.

Result and Discussion

Anti-diabetic activity

In the current study 24 plant species belonging to 15 families were reviewed for their anti-diabetic effects in the literature. They were chosen according to their traditional use among local communities in Sudan.[6;7;8;9] They were screened for their hypoglycemic activities during the period of (1983-2017). Family Caesalpiniaceae was the most screened family followed by Asteraceae. Other families reported were: Poaceae, Balanitaceae, Capparaceae, Poaceae, Cyperaceae, Cyperaceae, Euphorbiaceae, Combretaceae, Malvaceae, Brassicaceae, Anacardiaceae, Apocynaceae, Lamiaceae, Zygophyllaceae, Myrtaceae, Solanaceae and Asclepiadaceae. Data collected about the sources of collection of these plants showed that almost 60% of them were wild versus 33% to be cultivated (figure 1). 50% were herbs and 25% equally were shrubs and herbs (figure 2). According to their distribution in Sudan, most of them were found widely distributed in a wide range of Sudanese areas with at most in Western Sudan (figure 3).

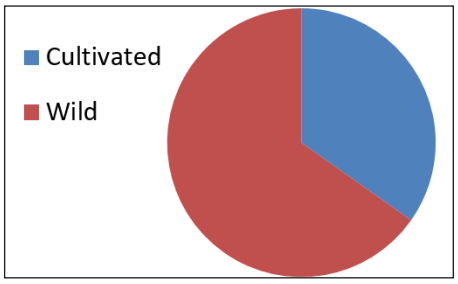

Figure 1.Sources of collection of the plants

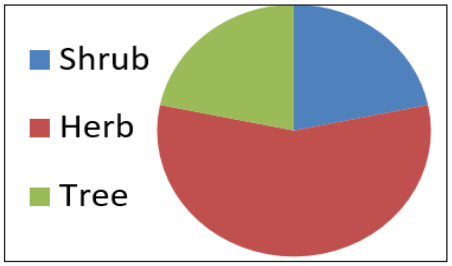

Figure 2.Life form of plants

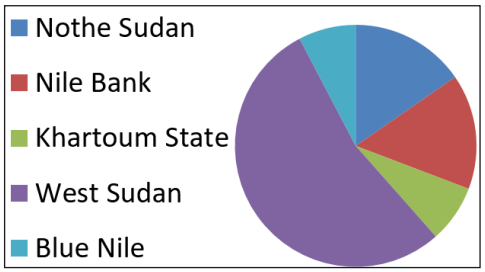

Figure 3.Distribution of the studied plants in Sudan

Review of these 24 plants showed that they all had anti-diabetic effects on streptozotocin and/or alloxan diabetic experimental animals (table 1). Some of them showed hypolipidemic activities on lipid profiles. Examples of these plants are: Adansonia digitata[10;11] Bauhinia rufescens,[12] Cymbopogon citratus,[13] Guiera senegalensis[14] and Solanum nigrum.[15] On the other hand, pharmacological actions of these plants underlining their hypoglycemic activities were elucidated; improvement of insulin production in Hibiscus sabdariffa calyces[16] and in Nerium oleander.[17] While Nymphea lotus has caused regeneration of B-cells of pancreas.[18] Ocimum basillicum showed inhibitory effects on α-glucosidase and α- amylase enzymes.[19] Toxicity studies conducted on these plants determined their LD_{50} are shown in table 2. Some of these plants were found to be non-toxic like Cymbopogon citratus[20] and Solenostemma argel.[21] Further studies on human subjects were carried out on Cymbopogon citratus[20] and Vernonia amygdalina.[22]

Table 1.Sudanese medicinal plants with potential hypoglycemic activity

S.No.	Botanical name	Family	Part used	Hypoglycemic activities and Toxicity studies
1	Adansonia digitata L.	Bombacaceae	Bulb, stem	Methanolic extract showed significant reduction of serum cholesterol, LDL and Triglycerides in alloxinized diabetic rats; LD 50 >5000 mg/kg[10;11]
2	Ambrosia maritima L.	Asteraceae	Whole plant	200 mg/kg showed a hypoglycemic effect on post prandial glucose level of hyperglycemic rats after 20 days 2 % in the diet is safe[23; 45]
3	Balanites aegyptiaca(L.) Del.	Balanitaceae	fruits	1.5 g/kg, hypoglycemic activity on STZ diabetic mice[46; 47]
4	Bauhinia rufescens Lam.	Caesalpiniaceae	leaves	200, 300, 400 mg/kg, hypoglycemic activity in alloxinized diabetic rats[48]
5	Cajanus cajan (L.)Millsp.	Caesalpiniaceae	Leaves	400 and 600 mg/kg, significantly suppressed the peak postprandial rise in blood glucose of normal rats, LD50 greater than 5 g/kg[49]
6	Capparis decidua (Forssk.)Edgew.	Capparaceae	Stem, bark, fruit	250 and 500 mg/kg , hypoglycemic activity in alloxanized diabetic rats[50; 51]
7	Cassia occidentalis	Caesalpiniaceae	Arial parts	250 and 500 mg/kg, significant hypoglycemic activity in normal and alloxanized diabetic rats LD 50 > 5 g/kg[52; 53; 54]
8	Cymbopogon citratus (DC. ex Nees) Stapf	Poaceae	Whole plant	200 mg/kg, significant hypoglycemic activity. Not toxic for humans (clinical trial)[13; 20]
9	Cyperus rotundus L.	Cyperaceae	Whole plant	500 mg/kg, significant anti-hyperglycemic activity. Safe up to 200 mg/kg.[55; 56; 57]
10	Euporbia hirta L.	Euphorbiaceae	Leaves	300 mg/kg, effect on streptozotocin diabetic rats. Up to 483.0 mg/kg body was not toxic to rats[58; 59]
11	Gueira senegalensis JF Gmel.	Combretaceae	Leaves	200, 400 mg/kg, lowered blood-glucose level in glucose loaded rats. LD_{50}> 5g/kg[14; 60; 61]
12	Hibiscus sabdariffa L.	Malvaceae	Calyces	200, 400, 600 mg/kg, hypoglycemic activity on alloxanized diabetic mice and improve insulin production[16; 62]
13	Lepidium sativum L.	Brassicaceae	Seeds	20 mg/kg, significant decrease in STZ-diabetic rats[63]
14	Magnifera indica	Ancardiaceae	leaves	350, 700 mg/kg, significant anti-diabetic activity, no effect on normoglycemic rats. LD_{50} of the extract was above 4.64 gm/kg per os[64; 65; 66]
15	Nerium oleander L.	Apocynaceae	Leaves	250 mg/kg improved insulin and glucose levels in STZ diabetic rats[17]
16	Nymphaea lotus L.	Nymphaeaceae	Rhizomes	100 mg/kg , significant antihyperglycemic activity in alloxan induced diabetic rats and regeneration of β –cells of pancreas. May be toxic, especially when used for a long period of time and at higher doses[1867]

17	Ocimum basilicum L.	Lamiaceae	Leaves	a-glucosidase and a-amylase inhibiting activities. LD 50 > 5 mg/kg[19]
18	Peganum harmala L.	Zygophyllaceae	seeds	30, 60, 120 mg/kg, good antidiabetic activity in streptozotocin diabetic rats.Safe up to 1g/kg body weight in rats[68;69]
19	Phyllanthus reticulatus Poir.	Euphorbiaceae	Leaves	200, 400 mg/kg had significant anti-diabetic effect in alloxanized mice[70]
20	Psidium guajava L.	Myrtaceae	Leaves	1 g/kg, remarkable hypoglycemic action in normal and alloxan-treated diabetic mice[71]
21	Sclerocarya birrea (A. Rich.) Hochst.	Anacardiaceae	Stem bark	100 up to 800 mg/kg produced dose-dependent, significant reductions in the blood glucose of both normal and diabetic rats[72]
22	Solanum nigrum L.	Solanaceae	leaves	200, 400 mg/kg , antihyperglycemic and hypolipidemic effects in alloxanized rats[15]
23	Solenostemma argel	Asclepiadaceae	Leaves	1g/kg, reduced fasting serum glucose in diabetic rats, no toxic effect[21]
24	Vernonia amygdalina	Asteraceae	Leaves	50 g elicited significant reductions in blood glucose levels at most postprandial time points (clinical trial). LD_{50} > 500mg/kg[73;22]

Phytochemistry

The present work revealed that the most abundant phytochemicals in the reviewed plants were the flavonoids followed by tannins and saponins, to a lesser extent were glycosides, alkaloids and triterpenes. While phenolic compounds, coumarins and anthraquinones were moderately present (table 1). Many previous studies confirmed that natural products and medicinal plants contain some active phytochemical components, which induce different biological activities; these phytochemicals produce definite physiological actions in the body.

One of the most proven activities of these phytochemicals included the anti-diabetic effect which is mostly induced by terpenoids, flavonoids and coumarins.[23] Other biological activities associated with diabetes, include effects on cholesterol level, cardiac dysfunctions and cells free radicals. Previous studies indicated the influence of phytochemical compounds on these abnormalities. It is reported that the anti-oxidant activity was induced by flavonoids and polyphenols while treatment of congestive heart failure and cardiac arrhythma was reported by cardiac glycosides.[24] Other influences of these phytochemicals on physiological actions were revealed by saponins and tannins as great anti-bacterials.[25; 26] Alkaloids, flavonoids and steroids were stated to have analgesic activities.[27]

Table 2edicinal plants used traditionally in Sudan for treatment of Diabetes mellitus and their phytochemical constituents

S. No.	Botanical name	Family	Vernacular name	Phytochemical constituents	References
1	Adansonia digitata L.	Bombacaceae	Tabaldi	tannins, saponin, flavonoids, steroids, terpenoids and cardiac glycosides	[28]
2	Ambrosia maritima L.	Asteraceae	Damssisa	terpenoids, flavonoids and coumarins, sesquiterpene lactone ambrosin 1, damsin 2, β-sitosterol 3 and stigmasterol 4	[23;29]
3	Balanites aegyptiaca(L.) Del.	Balanitaceae	Hegleeg	Cardiac glycosides, Phlobatannins, Polyphenols, Saponins, Alkaloids, Steroids	[24]
4	Bauhinia rufescens Lam.	Caesalpiniaceae	Kul Kul	Cardenolides, cardiac glycosides, flavonoids, saponins, resins, tannins, phlobatannins and anthraquinones	[25]

5	Cajanus cajan (L.)Millsp.	Caesalpiniaceae	Adassia	Steroids, glycosides, flavonoids, phenolic compounds	[30]
6	Capparis decidua (Forssk.) Edgew.	Capparaceae	Tundob	Alkaloids, glycosides,	[31]
7	Cymbopogon citratus (DC. ex Nees) Stapf	Poaceae	Hashishat El leymoon	flavonoids, carbohydrates, tannins, alkaloids, steroids	[32]
8	Cyperus rotundus L.	Cyperaceae	Seida	Essential oils (active compound Cyperone)	[33]
9	Euporbia hirta L.	Euphorbiaceae	Um lebena	Flavonoids, plyphenols, tannins, Triterpenes and phytosterols	[34]
10	Gueira senegalensis JF Gmel.	Combretaceae	Ghubeish	flavonoids and tannins, steroids, cumarin and triterpenes	[35]
11	Hibiscus sabdariffa L.	Malvaceae	Karkade	Flavonoids, carotenoids, triterpenoids, alkaloids, steroids, flavonoids, Anthocyanin and Anthocynadin, saponins, phenolic compounds	[36]
12	Lepidium sativum L.	Brassicaceae	Hab El Rashad	flavonoids, Saponoside, tannins, Alkaloid, Stereol and Polyterpene	[37]
13	Mangifera indica L.	Anacardiaceae	Manga	Terpenoids, flavonoids, saponins, tannins	[38]
14	Nerium oleander L.	Apocynaceae	Ward El Hameir	Alkaloids, Terpenoids, Cardiac glycosides, Saponins, Tannins, Carbohydrates	[39]
15	Nymphaea lotus L.	Nymphaeaceae	Sotaib	saponins, cardiac glycosides, tannins, phenolics, anthroquinones, terpenoid, quinones, catechins	[26]
16	Ocimum basilicum L.	Lamiaceae	Rehan	tannins, phenolic compound, triterpenoids steroids, sterols, saponins, flavones and flavonoids	[40]
17	Peganum harmala L.	Zygophyllaceae	Harmal	alkaloids, steroids, flavonoid	[27]
18	Phyllanthus reticulatus Poir.	Euphorbiaceae	Summeima	Alkaloids, Coumarins, Flavonoids, Phenols and sterols	[41]
19	Psidium guajava L.	Myrtaceae	Gawafa	Terpenoids, flavonoids, tannins, saponins, cardiac glycosides	[38]
20	Sclerocarya birrea (A. Rich.) Hochst.	Anacardiaceae	Himed	Cardenolides, cardiac glycosides, flavonoids, saponins, resins, tannins, phlobatannins and anthraquinones	[25]
21	Senna occidentalis (L.) Link	Caesalpiniaceae	Soreib	tannins, alkaloids, reducing sugar, phenols, anthraquinones, resins, saponins and glycosides	[42]
22	Solanum nigrum L.	Solanaceae	Anab El Deeb	Tannins, proteins, alkaloids, Flavonoids, Saponins	[43]

23	Solenostemma argel	Asclepiadaceae	Hargel	flavonoid, saponins cardiac glycoside	[44]
24	Vernonia amygdalina	Asteraceae	Garb El wadi	Terpenoids, flavonoids, saponins, tannins, alkaloids, cardiac glycosides	[38]

Conclusion

Sudanese flora is rich with medicinal plants used traditionally in the treatment of various ailments. Wide range of these plants is reported for the treatment of diabetes mellitus. These hypoglycemic plants are vigorously studied with the determination of their phytochemical components and safety margins. Thus, they may be ready to be prepared in pharmaceutical preparations and further use in human clinical trials.

References

1. Mohammed AMA. Research advances in Sudanese traditional medicine: opportunities, constrains and challenges. *Altern Integ Med* 2013; 2: 10.
2. Hassan K, Adalla WE, Gadir HA et al. Gems from traditional north-African medicine: medicinal and aromatic plants from Sudan. *Nat. Prod. Bioprospect* 2012; 2(3): 92-103.
3. Stryer, L Biochemistry 4th edition. W. H. Freeman and company, New York 2000: 779-780.
4. Cho NH, Shaw JE, Karuranga S et al. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Research and Clinical Practice* 2018; 138: 271-281.
5. Manha EM, Silva MC, Alves MGC et al. Plant-A bibliographic database about medicinal plants. *Brazilian Journal of Pharmacognosy* 2008; 18(4): 614-617.
6. Gamal GE. Medicinal Plants of the Sudan, Part 1 Medicinal Plants of Erkowit 1986.
7. Gamal GE, Bari EA, Bashir AK et al. Medicinal Plants of the Sudan, Part II Medicinal Plants of the Eastern Nuba Mountains 1987.
8. Gamal GE, Mahgoub S. Tohami EI et al. Medicinal Plants of the Sudan, Part III Medicinal Plants of the White Nile Provinces 1994.
9. Gamal GE, Abdalla WS, Khalid HEIS et al, Medicinal Plants of The Sudan, Part V Medicinal Plants of Ingassana Area 2003.
10. Bako HY, Mohammad JS, Waziri MP et al. Lipid profile of Alloxan Induced Diabetic Wistar Rats Treated with Methanolic extract of Adansonia digitata Fruit Pulp. *Science World Journal* 2014; 9(2): 19-24.
11. Tanko Y. Hypoglycemic Activity of Methanolic Stem Bark of Adansonnia digitata Extract on Blood Glucose Levels of Streptozocin-Induced Diabetic Wistar Rats. *International Journal of Applied Research in Natural Products* 2008; 1(2): 32-36.
12. Bruno. Hypolipidemic properties of Bauhinia rufescens in alloxan-induced diabetic rats. *Scientific Journal of Biological Sciences*, 2013; 2(4).
13. Adegbegi J, Ademuyiwa, Ogunyemi Y et al. The Effects of Cymbopogon Citratus (Lemon grass) on the Blood Sugar Level, Lipid Profiles and Hormonal Profiles of Wistar Albino Rats. *Merit Research Journal of Medicine and Medical Sciences* 2015; 3(6): 210-216.
14. Ahmed RH, Mohammed AH, Bagir El et al. Study of hypoglycemic and anti-diabetic effects of Guiera senegalensis leaves. *Omdurman journal of pharmaceutical sciences* 2005; (1)1: 69-73.
15. Poongothai K, Ahmed KSZ, Ponmurugan P et al. Assessment of antidiabetic and antihyperlipidemic potential of Solanum nigrum and Musa paradisiaca in alloxan induced diabetic rats. *Journal of Pharmacy Research* 2010; 3(9): 2203-2205.
16. Rosemary, Rosidah, Haro G. Antidiabetic Effect of Roselle Calyces Extract (Hibiscus Sabdariffa L.) in Streptozotocin Induced Mice. *International Journal of Pharm Tech Research* 2014; 6(5): 1703-1711.
17. Saleh N. Mwafy SN, Yassin MM. Anti-diabetic activity evaluation of glimeiride and Nerium oleander extract on insulin, glucose in experimental diabetic rat model. P*akistan Journal of Biological Sciences* 2011; 14(21), 984-990.
18. Chaurasia S, Sharma V, Dar AI et al. In-vivo Antidiabetic activity of Alcoholic and Aqueous Extract of Nymphaea lotus in Rat Model. *Inventi Rapid: Ethnopharmacology*; 2011; 1(3).
19. El-Beshbishy HA, SA Bahashwan. Hypoglycemic effect of basil (Ocimum basilicum) aqueous extract is mediated through inhibition of α-glucosidase and α-amylase activities: An in vitro study. *Toxicology and Industrial Health* 2012; 28(1): 42-50.
20. Leite JR. Pharmacology of Lemon grass (Cymbopogon Citratus stapf) Assessment of eventual toxic, hypnotic and anxiolytic effects on humans. *Journal of Ethnopharmacology* 1986; 17(1): 75-83.
21. Deen TA, Naqeb GA. Hypoglycemic effect and in vitro antioxidant activity of methanolic extract from Argel(Solenostemma Argel) plant. *International Journal of Herbal Medicine*. 2014; 2(2): 128-131.
22. Ojiako OA, Nwanjo HU. Is Vernonia amygdalina hepatotoxic or hepatoprotective? Response from biochemical and toxicity studies in rats. *African Journal of Biotechnology* 2006; 5(18): 1648-1651.
23. Ammar NM, Okbi SYA, Ibrahim H et al. The Hypoglycemic

Effect of Different Extracts of Ambrosia Maritima, L. Compositae. *Journal of Islamic Academy of Sciences*. 1993; 6(4): 298-301.
24. Tula MY, Dancha TB, Iruolaje FO et al. Studies on Phytochemical Constituents and Antibacterial Potentials of Extracts of Balanites aegyptiaca (Del.) Parts on Antibiotic Resistant Bacterial Isolates. *European Journal of Medicinal Plants*. 2014; 4(7): 854-864.
25. Usman H, Abdulrahman FI, Kaita HA et al. Comparative Phytochemical and Antimicrobial Evaluation of Stem Bark Extracts of Bauhinia rufescens Lam. (Cesaelpinioidaea- Leguminosae) and Sclerocarya birrea (A. Rich.) Hoscht (Anarcardiaceae). *Medicinal and Aromatic Plant Science and Biotechnology* 2009; 3(1) 110-116.
26. Adelakun KM, Mustapha MK, Muazu MM et al. Phytochemical screening and antibacterial activities of crude extract of Nymphaea lotus (water lily) against fish pathogens. J*ournal of Biomedical Sciences (JBS)* 2016; 2(4):38-42.
27. Kumar MRP, Joshi SD, Kulkarni VH et al. Phytochemical screening and evaluation of analgesic, anti-inflammatory activities of Peganum harmala Linn., seeds in rodents. *Journal of Applied Pharmaceutical Science* 2015; 5(5): 052-055.
28. Masola SN, Mosha RD, Wambura PN. Assessment of antimicrobial activity of crude extracts of stem and root barks from Adansonia digitata (Bombacaceae) (African baobab). *African Journal of Biotechnology* 2009; 8(19): 5076-5083.
29. Makkawi AJJ, Keshk EM, Shamy EMEI et al. Phytochemical and Biological Evaluation of Ambrosia Maritima. *Research Journal of Pharmaceutical, Biological and Chemical Sciences* 2015; 6(4): 1678-1688.
30. Mohanty PK, Chourasia N, Bhatt NK et al. Preliminary Phytochemical Screening of Cajanus cajan Linn. *Asian Journal of Pharmacy and Technology* 2011; 1(2): 49-52.
31. Muhammad UHZ, Ćavar S, Qayum M et al. Compositional Studies: Antioxidant and Anti-diabetic Activities of Capparis decidua (Forsk.) Edgew. *International Journal of Molecular Sciences* 2011; 12(12): 8846-8861. doi:10.3390/ijms12128846
32. Umar M, Mohammed IB, Oko JO et al. Phytochemical Analysis and Antimicrobial Effect of Lemon Grass (Cymbopogon citratus). *Journal of Complementary and Alternative Medical Research* 2016; 1(2): 1-8.
33. Oladipupo A. Lawal, Adebola O et al. Chemical Composition of the Essential Oils of Cyperus rotundus L. from South Africa. *Molecules* 2009; 14(8), 2909-2917. doi:10.3390/molecules14082909
34. Patil SB, MRS. Naikwade NS, Magdum CS. Review on Phytochemistry and Pharmacological Aspects of Euphorbia hirta Linn. JPRHC. 2009; (1): 1: 113-133p.
35. Ahmed RH, Barakat TE, Elnour RO et al. Potential Anti-pyretic Activity of Guiera senegalensis Leaves. *Journal of Advanced Research in Pharmaceutical Sciences & Pharmacology Interventions* 2018; 2(1&2): 18-21.
36. Mungole A, Chaturvedi A, Hibiscus sabdariffa L. A rich source of secondary metabolites. *International Journal of Pharmaceutical Sciences Review and Research* 2011; 6(1): 83-87.
37. Chatoui K, A. Talbaoui, M. Aneb et al. Phytochemical Screening, Antioxidant and Antibacterial activity of Lepidium sativum seeds from Morocco. *Journal of Materials and Environmental Science* 2016; 7(8): 2938-2946.
38. Ayoola GA, Coker HAB, SA Adesegun et al. Phytochemical Screening and Antioxidant Activities of Some Selected Medicinal Plants Used for Malaria Therapy in Southwestern Nigeria. *Tropical Journal of Pharmaceutical Research* 2008; 7 (3): 1019-1024.
39. Bhuvaneshwari L, Arthy E, Anitha C et al. Phytochemical analysis & Antibacterial activity of Nerium oleander. *Ancient Science of Life* 2007; (4): 24-28.
40. Alia B, Jahan N, Ahmed A et al. Phytochemical and Pharmacological Studies on Ocimum basilicum Linn. *International Journal of Current Research* 2012; 4(23): 73-83.
41. Narasimhudu CL, Vinkata R. Phytochemical Constituents of Phyllanthus Species (Euphorbiaceae) From Eastern Ghats of Andhra Pradesh, India. *International Research Journal of Pharmacy (IRJP)*. 2012; 3(5): 184-200.
42. Odeja O, Obi G, Ogwuche CE et al. Phytochemical Screening, Antioxidant and Antimicrobial activities of Senna occidentalis (L.) leaves Extract. *Clinical Phytoscience*. 2015; 1(6).
43. Ashrafudoulla Md, Bellah SF, Alam F ET AL. Phytochemical screening of Solanum nigrum. *Journal of Medicinal Plants Studies* 2016; 4(1): 35-38.
44. Hamadnalla HMY, Jack MM. Phytochemical Screening and Antibacterial Activity of Solenostemma argel: A Medicinal Plant. *Acta Scientific Agriculture* 2019; 3(6): 2-4.
45. Barakat SEM, Hizab FA, Bakhiet AO. Clinicopathological Effects of Various Levels of Ambrosia maritima in Wistar Rats. *Journal of Animal and Veterinary Advances* 2012; 11(15): 2672-2676.
46. Kamel MS, Ohtani K, Kurokawa T et al. Studies on Balanites aegyptiaca fruits, an Anti-diabetic Egyptian Folk Medicine. *Chemical and Pharmaceutical Bulletin* 1991; 39(5): 1229-1233.
47. Gad MZ, Sawalhi MM, Ismail MF et al. Biochemical study of the anti-diabetic action of the Egyptian plants Fenugreek and Balanites. *Molecular and Cellular Biochemistry* 2006; 281:173-183.
48. Aguh BI, Nock IH, Ndams IS et al. Hypoglycaemic Activity

and Nephro-Protectective Effect of Bauhinia rufescensin Alloxan-Induced Diabetic Rats. *International Journal of Advances in Pharmacy, Biology and Chemistry* 2013; 2(1).
49. Ezike AC, Akah PA, Charles C et al. Experimental Evidence for the Anti-diabetic Activity of Cajanus cajan Leaves in Rats. *Journal of Basic and Clinical Pharmacy* 2010; 1(2).
50. Rathee S, Mogla OP, Sardana S et al. Antidiabetic activity of Capparis decidua Forsk Edgew. *Journal of Pharmacy Research* 2013; 3(2): 231-234.
51. Goyal NK. Effect of Capparis decidua Extracts on the Serum Glucose Levels of Streptozotocin Induced Type 2 Diabetic Rats. *Journal of Cell and Tissue Research* 2009; 9(1): 1703-1707.
52. Arya S, Saini J, Singh S. Antidiabetic Activities of Cassia occidentalis. *Research in Science and Technology* 2013; 5(1): 51-53.
53. Onakpa MM, Ajagbonna OP. Antidiabetic Potentials of Cassia occidentalis Leaf Extract On Alloxan Induced Diabetic Albino Mice. I*nternational Journal of Pharm Tech Research* 2012; 4(4): 1766-1769.
54. Mirtes GB. Silva, Simone S.L. Lafayette. Acute and sub acute toxicity of Cassia occidentalis L stem and leaf in Wistar Rats. *Journal of Ethnopharmacology*. 2011; 136(2): 341-346.
55. Nishikant A, Raut, Gaikwad NJ. Antidiabetic activity of hydro-ethanolic extract of Cyperus rotundus in alloxan induced diabetes in rats. *Fitoterapia* 2006; 77: 585-588.
56. Esmail SA. A review on Cyperus rotundus A potential medicinal plant. *Journal of Pharmacy* 2016; 6(7).
57. Lemaure B. Touche A, Zbinden I et al. Administration of Cyperus rotundus tubers extract prevents weight gain in obese Zucker rats. *Phytotherapy Research* 2007; 21(8).
58. Ogbulie JN, Ogueke CC, Okoli IC. Antibacterial activities and toxicological potentials of crude ethanolic extracts of Euphorbia hirta. A*frican Journal of Biotechnology* 2007; 6(13): 1544-1548.
59. Sorimuthu P, Subramanian SP, Bhuvaneshwari S et al. Antidiabetic and antioxidant potentials of Euphorbia hirta leaves extract studied in streptozotocin-induced experimental diabetes in rats. *Journal of General Physiology and Biophysics* 2011; 30(3): 278-285.
60. Chahinez H, Elkhawad AO, Ayoub SMH. A comparative study on the anti-diabetic activity of extracts of some Algerian and Sudanese plants. *Journal of Diabetes and Endocrinology* 2012; 3(3): 25-28.
61. Aniagu SO, Gamaniel K. Anti-diaahoeal and ulcer-protective effects of aqueous root extract of Guiera senegalensis in rodents. *Journal of thnopharmacology* 2005; 97(3): 415-592.
62. Zakaria M, Rungkat F, Prangdimurti E. The Effect Of Roselle Extract (Hibiscus sabdariffa Linn.) On Blood Glucose Level And Total Antioxidant Level On Diabetic Rat Induced By Streptozotocin. J*ournal of Pharmacy* 2014; 4(10): 8-16.
63. Eddouks M, Maghrani M, Zeggwagh NA et al. Study of the hypoglycemic activity of Lepidium sativum L. aqueous extract in normal and diabetic rats. *Journal of Ethnopharmacology* 2005; 97(2): 391-395.
64. Basha D, Kumar KP, Teja BB et al. Antidiabetic activity on extracts of Mangifera indica in Alloxan monohydrate induced diabetic rats. *Drug Invention Today* 2011; 3(7): 165-168.
65. Gupta R, Gupta RS. Anti-diabetic efficacy of Magnifera indica seed kernels in Rats: A comparative study with glibeclamide. *Diabetologia Croatica* 2014.
66. Sharma SR, Dwivedi SK, Swarup D. Hypoglycemic Potential of Magnifera indica Leaves in Rats. *International Journal of Pharmacognosy* 1997; 35(2): 130-133.
67. Mireille KP, Désiré DDP, Pierre K. A Review of the Pharmacological potential of the Water Lily Nymphaea lotus. *Mod Appl Bioequiv Availab* 2017; 1(5): 1-3.
68. Poorbarkhordari E, Fooladsaz K, Hosseini SH et al. The Hypoglycemic Effects of an EthanolExtract of Peganum harmala in Streptozotocin-Induced Diabetic Rats. I*ranian Journal of Pharmaceutical Sciences* 2014; 10(3): 47-54.
69. Lamchouri F, Settaf A, Cherrah Y et al. Experimental Toxicity of Peganum harmala seeds. *Annales Pharmaceuticals Francaises*. 2002; 60(2) 121-129.
70. Khatun Mst, Hajera Mst, Nesa L et al. Anti diabetic and antidiarrheal effects of the methanolic extract of Phyllanthus reticulatus leaves in mice. *Asian Pacific Journal of Reproduction* 2014; 3(2): 121-127.
71. Cheng JT, Yang RS. Hypoglycaemic effect of guava juice in mice and human subject. *The American Journal of Chinese Medicine* 1983; 11: 74-76.
72. Ojewole JAO. Hypoglycemic effect of Sclerocarya birrea [(A. Rich.) Hochst.] [Anacardiaceae] stem-bark aqueous extract in rats.*Phytomedicine*. 2003; 10: 675-681.
73. Uchenna V, Chinwe OE. John OM et al. Hypoglycemic indices of Vernonia amygdalina on postprandial blood glucose concentration of healthy humans. *African Journal of Biotechnology* 2008; 7(24): 4581-4585.