TANG [HUMANITAS MEDICINE]

Original Article

Medicinal plants used in the management of diabetes by traditional healers of Narok County, Kenya

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ABSTRACT

The Maasai community from Kenya is highly esteemed for their strong adherence to traditional cultures and ethno medicine. This is attributed to their age-old traditional mechanisms of passing down knowledge to the younger generation. Adoption to new socio-economic lifestyle and urbanization has been associated with development of diabetes, which has been reported among some indigenous pastoral communities in Kenya. Documentation of traditional methods of treatment and management of diabetes by the Maasai has not yet been reported, yet it is noteworthy. Thirty traditional healers from Narok County were purposively selected and interviewed about traditional knowledge of antidiabetic medicinal plants, parts used, preparation dosage and administration. A total of 14 antidiabetic plant species distributed within 13 genera and 12 families were identified and documented as herbal medicine used in the management of diabetes. The most highly cited plant species was Dovyalis abyssinica (20%), the plant family Flacourtiaceae and Rhamnaceae (2 plant species each) recorded the highest number of plant species while the most frequently used plant part was the roots (46%). Literature review revealed that some of the cited plants have known phytochemicals with antidiabetic activity; the study recommends further scientific investigation to validate their efficacy and safety.

Keywords diabetes, traditional medicine, Narok County, Kenya

INTRODUCTION

Botanical remedies has been used to manage diseases from ancient times as they are easily accessible, affordable and over time been accepted as effective and safe (WHO, 2002). Emergence of non-communicable diseases has posed a great health challenge to countries particularly in Africa. Indeed, low and middle income economies in Africa are expected to lead with deaths arising from non-communicable diseases like diabetes by the year 2030, as a result of changes in lifestyle (Mbanya et al., 2010). Increased cases of diabetes mellitus have been reported among communities of both developed and developing countries (Onkamo et al., 1999). Sub-Saharan Africa is largely a developing region, in the year 2000, a total of 7.1 million people had diabetes; this figure is expected to rise to about 18.6 million by the year 2030 (Wild et al., 2004). In South Sudan, an upward trend of 8% to 14 % has been observed since independence while among the Tuareg and Moors indigenous communities of Mali, a prevalence of 2.61% has been recorded (IDF, 2012).

Kenya is one of the middle income economies, 43% of health facilities are provided by the government while a large proportion of its population (78%) lives in the rural area (Yonga, 2011). It is among countries with a high prevalence of diabetes and exponential rate of increase. The first medical case of diabetes in Kenya was diagnosed in an obese patient who worked for a British employer in 1933 (Trowell and Burkitt, 1981). Notably, by 2007 diabetes prevalence had reached 1.2 million and the figure is projected to reach 1.5million by 2025, which translates to a prevalence of 4.5 % among its general population (The Nation, 30 Jun 2007). In 2012, WHO attributed 1% of the total mortality in Kenya to diabetes (WHO, 2014) as result of overweight, obesity and other lifestyle habits like smoking (Yonga, 2011). Although Kenya is among countries with a growing level of diabetes knowledge (Atieno, 2006); majority of the rural population do not have diabetes knowledge (Maina et al., 2011). Isiolo County, which is largely occupied by pastoralist community, has a prevalence of 16% with a RBS ≥11.1 mmol/l, out of which 37.5% are unaware of their blood sugar level status (Hemed et al., 2014). In Rift Valley region of Kenya (Karekezi et al., 2011), has reported a prevalence of 2.4% among pastoralist communities. The Maasai are a pastoral community; they occupy the Northern part of Tanzania and Southern part of Kenya. A prevalence of 22.9% and 9.9% has been recorded in the urban and rural settings respectively, in Ngorongoro, Tanzania (Masaki et al., 2015) while in Simanjiro, a prevalence of 0.9% and 2.4 % type 2 diabetes and impaired fasting glucose tolerance has been reported respectively (Mandha et al., 2015). Significant health effects due to change in dietary lifestyle that led to increased cholesterol levels have been observed among the rural and urban Maasai (Day et al., 1979). Diabetes treatment using

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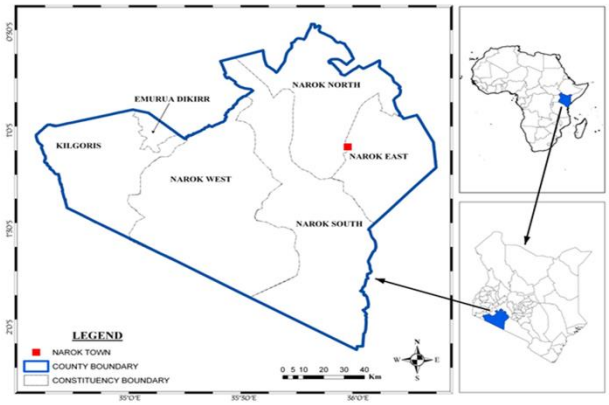

Fig. 1. Administrative map Narok County in Kenya

allopathic medicine is faced with a myriad of challenges like, high cost of the drugs, progression of the disease despite patient compliance to the prescribed regimen and undesirable side effects (DeRuiter, 2003).

However, traditional remedies have remained a mainstream source of primary healthcare in many communities. Among the Maasai people, use of traditional herbs is deeply rooted into their culture, thus a lot of knowledge on different plant resources that are of medicinal value has been retained (Sindiga, 1995). Indeed, every person in the Maasai family and by extension the entire community has basic knowledge on the use of ethno-medicine from childhood, a skill that is acquired as they grow and mature to elders (Kiringe, 2005). However, despite lifestyle changes and diabetes occurrence, the Maasai community (73%) has steadfastly considered traditional medicine their first line of treatment (Bussmann et al., 2006, Kiringe, 2006).

This study believed that, investigating medicinal plants used by the Masaai Traditional healers (TH) to treat diabetes would reveal significant plants possibly unknown to communities whose traditional knowledge has eroded with time. This study aimed at identification and documentation of; knowledge on diabetes, treatment approaches as well as demand for antidiabetic medicinal plants in Narok County.

MATERIALS AND METHODS

Study area: Historical background of the Maasai community and their habitat

The Maasai people are found in the southern and northern region of Kenya and Tanzania, respectively. In Kenya, one group of the Maasai community (which constitutes of the Ilsampur (Samburu) and the Ilcamus (Njemps)), live in the northern parts of the rift valley while the other group, (the Ilarusa, Ilmoitanik, Ilwuasinkishu, Isiria, Ilpurko, Ilkeekonyokie, Ildamat, Iloitai, Isikirari, Ildalalekutuk, Iloodokilani, Ildamat, Ilkaputiei, Ilkisonko and the Ilmatapato), occupy the southern part. Both groups speak "Maa" language whose historical roots are the Eastern Sudanic language (Maa). The Maasai community originated from Chad and migrated southwards through the Great Rift Valley and before colonialism, they had occupied two-thirds of Kenya, but in 1911, after signing an agreement with the white settlers, much of their land was taken away, thereby losing their native rights. Consequently, and in addition to further encroachment from the neighboring communities, the Maasai community has been confined to Kajiado, Narok and Samburu Counties (Patrick et al., 2001).

The current study was carried out in Narok County, which is situated in Kenya along the Great Rift Valley, it lies between; 0° 16' S 34° 39' E and 2° 09' S, 36° 15' E coordinates and is 1827 meters above sea level. It borders the republic of Tanzania to the South, Nakuru County to the North, Kisii, Nyamira and Bomet Counties to the Northwest, Migori County to the West and Kajiado County to the East. Narok has 6 constituencies namely; Narok North, Narok South, Narok West, Narok East, Kilgoris and Emurua Dikirr (Fig.1). The County has a total population of 850,920 within an area of 17,921.20 km^2. The climate consists of a temperature range of 8-28 degrees Celcius, characterized by a bimodal rainfall pattern and an average rainfall of 500-1800 mm per year. The lowland parts of the County experiences seasonal flooding. Mt. Suswa is a major land mark of the County and is one of the tourists' attractions.

Socio-economic activities

Traditionally, they have been a nomadic pastoralist community but have recently, visibly metamorphosed into a sedentary agro-pastoralist community, due to rapid socio-economic changes in addition to, rural urban migration in search of jobs. The rural Maasai engages in; livestock husbandry, subsistence farming and large scale farming, major cash crops are maize, wheat and barley.

Social amenities

There are a total of 104 health facilities, 3 level four, 1 level three, 16 level two, and 84 level one hospitals distributed within the county. There are 571 primary schools, 61 secondary schools and 1 university.

Study approval and collection of data

The study was approved by the National Commission for Science, Technology and Innovation (NACOSTI). Following consultation with officer in charge, in the Ministry of sports and culture and in addition to information from the local communities, 30 traditional healers (TH) were purposively selected based on their free will consent to participate. Selection criteria were TH that were born and had been practicing within the study area. Through a cross sectional survey, interviews were carried out in Maa language but recorded in English. The information obtained included; demographic details, diabetes prevalence, knowledge, cause and prevention, name of plant(s) used to treat diabetes in the study area, dosage and route of administration besides plant status and habitat.

Voucher specimen

After analysis of the survey data, the researchers undertook a follow up visit to the study area to identify and collect samples of plants that were used to manage diabetes as mentioned by the TH. The plant samples were given a voucher identification number and each plant specimen was deposited at the school of biological sciences- Herbarium (University of Nairobi).

Data analysis

Data was summarized into themes and analyzed using content analysis and descriptive statistics such as proportions, percentages and frequencies. Ethnobotanical relevance by the traditional healers was calculated as follows; UVs (total Use Value of each species by all informants) = (Σ UVis) / (ni); UVis represented the Use Value of each species mentioned by each traditional healer while nis represented number of interviews carried out in one informant (Hoffman and Gallaher, 2007; Phillips and Gentry, 1993).

Table 1 : List of antidiabetic plant species used to manage diabetes in Narok County, Kenya

Family	Scientific name Voucher number	Maasai name	Life-form	Habitat	Parts used	Preparati-on	Frequ-ency	Use value
Aloaceae	Aloe secundiflora Engl. LNM15/12	Osukuroi	Herb	Wild	Leaves	Decoc-tion	2	0.7
Amaryllid-aceae	Allium cepa L. LNM15/10	Kitunguu	Herb	Cultivat-ed	Leaves	Crush-ed	3	0.1
Apocynac-eae	Carissa edulis (Forssk.) Vahl LNM15/05	Olamuriaki	Tree	Wild	Roots	Decoc-tion	5	0.17
Canellace-ae	Warbugia ugandensis Sprague LNM15/14	Osokonoi	Tree	Wild	Bark	Decoc-tion	1	0.03
Mimosoid-eae	Acacia nilotica (L.) Delile LNM15/06	Olkirorit	Shrub	Wild	Roots	Decoc-tion	5	0.17

Cross referencing with existing literature

Information on ethnotherapeutic uses, pharmacological activity, and phytochemical components was obtained through content analysis on all antidiabetic plant species that were cited and documented during the survey.

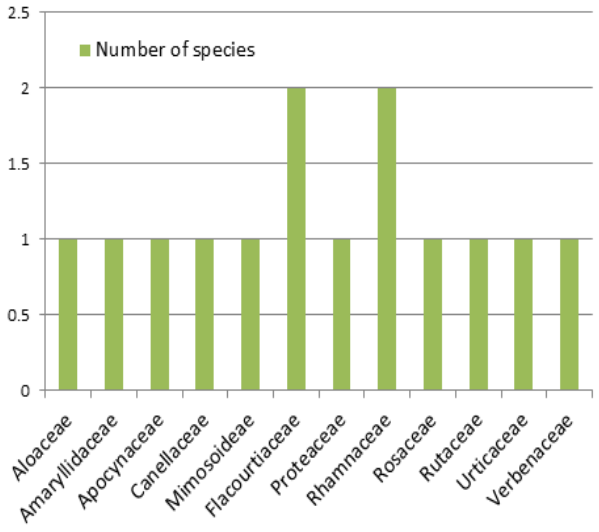

Fig. 2. Families of antidiabetic medicinal plants in Narok

RESULTS

It was revealed that, diabetes was locally known as engeae sukari (42%) or Emuyian esukari (58%). Eighty two percent (82%) of the TH reported its occurrence, but they (73%) added that, its prevalence was low. Additionally, 50% of the TH reported that there were cases of diabetes related deaths in the area, but morbidity was low, 67% of the TH had witnessed only 1-5 deaths and 33% 6-10 deaths. Results of the study showed that, the TH (33%) demonstrated possession of knowledge on medicinal plants traditionally used to manage and treat diabetes. Demand for traditional antidiabetic plants was high; reportedly, 27% of the TH had treated at least one diabetic patient in the past week, 9% in the past month while 36% in the past year. Forty one percent (41%) of the TH reported that, on average, they treated 1-5 patients while 6% had treated 6-10 patients within the past year.

Majority of the TH understood the causes of diabetes (81%) and its symptoms (85%). Major causes included; refined foods (95%) and stress (5%). According 50% of the TH, diabetes was common among old people while 29% and 8% said middle aged and youths, respectively. Additionally, it was more prevalent among men (46%) than women (37%) while 17% said both gender. According to the TH, the main predisposing factors in the area were; inheritance (18 %), stress in women (12%), inactivity among men (53%), or a combination of various factors (18 %). Modifiable factors included; in-activity (5%), diet (11%), obesity (5%), refined foods (5%), or a combination of factors (74%).

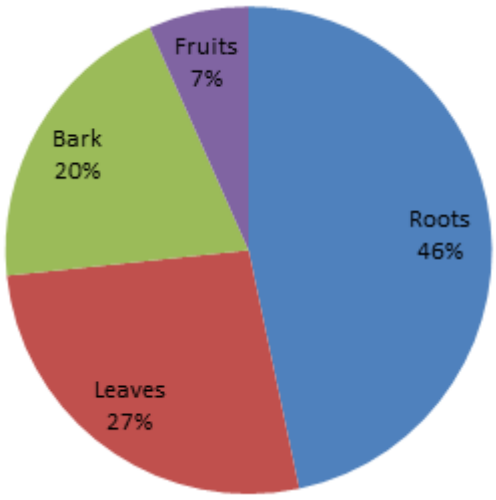

Fig. 3. Most used antidiabetic plant parts

The results showed that, the TH well understood how to control and treat diabetes. Forty two percent (42%) believed that diabetes could be controlled by avoiding meat, sugary and refined foods, and eating traditional foods and vegetables (13%). Ninety one percent (91%) believed in the use of herbs to treat diabetes, 9% said conventional drugs can also be used. Forty two percent (42%) incorporated modern methods of laboratory testing of blood sugar level to confirm diagnosis. Twenty five percent (25%) had treated a diabetic case referred to them by a medical practitioner while some of the clients

Table 2. Cross reference of antidiabetic plant species documented in Narok County against published data

Scintific and family name	Ethnopharmacological activity/ phytochemical components	Ethnomedicinal uses
Acacia nilotica (Mimosoideae)	Leaf extract has hypoglycemic activity and increases serum insulin in diabetic rats (Asad et al., 2011). Aqueous methanol pod extract lowers blood glucose levels, restores serum urea and creatinine, ameliorates diabetes complications; superoxide dismutase (SOD), lipid peroxidation (LPO), glutathione (GSH) activity (Omara et al., 2012). Conatins terpenoids, tannins, alkaloids, saponins and glycosides, antimicrobial activity (Banso, 2009).	Used to treat insomnia, skin diseases and fungal infections (Olowokudejo et al., 2008). Stem bark as a stimulant and excitant (Muthee et al., 2011). The leaves, roots and stem bark in the management of chronic pain (Wambugu et al., 2011).
Allium cepa L.*(Amaryllidaceae)*	Antioxidant and hypoglycaemic activity (Campos et al., 2003). Protects against diabetes induced vasoconstriction (Mahmoud et al., 2013). Contains quercetin (Lombard et al., 2005; Singh et al., 2009), ferulic, gallic, protocatechuic acids, and kaempferol, strong anti-mutagenic and antioxidant activity (Singh et al., 2009).	Manage sprain, edema and bruise (Ugulu et al., 2009); treat erectile dysfunction and sexual impotence (Mugisha and Origa, 2005).
Aloe secundiflora (Aloaceae)	Exudate contains anthrones (aloenin, aloenin B, barbaloin, isobarbaloin and other aloin derivatives), phenylpyrones and chromones (Waihenya et al., 2003), antibacterial (Wagate et al., 2010) and antihyperglycemic activity (Abdirahman et al. 2015).	Leaves used to treat malaria and wounds (Muthee et al., 2011) leaves and root juice applied topically to treat injured tissue (Wambugu et al., 2011) leaf gel of taken in the management of diabetes (Keter and Mutiso 2012). Leaf decoction taken to treat HIV/AIDs and STDs in general (Njoroge and Bussman, 2009).
Carissa edulis (Apocynaceae)	Hypoglycemic (Fathy et al., 1996) and anti-viral activity (Tolo et al., 2006). Lignan compound nortrachelogenin from methanolic root bark extract has anti-plasmodial activity (Kebenei et al., 2011), soxhlet root bark extract has diuretic activity (Nedi et al., 2004); Contains alkaloids, saponins, terpernoids and flavonoids (Jeruto et al., 2011).	Treatment of gonorrhoea, syphilis, headache, chest complaints, rheumatism, rabies and as diuretic (Nedi et al., 2004); and treat malaria (Njoroge and Bussmann 2006).
Dovyalis abyssinica (Flacourtiaceae)	Dichloromethane and methanol leaf extracts shows anti-trypanosomal activity (Tadesse et al., 2015). Contains alkaloids, tannins, polyphenols, saponins, sterols, terpenes, and glycosides, antimicrobial activity (Abebe et al., 2005).	Manage wound, hemorrhoids, ulcers, throat inflammation, oral hygiene (Engidawork and Abdissa, 2011), immune booster and chest ailments or pneumonia (Amadi, 2013; Amuka et al., 2014) and treat malaria (Njoroge and Bussmann 2006). Leaves used to treat indigestion (Muthee et al., 2011) and root decoction manage postpartum weakness (Njoroge and Bussmann 2009).
Faurea saligna (Proteaceae)	Antimicrobial (Mthethwa, 2009) and antifungal activity against candida albicans (Mangoyi and Mukanganyama, 2011).	Manage wounds and sores (Mthethwa, 2009) treat candidiasis and fungal infections (Masevhe et al., 2015) and roots stomach problems (Muthee et al., 2011).
Prunus Africana (Rosaceae)	Anti-HIV-1(Rukunga et al., 2002) antifungal, antibacterial (Bii et al., 2010) hypoglycemic activity (Maina et al., 2014). Has less acute toxic effect (Nabende 2015). Contains triterpenic acid including ursolic and oleanolic acids (Fourneau et al., 1996), n-tetracosanol, fatty acids, sitosterol, sitostenone, friedelin, maslinic acid (Catalano et al., 1984).	Treat malaria (Amuka et al., 2014; Njoroge and Bussmann 2006) and pneumonia (Amadi, 2013). Infusion of stem bark and roots orally taken in the treatment of cancer (Ochwang'I et al., 2014), prostate and urinary tract infections (Wambugu et al., 2011) bark decoction management of back pain in women and treatment of HIV/AIDs (Njoroge and Bussman, 2009).

Rhamnus prinoides (Rhamnaceae)	Contains anthraquinones emodin, emodinanthrone, prinoidin and the flavonoid rhamnazin (Berhanu and Martin GP, 1995), tannins, alkaloids, cardiac glycosides, triterpene, saponins, phenols and resins; methanol water extract has antibacterial (Amabye, 2015) antimalarial activity (Muregi et al., 2007).	Treat malaria (Njoroge and Bussmann 2006), roots, leaves, fruits and stem bark used in the treatment of gonorrhea, prostate, malaria and brucellosis (Muthee et al., 2011), root and stem decoction in management of back pain and postpartum weakness (Njoroge and Bussman, 2009).
Rhamnus staddo (Rhamnaceae)	Antimalarial activity (Muregi et al., 2007) root extract in combination with some selected herbs has antifungal activity (Odhiambo et al., 2009) leaf extract has taenicidal activity (Desta, 1995). Methanol root extract contains tannin, flavonoids, alkaloids, steroids, terpenoids, and flavone aglycone (Onyango et al., 2014).	Treat malaria[44] roots, stems, leaves and fruits in the management of gonorrhea, diabetes and endometritis (Wambugu et al., 2011).
Rotheca	Anti-mutagenic activity (Verschaeve and Van Staden, 2008). Contains alkaloids, terpernoids and flavonoids (Jeruto et al., 2011).	Used to treats malaria (Orwa et al., 2007), Njoroge and Bussmann, 2006) pneumonia (Amadi, 2013) root decoction in the management of chronic pain (Wambugu et al., 2011), STDs in general, as an aphrodisiac (Njoroge and Bussmann, 2006), leaf decoction in management of diabetes (Keter and Mutiso, 2012).
Trimeria grandifolia (Flacourtiaceae)	Contains idesin, lupenone and β-Sitosterol; anti- plasmodial activity[68].	Used to treat malaria (Orwa et al., 2007; Njoroge and Bussmann, 2006) roots in management of back pain in women and stem decoction in postpartum weakness (Njoroge and Bussmann, 2009).
Urtica massaica (Urticaceae)	Stems extract contains saponosides, flavonoids, anthocyanin, sterols and tannins. Hydromethanolic extract exhibits antibacterial activity against *Salmonella B, Escherichia coli,* and S*higela flexneri* (Nahayo et al., 2008). Safe, with slight renal toxicity up to high dose of 5000 mg/kg (Oloro et al., 2015)	Used to treat malaria (Njoroge and Bussmann, 2006) , dried powder applied topically to treat skin cancer (Ochwang'I et al., 2014) leaf decoction taken orally to manage diabetes (Keter and Mutiso, 2012). Roots decoction is used as an aphrodisiac (Njoroge and Bussmann, 2009).
Warbugia ugandensis (Canellaceae)	Has antiviral activity against measles virus (Parker et al., 2007), cytotoxicity (Choi et al., 2015), antibacterial activity against *Staphylococcus aureus* (Maobe et al., 2013), Merawie et al., 2013), *E. coli, P. aeruginosa, S. boydii,* and *Streptococcus pneumonia,* antifungal activity against *Candida albicans* (Merawie et al., 2013). Contain kaempferol and galangin, naringenin, flavanone and (Yonga, 2011); coloratane sesquiterpenes demonstrates antimicrobial activity (Wube et al., 2005).	Used to manage erectile dysfunction, sexual impotence (Mugisha and Origa, 2005) and diabetes (Maobe et al., 2013), treat malaria (Njoroge and Bussmann, 2006) and stem bark respiratory diseases (Muthee et al., 2011). Bark decoction used in management of back pain in women and leaves in regulation of menstrual cycle (Njoroge and Bussmann, 2009)
Zanthozylum usambarense (Rutaceae)	Anti-plasmodial activity, not toxic (Kirira et al., 2006).	Roots and fruits used to treat malaria, respiratory diseases and diarrhea (Muthee et al., 2011).

(46%) had had previous contact with a medical practitioner. They all (100%) reported that, major reasons why patients had sought herbal besides conventional treatment was because they believed that former was more effective than the latter.

About 14 antidiabetic medicinal plants occurring in 13 genera and 12 families were documented and identified as herbal medicine traditionally used in Narok County to treat and manage diabetes. The most frequently used plant species was Dovyalis abyssinica (20%), locally known as olmorogi, followed by Carissa edulis (Olamuriaki), Acacia nilotica (Olkirorit), Faurea saligna (Olorte), Rhamnus prinoides (Orkonyiel) and Urtica massaica (Entantamenjoi), 16.7% each (Table 1). Plant families with a higher proportion of antidiabetic plant species were Flacourtiaceae and Rhamnaceae (2 plant species each), other families were represented by one plant species (Fig. 2). The most preferred plant parts were roots (46%) and leaves (27%) (Fig. 3). The plants species were mainly trees (50%) and shrubs (29%) while herbs were not

frequently used (21%). The plants mainly occurred in the wild/bush (93%) but a few in crop farms (7%). Eighty six percent (86%) of the plants were prepared as decoction, the remaining were by either chewing or crushing. Oral route was the preferred method of administration while dosage was rarely disclosed.

Ethno therapeutic uses of antidiabetic plants that were documented and identified in Narok have been reported in various surveys in treatment and management of various diseases; as anti-inflammatory agents (18%), reproductive (17%), antiprotozoal (malaria in particular) (15%) anti-respiratory disease agent (7%) and others (21%). Interestingly, very few plants have been cited as antidiabetic agents (7%) in these studies. No phytochemical study has been carried out on two of the plant species namely; Faurea saligna and Zanthozylum usamabrense. Various studies have established presence of major phytochemicals in all the other antidiabetic plants: terpenoids occurred in 11 plants; flavonoids (11), alkaloids (7), phenolics (6), saponins (5), tannins (4), glycosides and steroids, each four plants (Table 2).

DISCUSSION

Encounter with diabetes patients and related deaths in the area as reported by the TH had largely contributed to the increased diabetes knowledge observed among them. Further, diabetes awareness campaigns country wide by the ministry of health had additionally played a major role (Nicolai et al., 2014). The low prevalence of diabetes could be attributed to its predominantly rural set up; a similar trend has been observed elsewhere (Dirk et al., 2009). Occurrence of diabetes among the Maasai community of Narok County which had no such previous record during the pre-colonial era is associated with sociocultural changes facing it in the post-colonial era (Karekezi et al, 2011; Mandha et al., 2015; Masaki et al., 2014). This explains why most of the reported causes of diabetes by the TH in Narok were attributed to; diet, stress and inactivity, these findings corroborate previous reports (Berg, 2012; Campbell et al., 2000; Cochrane et al., 2005). Similarly, Hemed et al., (2014) attributes diabetes to sedentary lifestyle (46.8%), abdominal obesity (43.7%) and high fat diet (59.4%). Notably, occurrence of diabetes related deaths in this community was a clear indicator that such changes have been engrained within their lifestyle for over a long period of time. The current study revealed a high prevalence of diabetes among men and old people as reported by the TH; WHO has reported a similar trend. Further, Yang et al., (2010) recorded a diabetes prevalence of 10.6% in men compared to 8.8% in women and 20.4% among old people compared to 3.2% among young people.

To treat and manage diabetes, the TH in the present study recommended use of traditional diet and vegetables both of which are rich in fiber. These foods have been shown to manage and reverse diabetes type 2 (https://www.pcrm.org). Notably, despite the low diabetes prevalence recorded in the study area, the number of diabetic clients seeking herbal treatment was relatively high; this is attributed to the positive attitude and faith in herbal medicine over conventional therapy by this community (Bussmann et al., 2006; Kiringe, 2006; Sankan, 1995; Sindiga et al., 1995).

The present study documented Urtica Massaica as one of the most used plants in Narok; which is similarly cited in a study carried out in the lower eastern region of Kenya, together with other plants like Aloe spp. and Rotheca myricoides (Keter and Mutiso, 2012). But a comparative analysis of other studies reveals that, plants used to manage diabetes in Narok were different from those from other communities such as Peru (Rainer et al., 2013), Trinidad and Tobago, except for aloe spp (Lans, 2006), and Embu County of Kenya (Kareru et al., 2007) and lower eastern region of Kenya, except for Urtica Massaica, Rotheca myricoides and Aloe spp. (Keter and Mutiso, 2012).

In the present study, roots were most preferred plant part compared to leaves in Lower Eastern Region (ibid) while effort of cultivating medicinal plants for ethno therapeutic use was reportedly rare. This raised the question of plant conservation. But according to the TH, they harvest a third of the roots or from plants that have not been previously/recently harvested. Preparation of the medicine as a decoction has also been reported (ibid).

Although, studies to establish their antidiabetic efficacy have been carried out, very few plants (43%) (Table 2) have been scientifically validated, 57% have not been investigated, they included; Dovyalis abyssinica, Faurea saligna, Rhamnus prinoides, Rhamnus staddo, Rotheca myricoides, Trimeria grandifolia, Urtica massaica, Warbugia ugandensis and Zanthozylum usambarensis. Although Acacia nilotica leaf and pod extract have been studied, antidiabetic efficacy of the roots which were mentioned by Narok TH have not been scientifically validated.

Terpenoids have known anti-hyperlipidemic, anti-obesity and Type 2 antidiabetic activity (Goto et al., 2010; Uma et al., 2011). Alkaloids express their antidiabetic activity through increasing insulin sensitivity (Uma et al., 2011); glucose uptake, antioxidant activity (Tiong et al., 2013) and reduction of glucose-6-phosphatase activity, triglyceride (TG) and total cholesterol (TC) content (Sharma et al., 2010). Phenolics antidiabetic activity (Uma et al., 2011), is attributed to its antioxidant (Chen et al., 2011; Rafehi et al., 2012) and antiglycation activity (Chen et al., 2011) decreasing of total cholesterol, triglyceride, LDL-cholesterol, serum glucose and body weight (Yin et al., 2011). Flavonoids increases glucose uptake (Granados et al., 2015), insulin secretion (Mohan and Nandhakumar, 2014), prevent Beta-cell apoptosis (Pinent et al., 2008) possess antioxidant activity and modulate renal glucose reabsorption (Lukačínová et al., 2008). Saponin hypoglycemic activity associated with increased insulin secretion by rejuvenating β-cells, modulating calcium channels (Koneri et al., 2014), antiglycation, antioxidant (Chen et al., 2011), anti-obesity activity (Park et al., 2005) and amelioration of diabetes complications related to liver and kidney function, and glucose metabolism (Patel et al., 2012). Tannins has antihyperlipidemic and hepatoprotective activity (Babby, 2014). Reported bioactivity of phytochemicals present in the antidiabetic plants used by TH from Narok confirms their reported use in the management of diabetes by the TH. However, further studies on efficacy of their antidiabetic activity, as well as potential toxic effect are inevitable, to form basis as future candidates for antidiabetic drug extraction.

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CONFLICT OF INTEREST

All authors declare no conflict of interest

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