

Identification and Determination of Wild Yam Distribution in Kenya

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Abstract: Yam (*Gen. Dioscorea*) comprise globally distributed plants, a few of which are domesticated as a food crop. Some of the wild species are also harvested for their starchy tubers and tubules or as herbals, among several communities. The wild yam species are rapidly threatened with extinction because of habitat loss. A study was carried out on the distribution of wild yams in fifteen diverse localities in Kenya with the aim of establishing the status and promoting their conservation. A questionnaire was used to determine the indigenous knowledgeable on the wild yams. Thirty one wild yam accessions, belonging to four species, namely; *Dioscorea schimperiana* Kunth., *Dioscorea bulbifera* L., *Dioscorea quartiniana* A. Rich. and *Dioscorea dumetorum* were collected and identified. The respondents in most of the localities were knowledgeable of the wild yams and their use as food or herbals. *Dioscorea schimperiana* Kunth was widespread, whereas *D. dumetorum* was only recorded in the Coastal region. In view of the rapid habitat loss in Kenya, there is the need to promote the conservation of the wild yam species.

Keywords: *Dioscorea*; species; wild yam; distribution; local community; Kenya

1. INTRODUCTION

1.1 Background Information

Yams (*Dioscorea spp*) are herbaceous or woody climbing tuber-bearing plants with distinct annual or perennial cycle of growth [1]. Although a few species of yam have been domesticated, there are many other species that are wild. Some of the wild yams have edible tubers and some are useful as medicinal plants in America, Asia and Africa. These wild yams constitute staple food for hunter-gatherers living in forests in Central Africa and Uganda [2, 3, 4].

Yams belong to the genus *Dioscorea* in the family Dioscoreaceae, order Dioscoreales [6, 7]. The diversity of the genus has been evolving over the years. For example, [8] reported that 350-400 species of yam exist worldwide, most authors have estimated their number to be over 600 [1, 9, 10], while [11] reported the genus to be comprised of 633 species and most recently, the genus *Dioscorea* was reported to be comprised of 644 species worldwide [12, 13]. Thus, the taxonomy of yams is complex and further groupings could emerge based on recent molecular biology techniques [14]. The genus *Dioscorea* is also divided into different sections, based on gross morphological traits [15], especially the direction of twining of the growing shoot on the support [16]. The most important sections in the genus *Dioscorea* include; *Enantiophyllum*, *Lasiophyton*, *Combilium*, *Opsophyton* and *Macrogynodium* [3]. The growing shoots of yams in the section *Enantiophyllum* that include *D. alata*, *D. cayenensis*, *D. opposita*, *D. japonica* and *D. rotundata*, twine to the right (anticlockwise) on their support and all are edible [3, 15]. The other sections, namely *Opsophyton* (e.g *Dioscorea bulbifera*), *Lasiophyton* (e.g *Dioscorea pentaphylla*, *Dioscorea dumetorum* and *D. hispida*) *Combilium* (e.g *D. esculenta*), *Macrogynodium* (e.g *D. trifida*) and *Macrourea* (e.g *Dioscorea sansibarensis* Pax.) have vines which twine to the left (clockwise).

Wild yam is common in uncultivated or undisturbed environments, including damp woods and swamps, thickets, roadsides, fence rows and hedges [17]. The major yam species which are also important food crops in most parts of the world originated in three distinct regions of the world: Southeast Asia, West

Africa and Tropical America, which are also considered the main centers of yam domestication and diversity [18].

Yams can grow from sea level to highland ecological zones, depending on the species, and even clones [19, 20]. Generally, yams grow best at moderate to high temperatures [21, 22]. The response to water availability is, however, more varied, and although high temperatures and limited water supply may be tolerated by some established yams, such conditions in the early growth stages can cause high mortality.

Yams are globally distributed, but mostly found throughout the tropics and sub-tropics with a few members in the temperate regions of the world [17, 8], especially in tropical West Africa, South East Asia and Tropical America [12, 13]. Therefore, sub-tropical to tropical climate is the most suitable for yam growth and survival. The wild yams occur in both Africa and Asia [23]. For instance, in India, 26 *Dioscorea spp* are reported, and of them, 13 are reported in Similipal Biosphere Reserve (SBR) in Odisha [24]. Out of these 13 species, only *D. alata* is cultivated, and the remaining species grow in the wild. Over 40 species of wild yams have been reported in Madagascar [25] while about 50 named species occur in Mainland Continental Africa; thus, summing up to about 90 species for the whole continent [26] which translates to about 23-26% of the 350-400 species currently recognized worldwide [8]. However, [26] reported absence of wild yams in the four deserts in Africa; namely Sahara in the north, Danakil in the northeast, Namib Desert in the southwest and Kalahari in the south-center, and also in regions with annual rainfall less than 200 mm. Furthermore, Ethiopia is an isolated center of yam cultivation in East Africa [27]. The current yam taxonomic status in Kenya comprises ten (10) species, both wild and cultivated types. The yam species that are still found in the wild environments include *Dioscorea dumetorum* Pax., *Dioscorea asteriscus* Burkill, *Dioscorea schimperiana* Kunth [28], *Dioscorea gilettii* and *Dioscorea odoratissima* Pax. [29, 30] and *Dioscorea kituiensis* [31] whereas the yam species that have been in cultivation include *Dioscorea minutiflora* Engl., *Dioscorea alata* L., *Dioscorea bulbifera* L., *Dioscorea dumetorum* Pax. and *Dioscorea odoratissima* Pax. that are grown for food especially by elderly farmers in the Eastern, Central, Western and Coastal regions of Kenya [32].

Although most yams have been classified to the species level, each species usually has a number of variants which have not been adequately studied and characterized. In spite of the over 600 and about 90 yam species identified in the world and Africa respectively, only a few have been identified in Kenya. To date, only few studies [29, 30, 32, 33, 34] have been undertaken concerning the diversity and distribution of landraces of *Dioscorea spp.* in Kenya. It is expected that there are still many wild yam species and/or subspecies that have not been identified but are at high risk of genetic erosion or even extinction due to habitat loss in many parts of Kenya. This study was therefore initiated to investigate the diversity of wild yams in some regions in Kenya, with the aim of establishing the yam species status and distribution, to guide future research, conservation and genetic improvement policies and programs.

2. MATERIALS AND METHODS

2.1 Survey, Mapping and Descriptions of the Study Sites

A survey was carried out with guidance of experienced local elders in six Counties in four regions of Kenya including Baringo, Elgeyo-Marakwet, Uasin Gishu and Nandi (North Rift), Kisii (South Nyanza), Kakamega (Western) and Kilifi (Coast), to identify and map sites with wild yams. Fifteen (14) locations were selected for this study. These locations were; Kombosang, Moigutwo, Kasaka, Mormorio, Kapkwang and Katimok Forest (Baringo), Kolol and Turesia (Elgeyo-Marakwet), Kapseret Forest (Uasin Gishu), Chepsangor and South Nandi Forest (Nandi), Lugusi (Kakamega) Nyakomisaro Stream (Kisii) and Kaya Tsolokero (Kilifi). The locations and brief descriptions of the selected sites are presented in Figure 1 and Table 1 respectively.

2.2 Data Collection

The study involved 27 wild yam accessions *in situ* in different selected localities. Identification, taking inventory and collection of wild yam specimens of each accession was carried out in the field.

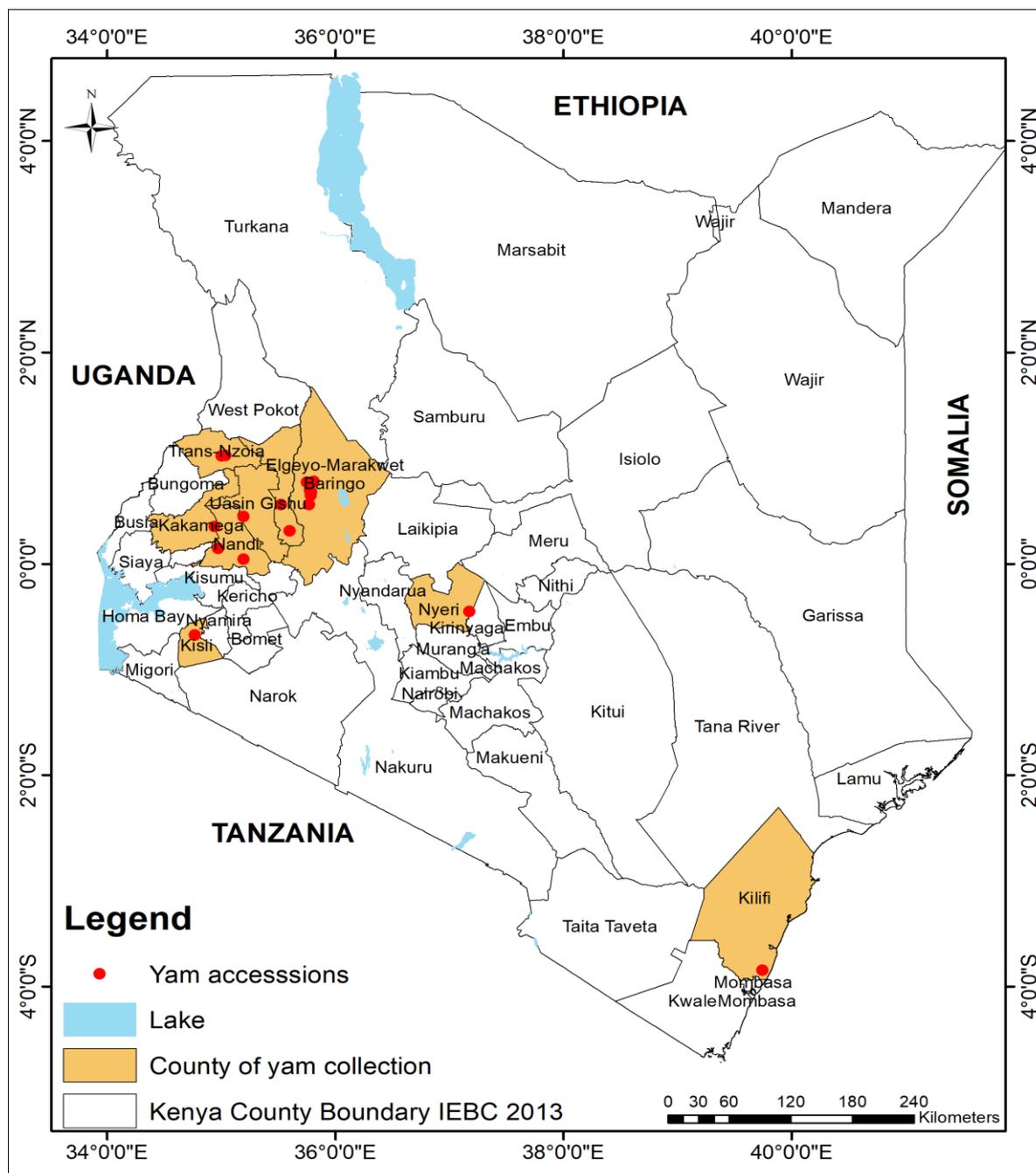


Figure1. A map of Kenya showing the sites and counties where the wild yam accessions were found and collected.

Table1. Brief descriptions of the sites where the yam accessions were found

Locality	Yam accession code	County	Region	Latitude	Longitude	Altitude (m)
Kombosang	KB1	Baringo	North Rift	0°46'26.07" N	35°44'52.66" E	1297
Moigutwo	MB1	Baringo	North Rift	0°46'51.27" N	35°48'38.95" E	1814
Mormorio	MB2a	Baringo	North Rift	0°41'55.52" N	35°46'27.99" E	1655
Mormorio	MB2b	Baringo	North Rift	0°41'55.52" N	35°46'27.99" E	1655
Kasaka	KB2	Baringo	North Rift	0°43'1.03" N	35°46'38.02" E	1455

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Bossei	BB	Baringo	North Rift	0°40'36.52" N	35°47'17.68 "E	1690
Kapkwang	KB3a	Baringo	North Rift	0°40'26.85" N	35°47'15.15" E	2110
Kapkwang	KB3as	Baringo	North Rift	0°38'54.31 "N	35°47'3.17" E	2111
Kapkwang	KB3b	Baringo	North Rift	0°38'54.31 "N	35°47'3.17" E	2110
Katimok Forest	KB4a	Baringo	North Rift	0°36'21.11 "N	35°46'27.28 "E	2213
Katimok Forest	KB4b	Baringo	North Rift	0°33'38.41 "N	35°46'8.66" E	2232
Katimok Forest	KB4c*	Baringo	North Rift	0°33'38.41 "N	35°46'8.66" E	2232
Kolol	KEa	Elgeyo- Marakw et	North Rift	0°33'42.70 "N	35°31'28.48 "E	1782
Kolol	KEb	Elgeyo- Marakw et	North Rift	0°18'45.65 "N	35°35'52.69 "E	1872
Kolol	KEc	Elgeyo- Marakw et	North Rift	0°18'45.65 "N	35°35'52.69 "E	1894
Turesia	TE	Elgeyo- Marakw et	North Rift	0°17'11.39 "N	35°34'58.46 "E	1868
Turesia	TEs1	Elgeyo- Marakw et	North Rift	0°17'11.39 "N	35°34'58.46 "E	1869
Turesia	TEs2	Elgeyo- Marakw et	North Rift	0°17'11.39 "N	35°34'58.46 "E	1870
Kapseret Forest	KUa	Uasin Gishu	North Rift	0°2'36.76" N	35°11'38.47 "E	2003
Kapseret Forest	KUb	Uasin Gishu	North Rift	1°1'19.97" N	35° 0'12.08"E	1987
Kapseret Forest	KUc	Uasin Gishu	North Rift	0°27'4.62" N	35° 12'0.42"E	1987
Chepsangor	CNa	Nandi	North Rift	0°21'5.99" N	34°56'28.61 "E	1638
Chepsangor	CNb*	Nandi	North Rift	0°21'5.99" N	34°56'28.61 "E	1638
South Nandi Forest	SNa	Nandi	North Rift	0°8'43.09" N	34°58'11.03 "E	1867
South Nandi Forest	SNb	Nandi	North Rift	0°8'43.09" N	34°58'11.03 "E	1867
South Nandi Forest	SNC*	Nandi	North Rift	0°21'5.99" N	34°56'28.61 "E	1867
Lugusi	Lka	Kakame ga	Western	0°40'22.70 "S	34°46'4.83" E	1831
Lugusi	LKb*	Kakame ga	Western	0°40'22.70 "S	34°46'4.83" E	1831
Nyakomisaro Stream	NK	Kisii	South Nyanza	0°26'59.55 "S	37°10'32.09 "E	1629
Kaya Tsolokero	KKa	Kilifi	Coast	3°50'45.40 "S	39°44'35.89 "E	148
Kaya Tsolokero	KKb	Kilifi	Coast	3°50'47.64 "S	37°44'38.85 "E	136
Kaya Tsolokero	KKc*	Kilifi	Coast	3°50'47.64 "S	37°44'38.85 "E	136

* Yam-like plants

The stem, leaf and floral morphological features including stem colour, presence/absence of prickles, presence/absence of vine bulbils, leaf shape and apex, twining direction, inflorescence type and number of flowers per inflorescence among other traits were recorded. During the field work, each wild yam accession discovered was locally named, photographed and three samples were collected. Their collection sites were georeferenced using GPS [35, 36] and their respective co-ordinates and altitudes were recorded (Table 1). After the field work in each locality, and using the collected specimens and/or photographs of the wild yam species (Plate 1, 2), interviews were also conducted on villagers using a questionnaire, to determine their indigenous knowledge on wild yam. Questions asked were mainly related to the folk nomenclature and distribution of yam in the localities.

All the voucher specimens of the wild yam accessions were deposited in the University of Eldoret Herbarium. Taxonomists from University of Eldoret and National Museum of Kenya identified the wild yam accessions. Identification of the field live and herbarium specimens was carried out based on their shoot morphological traits, and named using available taxonomic keys/information and the data compared to those from previous studies [37, 38, 31, 39, 40]. The yam accessions were finally identified to their species and/or sub-species taxa.

2.3 Data Analysis

A presence (+) or absence (-) matrix was performed to illustrate the yam geographic distribution and the type of habitat for each species was described.

3. RESULTS

3.1 Identity of the Wild Yam Accessions

The twenty seven (27) wild yam accessions which were collected across six counties in Kenya were classified into four species that were also reported by their local names (Table 2). The four wild yam species as identified and reported by their botanical and local names were:

1. *Dioscorea schimperiana* Kunth. that included accessions KB1, MB1, MB2a, KB3a, KB4b, KEa, TE, KUa, CN1a, CN2a, NK and LKa (Plate 1, Table 2). Accessions KB3as, TEs1 and TEs2 were identified as variants in *Dioscorea schimperiana* Kunth (Plate 1). The *Dioscorea schimperiana* Kunth. was also known by different local names by the respondents of the communities in the localities. It was identified as *Nyakanwo* (Tugen), *Yakanwet* (Keiyo/Nandi), *Omotabararia* (Abagusi) and *Limbama* by Bukusu/Luhya (Table 2). Despite some phenotypic differences in their shoot systems, KB3as, TEs1 and TEs2 were identified by same local names, *Nyakanwo* and *Yakanwet* by Tugen, Keiyo and Nandi ethnic groups respectively (Plate 2, Table 2).
2. *Dioscorea bulbifera* L. included KB4a, KUb, KEc, BB and KKb (Table 2; Plate 1). The Tugen, Keiyo and Nandi respondents gave *D. bulbifera* the same local name as *D. schimperiana*. Hence, the Tugen respondents in Baringo County, referred both *D. schimperiana* and *D. bulbifera* as *Nyakanwo*.

Table2. The local and botanical names of the wild yam accessions in North Rift, South Nyanza, Western and Coastal regions of Kenya

Yam accession			Ethnic group	County
Code	Local name	Botanical name		
KB1	<i>Nyakanwo</i>	<i>Dioscorea schimperiana</i> Kunth.	Tugen	Baringo
MB1	<i>Nyakanwo</i>	<i>Dioscorea schimperiana</i> Kunth.	Tugen	Baringo
MB2a	<i>Nyakanwo</i>	<i>Dioscorea schimperiana</i> Kunth.	Tugen	Baringo
KB3a	<i>Nyakanwo</i>	<i>Dioscorea schimperiana</i> Kunth.	Tugen	Baringo
KB3as	<i>Nyakanwo</i>	<i>Dioscorea schimperiana</i> Kunth. ssp1	Tugen	Baringo
KB4b	<i>Nyakanwo</i>	<i>Dioscorea schimperiana</i> Kunth.	Tugen	Baringo
KEa	<i>Yakanwet</i>	<i>Dioscorea schimperiana</i> Kunth.	Keiyo	Elgeyo-Marakwet
TE	<i>Yakanwet</i>	<i>Dioscorea schimperiana</i> Kunth.	Keiyo	Elgeyo-Marakwet
TEs1	<i>Yakanwet</i>	<i>Dioscorea schimperiana</i> Kunth. ssp 1	Keiyo	Elgeyo-Marakwet
TEs2	<i>Yakanwet</i>	<i>Dioscorea schimperiana</i> Kunth. ssp 2	Keiyo	Elgeyo-Marakwet

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KUa	<i>Yakanwet</i>	<i>Dioscorea schimperiana</i> Kunth.	Nandi	Uasin Gishu
CNa	<i>Yakanwet</i>	<i>Dioscorea schimperiana</i> Kunth.	Nandi	Nandi
SNa	<i>Yakanwet</i>	<i>Dioscorea schimperiana</i> Kunth.	Nandi	Nandi
NK	<i>Omotabararia</i>	<i>Dioscorea schimperiana</i> Kunth.	Abagusi	Kisii
LKa	<i>Limbama</i>	<i>Dioscorea schimperiana</i> Kunth.	Luhya/Bukusu	Kakamega
KB4a	<i>Nyakanwo</i>	<i>Dioscorea bulbifera</i> L.	Tugen	Baringo
BB	<i>Nyakanwo</i>	<i>Dioscorea bulbifera</i> L.	Tugen	Baringo
KEc	<i>Yakanwet</i>	<i>Dioscorea bulbifera</i> L.	Keiyo	Elgeyo-Marakwet
KUb	<i>Yakanwet</i>	<i>Dioscorea bulbifera</i> L.	Nandi	Uasin Gishu
KKb		<i>Dioscorea bulbifera</i> L.	Chonyi	Kilifi
KB2	<i>Sekawet</i>	<i>Discorea quartiniana</i> A. Rich.	Tugen	Baringo
MB2b	<i>Sekawet</i>	<i>Discorea quartiniana</i> A. Rich.	Tugen	Baringo
KB3b	<i>Sita/Sekawet</i>	<i>Discorea quartiniana</i> A. Rich.	Tugen	Baringo
KEb	<i>Chepkawat/Sakawat</i>	<i>Discorea quartiniana</i> A. Rich.	Keiyo	Elgeyo-Marakwet
KUc		<i>Discorea quartiniana</i> A. Rich.	Nandi	Uasin Gishu
SNb		<i>Discorea quartiniana</i> A. Rich.	Nandi	Nandi
KKa	<i>Riga</i>	<i>Dioscorea dumetorum</i> (Kunth) Pax,	Chonyi	Kilifi
KB4c*	<i>Kisong'ore</i>	<i>Smilax aspera</i>	Tugen	Baringo
CN1b*	<i>Mosoriot</i>	<i>Smilax aspera</i>	Nandi	Nandi
SN2c*	<i>Mosoriot</i>	<i>Smilax aspera</i>	Nandi	Nandi
LKb*	<i>Olusuli</i>	<i>Smilax aspera</i>	Luhya/Bukusu	Kakamega
KKc*		<i>Smilax aspera</i>	Chonyi	Kilifi

* Yam-like plant



Plate1. Shoots of different wild yam species that were observed in situ in three regions of Kenya; *D. schimperiana* (MB2a, KB3a, KEa, TE; in North Rift and NK, in South Nyanza, *D. quartiniana* (KEb and KB) and *D. bulbifera* (KUb and KEc) in North Rift, Kenya.



Plate2. Stems, leaves and floral parts of *D. schimperiana* sub-species 1 (KB3as and TEs1) and sub-species 2 (TEs2).



Plate3. Yam-like wild plants, *Smilax aspera*; KB4c* (Baringo County), CN1b* and CN2b* (Nandi County) and cultivated yam, *D. alata*, MN (Nyeri County).

Keiyo and Nandi respondents in the respective Kolol and Kapseret Forest in Elgeyo-Marawet and Uasin Gishu Counties, referred *D. bulbifera* and *D. schimperiana* plants as *Yakanwet* (Table 2). However, Chonyi respondents in Kaya Tsolokero in Kilifi County did not know the indigenous name of *D. bulbifera*.

3. *Dioscorea quartiniana* A. Rich. included KB2, KB3b, KEb, KUc and CN2b, was locally known as *Sekawet* or *Sita* by Tugen respondents in Kasaka, Mormorio and Kapkwang localities in Baringo County (Table 2). Keiyo informants in Kolol locality in Elgeyo-Marawet County referred *Dioscorea quartiniana* as *Chepkawat/Sakawat*, but it was unknown to the respondents of Nandi ethnic group in both Nandi and Uasin Gishu Counties.

4. *Dioscorea dumetorum* (Kunth) Pax. (KKa) was named *Riga* or *Mriga* by respondents of Chonyi ethnic group in Kaya Tsolokero.

5. In the study, yam-like plant species with prickled vines and leaf morphology that closely resembled *D. alata* L. (Plate 3) which included KB4c*, CNb*, Snc*, LKb* and Kkb* were found in Katimok Forest, Chepsangor, South Nandi Forest, Lugusi and Kaya Tsolokero localities Table 2, Plate 3). They were identified as *Kisong'ore* (Tugen), *Mosoriot* (Nandi) and *Olusuli* (Bukusu/Luhya) but were unknown to Chonyi in Kaya Tsolokero. They were botanically identified as *Smilax aspera*.

3.2 Distribution of the Wild Yam Species

Dioscorea schimperiana was found in gentle to steep rocky slopes, wet or dry habitats, with thickets of trees and shrubs at Kombosang, Moigutwo, Mormorio, Kapkwang (Baringo), Kolol, Turesia, (Elgeyo-Marawet County), Chepsangor (Nandi County), Nyakomisaro Stream (Kisii County) and Lugusi (Kakamega County). Furthermore, it was found in forest edges at Katimok, Kapseret and South Nandi Forests in Nandi County (Table 3). It occurred in an altitude between 1297 - 2110 m above the sea level.

Dioscorea quartiniana was discovered in dry habitats, gentle and steep rocky slopes climbing over thickets of trees and shrubs in Kasaka, Mormorio and Kapkwang (Baringo County) and Kolol (Elgeyo-Marawet), moist/wet forest edges and rocky forest outskirts, at Kapseret Forest (Uasin Gishu County) and, deep and forest edges as well as riverine at South Nandi Forest (Nandi County). It inhabited areas with an altitude range of 1455 - 2003 m above the sea level.

Dioscorea bulbifera occurred mostly in humid/moist habitats in deep forest and forest edges in Katimok, Kapseret and Kaya Tsolokero Forests. Only a few plants were found climbing over natural woodland trees in moist/wet steep rocky slopes springs in Kiptebeng'wo Springs in Kolol and moist/wet gentle slopes in Summet Springs in Elgeyo-Marawet and Baringo Counties. It occurred in an altitude range of 1882 - 2003 m above sea level.

Dioscorea dumetorum was found in the moist/deep forest and dry outskirts of Kaya Tsolokero in Kilifi forest. It occurred in an altitude of 136 m above sea level.

Table3. Distribution of wild yam species according to habitats in four regions of Kenya

Code	Species	Habitat			
		Moist/wet deep forest	Forest edges	Dry, steep rocky slopes	Moist/wet riparian/riverine
KB1	<i>Dioscorea schimperiana</i> Kunth.	-	+	+	+
MB1	<i>Dioscorea schimperiana</i> Kunth.	-	+	+	+
MB2a	<i>Dioscorea schimperiana</i> Kunth.	-	+	+	+
KB3a	<i>Dioscorea schimperiana</i> Kunth.	-	+	+	+
KB3as	<i>Dioscorea schimperiana</i> Kunth. ssp1	-	+	+	+
KB4b	<i>Dioscorea schimperiana</i> Kunth.	+	+	+	-

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KEa	<i>Dioscorea schimperiana</i> Kunth.	-	+	+	+
TE	<i>Dioscorea schimperiana</i> Kunth.	-	+	+	+
TEs 1	<i>Dioscorea schimperiana</i> Kunth. ssp1	-	+	+	+
TEs 2	<i>Dioscorea schimperiana</i> Kunth. ssp2	-	+	+	+
KUa	<i>Dioscorea schimperiana</i> Kunth.	+	+	+	+
CNa	<i>Dioscorea schimperiana</i> Kunth.	-	+	+	+
Na	<i>Dioscorea schimperiana</i> Kunth.	+	+	+	+
NK	<i>Dioscorea schimperiana</i> Kunth.	-	+	-	+
LKa	<i>Dioscorea schimperiana</i> Kunth.	-	+	+	-
KB4a	<i>Dioscorea bulbifera</i> L.	+	+	-	-
KEc	<i>Dioscorea bulbifera</i> L.	-	+	+	+
KUb	<i>Dioscorea bulbifera</i> L.	+	+	-	-
KKb	<i>Dioscorea bulbifera</i> L.	+	+	-	-
KB2	<i>Discorea quartiniana</i> A. Rich.	-	+	+	+
MB2b	<i>Discorea quartiniana</i> A. Rich.	-	+	+	+
KB3b	<i>Discorea quartiniana</i> A. Rich.	-	+	+	-
KEb	<i>Discorea quartiniana</i> A. Rich.	-	+	+	-
KUc	<i>Discorea quartiniana</i> A. Rich.	-	+	+	-
SNb	<i>Discorea quartiniana</i> A. Rich.	+	+	+	+
KKa	<i>Dioscorea dumetorum</i> Pax	+	+	-	-
KB4c*	<i>Smilax aspera</i>	+	+	-	-
CNb*	<i>Smilax aspera</i>	-	+	+	+
SNc*	<i>Smilax aspera</i>	+	+	-	+
LKb*	<i>Smilax aspera</i>	-		+	+
KKc*	<i>Smilax aspera</i>	+	+	-	-

- Absent + Present

4. DISCUSSION

4.1 The Identity of the Wild Yam Accessions

The present study has shown that the 27 wild yam accessions which were collected across seven Counties in Kenya belonged to four species that included *D. schimperiana* Kunth., *D. bulbifera* L., *D. quartiniana* A. Rich. and *D. dumetorum* (Kunth) Pax. *Dioscorea schimperiana* and *D. bulbifera* had some morphological variants that greatly differed from the other accessions that they could be sub-species. Therefore, there is the need for morphological and molecular characterization to determine the relationships and identities of these wild yam species. Relatively, other wild yam species that have been identified and reported in Kenya include *Dioscorea odoratissima* which was found in Malaba forest [29], *Dioscorea gilettii* that was identified near Moyale in northern Kenya and in Southern Ethiopia [29, 30] and *Dioscorea kituiensis*, found in woodlands of Kitui and some regions of Meru in Eastern Kenya [31].

The results also indicate that the same wild yam plants were known by different local names even among members of the same ethnic community. Thus, *D. schimperiana* was known as *Nyakanwo* (Tugen) and *Yakanwet* (Keiyo and Nandi). Similarly, members of Kipsigis, a sub-group of Kalenjin living in Kericho County, refer *D. schimperiana* as *Yagniat* [41]. Although some of the respondents could identify the wild yam by name, they could not discriminate different species and hence assigning them the same name. For instance, *D. bulbifera* and *D. schimperiana*, were assigned the same local name, *Nyakanwo* by the Tugen or *Yakanwet* by Keiyo and Nandi ethnic communities. Similar findings were reported by [28], where *Dioscorea odoratissima* and *Dioscorea alata* were locally named *Emodo*

by members of Teso ethnic group. Apparently, local naming and generally indigenous knowledge of yams by local communities in Kenya, mirrors trends of local naming of yam in many parts of the world. For example, *D. bulbifera* that has been named *Nyakanwo* (Tugen) and *Yakanwet* (Nandi), is named *Pita aalu* by local communities in India [24].

Although the folk taxonomy is important in identification, naming and preservation of indigenous knowledge of yam, it could not distinguish closely similar members of different species or sub-species, hence the use of botanical system of nomenclature. But still, botanic identification of the wild yam in this particular study was not easy since many yam-like plants were discovered including KB4c*, CN1b*, CN2c* and LKb*. Distinguishing yam from these yam-like plants in the field, was also difficult as they share similar shoot morphological features that are confusing, hence required experienced taxonomist to identify them. In fact, [42] observed the same yam-like plants in Tugen hills and identified them as *Dioscorea abyssinica*, but actually they were *Smilax aspera*. Nonetheless, the folk taxonomy and botanical nomenclature have been applied the world over in the study of *Dioscorea spp* [24]. Generally, four (4) wild yam species and three morphotypes have been shown to exist in Kenya. Therefore, the present wild yam species status in Kenya comprise, *D. gilletti*, *D. asteriscus*, *D. odoratissima*, *D. kituiensis*, *D. schimperiana*, *D. quartiniana*, *D. dumetorum* and *D. bulbifera*.

4.2 The Distribution of the Wild Yam Species

The results revealed the presence of wild yams in all the fifteen selected localities. They were present in a wide range of habitats such as in moist/wet deep forest, forest edges and outskirts, rocky slopes, and wet/moist riverine forest. *Dioscorea schimperiana* and *D. quartiniana* occurred in moist/wet deep forest, forest edges and outskirts, rocky slopes, and wet/moist riverine forest habitats. This is indicative of their ability to adapt to varied environments, thus their presence in most of the localities studied. Furthermore, the presence of *D. schimperiana* in only protected environments such as riverine and catchment zones, particularly in Nyakomisaro and Lugusi, also suggests that *D. schimperiana* must have occupied most of the ecosystems in North Rift, Western and South Nyanza. Similarly, existence of *D. schimperiana*, *D. quartiniana*, *D. asteriscus* and *D. odoratissima* in Western floristic zone of Kenya has been reported (FTEA 1952-2012; Dino, 2013), but are currently non-existent or rare in the same zone. However, the current yam occurrence only in the protected habitats, is as a result of human activities including conversion of the yam habitats into agricultural land, construction of buildings and roads and change of policy on environmental conservation. These human activities have led to habitat loss and consequently loss of wild yam species. For instance, Nyakomisaro Stream and Lugusi in Kisii and Kakamega Counties, were the only localities with only one (*D. schimperiana*) out of the four species of wild yams discovered. These two counties have large portion of their land converted to agriculture and settlement, leaving out only the unsuitable or protected lands such as hill/catchment areas, road reserves and riverine/riparian zones. In fact, some of the riparian reserve zones have been planted with the fast growing blue gum trees, especially along the Nyakomisaro riparian. These ecosystems supported the *D. schimperiana* populations that were encountered in this study. Harvesting of the trees could disrupt the plant community, especially if suitable non-commercial replacement trees are not maintained. Therefore, human activity in riparian areas, although controlled by law, can cause degradation to the ecosystem, such as waste dumping and cutting down of eucalyptus trees along Nyakomisaro Stream zone. Moreover, commercial tree growing in Katimok and Kapseret forests and cereal crop farming in Kombosang, Kolol and Chepsangor, have increasingly accelerated the disappearance of wild yam. Thus, with this trend, the wild yam species in Kenya face a great risk of extinction.

Dioscorea quartiniana has been reported to occur in altitudes ranging between 0 - 2280 m above sea level [45], hence the reason for its availability in most of the localities which also could imply that the species is present in most parts of Kenya. The findings also agree with the report that *D. quartiniana* is common and distributed in Sub-Saharan Africa, from Senegal to Sudan, throughout tropical Africa to South Africa and in Madagascar [38, 45]. And similarly, it has also been reported as an extremely variable and present in a range of forests, grassland and rocky habitats [15, 45]. Despite their widespread occurrence, *D. schimperiana* and *D. quartiniana* have not been cultivated Kenya.

Dioscorea bulbifera tended to occur in moist/wet deep forest, forest edges and outskirts, and moist/wet riverine habitats which indicates their adaptation to moist or wet forested habitats. Furthermore, its occurrence within an altitude range of 136 - 2003 m above sea level, suggests it can inhabit low to high

altitude areas. The discovery of *D. bulbifera* in some parts is noteworthy because there is no prior report on the presence of wild *D. bulbifera* in Kenya. However, *D. bulbifera* (cultivated type) has been in cultivation in central, eastern, western and coastal regions of Kenya [28, 43, 44], but there is no history of its domestication in Kenya. In addition, its occurrence in the wild suggests that it could either be native or unrecorded introduction to these regions. This finding is also supported by the earlier reports that *D. bulbifera* is common in wild state in Africa [15].

Furthermore, in spite of its occurrence in the deep forest habitat, *D. dumetorum* was only found in Kaya Tsolokero in Kilifi County, at an altitude of 148 m above sea level. Similarly, existing information indicates presence of *D. dumetorum* in the coastal region (FTEA. [16, 28, 32]. Hence, *D. dumetorum* is adapted to the climatic conditions of the coastal region. Generally, of the four wild yam species discovered in this study, *D. bulbifera* and *D. dumetorum* have cultivated relatives in Kenya, but *D. bulbifera* wild type has not been described [16, 28, 32]. Generally, *D. schimperiana* and *D. quartiniana* were the most widely distributed while *D. dumetorum* is the least distributed wild yam species in Kenya.

5. CONCLUSIONS AND RECOMMENDATIONS

The results show that diverse wild yam species exist in various geographical locations in Kenya. In view of the rapid habitat loss in Kenya, there is the need to promote the conservation of the wild yam species.

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