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Antidiabetic potentials of common herbal plants and plant products - Review

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Abstract

In spite of all the advances in therapeutics, diabetes still remains a major cause of morbidity and mortality in the world it is caused by the deficiency or ineffective production of insulin by pancreas which results in increase or decrease in concentrations of glucose in the blood. There are lots of chemical agents available to control and to treat diabetic patients, but total recovery from diabetes has not been reported up to this date. Alternative to these synthetic agents, many herbal plants with hypoglycaemic properties are known from across the world this has prompted great interest among researchers in this regard to study various plants with medicinal properties A list of medicinal plants with proven antidiabetic and related beneficial effects and of herbal drugs used in treatment of diabetes is compiled.

Key words: Diabetes, Herbal plants, Plant products

Introduction

According to the World Health Organization (WHO), herbal medicines should be regarded as finished, labelled medicinal products that contain active ingredients in the aerial or underground parts of plants or other plant materials or combinations thereof, whether in the crude state or as plant preparations. The plant materials include juices, gums fatty oils, essential oils and any other substances of this nature. Herbal medicine is sometimes referred to as herbalism or botanical medicine. It involves the use of herbs for their therapeutic or medicinal value. Herbs are plants or plant parts valued for their medicinal, aromatic or savoury qualities. They contain and produce a variety of chemical substances that act in the body ^[1]. Herbal medicines include herbs, herbal materials, herbal preparations and finished herbal products that contain an active ingredients parts of plants, or other plant materials, or combination ^[2]. Herbal medicines may contain excipients in addition to the active constituents. In some countries, herbal medicines may also contain, by tradition, natural organic or inorganic active constituents which are not of plant origin. Herbal medicine is the most primitive traditional approach to the treatment of diseases and ailments and it involves the use of plants and plant parts.

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There is no doubt that herbal medicines provided the first basis for therapeutics before the development or advent of orthodox medicine. Despite the fact that, over the years, chemists have synthesized a large number of chemical substances, many of which have proved useful in modern therapeutics, plants still remain potential sources of useful products. Many drugs listed as conventional medications were originally derived from plants. Salicylic acid, precursor of aspirin was originally derived from *Salix alba* and the meadow sweet plant *Cinchona officinalis* is the source of malaria fighting quinine. Vincristine, used to treat certain types of cancer, comes from *Vinca major*. The *Papaver somniferum* yields morphine, codeine and paregoric (a medicine consisting of opium flavoured with camphor and benzoic acid), a treatment for diarrhoea. Since time immemorial man has used various parts of plants in the treatment and prevention of many ailments ^[3]. Historically all medicinal preparations were derived from plants, whether in the simple form of plant parts or in the more complex form of crude extracts, mixtures, etc. Today a substantial number of drugs are developed from plants which are active against a number of diseases. Although the medicine prescribed may contain only one single active item, it is often a mixture of many components. Medicines containing plant materials combined with chemically defined active substances including chemically defined isolated constituents of plants are not considered to be herbal medicines ^[4]. In the past two decades, there has been a global resurgence of

interest in traditional medicine for the treatment of ailments that defy orthodox medicine principally because many diseases have defied or developed resistance to conventional drugs as well as a health system closer to the rural poor. As a result of this renaissance in unorthodox medicine, a lot of interest and attention have been drawn to the curative claims and norms (ethics) of herbal plants in different parts of the globe especially Africa and Asia [5]. Primitive men observed and appreciated the great diversity of available to them. How medicinal plants came to be used in many cases is lost in prehistoric times, but ethnic knowledge of beneficial herbal drugs in various societies has been handed down from generation to generation by both oral means and on writing on papyrus, baked clay tablets, parchments, and in manuscript herbals, printed herbals, pharmacopoeias [6]. Thousands of herbal medicines are used by people from every culture and various indigenous medicines are gradually being introduced into modern therapeutics. In developing countries about 80% of the people, especially the rural population, rely on the traditional medical remedies for their health care needs [79]. In developed countries, there has been a resurgence of interest in herbal medicines due to a large extent on the preference of many consumers for products of natural origin. It is important however; to distinguish between herbal medicine supplied by a "qualified" medical practitioner as a result of a consultation and those herbal remedies (in the form of "teas") freely available to the public for self-medication [7]. The current WHO reports, indicates that over 85% of the population in sub-Saharan Africa, which includes Nigeria depends on herbal traditional medicine for their health care delivery needs [8]. Even within a relatively small geographical area, the use of plants and herbs for food, maintenance of people's health and alleviation of numerous health problems such as mental disorders, diabetes, sickle cell anaemia, malaria and tuberculosis vary widely. The use of plant-based systems has continued to play a key role in health care. Many reports estimated that approximately 80% of the population in developing countries still relies on traditional medicine (TM) for their primary health care [2]; Hostettmann and Marston, 2002) [9]. In some African countries such as Ghana, Mali, Nigeria and Zambia, the first line of treatment for 60% of the children with high fevers, resulting from malaria, is the use of herbal medicines at home [2]. In these societies, the tradition of collecting, processing and applying plants and plant-based medications have been handed down from generation to generation. Traditional medicine, with medicinal

plants as their most important component are sold in market places or prescribed by traditional healers in their homes [2]. The development of resistance to most of the available antimicrobial agents and the high costs of treatment consequent upon this resistance has necessitated a search for new, safe, efficient and effective agents for the management of infections [10]. This research for new effective agents against infectious diseases and other diseases such as, cancers, diabetes, cardio-vascular, neurological, respiratory disorders, etc has led to increased interest in existing information about the remedies of these diseases from natural sources, principally the plants [11]. Because of this strong dependence on plants as medicines, ethnopharmacological studies are being conducted to determine their safety and their efficacy and on the other hand to find out new active principles from plants [12].

Plants and Plant Products in Folk Medicine for Treatment of Diabetes Mellitus

Several plants possess high hypoglycaemic properties and as such are potential sources of new drugs to complement existing oral hypoglycaemic agents in the management of diabetes mellitus. Several species of herbal drugs have been described in the scientific and popular literature as having anti-diabetic activity [13]. Biological actions of the plant products used as alternative medicines to treat diabetes are related to their chemical composition. Herbal products or plant products which are rich in phenolic compounds, flavonoids, terpenoids, coumarins, glycopeptide, alkaloids, steroids, and other constituents tend to show reduction in blood glucose levels [14].

In Nigeria, several plants have been identified to have antidiabetic effects among people in a selected district of Lagos state Nigeria (see tables 1a and 1b). They include *Vermonia amygdalia*, *Bidens pilosa*, *Carica papaya*, *Citrus aurantiifolia*, *Cimum gratissimum*, *Momordica charantia*, *Morinda lucida*. More recently in Nigeria, five plants have been added to the list of anti-diabetic drugs used traditionally for the treatment of diabetes. These plants include: *Anisopus manni*, *Daniella olivieri*, *Detarium macrocarpum*, *Leptadenia hastata* and *Mimosa invisa* [15]. Marles and Farnsworth estimated that more than 1200 plant species representing 725 genera in 183 families are being used as folk medicine for diabetes [16].

Mechanism of Action of Herbal Antidiabetics

The antidiabetic activity of herbs depends upon variety of mechanisms. The mechanism of action of herbal anti-diabetic could be grouped as- Adrenomimeticism, pancreatic beta cell potassium channel blocking, cAMP (2nd messenger) stimulation

Inhibition in renal glucose reabsorption

- Stimulation of insulin secretion from beta cells of islets or/and inhibition of insulin degradative processes
- Reduction in insulin resistance
- Providing certain necessary elements like calcium, zinc, magnesium, manganese and copper for the beta-cells
- Regenerating and/or repairing pancreatic beta cells
- Increasing the size and number of cells in the islets of Langerhans
- Stimulation of insulin secretion
- Stimulation of glycogenesis and hepatic glycolysis
- Protective effect on the destruction of the beta cells
- Improvement in digestion along with reduction in blood sugar and urea
- Prevention of pathological conversion of starch to glucose
- Inhibition of β -galactosidase and α -glucosidase
- Cortisol lowering activities
- Inhibition of alpha-amylase^[17]

Herbal drug formulation

Diabecon manufactured by 'to increase peripheral utilization of glucose, increase hepatic and muscle glucagon contents, promote B cells repair and regeneration and increase c peptide level

Epinsulin

Marketed by Swastik formulations, contains epicatechin, a benzopyran, as an active principle. Epicatechin increases the cAMP content of the islet, which is associated with increased insulin release. It plays a role in the conversion of proinsulin to insulin by increasing cathepsin activity. Additionally it has an insulin-mimetic effect on osmotic fragility of human erythrocytes and it inhibits Na/K ATPase activity from patient's erythrocytes. It corrects the neuropathy, retinopathy and disturbed metabolism of glucose and lipids. It maintains the integrity of all organ systems affected by the disease. It is reported to be a curative for diabetes, Non Insulin Dependent Diabetes Mellitus (NIDDM) and a good adjuvant for Insulin Dependent Diabetes Mellitus (IDDM), in order to reduce the amount of needed insulin. It is advised along with existing oral hypoglycemic drugs and is known to prevent diabetic complications. It has gentle hypoglycemic activity and hence induces no risk of being hypoglycemic.^[18]

Pancreatic Tonic (Ayurvedic herbal supplement):

Pancreas Tonic is a botanical mixture of traditional Indian Ayurvedic herbs currently available as a dietary supplement.

Bitter gourd powder marketed by garry and sun it lowers blood & urine sugar levels. It increases body's resistance against infections and purifies blood. Bitter Gourd has excellent medicinal virtues. It is antidotal, antipyretic tonic, appetizing, stomachic, antibilious and laxative. The bitter Gourd is also used in native medicines of Asia and Africa. The Bitter gourd is specifically used as a folk medicine for diabetes. It contains compounds like bitter glycosides, saponins, alkaloids, reducing sugars, phenolics, oils, free acids, polypeptides, sterols, 17-amino acids including methionine and a crystalline product named p-insulin. It is reported to have hypoglycemic activity in addition to being antihemorrhoidal, astringent, stomachic, emmenagogue, hepatic stimulant, and anthelmintic and blood purifier^[18]

The Future Prospects

Thousands of herbal medicines are used by people from every culture and various indigenous medicines are gradually being introduced into modern therapeutics. In developing countries about 80% of the people, especially the rural population, rely on the traditional medical remedies for their health care needs^[19]. In developed countries, there has been a resurgence of interest in herbal medicines due to a large extent on the preference of many consumers for products of natural origin. It is important however; to distinguish between herbal medicine supplied by a "qualified" medical practitioner as a result of a consultation and those herbal remedies (in the form of "teas") freely available to the public for self medication^[20]. The rapidly increasing incidence of diabetes mellitus is a serious threat to human health in all parts of the world. Recently, new bioactive drugs have been isolated from plants and have shown anti-diabetic activity with more efficacy than oral hypoglycaemic agents used in clinical therapy. Therefore in recent years, Attention has been drawn towards identification of plants with anti-diabetic ability that may be useful to man^[21]. They may also provide clue for the development of new and better oral drugs for diabetes mellitus^[22]

Conclusion

In the present study we conclude that main alterations found in the liver showed altered tissue architecture, nuclear vacuolization, hepatocyte damage and presence of Melano-macrophage aggregations cytoplasmic and nuclear degenerations were also observed. The tissues were slightly too moderately damaged as is evident by altered in histomorphological structure and cytoplasmic degeneration.

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Table1: Some medicinal plants used in traditional medicine for treatment of diabetes

Plant	Family	Part Used	Reference
<i>Abroma augusta</i>	Sterculiaceae	Root	Kar et al, 1999
<i>Acourtia thurberi</i> (Gray) Rev. et. King	Asteraceae	Root	Aguilar et al., 1994
<i>Ajuga iva L.</i>	Lamiaceae	Aerial parts	Ziyyat et al., 1997
<i>Anthocleista djalonensis</i> A. Chev)	Loganiaceae	Leaves	Olubomehin et al., 2013
<i>Artemisia herba-alba</i> Asso	Asteraceae	Root	Subramoniam et al, 1996
<i>Asianthus viminalis.</i>	Bignoniaceae	Whole plant	Alarcon-aguilara et al.,
<i>Beta vulgaris</i>	Chenopodiaceae		Yoshikawa M,etal. (1996)
<i>Bidens pilosa L</i>	Asteraceae	Whole plant	Alarcon-Aguilara et al.,
<i>Bombax ceiba L.</i>	Bombaceae	Leave	Saleem et al. (1999)
<i>Brassica oleracea L.</i>	Cruciferae	Leave	Roma-romos et al., 1995
<i>Bridelia micrantha</i> (Hochst)	Eupobiaceae	Leave	Bail Eton et., 2008
<i>Bauhinia monandra</i> K	Caesalpinica	Stem bark	e Abo et al., 2004
<i>Caesakoubua bonducella L.</i>	Leguminosae	Seeds	Rao et al., 1994
<i>Carica papaya L.</i>	Cariceceae	Fruits	Olagunju et al., 1995
<i>Capparis spinosa L.</i>	Capparaceae	Fruit	Ziyyat et al., 1997
<i>Ocimum gratissimum L.</i>	Lamiaceae	Leaves	Var Aguiyi 2000
<i>Cinnamomum tamal</i>	Lauraceae	leaves	Kar et al., 1999
<i>Cicciniaolitorius</i> Wright	Cucurbitaceae	Aerial	Kar et al., 1999
<i>Citrus aurantium L -</i>	Rutaceae	Fresh mull Alarcon	Aguilara et al., 1998
<i>Citrus colocynthis L</i>	Cucurbitaceae	Fruit	Alarcon-Aguilara

			<i>etal.</i> ,1998
<i>Cnidoscus multilobum</i> L	Euphorbiace	Leaves	Alarcon-Aguilara <i>etal.</i> , 1998
<i>Corchorus olitorius</i> L.	Titiaceae	Leaves	Oliver-Bever, 1986
<i>Eucalyptus globules</i>	Myrtaceae	Flower	labill Hideo <i>etal.</i> ,1994
<i>Exostema caribeum</i> (Jacq)	Rubiaceae	Bark	Alarcon-Aguilara <i>etal.</i> , 1998
<i>Euphorbia Preslli</i> I.	Euphorbiaca	Whole pla	Alarcon Aguilara <i>etal.</i> , 1998
<i>Eysenhardita polystachia</i> (Ort.) S.	Rubiaceae	Bark	Alarcon-Aguilara <i>etal</i> ,1998
<i>Ficus bengalensis</i> L.	Moraceae	stem-bark	Kar <i>etal</i> , 1999
<i>Ficus carica</i> L.	Moraceae	leaf Flower,	Ziyyat <i>etal.</i> , 1997

Table 2: Some medicinal plants used in the treatment of diabetes in traditional medicine

Plant	Family	Part Used	Authors
<i>Gongronema latifolium</i>	Asclepidaceae	Leaves	Akah <i>et al</i> 2011
<i>Gymnema sylvestre</i> R.	Asclepidiaceae	Leaves	Br Kar <i>et al</i> , 1999
<i>Magnifera indica</i> L.	Anarcadiaceae	Leaves	Alarcon-Aguilara <i>et al.</i> , 1998
<i>Marrubium vulgare</i> L.	Lamiaceae	Aerial parts	Ziyyat <i>et al.</i> , 1997
<i>Momordica charantia</i> L.	Cucurbitaceae	Leaves, fruits	Rivera, 1941
<i>Menthe piperita</i> L	Labiatae	Whole plant	Alarcon-Aguilara <i>et al.</i> , 1998
<i>Moriga oleifera</i> Lam	Moringaceae	Stem bark	Kar <i>et al</i> , 1999
<i>Neloumbo nucifera</i> Gaertn	Nymphaeaceae	Rhizome	Mukherjee <i>et al.</i> , 1995
<i>Nerium oleander</i> L.	Apocyanaceae	Leaves	Ziyyat <i>et al.</i> , 1997
<i>Ocimum gratissimum</i> L. Var.	Lamiaceae	Leaves	Aguiyi (2000)
<i>Orthosiphon astamineus</i>	Lamiaceae	Benth Whole plant	Mariam <i>et al.</i> , 1996
<i>Parkia biglobosa</i> (Jacq) Benth	Mimosoideae	Seed	Fred <i>et al.</i> , 2009
<i>Physalis angulate</i>	Solanaceae	Whole plant	Abo <i>et al.</i> , 2013
<i>Piper sarmentosum</i> Roxb	Piperaceae	Whole plant	Peungvicha <i>et al</i> , 1998
<i>Prenus amygdalus</i> var amara CD	Rhamnaceae	Leaf	Ziyyat <i>et al.</i> , 1997
<i>Ravolfia tetraphylla</i> L	Apocyanaceae	Leaves	IbanezCamacho 1983
<i>Salpianthus macrodonthus</i> Stand	Nyctaginaceae	Root	Perfumi and Tacconi, 1996
<i>Sesbania aegytiaca</i> pers	Papillionaceae	Leaves	Kar <i>et al</i> , 1999
<i>Spondias mombin</i> Linn	Anacardiaceae	Leaves	Fred <i>et al</i> 20

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