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Ethnobotanical studies of medicinal plants used by Traditional Health Practitioners in the management of diabetes in Lower Eastern Province, Kenya

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ABSTRACT

Ethnopharmacological relevance: Diabetes mellitus is a growing problem in many developing countries and the financial burden associated with it is enormous. In traditional African communities, majority of people relies on traditional medicines and Traditional Health Practitioners as the primary source of health care. Hence, this study was undertaken in the Lower Eastern province of Kenya to document the medicinal plants used by the traditional practitioners to treat diabetes and to assess the existing knowledge in management of this condition.
Materials and methods: Data was collected using structured open- and close-ended questionnaires.
Results: Thirty-nine species belonging to 33 genera and 26 families were encountered and the most frequently cited species were from Caesalpiniaceae, Ebenaceae, Solanaceae and Labiatae families. Twenty-eight percent of the plant species are reported to have hypoglycaemic activity.
Conclusions: Currently there is no data on medicinal plants used to treat diabetes in Kenya. Therefore, these findings are important in the management of diabetes and future research on traditional medicine in drug development.

1. Introduction

Diabetes is a major public health problem currently affecting 284.6 million people worldwide and according to the latest International Diabetes Federation estimates it is expected to affect 438.4 million adults by 2030 becoming one of the world's main disabler and killer (IDF, 2009). The major part of this numerical increase will occur in developing countries like Kenya due to population ageing, obesity and increase in sedentary lifestyle (IDF, 2009; Wild et al., 2004). In Sub-Saharan Africa, the current adult diabetes prevalence stand at 12.1 million and is projected to rise to 23.9 million by 2030 (IDF, 2009). This proportion is more than double the predicted global increase of 37%. In Kenya, diabetes prevalence ranges between 2.7% in rural areas and 10.7% in urban areas (Daily Nation, 2010). The vast majority (90–95%) of diabetes cases fall into type 2 (American Diabetes Association, 2005) and the clinical treatment for type 2 targets both insulin deficiency and resistance and more recently the prevention of pancreatic β-cell function decline.

More than 80% of the population in Sub-Saharan Africa relies on traditional medicines and Traditional Health Practitioners (THPs) as the primary source of health care (WHO, 2002) due to accessibility and cultural acceptance. In Kenya, several medicinal plants are used traditionally to treat diabetes according to oral communication with THPs visiting Centre for Traditional Medicine and Drug Research (CTMDR), Kenya Medical Research Institute (KEMRI). However, information on local medicinal plants used traditionally in Kenya for the management of diabetes mellitus is scarce. Hence, documentation of plants used to treat diabetes and evaluation of the traditional practitioners' understanding of the causes and symptoms of diabetes is critical for proper management. This study was therefore carried out among THPs residing in Machakos and Kangundo Districts in Machakos County, Kenya to assess traditional knowledge on diabetes and to document medicinal plants used to treat this condition.

2. Methods

2.1. Study area

The study was carried out in the districts of Kangundo and Machakos, on the Lower Eastern Province of Kenya. Lower Eastern Province is principally inhabited by the Kamba community who speak *Kikamba*. Administratively, the Lower Eastern Province is further divided into three County governments: Kitui, Machakos and Makueni and according to the 2009 National Census, Machakos County had a population of 1,098,584 (Kenya National Bureau of Statistics, 2009). The two study sites were selected based on extensive utilization of Traditional Medicines by the community in these

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districts. Also Kangundo and Machakos Districts provided both the urban and rural setup and its proximity to Kenya's capital city, Nairobi, makes them even more suitable.

2.2. Data collection

Ethnobotanical approach was used to explore the knowledge, diagnosis and treatment practices of diabetes by the Traditional Health Practitioners (THPs). A guided questionnaire interview was administered to participating THPs who were identified with the help of the local provincial administration officers (Chief) and a social scientist. On the appointed interview day, the THPs assembled at the nearest local provincial offices. Each THP was then interviewed alone to maintain confidentiality among them. The interviews educed information on the socio-demographic information of the interviewees such as age, school attendance and occupation, the causes and diagnosis of diabetes, medicinal plants, vernacular names, parts used, source of the plant materials, methods of preparation, routes of administration, duration of treatment and contraindications in traditional treatment of diabetes. The medicinal plants mentioned by the interviewees were identified in the field by a botanist from the University of Nairobi. Voucher specimens of each plant species reported were collected for confirmation and are deposited at the University's Herbarium.

2.3. Study approval

Ethical approval for this study was granted by the KEMRI SSC and ERC (SSC No. 1145). Before the interview was carried out, the objectives of the study and the planned use of the information were explained to the THP. Permission was then sought and written consent obtained in all cases.

3. Results

3.1. Interviewees' socio-demographic characteristics

Twenty-eight THPs were interviewed (19 male, 9 female) (Table 1). The mean age was 47.8 ± 15.1 years for male THPs and 67.6 ± 14.4 years for female THPs. The majority of the interviewees had attained primary level of education (39.3%) and secondary level (21.4%) while 17.8% had no formal education. Most of those without formal education were women. Ten (35.7%) of the interviewees engaged in peasant farming as their source of livelihood while 7 (25%) practiced as herbalists as the primary occupation (mostly men). The primary occupation for the female interviewees (6 out of 8) was peasant farming.

3.2. Traditional knowledge and practice

Seventy-nine percent of the THPs interviewed acquired the traditional medical knowledge from members of the family mainly grandparents and parents (8 out of 9 female and 14 out of 19 male interviewees), 14% through apprenticeship (4 male interviewees) and 7% (1 male and 1 female interviewee) through dreams/or God. Most of the interviewees had over 11 years of practice with 35.7% having practiced for between 1 and 10 years, 39.3% for 11–20 years, 17.9% for 21–30 years while 7.1% had over 41 years of practice. Majority (71.4%) of those interviewed were practicing from their residences/houses while 14.3% had clinics and another 14.3% were consulting at the market place. Only four (all male) of the interviewees had their practice recognized by the government with registration from the Ministry of National Heritage and Culture while 12 out of 28 were affiliated to Traditional Health practitioners' association.

Table 1
The socio-demographic characteristics of the interviewees ($n = 28$).

Characteristic	Number of interviewees		Total percentage
	Male	Female	
Sex			
Male	19		67.9
Female		9	32.1
Age (years)			
20–30	3	0	10.7
31–40	3	1	14.3
41–50	6	0	21.4
51–60	2	1	10.7
61–70	4	2	21.4
≥71	1	5	21.4
Education level			
Nil/none	1	4	17.8
Adult education	0	1	3.6
Primary	8	3	39.3
Secondary	6	0	21.4
Tertiary colleges	3	1	14.3
University	1	0	3.6
Primary occupation			
Peasant farmer	4	6	35.7
THP	6	1	25.0
Nurse	0	1	3.6
Driver	1	0	3.6
Laboratory technologist	3	0	10.7
Business	3	1	14.3
Mason	1	0	3.6
Agricultural extension officer	1	0	3.6
Secondary occupation			
Peasant farmer	4	0	14.3
THP	13	8	75.0
Business	2	1	10.7

3.3. Traditional Health Practitioners' knowledge of diabetes

The interviewees had good knowledge of diabetes on the basis of acceptable clinical symptoms such as smelly breath (4), frequent thirst (7), frequent urination (7), body weakness (fatigue) (4) and smelly urine (2). Fainting and swollen diaphragm were each cited by three interviewees while white foamy urine, fast heart beat and backache were each mentioned by one interviewee. Five of the interviewees had no idea on the signs and symptoms. However, 10 interviewees acknowledged relying on laboratory or hospital report and three on patient confession. The interviewees believed that the causes of diabetes included consumption of alcohol (2), sugary foods and beverages (10) and eating of fatty foods/or food related (9). Red meat, salt, contaminated water and acid in the diaphragm are other causes that were each indicated by one interviewee. Three of the interviewees associated diabetes to family history while two associated it with stress. Six (21%) interviewees did not know the possible causes of diabetes mellitus.

3.4. Plant species used to treat diabetes mellitus

Thirty-nine plant species distributed between 33 genera and 26 families were reportedly used in herbal preparations for the treatment of diabetes mellitus by the interviewees. Five of these species could not be identified to species level due to lack of reproductive features. Table 2 shows the plant species, the vernacular names, the parts used, the number of interviewees citing each species and mode of preparation. The families with the most reported plant species were Caesalpiniaceae with 4 species: Ebenaceae, Solanaceae and Labiatae families had 3 species each while Euphorbiaceae, Cucurbitaceae, Oleaceae and Passifloraceae had 2 species each and the rest had one species each (Table 2).

The most frequently mentioned medicinal plants were *Cassia abbreviata* Oliv., *Zanthoxylum chalybeum* Engl., *Momordica foetida*

Table 2
Plant species reported by the Traditional Health Practitioners for the management of diabetes.

Scientific name	Family	Local name (Kamba)	Collection number	Part used	Number of interviewees citing species	Mode of preparation
Tamarindus indica Linn.	Caesalpiniaceae	Kithumula	LKP 2010/003	RB/Fr	3	Decoction
Strychnos henninggsii Gilg.	Loganiaceae	Muteta	LKP 2010/004	L	1	Decoction
Euclea divinorum Hiern.	Ebenaceae	Kikuthi/Mukinyei	LKP 2010/001	RB	4	Decoction
Momordica foetida Schumach.	Cucurbitaceae	Iphunzu	LKP 2010/002	L	5	Decoction
Cassia abbreviata Oliv.	Caesalpiniaceae	Malandesi	LKP 2010/005	L/Pods	7	Decoction
Zanthoxylum chalybeum Engl.	Rutaceae	Mukenea	LKP 2010/006	SB	6	Decoction/hot infusion
Urtica massaica Mildbr.	Urticaceae	Kinyeleelya	LKP 2010/010	L	5	Decoction of pounded leaves
Ajuga remota Benth.	Labiatae	Wanjiru wa Rurii	LKP 2010/009	L/WP	4	Decoction
Aspilia pluriseta Schweinf	Compositae	Muti/Wuti	LKP 2010/008	L	2	Decoction
Fuerstia africana T.C.E. Fries	Labiatae	Kalaku	LKP 2010/007	Aerial parts	1	Decoction
Clerodendrum myricoides (Hochst.) Vatke	Verbenaceae	Muvweia/Munguya	LKP 2010/011	L	1	Decoction
Ficus natalensis (Miq.) Hochst.	Moraceae	Muuomo/Kiumo	LKP 2010/015	Fr	1	Cold infusion
Azardiracta indica A. Juss.	Meliaceae	Mwarubaine	LKP 2010/012	SB/L	6	Decoction
Cactus spp.	Cactaceae	Matomoko	Not Collected	L	6	Squeeze juice from fresh leaves
Bersama abyssinica Fres.	Melianthaceae	Mukilyulu	LKP 2010/017	RB	2	Decoction
Passiflora spp.	passifloraceae	Makundi	Not Collected	L	2	Decoction
Eucalyptus spp.	Myrtaceae	Musanduku	Not Collected	SB	4	Decoction
Aloe spp.	Aloeaceae	Kiluma	Not Collected	L	2	Leaves gel
Allium sativum L.	Alliaceae	Kitunguua kinene	LKP 2010/014	Bulb	3	Hot infusion of pounded bulb
Terminalia brownii Fres.	Combretaceae	Muuuku/Kiuuku	LKP 2010/016	SB	1	Decoction
Croton megalocarpus Hutch.	Euphorbiaceae	Muthulu/Kithulu	LKP 2010/018	L	1	Decoction
Senna singueana (Del.) Lock	Caesalpiniaceae	Mukengeka	LKP 2010/013	L	4	Decoction
Solanum incanum L.	Solanaceae	Mukondu/Mutungu	LKP 2010/022	L	2	Decoction
Senna didymobotrya (Fres.) I. & Bar.	Caesalpiniaceae	Muthaa/Ithaa	LKP 2010/019	L	3	Hot infusion
Steganotaenia araliacea Hoch.	Umbelliferae	Muvuavui	LKP 2010/023	L	1	Decoction
Ormocarpum kirkii S. Moore	Leguminosae	Muthii	LKP 2010/024	L	2	Decoction
Ocimum basilicum L.	Labiatae	Mutaa	LKP 2010/021	WP/L	2	Pounded leaf cold infusion/Decoction
Oxygonium sinuatum (Meisn.) Dammer	Polygonaceae	Song'e	LKP 2010/020	WP	1	Cold infusion of pounded whole plant
Passiflora subpeltata	Passifloraceae	Makundi	LKP 2010/025	L	1	Decoction
Withania somnifera (L.) Dunal	Solanaceae	Mwianzo	LKP 2010/026	R	2	Cold infusion
Solanum renschii Vatke	Solanaceae	Mukonda Kondu	LKP 2010/027	R/L	1	Decoction
Abrus precatorius L.	Papilionaceae	Kyuma Kyamditi	LKP 2010/028	L	1	Decoction
Momordica spp.	Cucurbitaceae	Iphunzu	Not Collected	L	3	Decoction
Euclea natalensis A. DC	Ebenaceae	Mukinyei	LKP 2010/029	R	1	Decoction
Euclea racemosa Murr.	Ebenaceae	Mukinyei	LKP 2010/030	L/SB/RB	2	Decoction
Schrebera alata (Hochst.) Welw.	Oleaceae	Mutoma	LKP 2010/031	SB/R/L	1	Cold infusion
Garcinia buchananii Bak.	Guttiferae	Mukanga	LKP 2010/032	SB	1	Decoction
Olea europaea L.	Oleaceae	Molialundi	LKP 2010/033	SB/R	1	Decoction
Croton macrostachyus Del.	Euphorbiaceae	Mutundu/Kitundu	LKP 2010/034	RB	1	

RB: root bark, L: leaves, SB: stem bark, WP: whole plant, R: whole root, and Fr: fruit.

Schumach., *Urtica massaica* Mildbr. and *Azadirachta indica* A. Juss. (Table 2). Other medicinal plants that were mentioned by at least four respondents were *Senna singueana* Del., *Ajuga remota* Benth., *Eucalyptus* spp. and *Euclea divinorum* Hiern. Interviewees reported that the appropriate plant parts were collected when needed without any time specification. The herbal medicines were mainly prepared as decoctions which were orally given (Table 2). It was noted that some plant species shared vernacular names (Table 2). Mukinyei could be referring to *Euclea divinorum*, *Euclea natalensis* or *Euclea racemosa*. Any passiflora was referred to as Makundi and *Momordica* spp. as Iphunzu.

3.5. Plant parts used

The leaves were the most frequently used plant parts (48%) followed by the stem bark (16%), roots and root bark (10%) while the fruits, whole plant, and aerial parts accounted for less than 10% each (Fig. 1).

3.6. Medicine preparation and administration

The medicines were processed mainly as mixtures of two or more plant species in the form of concoctions. To prepare a concoction, plant parts are obtained from more than one plant species and boiled together in water. Some of the commonly cited mixtures included: *Zanthoxylum chalybeum*, *Momordica foetida* and *Cassia abbreviata*; *Croton megalocarpus*, *Ormocarpum kirkii* and *Senna singueana*; *Solanum incanum*, *Ocimum basilicum* and *Senna singueana*; *Azadirachta indica*, *Zanthoxylum chalybeum* and *Cassia abbreviata.* The method of preparation employed primarily for single plant parts used were decoction (76%) and infusion (20%) (Table 2). A decoction is prepared by boiling plant parts of single plant species in water. Hot and cold infusions are prepared by soaking the plant parts in hot and cold water, respectively. These medicines were prepared when required, thus most interviewees did not preserve the medicines. The herbal medicines were administered orally and the most commonly mentioned quantities and

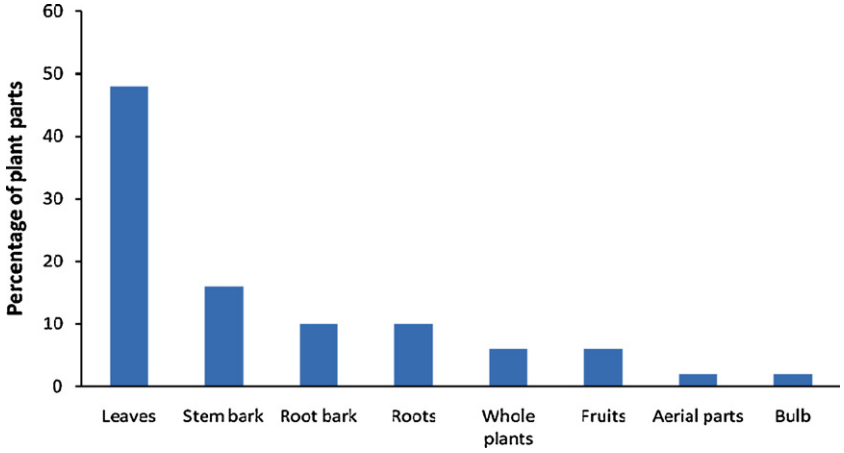

Fig. 1. Proportions of plant parts reported to be used in preparation of diabetes treatment.

frequency of administration were one tablespoonful (10 ml) three times daily (4), half a cup (approximately 125 ml) three times daily (2), one cup (approximately 250 ml) twice daily (9) and one cup three times daily (11). The need for treatment for 4 weeks was indicated by 53.6% (15) of the traditional practitioners. Thirty-nine percent (9) recommended treatment for 2–3 weeks while only two recommended treatment for 8 weeks and above. None of the interviewees reported any toxicity associated with their medications. However, interviewees admitted to advising their patients to avoid alcohol (8), meat (3), sugary foods (3), salt (4), hard labour (3), sex (4) and mixing therapies (3).

3.7. Relevant ethno-botanical use and reported pharmacological activity

Literature search was conducted on the reported medicinal plants to find out if they are used traditionally to treat diabetes mellitus in other cultures. Eleven of the species cited have been used similarly in communities within Africa and Asia (Table 3). These species include *Tamarindus indica*, *Strychnos henningsii*, *Azadirachta indica*, *Allium sativum*, *Abrus precatorius*, *Withania somnifera*, *Solanum incanum*, *Zanthoxylum chalybeum*, *Senna singueana*, *Euclea divinorum* and *Olea europaea*. *Aloe* and *Eucalyptus* species have also been used traditionally to treat diabetes. The hypoglycaemic activity of some plants reported in this study has been validated experimentally in the *in vivo* and *in vitro* diabetic models, clinical and chemical studies (Table 3). These medicinal plants include *Tamarindus indica*, *Momordica foetida*, *Azadirachta indica*, *Allium sativum*, *Abrus precatorius*, *Solanum incanum*, *Ocimum basilicum*, *Withania somnifera*, *Olea europaea*, *Cassia abbreviate*, *Aloe*, *Cactus* and *Eucalyptus* species.

4. Discussion

Diabetes mellitus is a metabolic disease characterized by hyperglycaemia resulting from defects in insulin secretion, insulin action or both (American Diabetes Association, 2005). The prevalence of diabetes mellitus is growing worldwide and in Kenya, approximately 1.5 million people are living with diabetes today and it is expected to rise to 2 million by 2030 if no interventions are put in place (Daily Nation, 2010). In Kenya, like in many traditional African societies, phytomedicines play a vital role towards the well-being of the rural population and numerous medicinal plants have been described for treatment of many diseases (Kokwaro, 2009). However, there is limited information on plants used to manage diabetes in Kenya. This ethnobotanical study documents medicinal plants used in the treatment of diabetes mellitus and the existing knowledge among traditional practitioners in the Lower Eastern Province of Kenya.

The educational status of both male and female interviewees was very low. However, the percentage of the males with tertiary education was higher when compared with that of the female interviewees. Most of the interviewees (79%) inherited the practice from their grandparents and parents but few males learned it through informal training and dreams. Similar findings on the traditional practitioners' socio-demographic characteristics such as educational level, age and the source of the traditional knowledge have been reported in other cultures (Adebo and Alfred, 2011).

The interviewees were found to have some knowledge of diabetes mellitus based on their ability to recognize a number of symptoms characteristic of the disease such as excessive thirst and frequent urination. Other clinical signs presenting in diabetes that were identified include fatigue, fainting spells, general body weakness and passage of urine which attracts bees. Regardless of the cultural differences, this study reveals that the THPs in the districts of Kangundo and Machakos, Kenya claim to diagnose diabetes mellitus in their patients the same way as the THPs in Tanzania and South Western Nigeria (Abo et al., 2008; Moshi and Mbwambo, 2002). They identified alcohol, high fat diet, stress and family history as some of the predisposing factors. The interviewees were generally aware of possible toxicity from phytomedicines, however, none reported any toxicity associated with their medication. They reported advising their patients against mixed therapies among others. Patients who continue to take plant remedies along with conventional medication may experience adverse effects due to possibility of adverse interaction between the two medicaments.

Twenty-eight percent of the plant species cited in this study have been reported in other scientific studies to be used traditionally to treat diabetes and related symptoms. *Tamarindus indica* (Dieye et al., 2008), *Strychnos henningsii* (Oyedemi et al., 2010), *Azadirachta indica* (Abo et al., 2008; Modak et al., 2007; Grover et al., 2002), *Allium sativum* (Ogbera et al., 2010; Modak et al., 2007; Grover et al., 2002) *Abrus precatorius* (Attal et al., 2010, Abo et al., 2008, Moshi and Mbwambo, 2002), *Withania somnifera* (Modak et al., 2007), *Aloe* spp. (Tahraoui et al., 2007; Grover et al., 2002), *Solanum incanum* L., *Zanthoxylum chalybeum*, *Senna singueana* (Moshi and Mbwambo, 2002), *Olea europaea* L. (Dieye et al., 2008; Tahraoui et al., 2007) and *Eucalyptus* spp. (Tahraoui et al., 2007; Grover et al., 2002) have been used to manage diabetes mellitus in other cultures while *Euclea divinorum* and *Withania somnifera* are used for general body weakness (tonic) in East Africa (Kokwaro, 2009). Though, *Senna singueana*, *Zanthoxylum chalybeum*

Table 3
Traditional uses of the species reported in this study and their reported relevant pharmacological activity.

Scientific name	Relevant reported traditional uses	Relevant pharmacological activity/chemical constituents
Tamarindus indica Linn.	Leaves, roots, bark and fruits used to treat diabetes in Senegal (Dieye et al., 2008)	Antidiabetic activity of aqueous seed extracts (Hamidreza et al., 2010; Maiti et al., 2004)
Strychnos henningsii Gilg.	Used for diabetes in Southern Africa (Oyedemi et al., 2010)	Antioxidant activity of the aqueous bark extracts (Oyedemi et al., 2010). Antidiabetic activity of related species, *Strychnos pseudoquina* (Honório-França et al., 2008).
Euclea divinorum Hiern.	Used as a tonic in East Africa (Kokwaro, 2009)	No reports
Momordica foetida Schumach.	No reports	Antidiabetic effect of whole plant extracts (van de Venter et al., 2008; Marquis et al., 1977). Hypoglycaemic effect of foetidin (Marquis et al., 1977).
Cassia abbreviata Oliv.	No reports	α-Glucaosidase inhibition and antioxidant activities of stem bark extract (Shai et al., 2010).
Zanthoxylum chalybeum Engl.	Roots used to treat diabetes and related symptoms in Tanzania (Moshi and Mbwambo, 2002)	No reports
Azadirachta indica A. Juss.	Leaves and fruits used for diabetes (Abo et al., 2008; Modak et al., 2007; Grover et al., 2002)	Antihyperglycaemic and antioxidant effect (Gupta et al., 2004; Biswas et al., 2002; Grover et al., 2002).
Cactus spp.	No reports	Antidiabetic activity of Prickly Pear Cactus (*Opuntia streptacantha* and *Opuntia fuliginosa*) (Cefalu et al., 2008; Trejo-González et al., 1996).
Eucalyptus spp.	*Eucalyptus* spp. leaf decoction/infusion used for diabetes (Tahraoui et al., 2007; Grover et al., 2002)	Antidiabetic effect of the leaf extracts of species *Eucalyptus globulus* (Mahmoudzadeh-Sagheb et al., 2010; Ahlem et al., 2009; Grover et al., 2002; Gray and Flatt, 1998; Swanston-Flatt et al., 1990).
Aloe spp.	*Aloe vera* Burm. leaf exudate/aerial part used for diabetes (Tahraoui et al., 2007; Grover et al., 2002)	Hypoglycaemic effect of leaves extracts of species *Aloe vera* (Jain et al., 2010; Kim et al., 2009; Rajasekaran et al., 2004; Grover et al., 2002) *Aloe arborescens* (Beppu et al., 2006) *Aloe barbadensis* (Grover et al., 2002; Ajabnoor, 1990).
Allium sativum L.	Raw bulb used for diabetes (Ogbera et al., 2010; Modak et al., 2007; Grover et al., 2002)	Anti-diabetic effect reported (Eidi et al., 2006; Grover et al., 2002) S-allylcysteine sulfoxide, S-methylcysteine sulfoxide, and diallyl trisulfide (Kook et al., 2009).
Senna singueana (Del.) Lock	Roots used to treat diabetes and related symptoms in Tanzania (Moshi and Mbwambo, 2002)	No reports
Solanum incanum L.	Roots used to treat diabetes in Tanzania (Moshi and Mbwambo, 2002)	Hypoglycaemic effects of the fruit extracts (Musabayane et al., 2006).
Ocimum basilicum L.	No reports	Antidiabetic effects of alcoholic leaf extract (Vats et al., 2002).
Withania somnifera (L.) Dunal	Used to treat diabetes in India and as a tonic in East Africa (Modak et al., 2007; Kokwaro, 2009)	Hypoglycaemic effect of root and leaf extracts (Udayakumar et al., 2009; Adallu and Radhika, 2000).
Abrus precatorius L.	Leaves and roots used to treat diabetes in S W Nigeria and Tanzania (Abo et al., 2008, Moshi and Mbwambo, 2002), used as a tonic in India (Attal et al., 2010)	Antidiabetic effects of chloroform–methanol seed extracts (Attal et al., 2010).
Olea europaea L.	Leaf decoction used for diabetes in some Africa countries (Dieye et al., 2008; Tahraoui et al., 2007)	Antidiabetic effect of the alcoholic leaf extract (Eidi et al., 2009). Polyphenols: oleuropein and hydroxytyrosol (Poudyal et al., 2010).

and Euclea divinorum have been used in traditional medicine to treat diabetes and its related symptoms, none of these plants has so far been reported to have hypoglycaemic activity (Table 3). *Ocimum sanctum*, a related species to *Ocimum basilicum* L., is used traditionally to treat diabetes (Grover et al., 2002). *Abrus precatorius*, *Garcinia buchananii* and *Bersama abyssinica* have been used in traditional fork-medicine as an aphrodisiac while *Clerodendrum myricoides* has been used to treat impotence (Kokwaro, 2009). Impotence is one of the manifestations of autonomic neuropathy in diabetics. Hence, the use of the same plant species in different culture in the management of diabetes strongly suggests that these species may be effective.

Literature review of the cited plants confirmed that *Tamarindus indica* (Hamidreza et al., 2010; Maiti et al., 2004), *Momordica foetida* (van de Venter et al., 2008; Marquis et al., 1977), *Azadirachta indica* (Gupta et al., 2004; Biswas et al., 2002; Grover et al., 2002), *Allium sativum* (Eidi et al., 2006; Grover et al., 2002), *Abrus precatorius* (Attal et al., 2010), *Solanum incanum* (Musabayane et al., 2006), *Ocimum basilicum* (Vats et al., 2002), *Withania somnifera* (Udayakumar et al., 2009; Adallu and Radhika, 2000), *Cassia abbreviata* (Shai et al., 2010) and *Olea europaea* (Eidi et al., 2009) have scientifically demonstrated hypoglycaemic activity (Table 3). Active principles have also been obtained from some of the plants cited in this study. oleuropein and hydroxytyrosol Polyphenols from *Olea europaea* (Poudyal et al., 2010), S-allylcysteine sulfoxide, S-methylcysteine sulfoxide, and diallyl trisulfide from *Allium sativum* (Kook et al., 2009) and foetidin from *Momordica foetida* (Marquis et al., 1977) are some of the phytochemical that have been obtained and have demonstrated hypoglycaemic activity in diabetic models.

Members of the genera such as *Cactus*, *Eucalyptus*, *Momordica* and *Aloe*, that were reported but were not fully identified due to absence of reproductive features at the time of the survey, have also been reported to have hypoglycaemic activity (Table 3). The *Aloe* species with proven hypoglcaemic activity are *Aloe vera* (Jain et al., 2010; Kim et al., 2009; Rajasekaran et al., 2004; Grover et al., 2002), *Aloe arborescens* (Beppu et al., 2006) and *Aloe barbadensis* (Grover et al., 2002; Ajabnoor, 1990). Antidiabetic effect of the leaf extracts of *Eucalyptus globules*, Prickly Pear Cactus (*Opuntia streptacantha* and *Opuntia fuliginosa*) and the stem and flowers extracts of *Momordica balsamina* L. have also been experimentally demonstrated (Mahmoudzadeh-Sagheb et al., 2010; Ahlem et al., 2009; Cefalu et al., 2008; van de Venter et al., 2008; Grover et al., 2002; Gray and Flatt, 1998; Trejo-González et al., 1996; Swanston-Flatt et al., 1990). Some related plant species such as *Ajuga iva* which is related to *Ajuga remota* and *Strychnos pseudoquina* a related species to *Strychnos henningsii* have demonstrated hypoglycaemic effects (Honório-França et al., 2008; Jaouad El and Badiâa, 2002).

Increasing evidence in both experimental and clinical studies suggests that oxidative stress plays a major role in diabetes mellitus development and pathogenesis of diabetic complications.

Increased free radicals formation or impaired antioxidant defenses occur in diabetic state (Maritim et al., 2003) and antioxidant therapy has been strongly correlated with decreased risks for diabetic complications. Both antioxidant nutrients and antioxidant phytochemicals has been reported to alleviate diabetes and diabetic complications (Lean et al., 1999). The antioxidant properties of some plants identified in this study: *Cassia abbreviata*, *Azadirachta indica* and *Strychnos henningsii* have been experimentally demonstrated (Oyedemi et al., 2010; Shai et al., 2010; Gupta et al., 2004) and this further supports the use of these plants in the management of diabetes mellitus.

Despite the penetration of conventional medicines, traditional medicine continues to be a feasible health care alternative for the majority of the Kenyan population. Thus, it is important to evaluate the existing traditional knowledge of the THPs in the management of various diseases. We reported for the first time the medicinal plants used to treat diabetes in Kenya and the THPs' existing knowledge in the management of diabetes mellitus. The widespread comparison between published information and claims by the interviewees justifies pharmacological and toxicological investigations to validate the antidiabetic properties of these identified plants.

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