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Diabetes & Obesity International Journal
ISSN: 2574-7770

Conditions for Better uses of Some Cameroonian Plants Potentially Anti-Diabetic and Reversing Insulin Resistance

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Research Article
Volume 5 Issue 1
Received Date: February 26, 2020
Published Date: March 12, 2020
DOI: 10.23880/doij-16000222

Abstract

Background: Hyperglycemia-induced oxidative and inflammatory harm are the major causes of chronic and fatal complications of diabetes. In many developing countries the products of socio-cultural medicine are more used by low income populations to fight against diseases particularly diabetes. The economic crises, the slump of agricultural product's prizes and the significant increase of the population, are at the origin of the strong dependence on African traditional medicine.

Objective: The objectives were to identify factors that influenced the better uses of potential bioactive plants published by Cameroonians, particularly used for diabetes management in order to select those that can improve insulin sensitivity and can be principally used to avoid diabetic complications.

Methods: To achieve this objective, the review was carried out in online databases including Google, Google Scholar and Pubmed, between 2018 and 2019. For the ethnopharmacological standardization of recipes, we proposed in this work the doses calculated by deduction from the doses used to treat in vivo alloxan or streptozotocin induced diabetic rats. The presence of one or several antihyperglycemic compounds in recorded plants and the hypoglycemic effects of their extract reinforced the herbal use of these species.

Results: All the admitted plants exhibited antidiabetic properties. Twenty-eight point fifty-seven percent (28, 57%) of them were confirmed antihyperglycemic and improved insulin sensitivity. Permanent stress is the important factor influencing the better management of diabetes by these plants. 1.5. Conclusion: The results of this study can be the scientific basis for antidiabetic drugs discovery that can prevent insulin resistant and consequently complications of diabetes type 2.

Keywords: Anti-diabetic Plants, Potential Antihyperglycemic plants, Adequate conditions for their good uses, Bioactive Antidiabetic Compounds, Insulin Resistance, Cameroon

Abbreviations: SCNPAPCPR: Scientific names of potential antihyperglycemic plants and Cameroonians' publications references; PPSEDT and BAS: Pharmacological previous scientific evidence of diabetes treatment and bioactive substances; PEPPEU: Previous experimental posology of a plant' extract used and PDCDTASDRBWD: Proposed doses calculated by deduction from the doses used to treat in vivo alloxan-induced or streptozotocin-induced diabetic rats for a 60 kg body weight diabetic.

Introduction

Worldwide Health Problem

The prevalence of diabetes mellitus is ever-increasing at a disturbing velocity. This chronic metabolic pathology thoughtfully damaged the human health, reduced the life standard, the lifestyle and quality of life. Two important factors which are involved in the pathophysiology of diabetes mellitus are insulin deficiency and insulin resistance. Furthermore, insulin resistance is being diagnosed currently in an increasing population of diabetic and obese patients, both in developed and in developing countries. Diabetes is therefore a metabolic disorder of three nutrients (carbohydrate, fat and protein). It affects a large number of nourished and unnourished populations in the world. Diabetes and its complications including cardiac problems, kidney failure, retinopathy, etc. are become one of the main terrorizations to world human health. Insulin resistance is a complication which precedes type 2 diabetes mellitus. It is a widespread pathology associated with the metabolic syndrome (obesity, dyslipidemia and atherosclerosis), myocardial ischemia, and hypertension which together are responsible for substantial morbidity and premature mortality [1,2].

Antidiabetic Bioactive Compounds

The bioactive compounds are responsible of plant activities. The regulation of hyperglycemia by plants is related to the presence of antihyperglycemic substance. Some plants contain many antidiabetic molecules. The concentration of each molecule plays an important role on its activities. More the antidiabetic bioactive compounds are high concentrated more the plant can potentially release the blood glucose levels. Many bioactive antidiabetic ingredients in a given plant can react in synergy.

Importance of Ethnopharmacology

It exist a large games of conventional antihyperglycemic drugs accessible to manage and to take care of diabetes, but they still very fare to offer total recovery up to date. Plants provided also strong varieties of natural hypoglycemic convincing herbal medicines, used widely in African, South American and Asian sociocultural medicine to prevent diabetes. The use of single or polyherbal medicine alone or parallel to the side of pharmaceutical drugs for diabetes treatment is convincingly universal. Our objectives were to identify factors that influenced the better uses of antihyperglycemic plants and carried out antidiabetic review on plants used frequently in Cameroonian socio-cultural medicine already published in order to select principally those with improving insulin sensitivity. The role of ecology in species chemical constitution and the previous evidence of antidiabetic activities of recorded plants, their non-toxicity, and the mechanisms of action of extracts or the actives ingredients are necessary for determining the better way to produce appropriate antihyperglycemic medicines. By this way certain recorded species can be highlighted by their possible integration into the healthcare system. But do mechanisms of action of plants compatible from those of oral hypoglycemic drugs?

Materials and Methods

The ethnopharmacological evaluation was realized through the research of some indices of credibility that include the promising extracts or the presence of one or several antihyperglycemic compounds in plants.

Criteria of Plants Inclusion

Plants include in this work are randomized distributed in Cameroon and already published by Cameroonians for their ethnomedical uses; previous pharmacological tests have demonstrated that their extracts showed diverse antihyperglycemic effects; they are least toxic and contain antidiabetic compounds. The review was carried out in online databases that include Google, Google Scholar and Pubmed between 2018 and 2019. Recorded Plants taxonomical accepted names or synonyms were searched in The Plant List database.

Improvement of the Ethno Pharmacological Doses Administration

The ethnopharmacological doses sometimes are insufficient or exaggerated. For the ethnopharmacological standardization of recipes, we proposed in this work the doses calculated by deduction from the doses used to treat in vivo alloxan-induced or streptozotocin-induced diabetic rats or diabetic patients in clinical trials cases. A person of 60 kg was adopted to determine the quantity of a given plant extract needed for one dosage. Generally the dose is related to the weight of a given person.

Results

Twenty-one plants belonging to 13 families and 16 genera were recorded. The predisposed causes or complications of diabetes that include hyperglycemia, hyperinsulinemia, hypercholesterolemia, hypertriglyceridemia and obesity were controlled unambiguously by these plants in alloxan-induced or streptozotocin-induced diabetic rats or in type 2 diabetic patients conferring to previous screening trials.

Factors Influencing the Antihyperglycemic Activity of Plants

During the use of a medicinal plant in general or especially an antidiabetic plant we must try to respect the following conditions which may be advantageous for their good activities.

Nature and Quantity of Food Consumed

Diabetic patients, who regularly drink alcohol,

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consumed fat foods; more carbohydrates and excitants, early develop complications that are related to the persistence of hyperglycemia.

Lack of Physical Exercises

Physical exercises aid the body to degrade excesses of glucose. Therefore diabetic patients who used herbal medicines do not neglect physical education.

Development of Permanent Stress

The state of persistent stress in diabetic patients maintains them in constant increasing of glucose levels and aggravation of their conditions through the development of fatal complications. In such conditions plants cannot help them appropriately.

Friendless Life

It is an introverted life which cultivates a lot of stress. Everybody lives far from her relatives and have no warm intimate relation each other. There are a lot of familial, social, professional, political and emotional conflicts which affect people and destroy their health conditions through diseases, especially diabetes. Such conditions limit the activity of plants.

Lifestyle

In Cameroon we assist to the increasingly change of food habit. People abandon traditional foods that include "taro soup rich in garden egg fruits, Medip-zon (water decoction of garden egg fruits) and crude consumption of garden egg" rich in Trigonellin (oral insulin of substitution which help naturally the body to regulate blood glucose concentration) for eggs, sweet tea-milk and bread every morning. A diabetic patient who has stock and continue to eat carbohydrates may have a lot of difficulty to release the blood glucose level with plants.

Late Diagnostic

Many diabetic patients in Cameroon start the treatment at the stage of complications. By consequence the used of plants may be late and unfruitful.

Insulin Resistance

Many plants cannot treat the insulin resistance in type 2 diabetic patients; the appropriate plants are needed.

Majority of local therapists don't know these conditions. But their application can be unavoidable for the successful uses of medicinal plants in general and antidiatic plants in particular.

The exploitation of randomized selected Cameroonians' publications has permitted to admit for this study medicinal plants that previous anti-diabetic activities are presented in table 1. The research of their mechanisms of action was helpful for determining those of them which can improve insulin sensitivity.

SCNPAPCPR	Common Name(s)	PPSEDT and BAS	PEPPEU and PDCDTASDRBWD
1-*Abrus precatorius* L. (Fabaceae-Papilionoideae) [3,4] Syn. *Abrus precatorius* var. *latifoliolatus* De Wild. *Abrus precatorius* var. *novoguineensis* Zipp. ex Miq. ' *Abrus precatorius* var. *villosula* Miq.	Jequirity (English) Precatory bean (USA), Saga (Indonesia), Gunchi (Pakistan), Rati gedi (Nepal), Weglis (Indonesia). Rosary pea (Egypt)	The leaves metabolic extract exerts the antihyperglycemic effect in streptozotocin-induced diabetic rats model through insulin secreted by pancreatic beta cells secretion by oral administration of 200 mg/kg body weight. Subsequently, this plant could be an ethnomedical medicine with insulinotropic activity in diabetes [5]. The seeds aqueous and ethanol extracts of *A. precatorius* contain alkaloids, flavanoids, saponins and tannins. These compounds especially tannins show many bioactivities include antidiabetic and anti-obesity [6]. Indeed *A. precatorius* play a role in hypocholesterolemia by inhibiting the effect of an important enzyme in the biosynthesis of cholesterol. These activities reveal that *A. Precatorius* could be used in the controlling of diabetes and obesity. But it may present immuno-inhibitory effects on hyper-immuned diseased conditions.and a strong toxicity on kidney manifested by hypercreatinemia [2,7].	200 mg/kg body weight corresponding to12 g of extract for a 60 kg body weight person

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2- *Adansonia digitata* L. [8] (Bombacaceae) *Syn. Adansonia baobab Gaertn.* *Adansonia integrifolia* Raf. *Adansonia situla (Lour.)* Spreng.	Baobab tree	Although the richness of carbohydrates in the pulp of fruit; *Adansonia digitata* still decreases the blood glucose at the dose of 300 mg/kg of the pulp. The negative effect of carbohydrate higher content may be overcome by other phytochemicals [9]. There are many antidiabetic active ingredients in *Adansonia digitata* inclusing proanthocyanidins major compounds represented by Epicatechin and Epicatechin procyanidins, and others constituents as Dihydroxy and Trihydroxy flavan-4-oneglycosides, Oleic, Linoleic and Myristic Acids, Quercetin glycosides, a-amyrin, ß amyrinpalmitate, Ursolic acid, Adansonin, ß sitosterol, Stigmasterol, Saponins, flavonoids, terpenes, tannins, alkaloid and carbohydrates [10,11]	300 mg/kg body weight corresponding to18 g of extract for a 60 kg body weight person
3- *Allium cepa* L. (*Amaryllidaceae*) [12] *associated to* 4-*Allium sativum* L. (*Amaryllidaceae*) [14]		Thirty days oral administration of aqueous bulbs extract of *A. cepa* L. (onion) and *A. sativum* L. (garlic) to diabetic rats induced by alloxan decreased hyperglycemia inverted weight loss and depletion of liver glycogen [14]. S-methylcysteinesulfoxide and S-allylcysteinesulfoxide are the main anti-diabetic bioactive compounds found respectively in onion and garlic [14]. These two principles stimulated insulin secretion as well as struggle with insulin for insulin inactivating sites in the liver. The first inhibited gluconeogenesis in the liver and the second hindered lipid peroxidation due to its antioxidant and secretagogue activities. Hypoglycemic and anti-hyperglycemic activities were revealed by saponins and glycosides which stimulate insulin release from isolated pancreatic Islets [14]. While the administration of the two plants caused significant enhance in the biosynthesis of cholesterol from acetate at the liver level. This result showed stumpy capacities of products derived from these species to shelter the diabetic rats against risk factors associated to diabetes mellitus [14].	. 300 mg/kg aqueous extract corresponding to18 g of extract for a 60 kg body weight person
5- *Aloe vera* (L.) Burm.f. [15] (Aloeaceae) Syn. *Aloe vera* L. ex *Webb* *Aloe vera* var. *aethiopica* Schweinf. and 6- *Aloe tenuifolia* Lam. (Aloeaceae) syn. *Aloe buettneri* A.Berger (1)		*Aloe vera* polyphenols-rich gel extract reduced significantly both body weight ($p < 0.00$) and blood sugar concentrations ($p < 0.005$) and by consequent treated insulin resistance mice which was observed in the negative control group. *Aloe vera* gel administrated in combination with dietary measures or in the form of medication could be effective for the control of insulin resistance. In addition, it is also free-radical scavengers [16]. In obese patients with prediabetes or early untreated diabetes, Aloe gel complex in clinical use has shown a promising result in body weight loss and consequently in insulin resistance [16]. Insulin resistant mice and randomized controlled trial in type 2 diabetic patients revealed improving insulin sensitivity calculated using the homeostasis model assessment for insulin resistance formula but the cellular mechanism still undetermined [17]. *Aloe tenuifolia* is used successfully par diabetic patients in Cameroon.	350 mg/kg body weight corresponding to 21 g of Aloe gel for a 60 kg body weight person

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7-*Anacardium occidentale* L. (Anacardiaceae) [18,19] *Syn. Anacardium occidentale* var. *americanum* Jacq. *Anacardium occidentale* var. *gardneri* Engl.	Cashew tree	The traditional use of *A. occidentale* leaves as antidiabetic herbal medicine in Cameroon is confirmed. Indeed, the leaves ethanol extracts (100 mg/kg) of this tree show showed 8.01% and 19.25% decrease in the fasting blood glucose levels on day 15 and day 30 respectively. These results revealed significant antihyperglycemic effects which is comparable to the standard hypoglycemic drug pioglitazone [20].	100 mg/kg body weight corresponding to 6 g of extract for a 60 kg body weight person
8- *Azadirachta indica* A. Juss (Meliaceae) [18,21] *Syn. Azadirachta indica* var. *minor* Valeton *Azadirachta indica* var. *siamensis* Valeton *Azadirachta indica* subsp. *vartakii Kothari,* Londhe & N.P.Singh	Neem	Nimbidin a bioactive compound isolated from the leaf is responsible of hypoglycaemic activity and perform these other beneficial effects: anti-inflammatory, antiarthritic, antipyretic, antigastric ulcer, spermicidal antifungal, antibacterial and diuretic [22]. The evaluation of the toxicity showed that no toxic effects were recorded in the organs at the dose of 2000 mg/Kg. Therefore aqueous leaf was safe. It contains the following active metabolites: coumarins, catechic tannins, polyphenols, tannins, flavonoids, phlobotannins and one new compound called meliacinolin, which were bioavailable in general circulation [22,23]. Particulary meliacinolin can efficiently reverse insulin resistance, recover renal function, control lipid abnormalities and oxidative stress [23].	2000 mg/Kg body weight corresponding to 12 g of extract for a 60 kg body weight person
9-*Brassica oleracea* L. subsp *oleracea* (Brassicaceae) [21]	Cabbage	The phytochemical screening tests on *Brassica* spp showed the presence of saponins, tannins, triterpenes, alkaloids and flavonoids which were present in the plants that possessed antidiabetic and glycogenesis activities [24]. *Brsassica oleracea* var gongylodes contains chlorogenic acid (5.9 mg/g) and its isomers, neo- and cryptochlorogenic, sinapic acid (2.7 mg/g), rutin (1.6 mg/g), flavonoids and hydroxycinnamic (most abundant group of polyphenols), flavonoid glycosides, hydroxycinnamic (most predominant phenolics), isothiocynates (hydrolytic products of glucosinolates) [25]. *Brassica oleracea* var gongylodes phenolic rich extract contain several other health-promoting phytochemicals that play a multi-component therapy include anti-diabetic, antilipidemic and antioxidant in streptozotocin-induced diabetic rats [25]. This variety of *Brassica oleracea* significantly abridged fasting blood glucose to normal levels and alleviates diabetes related complications including cholesterol lowering, ameliorating oxidative **stress** genes, body weight loss (by 24%), enhancing glycogenesis activity, restoration of renal function, attenuation of the adverse effect of diabetes on malondialdehyde, glutathione and superoxide dismutase activity [26]. Due to all these phytomolecules activities *Brassica oleracea* var gongylodes may be a potential plant for preparing a multi-component drug to control diabetes anti-diabetic and its related complications [24].	200 mg/kg body weight corresponding to 12 g of extract for a 60 kg body weight person

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10- *Bridelia ferruginea* Benth. [18] (Phyllanthaceae) syn. *Bridelia ferruginea* var. gambicola Hiern *Bridelia ferruginea var. orientalis* Hutch.		Njamen *et al.* have shown that methanol leaf extract of *Bridelia ferruginea* exhibited hypoglycaemic activity in glucose intolerant rats [27]. The aqueous stem back extract of *Bridelia ferruginea* repaired the β-cells destroyed by the alloxan monohydrate within few hours. This result shows that this plant reduces the blood glucose concentration by acting directly as insulin or increasing the discharge of insulin [27]. Batomayena Bakoma *et al*. found that catechins constituents (**Epigallocatechin and Epigallocatechin gallate**) from *B. ferruginea*, revealed significant anti-hyperglycemic and antihyperlipidemic activity at doses of 10 mg/kg/day, for 21 days in type 2 diabetes [28]. A wide classes of phytochemicals including quinones, polyphenols, alkaloids, carbohydrates, flavonoids, saponins, sterols, polyterpenoids, tannins catechic and gallic and saponosids were found in aqueous and alcoholic extracts [29].	10 mg/kg/day corresponding to 0, 600 g /for a person of 60 kg body weight
11-Bridelia micrantha (Hochst.) Baill. (Phyllanthaceae) [18] Syn. *Bridelia micrantha* var. ferruginea (Benth.) Müll.Arg. *Bridelia micrantha* var. gambicola (Baill.) Müll. Arg. *Bridelia micrantha* var. micrantha	Mitserie, Mitzeeri, Mitzeerie, Coastal Goldenleaf, bruinstinkhout, wild coffee	All plant parts, aqueous and organic extracts showed antidiabetic effect. Indeed the methanol leaf extract at the dose of 250, 500, and 1500 mg/kg showed significant time-dependent decrease in blood sugar concentration in Alloxan-induced diabetic mice. These results suggest that the leaf extract may possibly potential supply of a new antidiabetic for the management of diabetes worldwide [19]. Other activities including anticonvulsant and sedative, insecticidal and lactamase inhibitory activities .antioxidant, hepatoprotective, antidiarrhoeal, antinociceptive, antiplasmodial, antischistosomal, anthelmintic, antimicrobial [30]. Wide varieties of phytochemicals such as alkaloids, anthocyanidin, anthraquinones, carbohydrates, cyanogenic glycoside, essential oil, ester, flavonoids, oxalate, phenolic compounds, saponins, sterols, tannins, terpenoids and several minerals have been isolated from the bark, fruits, leaves and roots of this plant. Bark, fruits and leaves of *B. micrantha* contain manifold classes of nutrients including minerals, carbohydrates, polyol (hexahydroxy alcohol), and proteins. Numerous oligo-elements such as calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, phosphorus, potassium, sodium and zinc were also found in fruits [31]. Previous studies have demonstrated that *Bridelia. micrantha* is toxic and cytotoxic and may responsible of damage to genetic material and therefore, can produce long-term damage in patients who used this herbal medicine [31].	250, 500, and 1500 mg/kg corresponding to 1,5, 30, and 90 g for a person of 60 kg body weight

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12-*Ceiba pentandra* (L.) Gaertn. (Bombacaceae) [8,19] Ceiba pentandra f. albolana Ulbr. Ceiba pentandra var. clausa Ulbr. Ceiba pentandra var. dehiscens Ulbr. Ceiba pentandra f. grisea Ulbr.	Kapok (Silk Cotton Tree)	The dried aqueous extract of *Ceiba pentandra* stem bark shows the antihyperglycemic activities, the improvement of insulin resistance, the peripheral glucose consumption, the antitriglyceride and the antioxidant effects that traduce the importance of this tree in the management of type 2 diabetes [32]. The antidiabetic activity of *C. pentandra* is owed to its capacity to enhance glucose uptake and to reduce glucose discharge by target organs [33]. The stem bark aqueous and metabolic extracts of *Ceiba pentandra* enhance the glucose tolerance by stimulating glycogen synthesis and gluconeogenesis hang-up. These effects can be exploited to control cardiovascular complications associated with diabetes [34]. The phytochemical screening show the following groups of constituents in *Ceiba pentandra* bark and leaf extract: Tannins, phenol, phylate, oxalate, saponins, flavonoids and alkhaloids [23]. The effect of *Ceiba pentandra* (40 mg/kg) was more prominent when compared to glibenclamide in lowering blood glucose, with the added benefit of considerably reducing serum cholesterol and triglyceride concentrations [35].	40 mg/kg corresponding to 2,4 g for a person of 60 kg body weight
13-*Mangifera indica* L. [36] (Anacardiaceae) *Syn. Mangifera austroyunnanensis* Hu	Mango tree	Different extracts of *Mangifera indica* fruit, flesh, leaf, stem bark, seed kernel and isolated compounds including Mangiferin, phenolic acids and flavonoids (was found as a major chemical which is responsible for anti-diabetic activity), have been reported to exhibit anti-diabetic properties [37]. Mangiferin and its glucoside isolated in this plant were involved in improving insulin resistance effects [38]. These medicinal activities are attributable to insulin secretagogue effect, α-glucosidase inhibition, free radical scavenging properties, inhibition of a-amylase, α-glucosidase, glucose absorption in the gut and glucose transport, which were established by numerous studies, based on nondiabetic rats, alloxan, streptozotocin and feeding with high-fat diet induced diabetic rats [39-41]. The leaves contain higher level of phenols and flavonoids which exhibit greater antioxidant activity by lowering the diabetic complications [37,42]. This hypoglycemic upshot was significant when 400 mg/kg (body weight) of the extract was administrated orally for 45 days [42]. Aqueous extract especially seed kernel extracts decreased total cholesterol and triglycerides level, in diabetic rats when compared to diabetic controls, decreased the damage to beta cells and showed normal liver histology and minimal damage to hepatocytes as compared to animals treated with 550 and 750 mg/kg extract dose. It concluded that *M. indica* could therefore be a promising herbal therapy for the management of type 2 diabetes and its related complications [43,44]	400 mg/kg corresponding to 24 g of extract for a 60 kg body weight person

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14-*Momordica charantia* L. (Cucurbitaceae) [3,4,19] *Momordica charantia subsp. abbreviata (Ser.) Greb.* *Momordica charantia f. abbreviata (Ser.) W.J.de Wilde & Duyfjes* *Momordica charantia var. abbreviata Ser.* *Momordica charantia var. muricata (Willd.) Chakrav.*	Balsam Pear Bitter Gourd	Phytochemicals found in *Momordica charantia* comprising proteins, polysaccharides, flavonoids, triterpenes, saponins, ascorbic acid and steroids. Several biological effects of this herb including antihyperglycemic, antibacterial, antiviral, antitumor, immunomodulation, antioxidant, antidiabetic, anthelmintic, antimutagenic, antiulcer, antilipolytic, antifertility, hepatoprotective, anticancer and anti-inflammatory activities, have been demonstrated [45]. Concerning the antidiabetic effects two randomised controlled trials showed that there was no statistically significant difference in the glycaemic control with *momordica charantia* preparations compared to placebo or no significant change in reliable parameters of glycaemic control observed when compared to metformin or glibenclamide. No grave opposing properties were reported in any trial. No trial scrutinized death from any origin including morbidity, health-related quality of life or costs [46]. *Momordica charantia* is an herbal anti-diabetic remedy, used cost-efficiently in several developing countries for the treatment of type 1 and type 2 diabetes. It is an infrequent herb which still obtainable in nature for successfully management of diabetes in many developing countries [47].	100, 200 and 300 mg/kg.corresponding to 6g, 12 g and 18g of extract for a 60 kg body weight person
15- Psidium guajava L. [36] (Myrtaceae)	Red guava	All the rats in experimental groups took diets containing red guava as well as rosiglitazone showed significant decreasing in blood glucose levels, insulin resistance, creatinine, blood urea nitrogen, triglycerides, non-esterified fatty acids, cholesterol, creative protein, Tumor necrosis factor-α, and human cytokine synthesis or inhibitory factor (IL-10), when compared with the diabetes mellitus group. In addition, the expression of inflammatory proteins, such as inducible nitric oxide synthase (iNOS) and nuclear factor κB pathway (NF-κB), was suppressed via activated peroxysome proliferator-activated receptors (PPARγ), and the expression levels of Glutathione peroxidase 3 (GPx3) and *Allied Command Operations* (ACO) increased. In summary, red guava can significantly repress inflammatory and oxidative harm induced by hyperglycemia in diabetic rats. It can also lighten diabetic complications; consequently, it exerts protective activities [48]	100 g of red guava ate per diets

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16-*Sclerocarya birrea* (A. Rich.) Hochst (Anacardiaceae) [18,19] syn. *Sclerocarya birrea subsp. caffra (Sond.) Kokwaro* *Sclerocarya birrea subsp. multifoliolata (Engl.) Kokwaro* *Sclerocarya birrea* var. *multifoliolata* Engl.	Common Name: Marula	The phytochemical screening showed that fruit, leaves and stem bark of *S. birrea* contain different compounds. From the fruit soluble phenolics, K, Na, Ca, Mg, Fe, Zn, Mn, crude oils, carbohydrates, crude proteins, fibre, saponins, minerals, and ascorbic acid, tannins, catechins, and hydroxycinnamic acid, and many acids from oil-rich seeds have been isolated [49]. Form the leaves polyphenols, tannins, flavonoids (quercetin, kaempferol and their derivatives), alkaloids, anthocyans, and saponosides, tannins, coumarins, triterpenoids and phytosterols (β-sitosterol) were isolated [49]. From the stem bark of *S. birrea* gallotannins, flavonoids, alkaloids, steroids (β-sitosterol), coumarins, triterpenoids, sesquiterpene hydrocarbons, ascorbic acid, oleic acid, myristic, stearic and amino acids with a predominance of glutamic acid and arginine, tannins, and traces of alkaloids were isolated [49]. The *S. birrea* stem bark extract doses of 60–240 mg/kg, orally administrated to non-diabetic and streptozocin (STZ)-treated diabetic rats decreased blood Glucose concentration in a dose-dependent manner in acute study. The hypoglycemic effect was more persistent (4 h) in diabetic rats, comparative to non-diabetic animals [49,50]. Nevertheless, in a chronic study, on a daily basis administration stem bark extract dose of 120 mg/kg significantly reduced blood glucose level in STZ-treated diabetic rats, but didn't significantly decrease that of normal-diabetic rats. A 5 weeks daily treatment of rats with *S. birrea* stem-bark extract and metformin produced a significant surge in hepatic glycogen levels in normal-rats and diabetic rats. Though, in the untreated groups, significantly higher concentrations of hepatic glycogen were observed in non-diabetic, comparative to diabetic, rats. These results confirm that the stem bark extract exerts its antihyperglycemic activity through the same mechanisms like metformin [49]. Dimo et al. found that dichloromethane: methanol (1 : 1) extract of *S. birrea* stem-bark reduced blood glucose and augmented plasma insulin levels in streptozocin (STZ)-treated diabetic rats and contributed to an improved metabolism in the extract-treated diabetic animals. The stem-bark extract provoked a noticeable increase in glucose consumption in hepatic cells and muscle cells. This extra pancreatic mechanism is different to pancreatic one [51]. That why no significant loss in body weight at the end of the 3-week treatment period was observed [51]. These results show that the extract has antidiabetic activity at the dose of 100, 200 and 300 mg / kg. But the activity of the extract augments considerably the urea creatinine and uric acid after two weeks of diabetic rats treatment. The increasing of these parameters induces renal and hepatic intoxication [49-51].	120 mg/kg corresponding to 7,20 g of extract for a 60 kg body weight person

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17-*Scoparia dulcis* L. (Scrophulariacea) [52] *Ambulia micrantha* Raf. *Capraria dulcis* var. coerulea Kuntze *Scoparia nudicaulis* Chodat & Hassl. *Scoparia procumbens* Jacq. *Scoparia purpurea* Ridl. *Scoparia ternata* Forssk.	Deudeu-lefo (Bamileke) Sweet Broom	Different extracts types especially water extract of the whole plant and its isolated various compounds (diterpenes, triterpenes, coixol, glutinol and flavonoids), polyphenol, scoparic acid A, scoparic acid D, scutellarein, apigenin, luteolin have exhibited antihyperglycemic or hypoglycemic effects, attributable to its insulin secretagogue activity, a-amylase inhibition, α-glucosidase inhibition and glucose transport, which were demonstrated by several studies, based on alloxan or streptozotocin induced diabetic rats [53]. *S. dulcis* extracts mitigate the harmful properties resulting from hyperglycemia-induced oxidative stress and inflammatory reactions (ability to scavenge free radicals and anti-inflammatory activity). This hypoglycemic effect was extremely prominent when 0.45 g/kg (body weight) of the extract was administrated orally for 45 days. Aqueous extracts have shown antihyperlipidemic effects (cholesterol, triglycerides, fatty acids, and phospholipids), antihyperglycemic activity, Insulin secretagogue effects, Increase of glucose uptake, antioxidant activity, prevention of weight loss, on streptozotocin induced diabetic rats, when administered at a dose of 200mg/kg (body weight) [53,54].	0.45 g/kg corresponding to 27,0 g for a person of 60 kg body weight
18-*Solanum melongena* L. (Solanaceae) [55] *Solanum melongena* var. depressum L. *Solanum melongena* var. esculentum (Dunal) Nees *Solanum melongena* var. inerme (Dunal) Hiern	Garden egg Eggplant	The infusion of *Solanum melongena* called Medip-zon in Betty tribe produced significant antihyper-glycemic effect in the alloxan induced diabetic rats in comparison with the treatment of Glibenclamide (10 mg/kg). This result showed that hot water extract of this plant produced pancreatic secretion or extra-pancreatic effect. The methanolic extracts of *Solanum melongena* have remarkable anti-diabetic and lipid-lowering activities [56]. The water extract of two varieties such as White and Graffiti *S. melongena* have encouraging effect on hyperglycemia risk factors, biomarker of hypertension, moderate antioxidant effect and good inhibitory action against carbohydrate modulating enzymes that include a-glucosidase responsible of glucose absorption in the intestine, α-amylase and α-glucosidase [56].	10 mg/kg corresponding to 0,6 g for a person of 60 kg body weight
19-*Solanum torvum* Swartz. (Solanaceae) [52] *Solanum torvum* var. lasiostylum Y.C. Liu & C.H. Ou *Solanum torvum* var. ochraceo-*ferrugineum* Dunal *Solanum torvum* var. *pleiotomum* C.Y. Wu & S.C. Huang	Turkey berry	Phenolic compounds found in *S. torvum* fruit methanolic extract at 200 and 400 mg/kg was reported to decrease blood glucose concentrations in streptozotocin induced diabetic rats and to augment insulin secretion due to renewal of ß-cells, diminish oxidative stress and adjust enzymes in charge for glucose metabolism. Also Methyl caffeate other principle isolated from the fruit of *S. torvum* 10, 20 and 40 mg/kg showed significant hyperglycaemia activity in streptozotocin-induced diabetic by up regulation of Glucose transporter type 4 (GLUT-4) and renewal of pancreatic ß-cells in the pancreas [57]. The fruit of *S. torvum* was a rich source of phenolic and flavonoid content with enzyme inhibiting and free radical scavenging properties [57].	400 mg/k corresponding to 24 g for a person of 60 kg body weight

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20-Spathodea campanulata P. Beauv. (Bignoniaceae) [3] *Spathodea campanulata* subsp. *Campanulata* *Spathodea campanulata* subsp. *congolana* Bidgood	African tulip tree	Phytochemical screening of *Spathodea campanulata* stem bark extract gave positive tests for flavonoids, tannins, alkaloids, reducing sugars, saponins and amino acids. In term of phytochemical quantification based on the percentage values saponins (17.8) were first, following by tannins, (13.9) flavonoids (10) and alkaloids (7.5). The flower extract contains steroids, terpenoids, coumarins, carbohydrates, tannins, glycosides, and flavonoids [58]. The multiple phytochemical entities of the stem bark extract were responsible of the antihyperglycemic activity of the following fractions: hexane, ethylacetate and methanol with the first fraction exhibiting a clearer dose-dependent activity. While ethanol flower extract showed the reduction of blood glucose levels and prevents hyperalgesia in experimental diabetic neuropathy. It also decreases aldose-reductase level which plays an important function in dropping the trouble of diabetic neuropathy [58]. The beginning of neuropathic complications could be prevented by early glycemic controls. It was found that *Spathodea campanulata* contains valued phytochemicals in considerable quantities which controlled diabetes. The residual aqueous fraction decreased the glucose level by 67.3% at 50 mg/kg, 53.4% at 100 mg/kg and 74.7% at 200 mg/kg more than metformin, the standard euglycemic agent with 48% at the dose of 500 mg/kg. The residual aqueous fraction is the most effective antihyperglycemic of the solvent fractions [59].	200 mg/k corresponding to 12 000 mg/kg = 12 g for a person of 60 kg body weight
21-Syzygium cumini (L.) Skeels. (Myrtaceae) [55] Synonym Syzygium jambolanum,	Java plum, jambul, jamun, jaman, black plum, faux pistachier, Indian blackberry	The extract of *S. cumini* increases glucose uptake was observed in FL83B mouse hepatocytes. This effect confirmed the presence of gallic acid, ellagic acid, and umbelliferone (plant phenolic compounds) which are established to possess antihyperglycemic properties in the decoction and the ethnomedical remedy prepared with the decoction [60]. Oral administration of ethyl acetate and methanol extracts (200 and 400 mg/kg) showed significant decrease ($p<0.05$) in blood sugar level. The isolated compound, mycaminose at a dose level of 50 mg/kg also showed significant decrease ($p<0.05$) in blood sugar level. Vitalboside A is a compound isolated from Syzygium cumini that increases insulin sensitivity and decreases lipid intensification [60]	400 mg/kg corresponding to 24g/ for a person of 60 kg body weight

Table 1: Selected medicinal plants frequently used in Cameroon and their previous antihyperglycemic effects.

Discussion

This study reveals that seven conditions including nature and quantity of food consumed, Lack of physical activities, development of permanent stress, friendless life, lifestyle, late diagnostic, Insulin resistance, if well observed or managed, as in conventional medicine can improve the successful uses of antidiabetic plants. From the scientific studies carried out on antidiabetic plants recorded in this study, it is evident that these plants are worthy of being explored and promoted as complementary and alternative means of combating diabetes.

Additional biochemical opportunities of investigation in this aspect would be to assess whether the extracts or bioactive compounds are capable of reducing insulin resistance which is a distinctive characteristic of type 2 diabetes. Previous studies have shown that six plants including Psidium guajava (red guava), Azadirachta indica, Ceiba pentandra, Aloe vera, Syzygium cumini and Mangifera indica controlled insulin resistance in type 2 diabetes management.

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Likewise, insulin reversing as toxicity and safety, reproduction of beta cells, profile of the manifold recorded medicinal plants were not reported or investigated. The above missing gaps in the diabetic management research for acting agents might be connected to financial concerns. This is the main reason for which a high number of the studies from African, Asian and Latino-American developing and low-income countries might be just connected to the immense use of ethnomedical preparations of medicinal plants for the management of the diseases. Eighty percent (80%) of the population in these particular regions, especially South Saharan countries is related to ethnobotanical medicines for their primary healthcare requirements.

With respect to bioactive antidiabetic many were isolated and tested for confirming their antihyperglycemic activities. They include around 50 compounds with the following more frequent: gallic acid, ellagic acid, and umbelliferone, flavonoids, tannins, alkaloids, saponins terpenoids, coumarins, diterpenes, triterpenes, steroids (**β**-sitosterol), coumarins, triterpenoids, glutamic acid and arginine, anthocyanidin, anthraquinones, carbohydrates, phenolics, isothiocynates (hydrolytic products of glucosinolates) and Nimbidin. This study suggests that medicinal plants could serve as a potential source to develop antidiabetic therapies. But there is a need of more research to be done.

The following five plants Solanum torvum antiulcerogenic, Psidium guajava anti diarrheic, Scoparia dulcis and Mangifera indica, used against malaria and Adansonia digitata for filariosis control in Cameroon were confirmed antidiabetic by previous studies. Therefore the verification of antidiabetic activities of Cameroonian samples of these plants could demonstrate the use of the same plants for the management of many diseases.

Conclusion

At the end of this study some environmental factors must be respected to achieve better uses of antidiabetic plants. They are physical activities, development of permanent stress, friendless life, lifestyle, late diagnostic and Insulin resistance. Many plants react with a specific mechanism. Twenty percent of admitted plants have reversing effect of insulin resistance. Then, there is a need to investigate on the determination of new antidiabetic plants that reverse the insulin resistance. From the scientific studies carried out to date on antidiabetic plants recorded in this study, it is evident that these plants are worthy of being explored and promoted as complementary and alternative means of combating diabetes. Furthermore, plants which can stimulate a sustainable management of diabetes type 2 might provide the pharmaceutical phytodrugs able to prevent the insulin resistant.

Acknowledgement

The authors gratefully acknowledge the advices of their colleagues from the University of Yaounde 1, Faculty of Medicine and Biomedical Sciences and from the University of Dschang, Faculty of Animal and Plant Physiology.

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