Knowledge and demand for medicinal plants used in the treatment and management of diabetes in Nyeri County, Kenya

Loice N. Kamua, Mathiu P. Mbaabua, James M. Mbaria, Gathumbi P. Karurib, Stephen G. Kiama

A R T I C L E   I N F O

Article history:
Received 29 December 2015
Received in revised form 7 May 2016
Accepted 9 May 2016

Keywords:
Diabetes
Knowledge
Demand
Medicinal plants
Nyeri County

A B S T R A C T

Ethnopharmacological relevance: Non communicable diseases are currently a major health challenge facing humanity. Nyeri County has one of the highest diabetes prevalence in Kenya (12.6%), compared to the country’s prevalence of 5.6%. The purpose of the study was to document: diabetes knowledge, medicinal plants and demand for the services of traditional medicine practitioners, in the management and treatment of diabetes.

Methods: A cross-sectional study was carried out in the six constituencies in Nyeri, using pre-tested semi-structured questionnaires. Thirty practicing traditional medicine practitioners were purposively selected for the study. Field observation and identification was carried out on all plants that were cited during the interview. Plant samples were collected and voucher specimen deposited in the University of Nairobi Herbarium in the School of Biological Sciences.

Results: The study revealed 30 plant species in 28 genera and 23 families that are used by the traditional medicine practitioners to treat and manage diabetes. Demand for traditional medicine practitioners’ services in the treatment of diabetes is low and often occurs when conventional drugs fail.

Conclusion: Interaction with the TMPs unveiled significant diversity of potential anti diabetic medicinal plants and in-depth ethnobotanical knowledge that they possessed. Preference for traditional herbal medicine was low despite wide ethnobotanical knowledge in the face of high prevalence of diabetes in the locality. The findings form the basis of pharmacological studies for standardization of the documented ethnomedicine used in the treatment and management of diabetes in the study area.

© 2016 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

In the recent past, humanity has faced a growing and overwhelming healthcare challenge due to the devastating burden of non-communicable diseases (NCDs). Diabetes has become one of the leading NCDs in both the developed and currently developing countries. Complications related to diabetes reduce a person’s productivity with consequent loss of economic growth whilst placing a very heavy social-economic and health care burden on the community (IDF, 2013; Michael and Alethea, 2006). About 415 million and 14.2 million adults have diabetes worldwide and Africa, respectively. Additionally, 66.7% of diabetic persons are unaware of their hyperglycemic status (IDF, 2015). According to WHO; old age, cigarettes, excessive consumption of alcohol or refined foods and lack of regular physical activity are significant determinants of diabetes (WHO, 2002). However, disparities in predisposing factors in diabetes vary from one local or regional community to the other, due to demographic and social-economic pattern changes (Laakso et al., 1988).

About 50% of all adult hospital admissions in Kenya have been related to NCDs which accounts for 55% of hospital deaths, diabetes being among the leading (El-busaidy et al., 2014). Currently, Kenya has 478 thousand persons estimated to have diabetes (IDF, 2015) and a treatment expenditure of USD 61 per person (IDF, 2013).

In Kenya, studies have recorded a prevalence of 4.2%, 2.2% and 12.2% in the general population, rural areas and urban areas,
respectively (Dirk et al., 2009). The study about diabetes prevalence revealed an alarming increase in impaired glucose tolerance that ranged from 8.6% in the rural population to 13.2% in the urban. Diabetes prevalence in Kenya was also affected by gender with, 60.3% being women compared to 19.5% in men in the urban areas. In the rural areas, Diabetes mellitus was 22.6% and 10% in women and men, respectively (Christensen et al., 2009).

A study carried out in eight provinces of Kenya showed that 10.3% of the medical camp attendees had diabetes out of which 28.4% were recorded from Central Kenya and only 2.4% accounted for Rift Valley region (Karekezi et al., 2011). The mean random blood glucose (RBG) recorded from 51% of patients that attended Nyeri County general hospital was 8.0 Mmol/l, in another 31%, it was over 10.0 Mmol/l. Some patients had lived with the disease for over thirty years. The age of patients with diabetes complications ranged from ages 32–93 years. Moreover, overall rate of glycemric control was sub-optimal, notably, 60% had high blood pressure above 130/80 mmHg and a mean BMI of 27.6 which is a strong indicator of obesity and overweight (Kibachio et al., 2013). Results from another study in Nyeri County revealed high prevalence of diabetes, about 13.5% among HIV infected individuals as compared to 6.18% in HIV negative population, the mean blood glucose level was 7.6 ± 5.1 and 4.4 ± 1.1, respectively (Njagi, 2012).

There have been concerns over the alarming incidences of diabetes prevalence in Nyeri County (12.6%), compared to the country's prevalence of 5.6%, Kirinyaga County at 6.8% and, both Murang’a and Nyandarua at 10%. This prompted the need to establish a Diabetes Specialist Unit that would serve as the co-ordination Centre for all the 259 community health units (Nyawira, 2013). While such efforts by the County leadership were appreciable, awareness about Diabetes mellitus may have served as a prerequisite for activities aimed at preventing and controlling the disease effectively by either the individual or a community. This was tied to the fact that, choices about treatment and management approaches related to the health and well-being of people with diabetes were neither made by their physician or health professional but themselves (Anderson and Funnell, 1999).

For an individual to make rationally correct choices, adequate background information was necessary. Consequently, diabetes education aiming at improving knowledge, attitudes and skills was a widely accepted integral part of comprehensive diabetes care (Maina et al., 2011). Further, prior information on attitude, past behavior, affective believes of a community were shown to play a crucial role during awareness campaigns and patient counseling (Conner and Armitage, 1998; Norris et al., 2001). Study findings from Kisii County revealed that, Type II diabetic patients poorly failed to control their dietary behavior despite showing a positive attitude (Omondi et al., 2010). Diabetic patients and health care professionals continued to seek alternative treatment approaches related to antihyperglycemic medicinal herbs as they were believed to cause few side effects compared to synthetic drugs (Huang et al., 1992; Dey et al., 2002). But effective use of traditional medicine as an alternative approach towards treatment and management of diabetes ultimately depends on an individual or community’s background knowledge, understanding, attitude, perception and treatment prevalence.

In Kenya, traditional knowledge on the use of antidiabetic medicinal plants was documented among various tribes. Notably, eight plants used by the Mbeere and Kisii communities were documented (Kareru et al., 2007; Maobe et al., 2013). In Central Kenya, information on the use of traditional medicinal plants was documented (Gachathi, 2007; Kokwaro, 1976; Sindiga et al., 1990; Sindiga et al., 1995). However, a detailed account of the current use of traditional antidiabetic herbs in Nyeri County was not documented. Yet, rapid epidemiology of diabetes was accompanied with emergence of herbal treatment centers especially in the urban centers such as Nyeri town, Narumoru, Mukurweini, Karatina and Othaya (Culture and Social Services Department, 2013). The purpose of the current study was to establish, from traditional herbal practitioners, the level of diabetes knowledge and awareness and, treatment seeking behavior in relation to the use of traditional antidiabetic medicinal plants among the Kikuyu community in Nyeri County.

2. Materials and methods

2.1. Description of the study area and ethnographic background

Nyeri County is located in Central Kenya and borders; Laikipia County to the North, Meru to the North East, Kirinyaga to the East, Murang’a to the South, and Nyandarua to the West. It lies between 0° 09’S, 36° 30’E and 0° 50’S, 37° 20’E coordinates, within an area of 3337 km² and a population of 693,558 (Male – 49%, Female – 51%). It is divided into six constituencies; Tetu, Kieni, Mathira, Othaya, Mukurwe-ini and Nyeri town (Fig. 1). Temperatures range from a mean annual minimum of 12 °C to a mean maximum of 27 °C, with rainfall amounts of between 550 mm and 1500 mm per annum.

The long rains occur from March to May while the short rains come in October to December. Nyeri leads nationally with a forest cover of 38.5% compared to a national cover of 6.9%. The main physical features of the County are Mount Kenya (5199 m) to the east and the Aberdare ranges (3999 m) to the west; both densely forested with rich plant species diversity. Much of the land is used for agriculture which forms a mainstream source of livelihood, predominating economic activities include; tea and coffee grown for exports; large scale horticultural flower farms, greenhouse farming by small scale vegetable farmers and dairy farming. The predominant tribe is Kikuyu community; others include the Luo, Meru, Kamba, Embu, Borana and Somali. Majority of people living in Nyeri County are Christians. Nyeri County has one level 5 hospital, three level 4, 18 level 3 and 75 level two health facilities. It has also three mission and three private hospitals, one nursing home, one hospice and 228 private clinics spread across the County. The doctor/population ratio is about 1:6549 apopulation ratio of /population ratio of 1:143 (Commission of Revenue Allocation (CRA), 2012). According to African Palliative Care Association (APCA) database; Nyeri County has a high prevalence of hypertension, diabetes and heart diseases (http://integratepc.org/hospitals/kenya-only/). Diabetes prevalence is about 12.6% and ranks highest in Kenya and sub-Saharan Africa (Nyawira, 2013). However, despite the overwhelming level of non-communicable diseases, the County has constantly been at the forefront in discrediting the use of herbal medicine (Muigai, 2004).

2.2. Ethical approval

The survey study was carried out after permit to carry out the research was obtained from National Commission for Science, Technology and Innovation (NACOSTI).

2.3. Data collection

The study was carried out in the month of April 2014 after a permit to carry out the research was obtained from National Commission for Science, Technology and Innovation (NACOSTI). Respondents who willingly consented were selected to participate in the study by signing consent of agreement form. The study design was a cross sectional survey, 30 respondents were recruited for the study. Recruitment was done in consultation with the...
Ministry of Culture and Social Services. Data was collected through interviews; transect walk and administration of semi-structured questionnaires. The questionnaires constituted both open-ended and close-ended items, aimed at obtaining a detailed account of ethno-therapeutic approaches in treatment and management of diabetes. The questionnaires were pilot tested and thereafter used by the researchers and a team of trained research assistants to gather the information on; diabetes prevalence, control and treatment approaches, demand for the services and traditional knowledge about antidiabetic herbal medicine. The interviews were conducted in the vernacular language and translated by the research team. Medicinal plants cited during the interviews were observed from the study field, identified, photographed and collected through the assistance of TMPs and the taxonomist from the University of Nairobi, voucher specimens were deposited in the University of Nairobi Herbarium - in the School of Biological Sciences. Although most of the plants were identified in the field, a few were identified from the University of Nairobi Herbarium using taxonomic records and existing literature.

3. Data analysis

Ethnobotanical data that was collected was entered into SPSS programme version 20. The data was analyzed and summarized into proportions and percentages using descriptive statistics. Some responses were quoted verbatim and content analyzed. Relative importance of antidiabetic plant species among traditional medicine practitioners in Nyeri County was calculated as $UV_s = \frac{\sum UV_i}{n_i}$, where $UV_s$ is the total Use Value of the species for all informants, $UV_i$ is the Use Value of the species for a single informant, while $n_i$ is the number of interviews by the informant (in this study, one interview was conducted per respondent) (Hoffman and Gallaher, 2007; Phillips and Gentry, 1993).

4. Results and discussion

Diabetes in Nyeri County was described as “Múrimú wa cukari”, 30 TMPs (100%) acknowledged that diabetes was very common and they were aware of its occurrence. Each cited at least 1–5 diabetic persons within their local area and 1–5 deaths related to diabetes complication(s). Eighty nine (89%) of TMPs understood what diabetes was and gave a valid explanation of its cause(s). The other 11% in particular those that were old or illiterate did not understand the disease. Previous studies classified Central Kenya as one of the regions with the highest record of diabetes knowledge, education being a major determinant (Maina et al., 2011). A higher level of education was associated with better knowledge
(Al Shafae et al., 2008; Agu et al., 2014; Mohd et al., 2014). About 67% and 33% of the TMPs reported that diabetes was common among the old people and adults, respectively. Similarly, a mean age of 57 ± 12 years among diabetic patients from Nyeri County was recorded, with some being as old as 93 years of age (Kibachio et al., 2013). Seventy eight (78%) of TMPs reported that most of diabetic persons within their locality were men, the other 22% reported a high prevalence in women. A similar study showed high diabetes prevalence in men (9.8%) compared to 9.2% in women (Danaei et al., 2011), but this contradicts separate results that indicated a high prevalence in men than women (Christensen et al., 2009).

Concerning causes of diabetes in Nyeri County, 89% of TMPs related it to diet, obesity, inactivity and stress, only 11% believed that, it was caused by inheritance. These observations concurred with other findings (Mehta et al., 2006; WHO, 2007; Ziraba et al., 2009). In particular, diet was highly cited as a major contributor (95%), due to consumption of refined foods such as; sugar, maize, wheat and fats in addition to meat. Related findings established that, poor dietary habits were major predisposing factors in diabetes (WHO, 2007; Mehta et al., 2006). Similarly, high fat diet (59.4%), abdominal obesity 43.7% and sedentary lifestyle (46.8%) were linked to predisposing factors for diabetes (Chege, 2010; El-busaidy et al., 2014). Conversely, in Murang’a County, inheritance was cited by 50.4% of diabetic patients as a major predisposing factor. Notably, the county had lower diabetes prevalence than Nyeri (Mwangi and Gitonga, 2014). Considering that only a small percentage of diabetes in Nyeri County was caused by inheritance as reported by the TMPs, it was evident that, inheritance was not a major predisposing factor among Nyeri community. Doubtlessly, diabetes prevalence in Nyeri County could be significantly lowered by managing diet and body weight through proper lifestyle practices. Indeed, WHO, emphasizes that although overweight and obesity are common factors underlying NCDs, they can be preventable through dietary lifestyles (WHO, 2008).

About 89% of the TMPs cited personal responsibility and commitment as a prerequisite in the control and prevention of diabetes. They advocated for reduced consumption of meat, refined foods and fats, and instead supplement the diet with consumption of traditional foods and vegetables. This was in agreement with other reports; which underscored the centrality of traditional lifestyle which consisted of whole grain, vegetables and fruits, because they contained high fiber content (Christensen et al., 2009; IDF, 2009).

The TMPs emphasized that, local herbs were superior to conventional drugs as they rarely produced side effects. A cross-sectional survey among some Palestinian diabetic patients showed that, 70% confessed that use of CAM therapy had demonstrated greater efficacy than the allopathic remedies. Additionally, CAM had slowed down the disease progression, reduced both the disease symptoms as well as pathological effects caused by the allopathic therapies (Ali-Shtayeh, 2012). The TMPs in the current study recommended assimilation of modern technology in order to enhance correct diagnosis. Before administering any antidiabetic herbs and during subsequent review visits, 88% of the TMPs requested the patient to obtain a medical laboratory test report about the level of their blood sugar. This finding contradicted IDF (2006) report showing that TMPs rarely referred their patients to public health facilities due to ignorance. Further, the current study revealed challenges faced by the TMPs in their practice such as; although diabetic patients sought conventional medical services from the time of diagnosis; rarely did the medical practitioners refer these cases to TMPs. Only one herbalist acknowledged of having treated a case of diabetes referred to him by a medical practitioner. Moreover, unless probed by the TMP, the patients were unwilling to disclose any previous medical treatment. Therefore, to avoid double treatment, the TMPs had to inquire from the patients about use of any other form of medication, before they administered any treatment. The major reasons that were given about why patients would switched from conventional therapy to herbal medicine included; the patient realizing that their condition had become chronic, started experiencing side effects from the conventional drugs and therefore lost faith in them and lack of any other treatment option.

The TMPs reported that, patients did combine conventional and herbal medicine but they rarely informed the herbalist. Nevertheless, the TMPs always advised them to switch from conventional drugs to herbal medicine. Others preferred the patient to take herbal medicine for some period of time, like one week/month, and if there was no noticeable improvement, revert back to conventional medicine. A study carried out in Murang’a showed that, 7% of diabetic patients combined both herbal and conventional medicine as their diabetes management regime (Mwangi and Gitonga, 2014). Similar studies showed that, patients shy off from disclosing use of herbs and drugs; out of 17% of patients that used both herbs and drugs, 73% did not inform their doctors (Al-Rowais, 2002). Similarly, 68% of patients attending outpatient clinic in 7 Palestine government hospitals declined to declare to the medical practitioner that they had used Complementary and Alternative Medicine (CAM) (Ali-Shtayeh et al., 2012). This contradicted a study carried out in Jordan which revealed that, most patients (80.2%) had willingly disclosed information on CAM use to their physicians (Otoom et al., 2006). In the present study, all TMPs interviewed strongly believed that, such actions could result in herbo-drug interaction leading to a dangerous state of hypoglycemia, toxicity and serious physiological side effects. Herb-drug interactions have been cited as a potential physiological risk factor (Fugh-Berman, 2000; Izzo, 2005).

The present study showed that, 78% of the TMPs treated diabetes; and in a year, 67% had treated a diabetic case. However, the numbers of diabetic patients that had sought TMPs services was low compared to the high diabetes occurrence in the area. In a month, 11% of the TMPs had treated a diabetic patient, the other 89% had not. The average number of diabetic patients both per month and year ranged from 1 to 5 patients indicating low demand for their services in the treatment and management of diabetes. The low turnout of diabetic patients seeking herbal treatment was attributed to factors such as; association of TMPs with witchcraft (Mwangi and Gitonga, 2014) and easy access to medical health facilities (http://www.kenya-information-guide.com/nyeri-county.html).

The TMPs used a variety of treatment practices to improve efficiency of herbal medicine; 90% administered more than one antidiabetic herbs in addition to other forms of treatment approaches such as; recommending change of diet to one that included traditional and none fatty foods and, administration of herbs that enhanced digestive and blood circulatory system. Polyherbal therapy was proved to produce a higher antidiabetic effect than single herb therapy (Ebong et al., 2008). One TMP included herbs that rejuvenated the nervous system; he believed that, diabetes was partly caused by nervous communication breakdown. He added that, “to effectively treat diabetes one should treat stress” which according to him was “a major diabetes contributing factor”. This was supported by evidence from a study which indicated that there is a relationship between regeneration of the pancreas and the neural activity (Takayoshi, 2004). Additionally, there exists a strong link between depression and poor hyperglycemic control (Lustman et al., 2000); which validated the approach undertaken by this particular TMP. The most preferred method of administering herbal medicine as a decoction was the oral route.

The TMPs displayed extensive knowledge on antidiabetic herbs; each cited 1–5 herbs and, those that referred to other
sources of information named 6–10 plants. However, the main challenge that faced the present study was the TMPs unwillingness to disclose the dosage. Although the TMPs acknowledged that, they combined more than one antidiabetic herb in addition to other therapeutic approaches, only three were willing to disclose the constituent herbs within the combination (Table 1). Notably, literate TMPs regularly referred to other sources of information purposely to understand; which was the most appropriate herb to administer, its efficacy and side effects. That revelation underscored the importance of documenting therapeutic uses of traditional herbs and the need to validate their efficacy and safety using scientific methods.

A total of 30 plant species under 23 plant families and 28 genera believed to possess antidiabetic property were documented (Fig. 2; Table 2). The plant family with the highest proportion of antidiabetic species was Asteraceae (8); a similar trend was observed elsewhere (Heinrich et al., 1998). Interestingly, from the interviews, an herb locally known as “Müthinga” had the highest citation (13.9%), however, during specimen identification in the field with the TMPs, the researchers together with the botanist identified it as botanically different herbs which comprised of five species namely; Launaea cornuta, Lactuca inermis, Sonchus oleraceus and Sonchus asper. In practice, it was Launaea cornuta, Lactuca inermis, and Sonchus oleraceus that were prescribed during treatment depending on the availability of the species. Sonchus oleraceus and Sonchus asper were used as a nutritional supplement in the management of diabetes. Other antidiabetic herbs included; Mangifera indica (8.3%), Calisonga parviflora (5.6%), Rotheca myricoides (5.6%), Prunus africana (5.6%), Persea americana (5.6%), Hydnora abyssinica (5.6%), Periploca linearfolia (5.6%), Dracaena steudneri (5.6%), Rhamnus prinoides (5.6%) and Clematis hirsuta (5.6%). A study carried out in Israel, documented 16 hypoglycemic plants (Yaniv et al., 1987), but none was similar to what is used in the present study area, possibly due to ecological diversity. A similar report carried out in South -eastern Morocco documented 45 medicinal plants used to manage diabetes (El-Hilaly et al., 2007), it included Olea europaea which was also cited in the current study. In South-western Nigeria, Abo and Fred-Jaiyesimi (2008) documented 31 antidiabetic plants and only Rutaceae family was similarly cited in the present study. Ketera and Mutiso (2012), identified 39 plant species used to manage diabetes in the lower eastern region of Kenya which included; Allium sativum, Olea africana, Urtica massaica and Rotheca myricoides, that were also cited in the present study. From the foregoing survey report, it was evident that diverse ecological regions provided a unique variety of medicinal plants which met the therapeutic needs of each community in the treatment and management of diabetes. A high prevalence of diabetes in the study area could explain why the present study revealed a large number of medicinal plants used to treat and manage diabetes.

Several studies revealed that, some of the plants were used to manage various diseases (Table 3) as well as possessing antidiabetic activity (Table 3). The antidiabetic effect of most of the plants was attributed to their hypoglycemic (El-Fiky et al., 1996; Ferheen et al., 2009; Ranilla et al., 2010), α-amylase inhibitory (Ódhav et al., 2010), antiglucosidase (Ferheen et al., 2009; Ranilla et al., 2010; Gallardo-Williams et al., 2002), hypolipidemic (Ashraf et al., 2011; Eidi et al., 2006; Arulmozhi et al., 2010), lipid peroxidation inhibition (Singh et al., 2009), antioxidant (Singh et al., 2009; Al-Fatimi et al., 2015; Mosa et al., 2014; Jaiswal et al., 2009; Gupta et al., 2012; Jemai et al., 2009; Catherine and Edward, 2009; Asmamaw et al., 2007; Omwenga, 2011; Arulmozhi et al., 2010; Rahmat et al., 2012; Xiea et al., 2011; http://www.litg.ac.in/rakhi_chaturvedi/pdf/books/b1.pdf; Gallardo-Williams et al., 2002) and anti-inflammatory activity (Koko et al., 2015; Cáceres et al., 1992; Catherine and Edward, 2009; http://www.litg.ac.in/rakhi_chaturvedi/pdf/books/b1.pdf) and, improved insulin resistance (Somashekar et al., 2003). Plant phytochemicals such as; flavonoids, saponins, terpenes and alkaloids were reported in most of the cited plants (Table 3). Flavonoids were associated with improved insulin secretion, prevention of beta-cell apoptosis (Montserrat et al., 2011), potentiated glucose-induced insulin secretion, inhibition of α-amylase and α-glucosidase activity and glucose uptake from the intestines and, hypoglycemic effect (Mohan and Nandhakumar, 2014). Studies showed that, terpenes inhibited α-amylase activity (Li jiliana et al., 2014) and ameliorated the alterations of cardiomyopathy (Gong et al., 2012). Saponins were reported to possess antioxidant, anticycloglycation (Yun-Fang et al., 2011), hypcholesterolemic, hypoglycemic and anti-obesity effect (Olusola et al., 2014). Alkaloids were reported to possess hypoglycemic and hypolipidemic activity (Sharma et al., 2010; Zhou et al., 2012). The pharmacological activities of the chemicals isolated from the cited plants (Table 3) validated the traditional use of most of the medicinal herbs used by the TMPs to manage diabetes.

Seventeen (17) plant species which included; Clematis hirsuta, Dracaena steudneri, Gomphocarpus fruticosus, Grewia similis, Hydnora abyssinica, Lactuca inermis, Myrsine africana, Ornithogalum tenuifolium, Periploca lineatifolia, Rhamnus prinoides, Rotheca myricoides, Sonchus asper, Sonchus luxurian, Spilanthes mauritiana, Teclea simplicifolia, Urtica massaica and Vernononia lasiopus, were not investigated for their antidiabetic activity in the previous studies.

Table 1
Commonly used antidiabetic medicinal plant combination.

<table>
<thead>
<tr>
<th>Combination</th>
<th>Name of the herbs</th>
<th>Part(s) used</th>
<th>Preparation and dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mangifera indica</td>
<td>Leaves</td>
<td>Decoction</td>
</tr>
<tr>
<td>2</td>
<td>Rotheca myricoides</td>
<td>Leaves or</td>
<td>Decoction. Take one</td>
</tr>
<tr>
<td></td>
<td></td>
<td>bark</td>
<td>cup three times a day</td>
</tr>
<tr>
<td></td>
<td>Prunus africana</td>
<td>Bark</td>
<td>for 2 months</td>
</tr>
<tr>
<td>3</td>
<td>Rhamnus prinoides</td>
<td>Root or</td>
<td>Decoction</td>
</tr>
<tr>
<td></td>
<td>Acacia nilotica</td>
<td>bark or root</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Myrsine africana</td>
<td>Fruits</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Dracaena steudneri</td>
<td>Bark, root</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 2. Families of medicinal plants commonly used in the treatment and management of diabetes in Nyeri County.
<table>
<thead>
<tr>
<th>Family</th>
<th>Botanical name and voucher number</th>
<th>Name in Kikuyu</th>
<th>Growth form</th>
<th>Habitat</th>
<th>Part used</th>
<th>Preparation and dosage</th>
<th>Dosage and duration</th>
<th>Citations</th>
<th>Use value (UVs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANACARDIACEAE</td>
<td>Mangifera indica L. LNM14/07</td>
<td>Mũmbė</td>
<td>Tree</td>
<td>Cf Cp</td>
<td>Leaves</td>
<td>Slice the leaves and then prepare an infusion for 24 h (tea color)</td>
<td>Take 1 glass per day for 28 days</td>
<td>3</td>
<td>0.1</td>
</tr>
<tr>
<td>APOCYNACEAE</td>
<td>Carissa edulis (Forsk.) Vahl. LNM14/24</td>
<td>Mũkawa</td>
<td>Shrub</td>
<td>Bu</td>
<td>Leaves Bark Root</td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>ASCLEPIADACEAE</td>
<td>Periploca linearifolia Quart.-Dill. LNM14/06</td>
<td>Mwemba-guru</td>
<td>Liana</td>
<td>Bu</td>
<td>Stem Leaves</td>
<td>Decoction</td>
<td>2</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>ASCLEPIADACEAE</td>
<td>Gomphocarpus fruticosus (L.) W.T. Aiton LNM14/14</td>
<td>Mũkangaríthi</td>
<td>Herb</td>
<td>Cf Bu Cp</td>
<td>Seeds Roots</td>
<td>Prepare a decoction, take 250 ml twice daily for 2 months</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>ASTERACEAE</td>
<td>Sonchus luxurian (R. E. Fries) C. Jeffrey LNM14/04</td>
<td>Mũthũngia</td>
<td>Herb</td>
<td>Cf Bu Cp</td>
<td>Leaves</td>
<td>Chew the leaves or boil the whole plant. Take one cup for one month</td>
<td>5</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>ASTERACEAE</td>
<td>Launaea cornuta (Hochst. ex Oliv. and Hiern) C. Jeffrey. LNM14/03</td>
<td>Mũthũngia</td>
<td>Herb</td>
<td>Cf Bu Cp</td>
<td>Leaves</td>
<td>Chew the leaves or boil the whole plant. Take one cup for one month</td>
<td>5</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>ASTERACEAE</td>
<td>Luctua inermis Forssk LNM14/01</td>
<td>Mũthũngia</td>
<td>Herb</td>
<td>Cf Bu Cp</td>
<td>Leaves</td>
<td>Chew the leaves or boil the whole plant. Take one cup for one month</td>
<td>5</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>ASTERACEAE</td>
<td>Sonchus oleraceus L. LNM14/02</td>
<td>Mũthũngia</td>
<td>Herb</td>
<td>Cf Bu Cp</td>
<td>Leaves</td>
<td>Chew the leaves or boil the whole plant. Take one cup for one month</td>
<td>5</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>ASTERACEAE</td>
<td>Sonchus asper L. Hill LNM14/05</td>
<td>Mũthũngia</td>
<td>Herb</td>
<td>Cf Bu Cp</td>
<td>Leaves</td>
<td>Chew the leaves or boil the whole plant. Take one cup for one month</td>
<td>5</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>ASTERACEAE</td>
<td>Galinsonga parviflora Cavanilles. LNM14/08</td>
<td>Mũng’ei</td>
<td>Herb</td>
<td>Cf</td>
<td>Leaves Roots</td>
<td>Decoction taken for a month</td>
<td>2</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>ASTERACEAE</td>
<td>Vernonia lasiopus O. Hoffm. LNM14/23</td>
<td>Mũchathãa</td>
<td>Shrub</td>
<td>Bu Leaf</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>ASTERACEAE</td>
<td>Spilanthes mauritiana (A. Rich. ex Pers.) DC. LNM14/30</td>
<td>Gatharia ita</td>
<td>Herb</td>
<td>Bu Cf Whole plant</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>DRACAENACEAE</td>
<td>Draeca steudneri Schweinf. Ex. Engl. LNM14/31</td>
<td>Ithare</td>
<td>Tree</td>
<td>Cp</td>
<td>Bark Root</td>
<td>Decoction</td>
<td>2</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>HYACINTHACEAE</td>
<td>Ornithogalum tenufolium F. Delaroche LNM14/22</td>
<td>Migwace</td>
<td>Herb</td>
<td>Sma Rhizome</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>HYDRONORACEAE</td>
<td>Hydora abyssinica A. Braun ex Schweinf. LNM14/17</td>
<td>Mũthigira</td>
<td>Herb</td>
<td>Sma Stem</td>
<td></td>
<td>Decoction</td>
<td>2</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>LAURACEAE</td>
<td>Persea americana Mill. LNM14/19</td>
<td>Mũkuoríba</td>
<td>Tree</td>
<td>Cf Cp</td>
<td>Leaves Bark</td>
<td>Decoction</td>
<td>2</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>LILIACEAE</td>
<td>Allium sativum L. LNM14/13</td>
<td>caumu</td>
<td>Herb</td>
<td>Mkt cloves</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>MIMOSACEAE</td>
<td>Acacia nilotica (L.) Delile LNM14/16</td>
<td>Ning’íruírí</td>
<td>Shrub</td>
<td>Bu Bark Root</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>MORINACEAE</td>
<td>Morinda oleifera Lam. LNM14/28</td>
<td>Mũrínga</td>
<td>Tree</td>
<td>Cf Cp Seeds</td>
<td></td>
<td>Chew 2 seeds per day for a month</td>
<td>2</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>MYRISACEAE</td>
<td>Myroxylon balsamum L. LNM14/26</td>
<td>Mũgaíta</td>
<td>Shrub</td>
<td>Bu Fruits</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>OLEACEAE</td>
<td>Olea africana Mill. LNM14/27</td>
<td>Mũtëro</td>
<td>Tree</td>
<td>Bu Cp Leaf Root</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>RANUNCULACEAE</td>
<td>Clematis hirsuta Guill. and Perr. LNM14/10</td>
<td>Mũgaya ng’úndí</td>
<td>Shrub</td>
<td>Bu Leaves Roots</td>
<td></td>
<td>Decoction</td>
<td>2</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>RHAMNACEAE</td>
<td>Rhamnus prinoides L. Héí. LNM14/18</td>
<td>Mũkarakínga</td>
<td>Shrub</td>
<td>Bu Roots Bark</td>
<td></td>
<td>Decoction</td>
<td>2</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>ROSACEAE</td>
<td>Prunus africana Hook. (f) Kalkman LNM14/20</td>
<td>Mũéri</td>
<td>Tree</td>
<td>Cf Bu Cp Leaves Bark</td>
<td></td>
<td>Decoction</td>
<td>2</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>RUTACEAE</td>
<td>Teucrium sempervirens (Engl.) Verdoorn LNM14/25</td>
<td>Mũnderendũ</td>
<td>Herb</td>
<td>Bu Leaves</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>SOLANACEAE</td>
<td>Solanum nigrum L. LNM14/29</td>
<td>Managu</td>
<td>Herb</td>
<td>Cf Leaves Infusion</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>TILIACEAE</td>
<td>Grewia simili R. Schum. LNM14/21</td>
<td>Mũtheregenírdu</td>
<td>Shrub</td>
<td>Bu Leaves</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>TYPHACEAE</td>
<td>Typha domingensis Pers. LNM14/15</td>
<td>Ndóthuá</td>
<td>Herb</td>
<td>WI Rhizomes</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>URTICACEAE</td>
<td>Urtica dioica L. LNM14/12</td>
<td>Thábaí /Haítha</td>
<td>Herb</td>
<td>Cf Bu Leaves</td>
<td></td>
<td>Decoction</td>
<td>1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>VERBENACEAE</td>
<td>Rotheca myricoides (Hochst.) Steane and Mab. LNM14/09</td>
<td>Munjuga-iria</td>
<td>Shrub</td>
<td>Bu Leaves Roots Bark</td>
<td></td>
<td>Decoction taken for a month</td>
<td>2</td>
<td>0.07</td>
<td></td>
</tr>
</tbody>
</table>
### Table 3
Cross-reference of plants species used to treat and manage diabetes in Nyeri County with published literature.

| Botanical name | Plant chemical constituents/physiological activity | Ethnotherapeutic uses |

- **Acacia nilotica (Mimosaceae)**: It contains saponins, anthraquinones, tannins, flavonoids and cardiac glycosides (Deshpande and Kadam, 2013). It has antibacterial (Deshpande and Kadam, 2013) and antidiabetic (Mukund et al., 2015), antimutagenic (Arora et al., 2003) and antioxidant activities and inhibits lipid peroxidation (Singh et al., 2009). It contains proanthocyanidins which increases insulin sensitivity (Lerman et al., 2008).

- **Allium sativum (Liliaceae)**: It contains alkaloids, tannins, carotenoids, flavonoids, steroids and cardenolides (Orutola et al., 2010). It has antimicrobial (Benkeblia, 2004; Pandir et al., 2010), antidiabetic (Ojo et al., 2015; Aiyeloja and Babatunde, 2006; Thomison et al., 2007; Younas and Hussain, 2014), antioxidant (Amani et al., 2011; Edi et al., 2006), antibiotic and anti-hypertension (Ayelola and Bello, 2006) activity.

- **Carissa edulis (Liliaceae)**: It contains alkaloids, tannins, carotenoids, saponin, flavonoids, steroids and cardenolides. The shoot and whole plant is used in the management of asthma, colic, constipation, flatulence, and cardiovascular ailments (Khan and Khattan, 2008).

- **Clematis hirsuta (Ranunculaceae)**: It contains sterols and triterpenes (Maged et al., 2008). It has insignificant hepatoprotective activity (Saleh et al., 2008).

- **Dracaena steudneri (Dracaenaceae)**: It contains alkaloids, terpenoids, phenolics, tannins, flavone, steroids and saponins. The bark has antifungal activity against Cryptococcus neoforans, Aspergillus niger and Candida albicans (Mwambao et al., 2010 and Kisangau et al., 2009).

- **Galinsoga parviflora (Asteraceae)**: It contains galinosides A and B (flavonoid glucosides), chlorogenic acid and hydroxycinnamic acid derivatives. It possesses antioxidant, α-glucosidase inhibitory (Feherien et al., 2009; Kanila et al., 2010) and α-glucosidase inhibitory (Odhav et al., 2010) activities.

- **Gomphocarpus fruticosus (Asclepiadaceae)**: It contains triterpenoids, cardiac glycosides like cardenolides (Amani et al., 2010) and flavonol glycosides (Sama et al., 2008). It possesses growth inhibitory activity against cancer cell lines and antibacterial activity against gram-positive bacteria (Mothana et al., 2009). Acetone extract has strong (> 70%) antioxidant activity (Mulaudzi et al., 2015) but the methanol extract demonstrates less activity against Staphylococcus aureus, Bacillus subtilis, Salmonella typhi, Escherichia coli and Pseudomonas aeruginosa. It has no antioxidant activity (Omwenga et al., 2012).

- **Grewia similis (Tiliaceae)**: It has antimicrobial activity and contains steroids; 3β-sitosterol and 3β-stigmastanol (Muthya, 2013).

- **Hydrona abyssinica (Hydrophyllaceae)**: It contains tannins, cardiac glycosides, terpenes and flavonoids (Mosa et al., 2014) and phenols (Al-Fatimi et al., 2015). It has antioxidant and antibacterial activity against gram-positive bacteria (Al-Fatimi et al., 2015). The root aqueous extract has anti-diarrheal activity (Mohammed, 2015). It has anti-inflammatory, immunosuppressant (Koko et al., 2015) and antioxidant activity.

- **Lactuca inermis (Asteraceae)**: It contains sesquiterpene lactones (Klaudia et al., 2009), alkaloids, phenols, tannins and steroids. It has antibacterial activity (Jaurès et al., 2013).

- **Leucaena cornuta (Asteraceae)**: It contains; isoquinoline alkaloids, phytoestrogen, terpenoids, coumarins (Karau et al., 2014a,b), flavonoids, glycosides, and tannins (Mioso et al., 2015). It has antiinflammatory and antibacterial activity against gram-positive bacteria (Al-Fatimi et al., 2015). The root aqueous extract has anti-diarrheal activity (Mohammed, 2015). It has anti-inflammatory, immunosuppressant (Koko et al., 2015) and antioxidant activity.

- **Mangifera indica (Anacardiaceae)**: It has antidiabetic (Bhowmik et al., 2009), antihyperglycemic (Kemarsari et al., 2011) and antibacterial (Bboosa et al., 2007) activity.

- **Moringa oleifera (Moringaceae)**: It contains; tannins, steroids, triterpenoids, flavonoids, saponins, anthraquinones and alkaloids (Kasolo et al., 2010). It has antidiabetic and antioxidant (Jayavardhan et al., 2009; Gupta et al., 2012), antispasmodic, antiinflammatory and diuretic activity (Cáceres et al., 1992).

- **Myrsine africana (Myrsinaceae)**: The leaves contain flavonoids; myricetin, quercetin, kaempferol, gallic acid (Arot et al., 1996) and the fruits contain benzoquinone derivatives; methylvinlandin and methylvinlandiolvin (Manguro et al., 2003). It has antibacterial, haemagglutination (Bushi et al., 2011) and anti-spasmodic activity (Sadik et al., 2011).

- **Olea africana (Oleaceae)**: It contains; triterpenoids (oleuframicin and oleanolic acid) which improves insulin resistance (Somova et al., 2003). Hydroxytyrosol and Oleuropein possess anti-diabetic and antioxidant effects (Jenai et al., 2009).

- **Ornithogalum tenuifolium (Hyacinthaceae)**: It contains steroidal sapogenin (Orde et al., 2006).

The roots and leaves are used to treat gonorrhea, syphilis (Muthee et al., 2011), ENT diseases (Njoroge and Bussmann, 2006a), fever, malaria, measles, helminth infection (Okullo et al., 2015). Pecipic ulcers and diabetes (Kigen et al., 2014). It is used to treat ear pain and headache (Berhane et al., 2014) and anthrax. The leaves are crushed together with those from Dodonaea angustifolia and used to treat Herpes zoster (Abrahim et al., 2015).

The dried powder is applied on wound (Fiseha et al., 2009). The bark is used to treat oral candidiasis, cryptococcal meningitis and tuberculosis (Kisangau et al., 2007) and leaves to manage diarrhea (Jane et al., 2013).

Whole plant decotion is used to treat the wound (Jena and Satapathy, 2015).

The shoot and whole plant is used in the management of chronic pain (Wambugu et al., 2011), breast and prostate cancer and, diabetes (Kareru et al., 2007). The stem is chewed to treat throat cancer (Kigen et al., 2014). The leaves are eaten as traditional vegetable (Chweya and Esyazurru, 1999).

The leaf decoction is used to treat ENT diseases (Njoroge and Bussmann, 2006a). It is used to manage pain caused by inflamed joints (Wambugu et al., 2011), amoebiasis (Getnet et al., 2015) constipation and as a diuretic (Olowokudejo et al., 2008). The leaf decoction is taken orally to manage ENT (ear, nose and throat) diseases (Njoroge and Bussmann, 2006a).

The stem bark and leaves are used to deworm, expel retained afterbirth, treat respiratory diseases and anaplasmosis (Muthee et al., 2011), manage chronic pain (Wambugu et al., 2011), helminthosis, asthma, rheumatism, and lumbago (Nanyingi et al., 2008). The sap is used in bone setting (Kareru et al., 2007). The stems bark and roots are used to manage diabetes (Ketera and Mutiso, 2012).

The stem and bark is used as a stimulant and appetite (Kiendo et al., 2015; Muthiee et al., 2011). Whole plant is used to manage chronic pain (Wambugu et al., 2011), GIT complications and Babesiosis (Nanyingi et al., 2008).
Table 3 (continued)

<table>
<thead>
<tr>
<th>Botanical name</th>
<th>Phytochemical constituents/pharmacological activity</th>
<th>Ethnotherapeutic uses</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Periploca linearifolia</em></td>
<td>It possesses antimarial (Nyangasi, 2014) and antibacterial activity; It has no antifungal activity (Asamaw et al., 2007).</td>
<td>It is used manage postpartum haemorrhage (D’Avigdor et al., 2014) hemorrhoid (Getnet et al., 2015) and malaria (Muthaura et al., 2007). The root decoction is used to treat colds, Herpes zoster and oral thrush (Amuka et al., 2014). It is used in the management of hypertension and diabetes (Gbolade, 2012; Kpodar et al., 2013).</td>
</tr>
<tr>
<td><em>Persea americana</em> (Lauraceae)</td>
<td>It contains protocatechuic acid, clorogenic acid, rutin, syringic acid, kaempferide and kaempferol (Pahua-Ramos et al., 2012). It has anti-diabetic, diuretic (Gondwe et al., 2008) and hypolipidemic (Pahua-Ramos et al., 2012) activity.</td>
<td>The stem bark, roots and flowers are used to treat prostate cancer and urinary tract infections (Muthee et al., 2011; Focho et al., 2009). The bark decoction is taken to treat pimples, skin itching (Njoroge and Bussmann, 2007) and, breast and prostate cancer (Karera et al., 2007).</td>
</tr>
<tr>
<td><em>Prunus africana</em> (Rosaceae)</td>
<td>It contains; β-sitostosterone, campesterol, β-sitosterol, palmitic acid, (3,3,5a) - stigmast-7-en-3-ol, stigmasteran-3, 5-diene, lup-20 (29)-en-3-one and α-tocopheryl compounds (Nyamai et al., 2015). It has GLP-1 secretory activity (Singh et al., 2015).</td>
<td>Root decoction is taken orally to manage ENT diseases (Njoroge and Bussmann, 2006a), treat tonsillitis (MoA, 2013; Getnet et al., 2015), pneumonia, bacillary dysentery, amoebiasis and as a tonic (Amuka et al., 2014), hepatitis (in formula) (D’Avigdor et al., 2014) and herpes (Getnet et al., 2015).</td>
</tr>
<tr>
<td><em>Rhamnus prinoides</em> (Rhamnaceae)</td>
<td>It contains anthraquinones and flavonoid (Berhana and Martin, 1995). It has anti-inflammatory, antioxidant and acetylcholinesterase inhibitory (Catherine and Edward, 2009) and anti-mutagenic activities (Verschaere et al., 2004).</td>
<td>It is used to manage pain caused by inflamed joints (Wambugu et al., 2011), stem bark to manage abdominal colics, malaria and febrile convulsions (Maien et al., 2012) and roots to treat gonorrhea and syphilis (Muthee et al., 2011).</td>
</tr>
<tr>
<td><em>Rotheca myricoides</em> (Verbenaceae)</td>
<td>It contains polyphenols, alkaloids, anthraquinones and terpenes (Nasser et al., 2010) and tannins (Omwenga, 2011). It possesses antiplasmodial (Mekonnen et al., 2012), antimutagenic (Reid et al., 2006) and antibacterial activity (Asamaw et al., 2007; Omwenga, 2011) and antitumor activity (Asamaw et al., 2007) against P. aeruginosa and S. aureus (Omwenga, 2011). It does not possess antifungal activity (Asamaw et al., 2007; Omwenga, 2011).</td>
<td>The decoction of the whole plant is taken to treat erectile dysfunction (Kareu et al., 2007), liver cirrhosis and, as a diuretic, laxative and antispasmodic (Mahroof et al., 2009).</td>
</tr>
<tr>
<td><em>Solanum nigrum</em> (Solanaceae)</td>
<td>It contains alkaloids, saponins, tannins and flavonoids (Gogoi and Islam, 2012). It has antioxidant, antihyperlipidemic (Adumezohi et al., 2010) and hypoglycemic effect (Tiware and Jain, 2012).</td>
<td>It is used as a vegetable (Hassan, 2014).</td>
</tr>
<tr>
<td><em>Solanum nigrum</em> (Solanaceae)</td>
<td>It contains alkaloids, saponins, tannins and flavonoids (Gogoi and Islam, 2012). It has antioxidant, antihyperlipidemic (Adumezohi et al., 2010) and hypoglycemic effect (Tiware and Jain, 2012).</td>
<td>The root decoction is taken to manage ENT diseases (Njoroge and Bussmann, 2006a) and sap to treat tonsils (Kalwa et al., 2014).</td>
</tr>
<tr>
<td><em>Sonchus asper</em> (Asteraceae)</td>
<td>It contains proanthocyanidins, flavonoids, flavonols, total phenols and low levels of alkaloids, saponins, and phyate. It has antibacterial, antioxidant (Florence et al., 2011), hepatoprotective (Khan et al., 2012) and brain antioxidant activities. It increases cognitive performance (Rahmat et al., 2012) and protects the kidneys against oxidative stress (Rahmat et al., 2010).</td>
<td>Whole plant crushed is used to treat toothache, oral thrush and manage craniotomy (Kipkore et al., 2014). The shoot is used as a vegetable and, the flower paste to treat sore throat, jaundice (Jain et al., 2011) and cough (Manju et al., 2010).</td>
</tr>
<tr>
<td><em>Sonchus oleraceus</em> (Asteraceae)</td>
<td>It contains alkaloid, glycosides, terpenoid, steroid, flavonoids, tannins, trace amounts of saponins (Waiganjo et al., 2013) and, triterpenes. It does not have molluscidical activity (Kindiki, 2014).</td>
<td>It is used as vegetable to treat malaria (Njoroge and Bussmann, 2006b).</td>
</tr>
<tr>
<td><em>Solanum nigrum</em> (Solanaceae)</td>
<td>It contains phenolics and flavonoids (Xiaa et al., 2011). It has antioxidant and antibacterial activity.</td>
<td>It is used to treat malaria (Njoroge and Bussmann, 2006b).</td>
</tr>
<tr>
<td><em>Solanum nigrum</em> (Solanaceae)</td>
<td>It contains alkylamides, phenolics, caurmarin and triterpenoids (Mithlesh and Rakhi, 2015). It has antibacterial activity against (Werner et al., 1998) against Helicobacter pylori (Fabry et al., 1996a), larvicidal activity against Aedes aegypti mosquito (Jondiko, 1986), antifungal activity against Aspergillus spp. but not candida spp. (Fabry et al., 1996b), anti-inflammatory, antioxidant, antimicrobial and diuretic activities (Mithlesh and Rakhi, 2015).</td>
<td>It is used as a vegetable (Njoroge and Bussmann, 2006a) and diarrhoea (Njoroge et al., 2008).</td>
</tr>
<tr>
<td><em>Solanum nigrum</em> (Solanaceae)</td>
<td>It contains alkaloids; ribalnine, montrofile, skimmianne, iso-platydesmine and eduline, isohapoline (8-hydroxy-4, 7-dimethoxy-fluoroquinoline) , 3,3-dimethylallylfetether (Asseta et al., 1988) and triterpenes. It has analgesic (Njeru, 2015) and antiplasmodial activity (Rukunga et al., 2009).</td>
<td>Leaf decoction is taken orally to manage ENT diseases (Njoroge and Bussmann, 2006a), treat malaria (Njoroge and Bussmann, 2006b) and diarrhea (Njoroge et al., 2008).</td>
</tr>
<tr>
<td><em>Teclera simplicifolia</em> (Rutaceae)</td>
<td>It contains alkaloids; ribalnine, montrofile, skimmianne, iso-platydesmine and eduline, isohapoline (8-hydroxy-4, 7-dimethoxy-fluoroquinoline) , 3,3-dimethylallylfetether (Asseta et al., 1988) and triterpenes. It has analgesic (Njeru, 2015) and antiplasmodial activity (Rukunga et al., 2009).</td>
<td>It is used in wound healing (Sharma et al., 2014).</td>
</tr>
<tr>
<td><em>Typha domingensis</em> (Typhaceae)</td>
<td>It has wound healing (Akkol et al., 2011), antioxidant and anti-glycoside activity. There is presence of polyphenols, flavonoids (Chai et al., 2014), inoleic acid and α-inoleic acid (Gallardo-Williams et al., 2002).</td>
<td>It is used in wound healing (Sharma et al., 2014).</td>
</tr>
<tr>
<td><em>Urtica massaica</em> (Urticaceae)</td>
<td>It contains tannins in large quantity and, terpenes, saponosides, flavonoids and anthocyanes in small quantities (Nahayo et al., 2008).</td>
<td>Leaf decoction is taken orally to manage ENT diseases (Njoroge and Bussmann, 2006a), treat malaria (Njoroge and Bussmann, 2006b) and diarrhea (Nahayo et al., 2008).</td>
</tr>
<tr>
<td><em>Vernonia lasiopus</em> (Asteraceae)</td>
<td>It has hepatotoxic (Marie-Jeanne et al., 2010), antimarial (Francis et al., 2007) and anthemimtic activity (Njorge et al., 2013).</td>
<td>It is used to manage ENT diseases (Njoroge and Bussmann, 2006a) malaria, stomachache, cough, migraine and to delay delivery (Patience et al., 2016).</td>
</tr>
</tbody>
</table>

(Table 3) and were therefore mentioned for the first time in the present study as potential antidiabetic herbs.

5. Conclusion and recommendation

The present study revealed that, traditional practitioners from Nyeri County possessed in-depth knowledge about traditional medicine used to manage diabetes. Seventeen (17) plants were identified and documented for the first time as potential antidiabetic medicine. Polyherbal treatment was the preferred mode of treatment, which promotes synergistic activity of herbal medicine. Further, some of the cited plants were reported to possess hypoglycemic, antioxidant and inhibition of α-amylase and α-glucosidase activity and, improved insulin secretion. The TMPs in this area demonstrated extensive conventional knowledge about diabetes occurrence, symptoms, prevention and control and, appreciated the need to assimilate modern medical laboratory
technology in the treatment of diabetes. Notably, services from the TMPs were rarely sought because of the low attitude among members of the community; indicating that, herbal medicine was not well accepted. Therefore, traditional knowledge from the TMPs traditional healers from Nyeri County should be documented so that it does not become eroded due to natural attrition of the present custodians. Moreover, findings from the present study form the basis for further pharmacological studies of the cited medicinal plants, with a purpose of validating their efficacy and safety as well as developing drugs to be used in the management of diabetes.

Author’s contribution

LKN carried out the study, analyzed the data and wrote the manuscript, MPM, JMM, GPK and SGK designed the study, carried out field work, supervised the study and revised the manuscript.

Acknowledgement

This study was funded by Carnegie Corporation of New York – Science Initiative Group through Regional Initiative in Science and Education (CR-APFNET) African Natural Product Training Network (Grant No. 500-661-374). Special thanks go to the traditional herbal practitioners from Nyeri County for their willingness to share the knowledge with us. We acknowledge support from; the Ministry of Social and Cultural Services officials for providing contact information about the herbalists and, botanist from University of Nairobi (Mr. Mutiso) for assisting in the identification of plant specimen. The scientific findings from the pharmacological studies carried out using antidiabetic plants documented in this study will be shared with the traditional practitioners of Nyeri County; so that their knowledge about which medicinal plants are effective in treatment of diabetes can be boosted.

References


Culture and Social Services Department, 2013. Nyeri County Roll of Herbalists. Department of Culture and Social Services, Nyeri.


Omwenga, E.O., Okemo, P., Mbogua, P., 2012. In vitro antimicrobial and pre-
liminary phytotoxic screening of some Samburu anti-diarrhoeal medicinal
Phytochemical Screening of Selected of Selected Anti-diarrhoeal Medicinal
Plants Used by the Samburu community, Wamba, Samburu districts, Kenya.
Kenyatta University Institutional Repository. URI: http://ir-library.ku.ac.ke/
d1324567890/675.
theoretical studies of a naturally occurring non-oligomeric steroidal su-
B513724A.
fects of Some Native Plants Used by the People of Ma’rib, Yemen. J. Ethnobiol.
Ethnomed. 7, 8.
Overview of Nyeri County. (http://www.kenya-information-guide.com/nyeri-
Pahuva-Ramos, M.E., Ortiz-Moreno, A., Chamorro-Cevallos, G., Hernández-Navarro,
M.D., Cardoso-Siciliano, L., Necochea-Mondragón, H., et al., 2012. Hypolipi-
demic effect of avocado (Persea americana Mill) seed in a hypercholesterolemic
s11130-012-0280-6.
Patience, T., Esezah, K.K., Mukadasi, B., Justine, N., Maud, K., Patrick, M., James, K.,
2016. Ethnobotanical survey of medicinal plant species used by communities
around Mabira Central Forest Reserve, Uganda. J. Ethnobiol. Ethnomed. 12, 5.
Syzygium aromaticum and Allium sativum against food associated bacteria and
cognitive performance and acetylcholineesterase activity of rats: efficiency of
duced nephotoxicity with Sonchus asper in rat. Food Chem. Toxicol. 48 (8–9),
2460–2476.
Ranilla, L.G., Kwonb, Y., Apostolidis, E., Shetty, K., 2010. Phenolic compounds, an-
microbiological and activities of plant extracts. Chem. Mater. Res. 3 (9), 12
http://dx.doi.org/10.1080/J157v06n02_03.
etic and hypolipidaemic properties of garlic (Allium sativum) in streptozo-
cotin-induced diabetic rats. Int. J. Diabetes Metab. 15, 206.
Ranilla, L.G., Kwonb, Y., Apostolidis, E., Shetty, K., 2010. Phenolic compounds, an-
microbiological and activities of plant extracts. Chem. Mater. Res. 3 (9), 12
http://dx.doi.org/10.1080/J157v06n02_03.
etic and hypolipidaemic properties of garlic (Allium sativum) in streptozo-
cotin-induced diabetic rats. Int. J. Diabetes Metab. 15, 206.
Ranilla, L.G., Kwonb, Y., Apostolidis, E., Shetty, K., 2010. Phenolic compounds, an-
microbiological and activities of plant extracts. Chem. Mater. Res. 3 (9), 12
http://dx.doi.org/10.1080/J157v06n02_03.
etic and hypolipidaemic properties of garlic (Allium sativum) in streptozo-
cotin-induced diabetic rats. Int. J. Diabetes Metab. 15, 206.
etic and hypolipidaemic properties of garlic (Allium sativum) in streptozo-
cotin-induced diabetic rats. Int. J. Diabetes Metab. 15, 206.
etic and hypolipidaemic properties of garlic (Allium sativum) in streptozo-
cotin-induced diabetic rats. Int. J. Diabetes Metab. 15, 206.
etic and hypolipidaemic properties of garlic (Allium sativum) in streptozo-
cotin-induced diabetic rats. Int. J. Diabetes Metab. 15, 206.