Identity, Preparation, Dosages and Conservation Knowledge of the Antidiabetic Herbs Used by The Tugen Living in Baringo County-Kenya

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Summary

INTRODUCTION

The primary goal of managing Diabetes Mellitus (DM) is to regulate blood sugar levels within the physiologic limits (3Mmol/l to7Mmmol/l-fasting blood sugars). This can be either done pharmacologically (conventional or non-conventional) or non- pharmacologically (exercises etc.). Available reports show that, more than 80% of the African population use non-conventional pharmacological approaches- especially herbal remedies in the management of their ailments including DM.

OBJECTIVES

The study sought to identify the antidiabetic herbs used by the Tugen community living in Baringo county-Kenya. Establish the plant parts in use, preparation methods and the dosage of each specific herb. Equally assess the knowledge of both the diabetics and the antidiabetic herbalists on possible antidiabetic herbal medicine conservation.

MATERIALS AND METHODOLOGY

A descriptive cross-sectional survey study design was adopted. Information about the local names of commonly used herbs and the plant parts, their preparation, their doses and the knowledge of antidiabetic herbal conservation was obtained from 39 medically ascertained diabetics between 27 to 70 years old and 12 herbalists, using a researcher administered questionnaire and an interview guiderespectively. They were identified through snow balling and purposive sampling method. Samples of the identified plants'/ herbs' parts were collected and taken for taxonomic identification and Assigning of botanical names based on their morphological characteristics was done at the department of Botany, University of Eldoret, Kenya. Data entry, cleaning, and coding was done using Excel Office 13. Analysising with SPSS version 21 software. The summarized data were presented in tables of frequencies and graphs where applicable.

RESULTS

The commonly used herbal medications in the management of diabetes, in Baringo as reported by the herbalist were *Urtica dioica (*stinging nettle **(UD)) (75%)** and *Carissa edulis* **(CE) (58%).** Most (85%) of the herbs according to the diabetics were dried, crushed to powder then added to boiling water before drinking. Dosage, unanimously, the herbs were taken twice a day 2-3 teaspoonfuls in either 250mls or 500mls of boiled and/or cooled water. Diabetics (77%) took these herbs because they believed herbal medicine improve their health. Herbalists (67%), believed their diabetic herbal medications stabilize blood sugars and cured their patients. Diabetic patients

and herbalists had some knowledge about bio conservation, 44% of the diabetics understood conservation as planting more medicinal herbal plants/herbs. Herbalists 75% of them described conservations as a surity of constant supply annually. According to the herbalists "those herbs which can be dried and stored, could be harvested in plenty during the rainy season to last till the next rainy season".

CONCLUSIONS

Among the Tugen living in baringo, *Carissa edulis (CE)* and *Urtica dioica (UD)* were the most frequently used antidiabetics followed by *Hypoestes forskaolii (HF)* to regulate sugar levels. There was no standard method of preparation and dosaging of these herbs due variations from patients/herbalists.

RECOMMENDATIONS

Policymakers need to create awareness on the importance of standardization and bio conservation for enhancement of sustainability and careful use of these very important scarce environmental resources and not loose the diabetic herb/plant biodiversity. Taking care of biodiversity and its services in the community, creates one of the reasons why we should enhance and promote conservation and sustainable use of medicinal plants

Introduction

The burden of Diabetes Mellitus (DM) in the world was steadily increasing [1]. Currently, it is a major public health and economic problem accounting for the largest proportion of non -communicable disease burden in the world. In the year 2017, an estimated 425 million (approx. 6%) of the world's population were diagnosed with DM. It was projected that, by the year 2045, there will be nearly 629 million people with DM. Most of them being in their economic productive ages [2].

Hence, there was need for concerted efforts in the management of DM, which is primarily geared towards the regulation of the body's blood sugars within physiologic limits [3Mmol/l-7Mmmol/l (fasting blood sugars)] [3]. That could be done through either; non-pharmacological (diet and physical exercises) or pharmacological approaches (conventional or non-conventional) [4].

Conventional (western or mainstream medications) refer to drugs such;
- exogenous insulin
- sulphonylureas
- thiazolidinedione's
- biguanides
- glinides

and *alpha-glucosidase* inhibitors, which, utilize varied mechanisms in regulating blood sugars in the body of an individual within the normal ranges [5-7].

Non-conventional approaches refer to the use of medical products and practices that are not part of hospital-based care. One such way is the use of plant/herbal parts as drugs such as;
- the American ginseng roots,
- *Gymnema sylvestre*[8]
- *Trigonella foenum graecum* (fenugreek) [9] and *Ficus carica.*

More than 80% of the African population use plant or herb parts [10] in the management of their ailments such as DM, but documented literature on the identity, ways of preparation, dosaging, and knowledge of conservation by the users and those prescribing them was largely scarce.

Therefore, this study, sought to establish the identity, methods of preparation, dosaging and conservation knowledge of diabetic herbs, among diabetic and antidiabetic herbalists living within the Tugen community of Baringo County in Kenya. That was a county where the use of herbal/plant medicines was flourishing.

Materials and Methodology
Study Area

The study was carried out in Baringo County, Kenya, where the Tugen community live. Baringo covers an area of 11,075.3 km2 and is located at latitude $00_{\circ}13"$ south and $1_{\circ}40"$ north and longitudes $35_{\circ}6"$ and $36_{\circ}30"$ east in mid-Western Kenya. The administrative and economic headquarters of Baringo County is Kabarnet town. The county has five constituencies namely; Baringo Central, Baringo East, Baringo North, Eldama Ravine, and Mogotio (*Figure 1*).
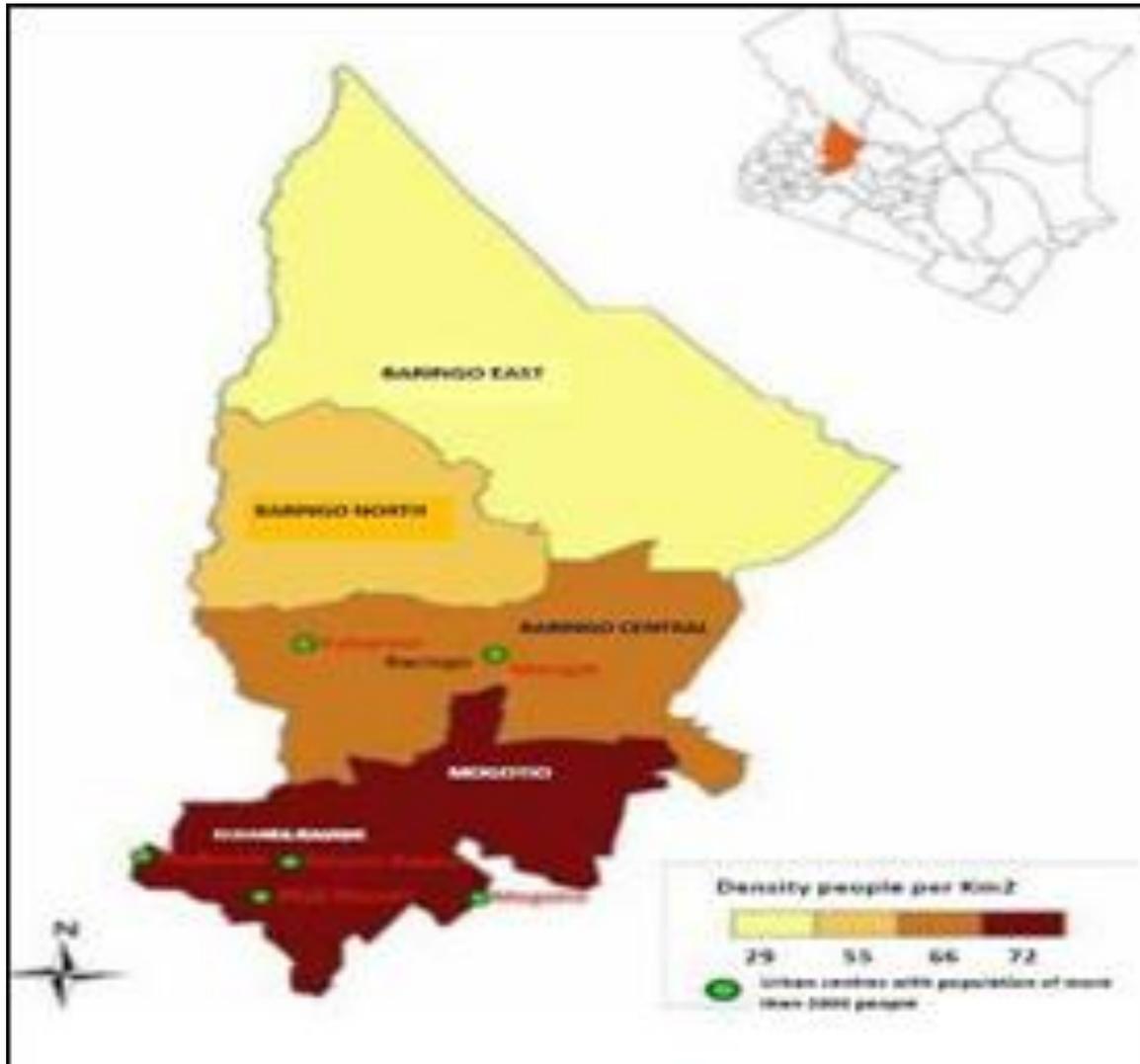
Figure 1: *Map of Baringo County*.

The use of herbal remedies in the management of various ailments was common in this county with most herbalists operating from Kabarnet, Marigat, Barweza, Kabartonjo and Eldama-Ravine towns. They usually did their business during designated market days. That was either on a Wednesday or Saturday though there were those who had consulting clinics throughout the week. Patients using herbs got their medications from those herbalists or from their surroundings.

Sample Size and
Sampling Procedure

The study recruited 39 medically ascertained diabetic cases, 12 herbalists using and prescribing plant/herbal antidiabetics. They were identified through snow balling and purposive sampling methods. An interviewer-administered questionnaire and a face to face interviews were conducted, respectively. All the herbs that were described by the herbalists and diabetics were then collected from the various places of their

origin, with exception of a few herbs which were not found within the ecosystems of Baringo County (gotten within supermarket shelves and diabetic herbal clinics in Baringo). They were then taxonomically identified at the Department of Botany, University of Eldoret, Kenya. Morphological characteristics of the sampled herbs/ plants were used in the identification and assigning of botanical names [12, 13].

Ethical Clearance

The study was approved by the Human and Animal Research and Ethics Committee (HAREC) of the University of Eastern Africa Baraton, Kenya (UEAB/3/1/2018) and license to conduct the study was issued by the National Commission of Science Technology and Innovation, Kenya (license number NACOSTI/P/18/23407/22472).

Data Analysis

Completeness of entry on forms, dual entry, cleaning, and coding was done using Excel Office 13 and analysis done using SPSS version 21 software. The summarized data were presented in tables of frequencies and graphs where applicable.

Results

Demographics of the Diabetics and Antidiabetic Herbalists Diabetics

Table 1: Demographics of Diabetic Patients Interviewed

Variable	Mean=46.8(SD11.2)		Range 27 – 70(age range)
Age	Category	Frequency=x/39	Percentage=x/39x100
Sex	Male	21/39	54%
	Female	18/39	46%
Marital Status	Married	24/39	62%
	Single	5/39	13%
	Separated/widowed/ divorced	10/39	26%
Education Level	No formal education	2/39	5%
	Primary	10/39	26%
	Secondary	12/39	31%
	Tertiary	15/39	39%

The age of the respondents ranged from 27 to 70 years old with a mean of 46.8 (SD 11.2) years. Half of the participants were below 47 years (IQR 37, 56). Males were slightly more 21(54%) than females. Majority 24 (62%) were married. Those who had completed secondary school education were 12 (31%) and tertiary level education level was 15 (39%). The age distribution was similar across all the sexes (p -value =0.936), male with a mean of (and females , though the females seemed to be more dispersed. Most (11/39 =28%) of the respondents were businessmen and women followed by farmers (9/39=23%) and teachers (6/39=15%).

Herbalists

The age of the respondents ranged from 43 to 69 years old with an average of 54 (SD 8.0) years. Majority 8(67%) being women. About 58% of the respondents had no formal education.

Antidiabetic Herbs Commonly Used by The Tugen Living in Baringo County

Table 2: *Antidiabetic Herbs as Prescribed by the Herbalists*

Herb/plant	Part used	Percentage % of the herbalist prescribing them
1. Siwot (*Urtica dioica*)	Leaves and Stems	75
2. Legetetwet (*Carissa edulis*)	Roots	58
3. Sirar (*Hypoestes forskaolii*)	Roots	50
4. Mosong -Sorghum (*Sorghum bicolor*)	Seeds	50
5. Cinnamon (*Cinnamomum verum*)	Bark	42
6. Arwo-Tamarind (*Tamarindus indica*	Seeds and Pulp	42
7. Ginger (*Zingiber officinale*)	Roots	33
8. Kokian tree seeds (*Zanthoxylum chalybeum*)	Seeds	33
9. Loquat (*Eriobotrya japonica*)	Leaves	25
10. Mango (*Mangifera foetida*)	Leaves	25
11. Kipnyalil bei (*Tinospora cordofolia*)	Leaves and Stems	17
12. Tengeretwet (*Aloe tweedie*)	Leaves	17
13. Suchon (*Solanum nigrum*)	Leaves	08

Urtica dioica (Siwot) was reported by the highest number of herbalists at 75%, followed closely by *Carissa edulis* (58%) and *Hypoestes forskaolii* & *Sorghum bicolo*r each at (50%). A finding in congruence with that of the antidiabetics. Suchon (*Solanum nigrum*) was the least prescribed at (08%).

Description of the Reported Herbs
a). *Carissa edulis vahl*

Carissa edulis vahl is a spiny shrub that rises to about 5 m high and found in dry deciduous forest, throughout the drier parts of Baringo County. Its roots

are used for medication and emit a strong smell of methyl salicylate when crushed [14, 15] *(Figures 2 & 3)*. Other than diabetes this herb is also used for abdominal related ailments. Concerning its safety, available literature indicates that the roots of this herb do not cause any harm to the body tissues, an assessment that was done on both rats and mice, (LD50 >5000 mg/kg) by [16-19].

Figure 2: Carissa edulis vahl tree

Figure 3: Chopped pieces of CE roots

b). *Urtica Dioica*

Urtica dioica (stinging nettle) is a member of the *Urticaceae* family. It is an erect, herbaceous perennial herb *(Figure 4)*. Its stems are usually unbranched and grow between 3 and 6 ½ feet tall, covered with bristly stinging hairs. Its' flowers are tiny, greenish to white, and are arranged in clusters. It also has branched spiked

Figure 4: Stem and Leaves of Urtica dioica

formations in its' leaves [20]. Other than diabetes, this herb is also used as an anti-hypertensive. Biological screening on *Urtica dioica* done by Turker, estimates the LC50 of this herb extract to be <1000 mg L−1 [21].It can also be used as an anti-inflammatory [21-24].

c). *Tinospora Cordofolia*

Tinospora cordofolia is a climbing shrub that belongs to the family *Menispermaceae*. It is normally found in warm climatic regions of Baringo County, often near riparian regions. It is a large deciduous shrub with several coiling branches *(Figure 5)*. Its' stem is succulent often with long *filiform*. It has also a creamy white to grey and deeply left spiralling bark. It is the stems that are harvested for medicinal purposes in Baringo County, not only for diabetes but also for diarrhoeal, abdominal related ailments and as an anti- oxidant [25-27]. There are no known side effects of this herb.

Figure 5: Tinospora cordofolia Chopped Stems

d). *Aloe tweedie*

Aloe tweedie is a short- stemmed shrub, an evergreen perennial succulent plant species of the genus Aloe, with a broad, glossy green, mottled leaves which are well-branched *(Figure 6)*. In Baringo County, *Aloe tweedie* occurs naturally in many of the arid and semi-arid areas. It is the leaves that are harvested for medicinal purposes, not only for diabetes but also for hypertension.

Figure 6: *Aloe tweedie Plant*

e). *Solanum nigrum (African nightshade)*

African nightshade (*Solanum nigrum*) is an annual or occasionally perennial plant in the *Solanaceae* family. It grows between 15–60 cm tall and usually has many branches. Its leaves are triangular to elliptic in shape and stems are circular and sometimes slightly hairy *(Figure 7)*. It is the stems and leaves that are harvested for food by many Baringo citizens and for medicinal purposes. Other than being antidiabetic, this herb has also been found to possess potent hepatoprotective, *antiulcerogenic, cytoprotective, antinociceptive*, anti-inflammatory, and antipyretic properties [28, 29].

Figure 7: African Nightshade Plant

f). *Sorghum bicolor*

Sorghum bicolor is an annual grass-like plant from the family *Gramineae,* subfamily *Panicoideae*. It grows in drought-like, warm humid conditions of Baringo County. The seeds are the ones that are harvested for food and their medicinal purposes *(Figure 8)*. Other than use in management of diabetes, it is also used as an anti-inflammatory, antioxidant, anticancer, *antihypercholesterolemia* and a neuroprotective [30, 31].

Figure 8: Sorghum Seeds

g). *Hypoestes forskaolii*

Hypoestes forskaolii is classified under the family, *Acanthaceae*. It is a shrub-like plant that grows to a maximum height of 1-1.5 meters *(Figure 9)*. It has pale pink or white flowers. The lower stems proximal to the ground and the roots are the ones that are harvested for medicinal purposes. It has also been found to possess anti- cancer properties and anti-protozoans properties[32] and [33].

Figure 9: Leaves, Flower, and Stem of Hypoestes forskaolii Shrub

h). *Tamarindus indica*

Tamarinda indica is a leguminous tree that belongs to the family of *Fabaceae*. It produces pod-like fruits that contains a brown, edible pulp. It is a long-lived, medium-growth tree, which attains a maximum crown at a height of 12 to 18 meters (39 to 59 ft) *(Figure 10)*. It is the pulp (used also as food) and the seeds that are used for medicinal purposes *(Figure 11)*. With regards to toxicity, a study done by [35] found that its toxicity (LD50) ranges between 832 μg/mL and 5,019 μg/mL [34].

Figure 10: *Tamarindus indica Tree*

Figure 11: *Tamarindus indica Fruit*

Figure 12: *Zanthoxylum chalybeum Tree*

i). *Zanthoxylum chalybeum*

Zanthoxylum chalybeum is a deciduous shrub or tree from family *Rutaceae*. It can grow up to 12 meters high. It grows in medium to low altitudes of dry woodland or grassland, which is found mostly in the lowlands of Baringo along Kerio Valley escarpment (F*igure 12*). Its fruits were spherical, about 5 mm in diameter, reddish-brown, splitting to allow the shiny black seeds to partly protrude. It was those fruits that were harvested and used as antidiabetic herbal medicine (Figure 13). The herb had an LD 50 of 268.28 μg/ml[36, 37].

Figure 13: *Zanthoxylum chalybeum Seeds*

j). *Eriobotrya Japonica*

Loquat is botanically referred to as *Eriobotrya japonica*, belongs to the family *Rosaceae*. Its tree can grow to 5 to10 meters (16–33 ft) tall, but is often smaller, about 3–4 meters (10–13 ft). The leaves are alternate, simple, 10–25 centimetres (4–10 in) long, dark green, tough and leathery in texture, with a serrated margin,

and densely velvety-hairy below with thick yellow-brown pubescence. It is grown in most parts of Baringo climatic regions. It is the young top leaves which are harvested and used as an antidiabetic (*Figure 14*). Other than its antidiabetic activity, studies have shown that loquat extracts contain many antioxidants capable of counteracting inflammation, cancer, bacterial infection, aging, pain, and allergic reactions [38-40].

Figure 14: Loquat Tree

k). *Mangifera foetida*

Mango tree botanically referred to as *Mangifera foetida* belongs to the family *Anacardiaceae*. It is well distributed worldwide and it is one of the most widely cultivated fruits in the tropics. It grows in almost all climatic regions of Baringo County. The orange-pink young leaves are the ones harvested as antidiabetic medicine *(Figure 15)*. From literature, its' leaves have also been found to be an potent antioxidant [41-43].

Figure 15: Mango Tree (Mangifera foetida)

Herbs Grown in Baringo County, but Not Native of Baringo County

l.) *Zingiber officinale*

Ginger plant is a grass-like plant that is classified in the family of *Zingiberaceae*. Botanically it is referred to as *Zingiber officinale*. It is an herbaceous perennial herb with pseudostems. Its roots are what is harvested as ginger root or ginger and used for medicinal purposes *(Figure 16)*.

Figure 16: Ginger Root

m.) *Cinnamomum Verum*

Cinnamon is a spice obtained from the inner bark of the *Cinnamomum* tree. It is an evergreen and aromatic plant which belongs to the family of *Lauraceae* (*Figure 17*). It has been found to possess antioxidant enzymes which enables it to reduce sugar levels in rats [44]. It is also known to have, antimicrobial and anticandidal capabilities [45-47].

Figure 17: Cinnamomum Tree Barks

Sources of the Herbs

Except for *Zingiber officinale* and *Cinnamomum verum* which were obtained from the supermarkets and diabetic herbal clinics within Baringo County, *Carissa edulis* roots with its barks were obtained from Kabartonjo in North Baringo constituency in Kitimok forest. The stem & leaves of *Urtica dioica* and the stems and roots for *Hypoestes forskaolii* were obtained from the Eldama-Ravine forest in Eldama-Ravine constituency. *Aloe tweedie* leaves were obtained from escarpments of Kabarnet town-Central Baringo Constituency. *Solanum nigrum* leaves (African Nightshade) and *Sorghum bicolor* seeds were obtained from Kabartonjo, Baringo North constituency. Whereas *Tinospora cordofolia* stems were obtained from the outskirts of Kabarnet town along the river Kiboino. *Tamarinda indica* and *Zanthoxylum chalybeum* were obtained from the lowlands of Baringo County along river Kerio. *Mangifera foetida* and *Eriobotrya japonica* leaves were obtained from the Eldama-Ravine constituency.

Table 3: *Preparation of The Herbs as Reported the by Diabetics*

Herb	Preparation methods	x / 39 (Frequency of diabetic respondents)	Percentage x / 39 *100
1. (*Carissa edulis* roots and bark, *Urtica dioica* leaves, *loquat* leaves, *Hypoestes forskaolii* mango leaves, *Zanthoxylum chalybeum* seeds, and *Tamarinda indica* seeds)	Crushed then dried and resultant powder put in boiling water	33/39	84.61
2. (sorghum seeds, leaves of *Aloe tweedie, Tamarinda indica* pulp)	Taken raw / chewed	10/39	25.64
3. (*aloe tweedie* leaves)	Squeeze sap into a cup	2/39	5.13
4. (*sorghum seeds*)	Dried seeds- taken the way they are	1 /39	2.56
5. (*Hypoestes forskaolii)*	Chopped and boiled in water	1/39	2.56
6. (*Tinospora cordofolia, Tamarinda indica*)	Soaked in cold water for 3 days	6/39	15
7. (*ginger* and *cinnamon*)	Crushed raw into small pieces and mixed with beverages	5/39	12.82
8. (*Solanum Nigrum* and *Sorghum Bicolor*)	Cooked as food	2/39	5.12

The method of preparation of the herbs as described in **table 3** above, vary from one part of the herb to another, from one herb to another and from one diabetic to another. However, as reported by most(84%) of the diabetics, once a herb is obtained from the field, it is cleaned and dried for about 72 hours in the sun after which they crushed into powder in readiness for use.

Herbalists

In spite of the difference in preparation methodology as described by herbalists, over 75% crushed their herbs into powder while approximately 58 (30%) believed in boiling the herbs That is the leaves or the roots fresh as soon as they were harvested or collected

from the forest. They were then administered until the original taste of the herb is no longer perceived. Others (8%) advised their clients to take (chew some pieces) the fresh herb (*Aloe tweedie* and *sorghum bicolor*).

Dosage of the Reported Herbs

The dosage of the herbs also varied from one herbalist / diabetic to another. It also varied from one herb to the other. Nevertheless, 58.% of them especially those who gave / took ground crushed powder of any selected / preferred herb, used two teaspoonful soaked in 250 mls of hot water twice a day (i.e. morning and evening) while others (approx. 42%) preferred the same two teaspoonful soaked in 500 mls of hot water twice a day.

Some diabetic/herbalists(47%) preferred boiling them as soon as they were harvested and later took in a cup of 500 mls daily. The latter was supposed to be taken daily until the original taste of the herb was no longer perceived. (**Table 4**) below summarizes the approximate dosages and the equivalent dry weights in grams for the herbs as reported by both the diabetics and the herbalists interviewed.

Table 4: Approximate Dosage of the Herbs Used in Grams as Reported by Both the Antidiabetics and Herbalists

Herb	Herbalist /Diabetic herbal Dosages	The equivalent amount of dried herb weight consumed in grams
1. *Carissa edulis*	2 teaspoonfuls in 500 mls twice a day	Approx. 16.5g of the herb B. D
	2 teaspoonfuls in 250 mls twice a day	Approx. 16.5g of the herb B. D
2. *Sorghum bicolor*	Chewing a handful of sorghum when the client has fatigue and general malaise (PRN)	Approx. 100g of the herb PRN
	Sorghum flour prepared as Ugali and taken once daily (OD)	Approx. 500g of the herb / day / OD
3. *Urtica dioica*	Used as vegetables 3 times in a week	Approx. 152g of the herb /per serving x3= 456g / day
	As vegetables once daily.	Approx. 152g of the herb per serving x1= 152g / day / OD
	Once a day as vegetable/OD	152g of the herb /day/OD
	Boiling approx. 1kg of dried herb in 2litres of water till boiling point and taking 50mls of resultant product as herbal tea twice daily/BD	Approximately 33.3g / 50mls twice a day/BD
4. *Hypoestes forskaolii*	Taken once daily as herbal tea in a 250mls cup-which was approximately 2-3 teaspoonful per cup/BD	5.8921g per teaspoonful 2 teaspoonfuls =11.78g (BD) 3 teaspoonfuls =17.67g(TID)
5. *Aloe tweedie*	Around 50mls, sap squeezed into a cup and taken once daily	Approximately. 40g / day / OD

Herb	Herbalist /Diabetic herbal Dosages	The equivalent amount of dried herb weight consumed in grams
6. *Zingiber officinale*	½ a teaspoonful mixed with 250mls of tea and taken once daily in the morning as herbal tea	Equivalent to 3.625 grams of ZO per day
7. *Tinospora cordofolia*	About 500g of the herb soaked in 1000 mls of clean cold water for 48hrs, after which approximately 50mls taken twice daily	50mls is Approx. 10g of the herb /day
8. *Solanum nigrum*	As vegetables once daily,	Approx. 152g per serving x1= 152g/ day
9. *Cinnamomum verum*	2 teaspoonfuls mixed with a 250 ml cup of tea/ coffee/milo etc. and taken once daily	6.5197 g per teaspoonful which is approx. 13g/day of *cinnamon*
10. *Pulp -Tamarindus indica*	Approximately 500g of tamarinda Indica sap (i.e. after removal of the seeds) soaked in 1.5l of cold water for 48 hours. The resultant mixture was taken at a dose of 100mls three times a day	100mls was approximate = 33.3g
11. *Seeds-Tamarindus indica*	The seeds crushed into coarse powder and 2 teaspoonfuls added in 250 mls of hot water and taken twice a day	2 teaspoonfuls is approximately=12.68g/day
12. *Zanthoxylum chalybeum*	One teaspoonful of dried fruits crushed into coarse powder and added into 500 mls boiling water and taken twice a day	One teaspoonful is equivalent to 5.43g Therefore 2=10.86g/day
13. *Mango leaves (Mangifera foetida)*	Approximately 500g of leaves boiled in 1.5 litres of water until boiling point and 50mls taken twice per day	50mls is approximately equivalent to 10g of the dried herb/day
14. *Loquat leaves (Eriobotrya japonica)*	Approximately 500g of leaves boiled in 1.5 litres of water until boiling point taken once a day	50mls is approximately equivalent to 10g of the dried herb/day

Key: **PRN**- When necessary, **B.D-** Twice daily, **g**-grams, = equal to, *approx*.-approximately, **TID**-three times a day, **OD**-Once a day

Most (8/12, 66.7%) of the herbalist administer most of their medications singly while around (3/12, 25%) herbalist use in combinations of either 2 or 3 herbs. Most (3/12, 25%) of the preferred combinations was that of *Urtica dioica* and *Hypoestes forskaolii*. Those who combined believed that combinations enhanced the process of sugar reduction.

Reasons for Using/Prescribing Diabetic Herbal Medications Diabetics

A majority (76.9%) of the diabetics believed that diabetic herbal medicines improved their health status. About 43.59% used them because they are cheap. Around

64 (10%) used them because they are easily available and accessible compared to conventional drugs and there were also those 17 (94%) who used herbs because they had not felt any better having used conventional medicine for quite some time. They preferred herbs with the hope of getting better results. Those herbal drugs according to 79 (48%) of the diabetic respondents were culturally and socially acceptable

Herbalists

With regards to the herbalists, they did not only believe that the herbal medications stabilized the blood sugars (67%) but also cured in the long run (25%).

Knowledge of Diabetic Medicinal Plants Conservation
Diabetics

With regards to their understanding of conservation (careful and sustainable use of diabetic medicinal plants/herbs), 31%, of the diabetics described conservation as;
'using of medicinal plants wisely or efficiently and harvesting them only, if needed.'

44% understood conservation as planting more medicinal herbal trees / shrubs upon collecting them and teaching the future generations the importance of medicinal plants so that they also could plant more. 5% understood conservation as protecting medicinal plants from predators

Herbalists

Only 16.7% of the herbalists said they have never heard of herbal medicine conservation. Those 83.3% who had heard about it gave different opinions on what they know about conservation. 75% described conservations as a way of ensuring that they have a constant supply,
'those herbs which can be dried and stored, would be harvested in plenty during the rainy season to last till the next rainy season'.

33% described conservation as responsible harvesting

'If one is harvesting roots in a herb, one has to harvest some and leave some to ensure that the herb does not die'.

Discussion

The antidiabetic herbs commonly used by the Tugen community in Kenya as reported by the herbalists were *Urtica dioica* (75%) and *Carissa edulis* (58%), which have also been reported elsewhere in the world [48-53]. These two herbal medications are not only used to manage diabetes, but also other conditions like hypertension and abdominal related ailments. Their abundance and the ease in obtaining them in many parts of Baringo County, could explain why these herbs were commonly in use. The other herbs which include *Tamarinda indica, Zanthoxylum chalybeum, Eriobotrya japonica, Zingiber officinale, Sorghum bicolor, Tinospora cordofolia,* and *Cinnamomum verum* have also been reported elsewhere, though not widely used compared to the earlier two [54-60].

Apart from the herbs mentioned above, the others reported were *Hypoestes forskaolii, Mangifera foetida* and *Aloe tweedie* species which have seldom been reported elsewhere as an antidiabetic, though their sister species *Aloe vera* and *Mangifera indica* respectively has been reported widely [61].

Since the diabetics and herbalists obtain these herbs from varied sources, so are the methods of preparation and dosaging. Thus, most diabetics crushed their herbs, some boiled and others took them while fresh without subjecting to any process. That made it difficult to define clear methodology of preparation and dosaging. That can subject users to various degrees of toxicities because some might take under dose, others over dose. This finding concurrent to a study done in 2017 by [62].

In terms of efficacy, more than 70% of the herbalists and 76.9% diabetics respectively reported effectiveness and safety of the herbs they were prescribing in management of diabetes. Those results resonates with findings of an earlier study. Herbalists prescribed their herbs because of the belief that they work and that was why they are in business.

Diabetic patients took these herbs because of their beliefs. That is; 64(10%) believed they were cheap, to 43(59%), they helped in reducing their blood sugars when high, to 79(48%) they were easily available and accessible compared to conventional drugs. They also took them because, after having taken conventional

drugs for quite some time they had not felt better. A finding that concurred with studies done by [63-65].

With regards to knowledge on conservation both the herbalist and the diabetic patients seemed to have had an idea of what conservation was, despite the fact that, most of the herbalists had no formal education. a finding consistent with a study done by [66, 67].

It was of the essence to note that, unsustainable exploration of those important biological resources of social and economic value (such as diabetic herbal medications), might lead to loss of biodiversity if not well regulated [66-68]. Taking care of biodiversity and its services in the community, creates one of the reasons why we should enhance and promote conservation and sustainable use of medicinal plants. [69].

Conclusions

This study found out that *Carissa edulis* (CE) and *Urtica dioica* (UD) were the most frequently used antidiabetics followed by *Hypoestes forskaolii, Tamarinda indica* and *Zanthoxylum chalybeum* in Baringo County. The preparation and dosaging of these herbs varied from one diabetic patient to another and from one herbalist to another. Diabetics believed that, these herbs improved their health status while the herbalists believed they stabilized the blood sugars. Also they might cure diabetes in the long run. With regards to conservation, diabetic patients and herbalists using and prescribing these herbs, seem to remotely understand the issues of bio conservation respectively.

Recommendations

Since there is no standard method of preparation and dosaging of these herbs, need to create awareness to the diabetics and herbalists on issues and importance of standardization is now. More studies to be explored in reference to *Hypoestes forskaolii, Mangifera foetida* and *Aloe twedee* species to cornfirm their antidiabetic tendencies and benefits. The assertions by the diabetics and herbalists with reference to effectiveness of the antidiabetic herbal medications by using and prescribing respectively, require scientific determination. Even though they seem to understand the issues of bio conservation, much more knowledge is needed. The diabetics and herbalists to enhance sustainability and careful use of these very important environmental resources, for now and in the future.

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