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Review Article

Diabetes & Endocrinology Research

Review of Sudanese Medicinal Plants Screened for Antidiabetic Activity

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Received: **23-APR-2021;** Published: **01-Jun-2021;**

Citation: Ahmed Saeed Ali Kabbashi, Review of Sudanese Medicinal Plants Screened for Antidiabetic Activity

Abstract

Introduction: *Diabetes is a serious metabolic disorder and plenty of medical plants are used in traditional medicines to treat diabetes. These plants have no side effects, and many existing medicines are derived from the plants. The purpose of this systematic review is to study diabetes and to summarize the available treatments for this disease, focusing especially on herbal medicine.*

Methods: *Scientific data bases were investigated for and screening through google engine for diabetes and effective plants informatics data. However, the investigation included Science direct, PubMed, Wiley, Scopus, and Springer. Out of the 100 collected articles (published in the period between 1997 and 2018).*

Results: *Diabetes is mainly due to oxidative stress and an increase in reactive oxygen species that can have major effects. Many plants contain different natural antioxidants, in particular tannins, flavonoids, C and E vitamins that have the ability to maintain β-cells performance and decrease glucose levels in the blood.*

Conclusion: *According to published results, it can be said that medical plants are more affordable and have less side effects compared synthetic drugs and are more effective in treatment of diabetes mellitus. Also order to harness these natural resources and maximize the socioeconomic benefits derivable from Sudanese medicinal plants efforts should be geared toward research funding and deployment of Research and Development (R & D) policy framework into medicinal plants research endeavors.*

Keywords: Diabetic, Medicinal plants, Sudan.

Diabetes mellitus According to WHO, the term diabetes mellitus is defined as a metabolic disorder of multiple etiology characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both. The effects of diabetes mellitus include long-term damage, dysfunction and failure of various organs (Mellitus et al., 2010). Diabetes mellitus may have the characteristic symptoms such as thirst, polyuria, blurred vision and loss of weight (Association, 2014).

Diabetes disease is known since antiquity, it is mentioned in the writings of the ancient civilizations, particularly Egypt, Arabia, India, China and Asia Minor (Singh, 2016). Recently, Diabetes Millets is highly prevalent worldwide when compared with many other diseases, it is fast becoming the epidemic of the 21st century (Matthews and Matthews, 2011). It is estimated that in the year 2000, there were 171 million diabetic peoples in the world. This estimation is expected to increase to reach 366 million diabetic peoples by 2030 (Ogurtsova et al., 2017). Diabetes mellitus is defined as a disease in which the body is unable to use and store glucose, properly. It is caused by the abnormality of carbohydrate metabolism which is linked to either low blood insulin level or insensitivity of target organs to insulin (Anstee et al., 2013). Moreover, there are many types of diabetes, however, the two main types of diabetes are Type 1 (insulin-dependent), where the body is completely stop producing insulin, accordingly patients must take insulin injections daily to survive (Ashcroft and Rorsman, 2012). Type 2 (non-insulin dependent) where the body is unable to produce enough insulin or the produced insulin does not work properly (Ashcroft and Rorsman, 2012). Patients of type 2 mostly have a family history of diabetes (inherited), overweight or over 40 years of age (Association, 2015). Interestingly, type 2 (non-insulin dependent) diabetes mellitus is much more prevalent than type 1 (insulin dependent) diabetes, affecting the people of both developed and developing countries (Dunstan et al., 2002). Up to 250,000 children in developing countries under the age of 14 years have type 1 diabetes; around 38,000 of these children are in Africa (Dunstan et al., 2002).

The total population in Sudan is about 34 million, with 70% of it in the Northern parts. Prevalence of type 1 diabetes is estimated to be 0.1% among school-age children 7 to 14 years old while type 2 diabetes is estimated at 10.4% among adult population (over 25 year of age) in Northern Sudan (Yagi and Yagi, 2018). Both insulin and glucagon, pancreatic endocrine hormones, are responsible for controlling blood-glucose level within the body in an adequate level based on the body needs. Normally, insulin is secreted by the β-cells found at the islets of Langerhans in response to high levels of blood sugar (Kahn et al., 2006). It potentiates the ability of muscle, red blood cells, and fat cells to absorb sugar out of the blood and consume it in other metabolic processes, which restore the sugar levels to the normal level (Singab et al., 2014).

Natural compounds may be possible alternatives for the treatment of diabetes and its associated complications at the behest of failure in sustainable cure from the modern drugs. In view of the effectiveness, safety and low cost production of plant medicines, consumption of the source in the daily diet can potentially manage and may even reduce the risk of the disease (Patwardhan and Partwardhan, 2005). The medicinal plants have played a remarkable and characteristic role as therapeutic agents in the treatment of chronic pathologies that are linked to diabetes before the introduction of insulin in 1922 (He et al., 2015). In this connection the plant sources (if taken in the form of diet) are considered to be very effective and safe because they potentially manage and control the risk factors associated with the diabetes (Association, 2016).

Recently, some medicinal plants have been reported to be useful in diabetes worldwide and have been used empirically as antidiabetic and antihyperlipidemic remedies (Efferth and Kuete, 2010). Despite the presence of known antidiabetic medicine in the pharmaceutical market, diabetes and the related complications continued to be a major medical problem (Malviya et al., 2010). Antihyperglycemic effects of these plants are attributed to their ability to restore the function of pancreatic tissues by causing an increase in insulin output or inhibit the intestinal absorption of glucose or to the facilitation of metabolites in insulin dependent processes (Tiwari et al., 2014). However, More than 400 plant species having hypoglycemic activity have been available in literature, however, searching for new antidiabetic drugs from natural plants is still attractive because they contain substances which demonstrate alternative and safe effects on diabetes mellitus (Balamurugan et al., 2014). Most of plants contain glycosides, alkaloids, terpenoids, flavonoids, cartenoids, etc., that are frequently implicated as having antidiabetic effect. Species will be described in alphabetical order and information about each species will include in sequence: general botanical and taxonomic data, distribution in the world, experimental study and mechanism of action (Mngeni, 2017).

Traditional, complementary and alternative medicines have been used since ancient times (Harvey, 2008). Yet the use of traditional medicine (TM) remains widespread in developing countries, while use of complementary and alternative medicine (CAM) is increasing rapidly in developed countries. In many parts of the world, policy-makers, health professionals and the public are wrestling with questions about the safety, efficacy, quality, availability, preservation and further development of this type of health care (van Andel and Carvalheiro, 2013). TM is sometimes also the only affordable source of health care especially for the world's poorest patients (D'Amato et al., 2015).

Traditional medicine has been used for the treatment of human illnesses since long time and is mainly based on components derived from natural products, from herbs, plants, and animals. Medicinal natural products are very frequently used in Sudan and also are widely consumed in Africa and all over the world. About 80% of the populations in African countries depend on traditional medicine for their primary health care (Fabricant and Farnsworth, 2001). In Sudan, 90% of Sudan's population depends mainly on traditional medicine since admission to hospitals and obtaining modern synthetic drugs are limited and a high percentage of the population is nomads (Karar and Kuhnert, 2017). Sustainability of the use of medicinal plants is an important concern. The demand for medicinal plants is increasing in Africa as the population grows and pressure on medicinal plant resources will become greater than ever. Interest in plant-derived medicines has also increased in the developed countries among the pharmaceutical companies (Alves and Rosa, 2007). In contrast, due to their minor side effects, the medicinal plants are widely used to treat many human diseases (O'Hara et al., 1998).

A number of reviews from different countries have highlighted the significance of medicinal plants application for the control of diabetes (Uprety et al., 2012). In this review article, an attempt has been made to compile the reported hypoglycemic plants available in different scientific journals and may draw the attention useful to health professionals, scientists and scholars working in the field of pharmacology and therapeutics to develop evidence based alternative medicine to cure different kinds of diabetes in man and animals. However, this review shows the importance and the interest placed on Sudanese medicinal plants in the drive to demonstrate their antidiabetic effects and the responsible bioactive agents. This review also covers the common name of a plant, the parts that are commonly used as a remedy sources, extracts, doses, and a test model.

MATERIALS AND METHODS

Materials:

Publication regarding diabetes and effective plants were found in databases such as Science Direct, PubMed, Wiley, Scopus, and Springer. In addition to the above poinbs of interest search Keywords used in this study included "medicinal plants", "diabetes", "Sudan", "herbal", and "treatment". Out of the 50 collected articles (published in the period between 1997 and 2018). As shown in (**Table 1, 2 and 3**).

Inclusion and exclusion criteria:

The search was restricted to English language articles. All studies found during the search were independently evaluated for competence and inclusion by two different authors. After compliance with inclusion criteria, experimental research and clinical trials that evaluate the effect of Sudanese medicinal herbs or plant component in diabetic animals or patients were included in the current research.

RESULTS AND DISCUSSION

Diabetes is a chronic disease that occurs when the body cannot produce enough insulin or cannot use insulin effectively (Bullon et al., 2014). It is projected that 300 million people will have the
disease by the year 2025 (Mathers and Loncar, 2006) and it may reach to 366 million in the year 2030 (Hossain et al., 2009). Moreover, type 2 diabetes is a common condition and a serious global health problem (Narayan et al., 2000).

In most countries, diabetes has increased alongside rapid cultural and social changes: ageing populations, increasing urbanization, dietary changes, reduced physical activity and unhealthy behaviours (Petersen, 2003). Moreover, a person's risk of developing Type 2 Diabetes Mellitus has been shown to be highly linked to obesity and any family history or consequently of diabetes (Association, 2014).

Hyperglycaemic condition causes increased glycosylation leading to biochemical and morphological abnormalities due to altered protein structure and develop the neuropathy, retinopathy, neuropathy and cardiomyopathy (Kumar et al., 2011). All Statistical tabulation and analysis were done using Microsoft Excel Program (2016). Diabetes kills 1.1 million people in 2005 and more than 220 million people worldwide have diabetes, almost 80% of diabetes deaths occur in low- and middle-income countries(Cruz, 2007). The rising cost of medical care in Sudan is increasingly driving patients to herbal medicine and in case of diabetes, emerging experience with certain plants drew attention to some communities rarely known for such experience in the country.

Sudan is a developing country that frequently depends on folk medicine in all areas of the country. Several herbal preparations have been used in folklore practice for the management of diabetes with claims asserting their hypoglycemic effect. In this paper, an effort was made to refer to the different parts of 50 belonging to 32 families' plant species that are used in the Sudanese traditional medicine.

As shown in Table (1), detailed information about the plants and their antidiabetic activity from Sudan are presented. It was revealed that, up to 50 plant species belonging to 32 families were reported to have antidiabetic activity.

The family Fabaceae is considered a large family. The most common families are Fabaceae 9 species (18%) followed by Rubiaceae 6 species (12%), Amaryllidaceae, Apiaceae, Asteraceae, Poaceae and Zygophyllaceae 2 species (4%), Acanthaceae,

Apocynaceae, Arecaceae, Balanitaceae, Boraginaceae, Burseraceae, Capparaceae, Combretaceae, Cucurbitaceae, Cyperaceae, Ebenaceae, Euphorbiaceace, Lamiaceae, Lauraceae, Leguminosae, Martyniaceae, Meliaceae, Menispermaceae, Moringaceae, Myrtaceae, Pedaliaceae, Ranunculaceae, Rhamnaceae, Scrophulariaceae and Xanthorrhoeaceae one species (2%) shown in Table (2).

Distribution was prepared from family. The Fabaceae (Lupinus albus, Trigonella foenum-graecum, Acacia albida, Acacia nilotica, Abrus precatorius, Bauhinia rufescens, Cicer arietinum and Acacia Senegal). Rubiaceae (Mitragyna inremis, Nauclea latifolia, Randia nilotica, Vangueria madagascariensis, Cephaelis ipecacuanha and Ruta graveolens), Amaryllidaceae (Allium Sativum and Allium cepa), Apiaceae (Foeniculum vulgare and Ammi visnaga), Asteraceae (Ambrosia maritima and Geigeria alata), Poaceae (Pennisetum glaucum and Cymbopogon proximus) and Zygophyllaceae (Zygophyllum coccineum and Balanites aegyptiaca), Acanthaceae (Blepharis linariifolia), Apocynaceae (Solenostemma argel), Arecaceae (Solenostemma argel), Arecaceae (Hyphaene thebaica), Balanitaceae (Balanites aegyptiaca), Boraginaceae (Cordia sinensis), Burseraceae (Boswellia papyrifera), Capparaceae (Capparis decidua), Combretaceae (Guiera senegalensis), Cyperaceae (Citrullus colocynthis), Cyperaceae (Cyperus rotundus), Ebenaceae (Diospyros mespiliformis), Euphorbiaceace (Croton zambiescus), Lamiaceae (Salvia officinalis), Lauraceae (Cinnamomum verum), Leguminosae (Lupinus albus), Martyniaceae (Martynia annua), Meliaceae (Khaya senegalensis), Menispermaceae (Tinospora bakis), Moringaceae (Moringa oleifera), Myrtaceae (Eucalyptus globulus), Pedaliaceae (Sesamum indicum), Ranunculaceae (Nigella sativa), Rhamnaceae (Ziziphus spina-christi), Scrophulariaceae (Striga hermonthica) and Xanthorrhoeaceae (Aloe sinkatana).

The different parts plants and their antidiabetic Activity from Sudan are presented. Different plant parts including (Fruits, Leaves, Seeds, Roots, Whole plant, Stem bark, Bulb, Aerial parts, Epicarp, Grains, Mature Fruit, Pods, Rhizome, Root bark and Stem). There is a distinct preference for Fruits (23.08%), Leaves (17.31%), Seeds (15.38%), Roots (9.61%), Whole plant (7.69%), Stem bark (5.77%), Bulb (3.58%), Aerial parts (1.92%), Epicarp (1.92%), Grains (1.92%), Mature Fruit (1.92%), Pods (1.92%), Rhizome (1.92%), Root bark (1.92%) and Stem (1.92%) Table (2).

The Different used of solvent extracts (Aqueous, Ethanol, Methanol, Petroleum Ether, Dichloromethane and Ethyl Acetate). It was the highest percentage (%) of used solvent extracts Aqueous (48.61%), Ethanol (37.50%), Methanol (5.56%), Petroleum Ether, Dichloromethane and Ethyl Acetate (2.78%). The most used of extracts (95.74) and fractions (4.26%) Figure (1 & 2). Investigations of medicinal plants with different species and families were studied. Different parts of the plants were used for the antidiabetic study. The methanol, ethanol and aqueous solvents were most commonly used for the extractions. The preliminary phytochemical analyses mostly show the presence of terpenoids and flavonoids. Efficacy evaluation of medicinal plants was done by streptozotozine or alloxone induced diabetic modules. Most of the research results showed the hypoglycaemic effects and almost the same effect of standard drugs. Numerous mechanisms of action had been proposed for the plant extracts.

In addition, systematic and integrated studies on Sudanese medicinal plants in order to discover new antidiabetic drugs are bsent; the majority of the studies are at the screening level on
crude extracts.

The most commonly involved active constituents are Flavonoid, Tannin, Phenolics, and Alkaloid. Numerous mechanisms of actions have been proposed for these plant extracts. Some hypotheses relate to their effects on the activity of pancreatic ß cells (synthesis, release) or the increase of the insulin sensitivity or the insulin-like activity of the plant extracts. All of these actions may be responsible for the reduction or abolition of diabetic complications.

CONCLUSION

Natural resources are still considered as potent candidates for drug discovery and are playing a pivotal role in drug development programs. Moreover, many medicinal herbs provide a rich mine for bioactive chemicals that are markedly free from undesirable side effects and of powerful pharmacological actions. The quest for control of diabetes has led to an increasing research at different fronts, among which is medicinal plants. Given the observation of an increasing use of medicinal plants for diabetes in Sudan, this necessitates validation of efficacy and safety. The attributed anti hyperglycaemic effects of these plants are due to their ability to restore the function of pancreatic tissues by causing an increase in insulin output or a decrease in the intestinal absorption of glucose. Hence, treatment with herbal drugs has effect on protecting cells and smoothing out fluctuation in glucose levels. In general, there is very little biological knowledge on the specific modes of action in the treatment of diabetes, but most of the plants have been found to contain substances like glycosides, alkaloids, terpenoids, flavonoids etc. that are frequently implicated as having anti diabetic effects. The research for alternative remedies (from the plant kingdom) for diabetes mellitus will continue all over the world as the disease poses many challenges not only to the physician but also to the researcher. However, data represented in this article prove a promising findings of getting a new herbal drugs which many reduce the heavy louden using synthetic compounds and hence wise the anthers this article recommend more case studies involving standardized medicinal plant products should be carried

out in order to validate the usefulness of plant preparations in diabetes management, which will give support to the pre-clinical results. Consequently, much effort should be afforded to optimize a procedure for antidiabetic screening of different plants' extracts as well as isolated bioactive compounds for the discovery of new natural herbal antidiabetic drugs.

Table (1): Plants used in Sudanese traditional medicine for treatment of diabetes:

S/N	Plant Family	Plant Scientific Name	Plant Vernacular Name	Plant Part	Method used	Solvent used	Reference
1.	**Acanthaceae**	*Blepharis linariifolia*	Al-Bighail Shoak Al-Dhab	Whole plant	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
2.	**Amaryllidaceae**	*Allium Sativum*	Toom	Bulb	Extracts	Aqueous	**(Kamal Eldin Gaber et al., 2013) (Eldin et al., 2009) (Ebrahim et al., 2012)**
3.		*Allium cepa*	Basal	Bulb	Extract	Aqueous	**(Gaber et al., 2013) (Eldin et al., 2009)**
4.	**Apiaceae**	*Foeniculum vulgare*	El Shamar	Fruits	Extracts	Ethanolic	**(Hilmi et al., 2014) (Yagi et al., 2013)**
5.		*Ammi visnaga*	Khella	Fruits	Extracts	Ethanolic	**(Hilmi et al., 2014) (Yagi et al., 2013)**
6.	**Apocynaceae**	*Solenostemma argel*	Harjal	Leaves	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
7.	**Arecaceae**	*Hyphaene thebaica*	Nabag	Epicarp	Extracts	Aqueous	**(Kamal Eldin Gaber et al., 2013) (Gaber et al., 2013)**
8.	**Asteraceae**	*Ambrosia maritima*	Damesisa	Leaves	Extracts	Ethanolic	**(Hilmi et al., 2014) (Yagi et al., 2013)**
9.		*Geigeria alata*	El Gadgad	Aerial parts Roots	Extracts	Ethanol, Aqueous Methanol	**(Elbashir et al., 2018) (Hafizur et al., 2012)**
10.	**Balanitaceae**	*Balanites aegyptiaca*	Laloub	Fruit	Extracts	Aqueous	**(Kamal Eldin Gaber et al., 2013)**
11.	**Boraginaceae**	*Cordia sinensis*	Andrab	Leaves	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
12.	**Burseraceae**	*Boswellia papyrifera*	Tarag tarag, Shagar El-luban	Gum	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
13.	**Capparaceae**	*Capparis decidua*	Tundub	Stem	Extract	Methanol	**(Zia-Ul-Haq et al., 2011)**
14.	**Combretaceae**	*Guiera senegalensis*	Ghubeish	Leaves	Extracts	Ethanolic Aqueous	**(Houacine et al., 2012) (Gaber et al., 2013) (Kamal Eldin Gaber et al., 2013)**
15.	**Cucurbitaceae**	*Citrullus colocynthis*	Handal	Seeds	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018) (El Ghazali et al., 1997)**
16.	**Cyperaceae**	*Cyperus rotundus*	Sieda	Rhizome Roots	Extracts	Ethanol Aqueous	**(El Ghazali et al., 1997) (Elbashir et al., 2018)**

17.	**Ebenaceae**	*Diospyros mespiliformis*	Gughan	stem barks	Fraction	Petroleum Ether Dichloromethane Ethyl Acetate Methanol	**(Mohamed et al., 2009)**
18.	**Euphorbiaceae**	*Croton zambiescus*	Um glela	Fruits	Fraction	Petroleum Ether Dichloromethane Ethyl Acetate Methanol	**(Mohamed et al., 2009)**
19.	**Fabaceae**	*Lupinus albus*	Tormus	Fruit	Extracts	Aqueous	**(Kamal Eldin Gaber et al., 2013)**
20.		*Trigonella foenum-graecum*	Hilba	Seed	Extracts	Aqueous	**(Kamal Eldin Gaber et al., 2013)**
21.		*Acacia albida*	Haraz	Root bark	Extracts	Aqueous	**(Kamal Eldin Gaber et al., 2013)**
22.		*Acacia nilotica*	Garad Sunt	Pods	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
23.		*Abrus precatorius*	Habbat Al-Arus	Seeds	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
24.		*Trigonella foenumgraceum*	Hilba	Seeds	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018) (Gaber et al., 2013)**
25.		*Bauhinia rufescens*	Kulkul	Leaves	-	-	**(El Ghazali et al., 1997)**
26.		*Cicer arietinum*	Kabkabe	Seed	-	-	**(Mustafa et al., 2013)**
27.		*Acacia Senegal*	Hashab	Fruits	Extracts	Ethanolic	**(Hilmi et al., 2014) (Yagi et al., 2013)**
28.	**Lamiaceae**	*Salvia officinalis*	Meramia	Leaves	Extracts	Ethanolic	**(Houacine et al., 2012**
29.	**Lauraceae**	*Cinnamomum verum*	Gerfa	Stem bark	Extracts	-	**(Howeida et al., 2010)**
30.	**Leguminosae**	*Lupinus albus*		-	Extract	Aqueous	**(Gaber et al., 2013)**
31.	**Martyniaceae**	*Martynia annua*	Gara Gebei	Mature Fruit	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
32.	**Meliaceae**	*Khaya senegalensis*	Mahogany	Stem bark	-	-	**(El Ghazali et al., 1997)**
33.	**Menispermaceae**	*Tinospora bakis*	Irg alhager	Seeds and Roots	Extracts	Ethanol Aqueous	**(Alamin et al., 2015) (Elbashir et al., 2018)**
34.	**Moringaceae**	*Moringa oleifera*	Moringa	Leaves	Extracts	Aqueous	**(Selma et al., 2016)**
35.	**Myrtaceae**	*Eucalyptus globulus*	ELBan; Kafour	Leaves	Extracts	Ethanolic	**(Houacine et al., 2012)**
36.	**Pedaliaceae**	*Sesamum indicum*	Simsem	Seeds	Extracts	Ethanolic	**(Hilmi et al., 2014) (Yagi et al., 2013)**
37.	**Poaceae**	*Pennisetum glaucum*	Dukhun	Grains	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
38.		*Cymbopogon proximus*	Mahareb	Whole plant	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**

39.	**Ranunculaceae**	*Nigella sativa*	Kamon	Seeds	Extracts	Ethanolic	**(Hilmi et al., 2014) (Yagi et al., 2013)**
40.	**Rhamnaceae**	*Ziziphus spina-christi*	Sidir	Roots	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
41.	**Rubiaceae**	*Mitragyna inremis*	Hikmat	Fruits	Extracts	Aqueous	**(Alamin et al., 2015).**
42.		*Nauclea latifolia*	Karmadoda	Fruits	Extracts	Aqueous	**(Alamin et al., 2015)**
43.		*Randia nilotica*	Kir Kir	Fruits	Extracts	Aqueous	**(Alamin et al., 2015)**
44.		*Vangueria madagascariensis*	Karkar	Fruit	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
45.		*Cephaelis ipecacuanha*	Irg Al-dahab	Roots	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
46.		*Ruta graveolens*	Sathab	Fruit	Extracts	Ethanol Aqueous	**(Elbashir et al., 2018)**
47.	**Scrophulariaceae**	*Striga hermonthica*	Boda	Whole plant	Extracts	Aqueous	**(Alamin et al., 2015)**
48.	**Xanthorrhoeaceae**	*Aloe sinkatana*	Sabar	Leaves	Extracts	Aqueous	**(Kamal Eldin Gaber et al., 2013) (Gaber et al., 2013)**
49.	**Zygophyllaceae**	*Zygophyllum coccineum*	Tartir	Whole plant	Extracts	Aqueous	**(Kamal Eldin Gaber et al., 2013) (Gaber et al., 2013)**
50.		*Balanites aegyptiaca*	Laloub	Fruit	Extract	Aqueous	**(Gaber et al., 2013)**

Table (2): Number and Percentage (%) of plant species tested for anti-diabetic activity peer plants family:

No.	Plant Family	Number of Plants	Percentage (%)
1.	**Acanthaceae**	**1**	**2**
2.	**Amaryllidaceae**	**2**	**4**
3.	**Apiaceae**	**2**	**4**
4.	**Apocynaceae**	**1**	**2**
5.	**Arecaceae**	**1**	**2**
6.	**Asteraceae**	**2**	**4**
7.	**Balanitaceae**	**1**	**2**
8.	**Boraginaceae**	**1**	**2**
9.	**Burseraceae**	**1**	**2**
10	**Capparaceae**	**1**	**2**
11	**Combretaceae**	**1**	**2**
12	**Cucurbitaceae**	**1**	**2**
13	**Cyperaceae**	**1**	**2**
14	**Ebenaceae**	**1**	**2**
15	**Euphorbiaceace**	**1**	**2**
16	**Fabaceae**	**9**	**18**
17	**Lamiaceae**	**1**	**2**
18	**Lauraceae**	**1**	**2**
19	**Leguminosae**	**1**	**2**
20	**Martyniaceae**	**1**	**2**
21	**Meliaceae**	**1**	**2**

22	**Menispermaceae**	**1**	**2**
23	**Moringaceae**	**1**	**2**
24	**Myrtaceae**	**1**	**2**
25	**Pedaliaceae**	**1**	**2**
26	**Poaceae**	**2**	**4**
27	**Ranunculaceae**	**1**	**2**
28	**Rhamnaceae**	**1**	**2**
29	**Rubiaceae**	**6**	**12**
30	**Scrophulariaceae**	**1**	**2**
31	**Xanthorrhoeaceae**	**1**	**2**
32	**Zygophyllaceae**	**2**	**4**
	Total	**50**	**100**

Table (2): Various parts of the plant are used and the number and Percentage (%) of plant species:

No.	Plant Parts Used	Number of Species	Percentage (%)
1.	**Fruits**	12	**23.08**
2.	**Leaves**	9	**17.31**
3.	**Seeds**	8	**15.38**
4.	**Roots**	5	**9.61**
5.	**Whole plant**	4	**7.69**
6.	**Stem bark**	3	**5.77**
7.	**Bulb**	2	**3.85**
8.	**Aerial parts**	1	**1.92**
9.	**Epicarp**	1	**1.92**
10.	**Grains**	1	**1.92**
11.	**Gum**	1	**1.92**
12.	**Mature Fruit**	1	**1.92**
13.	**Pods**	1	**1.92**
14.	**Rhizome**	1	**1.92**
15.	**Root bark**	1	**1.92**
16.	**Stem**	1	**1.92**
17.	**Total**	**52**	**100**

Figure (1): Percentage (%) of different used of extracts and Fractions.

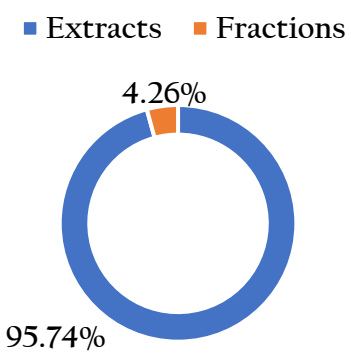
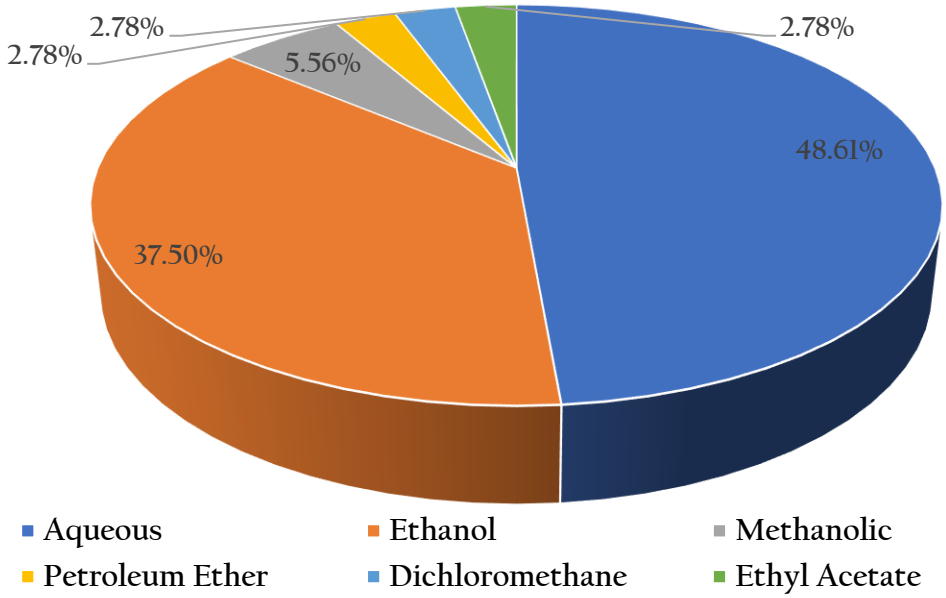


Figure (2): Different uses of solvent to make plant extract.



ACKNOWLEDGEMENTS

We would like to thank group research of the International University of Africa (IUA), Faculty of Pure and Applied Sciences for financial support of the project. We also thank the leader of project **Prof. Dr.: Elbadri Elamin Osman,** Department of Microbiology**,** International University of Africa (IUA), Faculty of Pure and Applied Sciences, Khartoum, Sudan.

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