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Density and Aboriginal Uses of Wild Tree Species in Milawilila Forest Reserve in Morogoro Region, Tanzania

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Abstract

This study assessed density and local uses of wild tree species in Milawilila forest reserve, Morogoro rural district. A total of six transects were set in the forest for assessing density and diversity of trees. In each transect, three plots of 20 m x 20 m were established and all trees with Diameter at Breast Height (DBH) ≥ 10 cm were identified, counted and DBH recorded in each plot. A semi structured questionnaire was used to obtain data on the use of tree species by the locals. Data were analyzed using Microsoft Excel and Statistical Package for Social Science software. A total of 172 trees/ha belonging to 20 species and 15 families were recorded in the forest. Among the families, Fabaceae was the richest family with 3 species, followed by Annonaceae and Cluciaceae with 2 species each. The most abundant species were *Xylopia parviflora*, *Ehretia amoena* and *Diospyros squarrosa*, which contributed 46% of the total tree density in the forest while the remaining 17 species contributed 54%. The Shannon-Wiener diversity index and basal area of the forest was 2.62 and 13.0 m^2/ha, respectively. The forest exhibited good regeneration pattern. The proportion of tree species used for medicines was 76%, constructions 60%, fuelwood 56%, crafts 52%, and food/fodder 28%. The three species with high citation index were *Albizia glaberrima* (3.58), *Annona senegalensis* (3.38) and *Scorodophleous fischeri* (3.16). Since, majority of the observed species were less dense, the study suggests planting of the wild tree species should be prioritized to guarantee sustainability of the forest reserve and viable supply of forest products and services to the community.

Keywords: Aboriginal uses, IVI, Milawilila forest, tree density, wild tree species

Introduction

In the developing world, forests play significant role in the livelihoods of rural and urban dwellers. They provide goods and services, which improve welfare of a respective society (Langat et al. 2016, Mgumia et al. 2017). Goods provided by forests include but not limited to timber, constructing materials such as poles and thatches, medicines, food, fodder, fuelwood, furniture, resin and agricultural gears (Luoga et al. 2000, Wilfred et al. 2006). Also, forests offer various services such as soil formation, soil fertility, soil erosion control, water supply, climate regulation and carbon sequestration (Kacholi 2014a, Adagba et al. 2016). Therefore, forests especially tree communities are imperative to the indigenous people's lives, household and country economy (Sharma and Gairola 2009, Fikir et al. 2016). Regardless of their importance to society, there are records of increasing degradation towards forests due to exploitation, for which attention is sought (Koller and Samimi 2011, Kacholi et al. 2015). Wild tree species are exploited for various purposes including energy, medicines, food, and constructing purposes. The uses of trees are largely influenced by locality, time and culture of a community (Luoga et al.

2000). While societies' necessities change with time, the change of taste, dimension and qualities of forest goods are markedly influenced by increase in human population and enhanced technology, which all together cause variation in density and uses of wild tree species (Mndolwa et al. 2008, Maguzu et al. 2017).

Since time immemorial, people have been exploiting the Mother Nature as source of their livelihoods (Fetene et al. 2012). Through this, an amassed body of knowledge, know-how and practices were developed and passed from one generation to the next by people with comprehensive histories of interaction with the environment. This accrued knowledge and traditional practices of indigenous communities are influential resources that can greatly facilitate the task of identifying useful wild plants (Adagba et al. 2016). The presence of tree species in any habitat is fundamental to man and other components of the ecosystem as all plants are valuable for one purpose or the other, but human activities can influence trees by altering their environment (Buba 2015). For instance, increased human population living near and within forested areas have exerted pressure on forest communities, which consequently resulted to deforestation, forest degradation and loss of biodiversity (Davidar et al. 2010).

In Tanzania, the majority of the rural population depends on forest resources for sustenance and cash income (Luoga et al. 2000, Robinson et al. 2002). Among the forest communities, trees are frequently sought for various uses but baseline information on their density and potential local uses in many local forests is lacking. Data on tree species composition, density and their aboriginal uses is very important in providing baseline information on the values of forests for management planning and monitoring (Mndolwa et al. 2008). Moreover, in order to warrant good management and sustainable productivity in the forest ecosystems, there is a need to know the priority use of diverse tree species. Simultaneously, in order to avoid the use of publics' perceptions, undertaking inventory is imperative for obtaining baseline data for assessment of effectiveness of the management systems as management of natural forests depends solely on existing information on the growing stock and utilization (Chamshama et al. 2004). Thus, this study was conducted to assess composition, density and articulate uses of wild tree species of Milawilila forest reserve.

Materials and Methods

Study area

Milawilila forest reserve is located at latitude 06°58´S and longitude 37°45´E in Tawa ward in Morogoro rural district, Morogoro region (Figure 1). The forest is at about 320 – 400 m above sea level and covers an area of about 13 hectares. The forest is characterized by lowland vegetation. The climate of the region is tropical sub-humid with bimodal rainfall regime. The long rains start in March and end in May of each year climaxing in April, while the short rains start in October and end in December. The mean annual rainfall and temperature of the area is around 740 mm and 25.1 °C, respectively (Figure 2). The population of the ward is around 11,000 people with a growth rate of 2.4% per annum with an average household of 4.1 (NBS 2012).

Data collection

The study was conducted between August and September 2017. The field survey was conducted to assess tree species composition, density and distribution in the forest, while a semi-structure questionnaire was given to selected heads of households in the community to obtain information on use categories of various tree species in the area. In order to determine tree species composition, density and distribution, a total of six transects were established in the forest, each having three plots of 20 m x 20 m, two placed at the edges and one in the middle of a transect. In each plot, trees with Diameter at Breast Height (DBH) $\geq$ 10 cm were identified, counted and their DBH recorded. The identification of species was done by the villagers and experts from the regional forest and beekeeping division. The semi-structured questionnaire was administered to 50 heads of chosen households living in the vicinity of the forest for the purpose of obtaining data on the use of trees. All respondents were guided on how to fill the questionnaire.

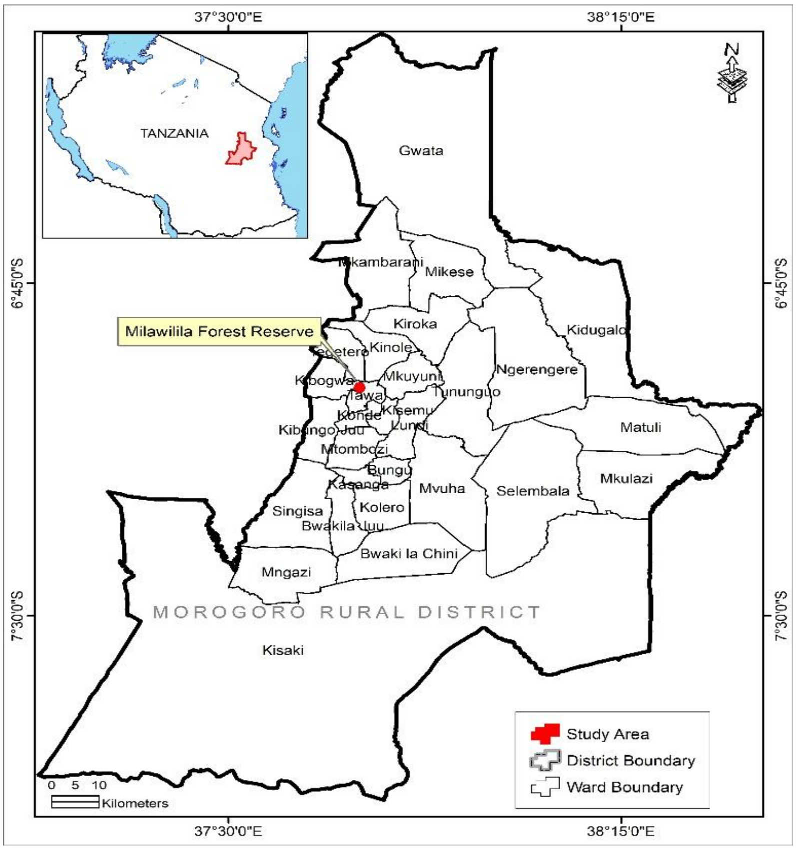

Figure 1: Map showing location of Milawilila forest reserve in Morogoro rural district and the location of the district in the country.

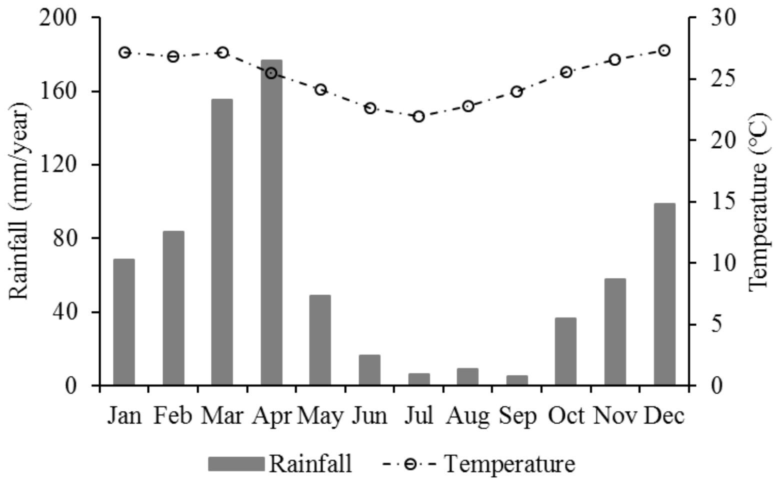

Figure 2: Monthly mean rainfall and temperature of Morogoro region.

Data analysis

Density of trees was calculated and expressed as number of individuals per unit sampled area as shown in equation 1. The species richness was determined by the number of observed species and the Michaelis-Menten Means (MMMeans) species richness estimator using the Species Diversity and Richness IV (SDR IV) software. The Shannon-Wiener diversity index (H') was calculated as per equation 2 below, where H' is Shannon-Wiener index, S is species richness encountered, P_i is a number of individuals of one species in relation to a number of individuals in a population and In is natural logarithm. Species dominance was determined by the importance value index (IVI), calculated as the summation of relative density (RDe), relative frequency (Rf) and relative dominance (RDo) as shown in equation 3 below. Forest basal area (BA) was computed based on equation 4 below. The regeneration status of the forest and selected tree species were determined using the following DBH classes: 10.0–19.9, 20.0–29.9, 30.0–39.9, 40.0–49.9, 50.0–59.9, 60.0–69.9 and > 70.0 cm following Kacholi et al. (2015). The obtained list of tree species and their uses were documented and analyzed using the Microsoft Excel and Statistical Package for Social Science (SPSS ver. 16). The citation index (CI) for each tree species was calculated using equation 5 below.

$$Density = \frac{Individuals}{Unit\ area} \quad (1)$$

$$H' = -\sum_{i=1}^{s} P_i\ InP_i \quad (2)$$

$$\text{IVI} = \text{Rf} + \text{RDe} + \text{RDo} \quad (3)$$

$$BA = 0.00007854\ x\ DBH^2 \quad (4)$$

$$Citation\ Index\ (CI) = \frac{Total\ number\ of\ citations\ of\ a\ tree\ species}{Total\ number\ of\ respondents} \quad (5)$$

Results

Density, IVI, diversity and basal area

A total of 172 individuals/ha belonging to 20 species and 15 families were recorded in the forest. The richest family was Fabaceae with 3 species, followed by Annonaceae and Cluciaceae, each with 2 species (Table 1). The remaining twelve families were represented by one species. The most abundant species was *Xylopia parviflora* with

20.2% of the total individuals, followed by *Ehretia amoena* and *Diospyros squarrosa* having 16.9% and 8.9% of the total individuals, respectively. The three most frequent species were *X. parviflora, E. amoena* and *Synsepalum cerasiferum* with 14.1%, 13.0% and 9.8% of the total occurrence of all species, respectively, and the same three species had higher relative dominance in the order of *S. cerasiferum* (32.1%), *X. parviflora* (20.4%) and *E. amoena* (11.0%). The top three species in terms of IVI were *X. parviflora* (54.7), *S. cerasiferum* (49.1) and *E. amoena* (41.0), all together contributing 48.3% of the total IVI (Table 1). The species diversity index and basal area were 2.62 ± 0.09 and 13.0 ± 3 m^2/ha, respectively.

Table 1: Forest tree species composition and importance value indices (IVI)

Family	Species Name	Rf	RDe	RDo	IVI
Anacardiaceae	*Sorindeia madagascariensis* DC.	6.5	5.6	1.3	13.5
Annonaceae	*Xylopia parviflora* (A. Rich.) Benth.	14.1	20.2	20.4	54.7
	Annona senegalensis Pers.	2.2	1.6	1.5	5.3
Apocynaceae	*Voacanga africana* Stapf.	5.4	4.8	1.8	12.0
Bignoniaceae	*Markhamia zanzibarica* (Bojer ex DC.)	5.4	4.8	1.4	11.7
Bombaceae	*Bombax rodognaphalon* K. Schum.	3.3	2.4	5.2	10.9
Boraginaceae	*Ehretia amoena* Klotzsch.	13.0	16.9	11.0	41.0
Cannabaceae	*Trema orientalis* (L.) Blume	3.3	2.4	0.7	6.4
Cluciaceae	*Allanblackia stuhlmanii* (Engl.) Engl.	4.3	3.2	1.7	9.3
	Allanblackia ulugurensis Engl.	1.1	0.8	0.1	2.0
Ebenaceae	*Diospyros squarrosa Klotzsch.*	7.6	8.9	7.3	23.8
Euphorbiaceae	*Bridelia micrantha* (Hochst). Baill.	3.3	3.2	0.7	7.2
Fabaceae	*Scrodophleous fischeri* (Taub) J. Leon	4.3	5.6	2.4	12.4
	Albizia glaberrima (Schum & Thonn.) Benth.	3.3	2.4	4.1	9.8
	Albizia versicolor Welw. Ex Oliv.	3.3	2.4	0.3	6.0
Hypericaceae	*Harungana madagascariensis* Lam. ex Poiret	1.1	0.8	0.5	2.4
Rhizophoraceae	*Cassipourea malosana* (Bak.) Alston	2.2	1.6	5.2	9.0
Rubiaceae	*Oxyanthus goetzei* K. Schum.	3.3	2.4	1.3	7.0
Sapotaceae	*Synsepalum cerasiferum* (Welw.) T.D. Penn.	9.8	7.3	32.1	49.1
Sterculiaceae	*Dombeya natalensis* Sond.	3.3	2.4	1.0	6.7
	Total	100	100	100	300

Note: Rf = Relative frequency, RDe = Relative density, RDo = Relative dominance and IVI = species importance value index

Species area curve

The species area-curve displayed an increasing trend with increasing sample efforts (Figure 3). The curve closely approached an asymptote. The Michaelis-Menten Means (MMMeans) non-parametric species richness estimator revealed higher number of species (26 species) than the observed ones.

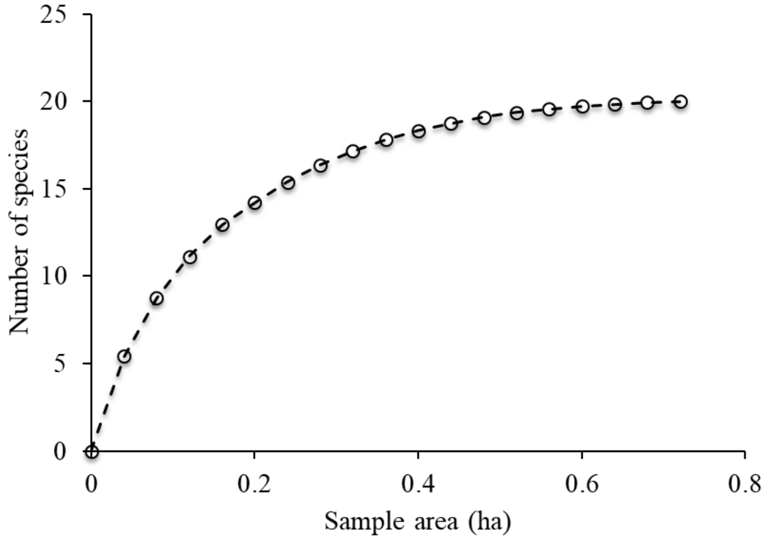

Figure 3: Species-area curve.

Forest regeneration status

The forest DBH class distribution versus number of individuals revealed the inverse J-shaped curve (Figure 4). The number of trees within the first two DBH classes (10–19.9 cm and 20–29.9 cm) were 71 and 25 individuals, respectively, which all together contributed 77.4% of the total individuals in the forest. The maximum DBH of 106 cm was recorded for *S. cerasiferum*. The highest basal area of 5.6 m^2/ha was recorded at > 70 cm DBH class while the lowest basal area of 0.5 m^2/ha was registered at 60 - 69.9 cm DBH class, followed by 1.2 m^2/ha at 40 - 49.9 cm DBH class (Figure 4).

Demographic information of respondents

Out of the total respondents, 68% were males and 32% were females. 66% of the respondents were of age group 21–40 years, followed by age group 41–60 years (28%), > 60 years (4%) and < 20 years (2%). In terms of educational background, 70% and 22% of the respondents in the surveyed households had primary and secondary education, respectively. 8% did not have an opportunity to formal education system and no one had tertiary education. 82% of the respondents were farmers, 10% self-employed doing petty businesses and 8% were carpenters (Table 2). About 52% admitted to access forests to acquire their needs, especially for medicinal, constructional and fuel wood acquisition purposes.

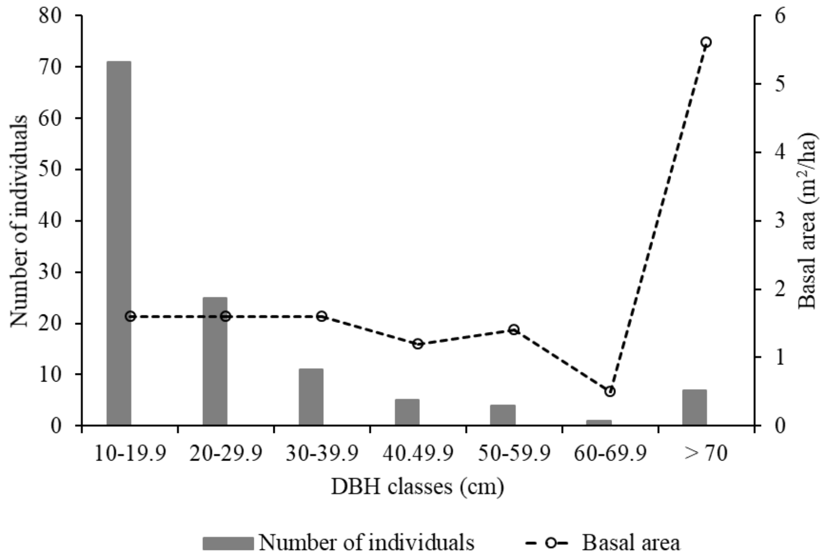

Figure 4: DBH class and basal area distribution in Milawilila forest.

Table 2: Respondents' demographic data

Variables		**Frequency**	**% frequency**
Sex	Male	34	68
	Female	16	32
Age group (years)	< 20	1	2
	21 - 40	33	66
	41 - 60	14	28
	> 60	2	4
Education	No formal	4	8
	Primary	35	70
	Secondary	11	22
	Tertiary	0	0
Occupation	Farmer	41	82
	Carpenter	4	8
	Self employed	5	10
	Government employee	1	2

Aboriginal uses of wild tree species by the locals

On top of the observed tree species in the forest reserve, five more wild species, namely; *Adansonia digitata, Combretum molle, Deinbollia borbonica, Dicrostachys cinerea* and *Vangueria infausta* were also listed by the respondents to be used for various purposes by the locals in the Ward. All the listed tree species were reported to be used either for food, medicines, crafts, construction materials and fuel wood including firewood and/or charcoal (Table 3). The five tree species with high citation index were *Albizia glaberrima* (3.58), *Annona senegalensis* (3.38), *Scorodophleous fischeri* (3.16), *Albizia versicolor* (2.68) and *Allanblackia ulugurensis* (2.66). The species with lowest citation index were *D. borbonica* and *D. squarosa* with citation index of 0.24

each. 76% of the tree species were used for medicinal purposes, 60% construction, 56% fuel wood purposes, 52% crafts and 28% food (Figure 5). The *X. parviflora* had higher medicinal citation index of 0.96, followed by *A. glaberrima* (0.92). *S. fischeri* had higher craft and constructional citation index while *D. natalensis* had higher fuel wood citation index than the rest of the species. Tree parts utilized for medicinal values include roots, seeds, trunk (bark) and leaves of different species depending on type of ailment cured. Seeds, leaves and fruits were listed as tree parts that are largely utilized for food depending on species. Local construction, fuel wood and craft making used mainly tree trunk.

Table 3: Aboriginal uses of wild tree species in Tawa Ward

Species Name	Local Name	Fod	Med	Cra	Con	Fue	CI
Albizia glaberrima	Mkenge	38	46	32	15	48	3.58
Adansonia digitata	Mbuyu	-	18	-	-	-	0.36
Albizia versicolor	Mnyanza	12	43	29	20	30	2.68
Allanblackia stuhlmanii	Msambu/Mkange	-	36	36	40	-	2.24
Allanblackia ulugurensis	Mkani	-	42	28	33	30	2.66
Annona senegalensis Pers.	Mtopetope	34	12	45	45	33	3.38
Bombax rodognaphalon	Msufi pori	-	31	18	43	23	2.30
Bridelia micrantha	Mwiza	-	26	39	-	-	1.30
Cassipourea malosana	Msengela	-	-	10	17	24	1.02
Combretum molle	Mlama mweusi	-	17	-		32	0.98
Deinbollia borbonica	Mmoyomoyo	-	12	-	-	-	0.24
Dicrostarchys cinerea	Mtogo	-	8	-	9		0.34
Diospyros squarrosa	Mnyachititu	12	-	-	-	-	0.24
Dombeya natalensis	Msambwa	-	-	30	-	50	1.60
Ehretia amoena	Mkilika	28	-	32	27	16	2.06
Harungana madagascariensis	Mtunu	-	-	16	25	-	0.82
Markhamia zanzibarica	Mtarawanda		14		16	8	0.76
Oxyanthus goetzei	Mbuni pori	-	-	32	-	44	1.52
Scrodophleous fischeri	Mhande	-	12	50	50	46	3.16
Sorindeia madagascariensis	Mpilipili	20	43	-	-	-	1.26
Synsepalum cerasiferum	Mkumbulu	-	36	-	-	-	0.72
Trema orientalis	Mbefu	6	33	-	18	-	1.14
Vangueria infausta	Msada	-	30	-	6	20	1.12
Voacanga africana	Mlengwelengwe	-	36	-	11	25	1.44
Xylopia parviflora	Mlawilila	-	48	-	-	-	0.96

Note: Fod = Food; Med = Medicinal; Cra = Crafts; Con = Construction; Fue = Fuel wood and CI = Citation index

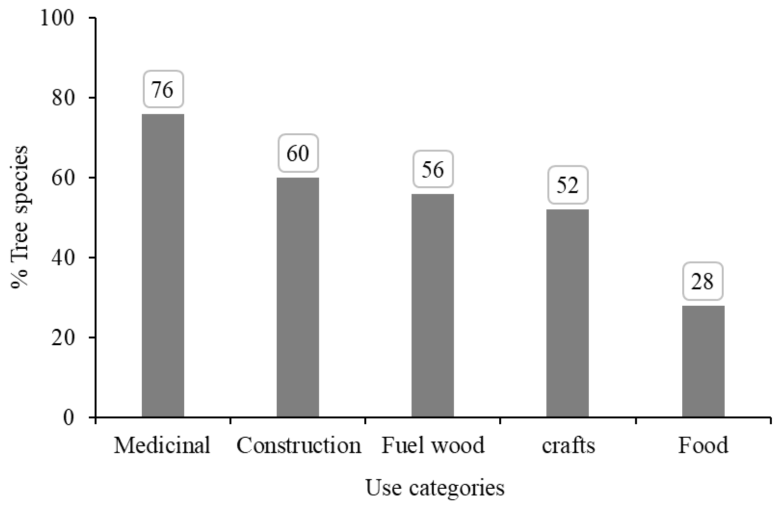

Figure 5: Proportion of tree species by use categories.

Many registered tree species with medicinal values treat more than one ailment (Table 4 and Figure 6). For instance, *D. cinerea* was listed to cure 27% of the registered ailments, followed by *C. molle* treating 18% of the ailments and *Trema orientalis* and *Bridelia micrantha* treating 16% of the ailments each. Only five species, *X. parviflora*, *S. ceraciferum*, *S. fischeri*, *D. borbonica and B. rodognaphalon* were described to cure one (2%) ailment each (Figure 6). Among the tree parts, barks of the eleven listed tree species were mentioned to be used as remedies of 19 ailments, followed by roots of nine species curing 13 ailments, leaves of seven species 12 ailments and seeds of one species 4 ailments (Figure 7). The dominant mode of administration was oral followed by topical (Table 4).

Table 4: Tree species with medicinal values, tree parts used, ailments cured and mode of application

Species Name	Part used	Ailment cured	Use mode
Albizia glaberrima	Barks	Chest pain	Oral
		Fever	Oral
Adansonia digitata	Leaves	Fatigue, and diarrhoea and worms	Oral
		Insect bite	Topical
	Barks	Calming shivering and high fever	Oral
Albizia versicolor	Barks	Skin rashes	Topical
		Anaemia and venereal diseases	Oral
Allanblackia stuhlmanii	Leaves	Coughs	Oral
	Seed	Rheumatism, stinging joints, wounds and rashes	Topical
Allanblackia ulugurensis	Seeds	Coughs and chest problem	Topical
Annona senegalensis	Barks	Human body breakage	Topical
	Roots	Stomach-ache and snake bite	Oral
Bombax rodognaphalon	Barks	Diarrhoea	Oral
Bridelia micrantha	Barks	Malaria	Oral
		Toothache and sore eyes	Rinsing
	Roots	Stomach-ache, worms and diarrhoea	Oral
	Leaves	Sore eyes	Topical
Combretum molle	Leaves	Pneumonia, headache and epilepsy	Oral
	Roots	Infertility, hernia and body swelling	Topical
		Abdominal pains, and schistosomiasis	Oral
Deinbollia borbonica	Roots	Stomach-ache	Oral
Dichrostachys cinerea	Barks	Dysentery, headaches, toothaches and elephantiasis	Oral
	Roots	Snake bites, coughs, syphilis and contraceptive for women	Oral
	Leaves	Gonorrhoea, fractures, sore eyes, and toothaches	Topical
Markhamia zanzibarica	Barks	Syphilis	Oral
	Roots	Stomach-ache	Oral
Scrodophleous fischeri	Roots	Stomach-ache	Oral
Sorindeia madagascariensis	Roots	Malaria and schistosomiasis	Oral
Synsepalum cerasiferum	Barks	Wounds	Topical
Trema orientalis	Leaves	Coughs, sore throats, asthma, bronchitis, malaria and intestinal worms	Oral
	Barks	Coughs and intestinal worms	Oral
Vangueria infausta	Roots	Snake bite, anthelmintic, malaria, pneumonia, cough and heart ailment	Oral
Voacanga africana	Barks	Fungal infections and eczema	Oral
	Leaves	Fatigue and diarrhoea	Oral
	Roots	Heart ailment and pregnancy miscarriage	Oral
Xylopia parviflora	Barks	Ulcers	Oral

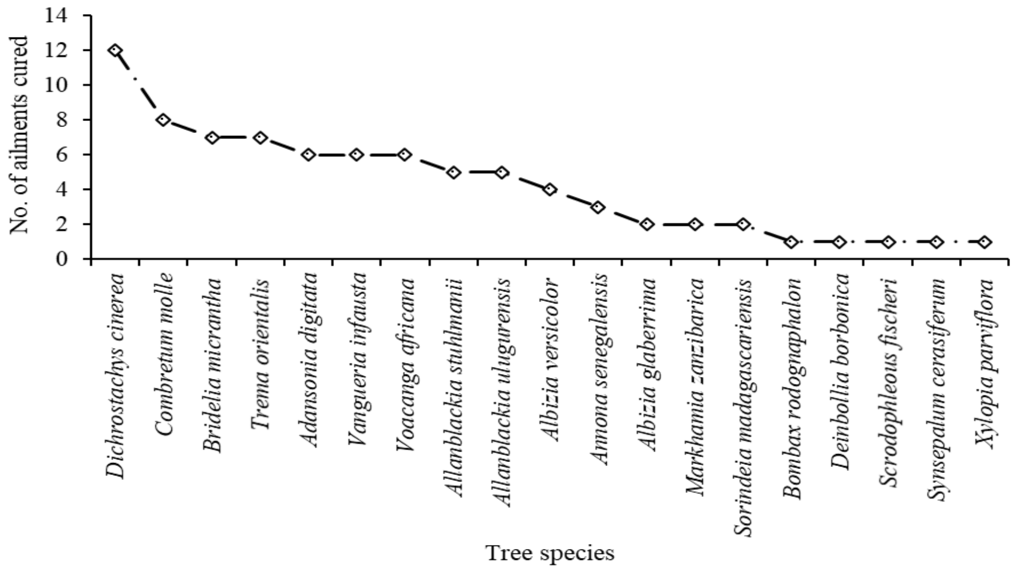

Figure 6: Trees species and number of ailments cured by each.

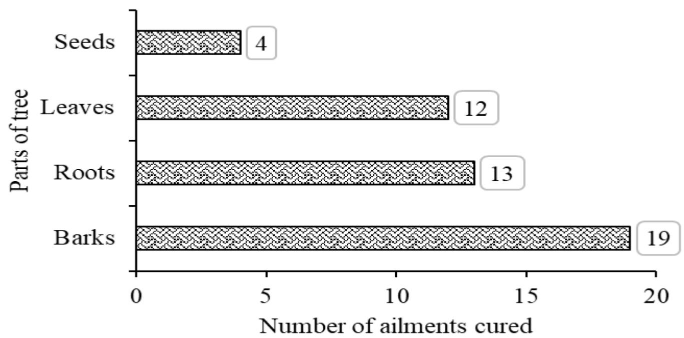

Figure 7: Tree parts used for medicinal purposes and number of ailments cured.

Discussion

The observed species richness of 20 species in the forest is within the range of global tropical rainforests of 20 to 223 species (Whitmore 1998), Mvomero forests of 8–66 species (Malimbwi et al. 2005) and Taita Hills forests of 15 to 32 species (Wilder et al. 1998). Nonetheless, the observed richness was lower compared to other nearby forests such as Kilengwe (Kacholi 2014b) and Kimboza forest reserves (Kacholi 2013) in Morogoro rural district, The variations may be due to differences in habitats, disturbances, competition and availability of resources for survival (Padalia et al. 2004). Also, disparity in sampling protocols may result to the observed variations (Kacholi 2013). Family Fabaceae dominated the forest by 15%; the same trend has been also noticed in various lowland African forests (Gentry 1988, Addo-Fordjour et al. 2009, Kacholi et al. 2015). The percentage dominance of the Fabaceae family was very low compared to the range of 25–50% dominance reported in the Coastal forests of Tanzania (Burgess and Muir 1994, Burgess and Clarke 2000). Additionally, the number of species and families registered in the forest were small due to small size of the forest (Magurran 2004).

The species diversity index normally expresses stability of a specific community or population. The observed forests' Shannon-Wiener diversity index of 2.62 lies within the tropical forest diversity range of 1.5 to 3.5 (Kent and Coker 1992), indicating that the forest is in normal state. When the Shannon-Wiener diversity index values are higher, it indicates greater community structure stability (Kohli et al. 1996). The higher diversity values can be used to confirm good efforts in conservation undertakings. For instance, the comparison of protected areas versus non-protected areas revealed higher species diversity for protected than non-protected areas (Miller et al. 2018). Thus, this means that the Milawilila forest reserve is contained by the average of stability and possibly the adjacent community have conceited the tree species diversity positively. But still care is needed as any significant removal of trees for various anthropogenic uses may result into the index decline, which may subsequently cause loss of biodiversity and decline in supply of forest products and services (Rao et al. 1987, Kacholi et al. 2015).

The use of species importance value index (IVI) in forest ecology is a common practice that helps to disclose the ecological significance of species in an ecosystem. The IVI is used to prioritize species conservation. When a species possesses low IVI value that means it has to be considered for conservation priority than those with high IVI values (Zegeye et al. 2006). The high IVI revealed by *X. parviflora*, *S. cerasiferum* and *E. amoen*a were primarily contributed by their higher relative frequency, density and dominance compared to other species in the forest. Due to higher IVI, these three species are ecologically important in the Milawilila forest reserve than those with low IVI. The presence of several species with low IVI is a sign of their rarity in the forest. The rarity of species is attributed by occurrence of abundant infrequent species with low frequency in the forest (Oyun et al. 2009). The species that had low IVI were less frequent, less dense and with low basal areas. About 65% of the observed species occurred in less than 25% of the established plots. This endorses the commonly hailed concept that most of species in ecological community are rarer, rather than common (Magurran and Henderson 2003). Though the species diversity revealed the forest to be normal, all species with low IVI less than 10 should be given high conservation priority.

The trend revealed by the species-area curve suggests that more sampling efforts would have increased the number of species richness in the forest. This is due to the fact that when a large part of the forest is covered, the more environmentally heterogeneity and more species are likely to be encountered (Magurran 2004). The observed species-area curve concurs with the MMMeans species richness estimator that provides higher richness (26 species) than the observed species in this study (20 species). The curve is essentially telling that the sample size used was not sufficient to capture all the species in the forest, which suggests that more plots are compulsory for future inventories in the forest.

The number of trees decreased with the increase in the size classes (DBH) and the overall distribution revealed an inverse J shaped curve. This display in Figure 3 indicates that the Milawilila forest reserve is recruiting well and regeneration in the forest is good (Hadi et al. 2009, Kacholi et al. 2015). Natural regeneration is typically influenced by presence of mature trees, fruiting patterns and favorable environmental conditions (Maguzu et al. 2017). Though the forest showed good regeneration, some anomaly was noted with DBH class > 70 cm, which had many individuals compared to the three preceding DBH classes. This was perchance due to differences in in tree species among them, which is echoed by growth property or customary removal of trees for poles and building by the locals. The observed good regeneration patterns, also confirmed by the species diversity index, showed that the forest had great structural stability.

This study revealed that the observed tree species from the forest reserve are used for various purposes by the people of Tawa ward. These findings uphold many studies including Adagba et al. (2016), Maguzu et al. (2017) and Mgumia et al. (2017) who reported traditional uses of wild tree species and their importance to locals in their study areas. For instance, some of the species mentioned in this study have been also listed by other authors elsewhere in Tanzania to play the same roles. These include but not limited to *A. glaberrima* and *B. micrantha* (Maguzu et al. 2017), *D. cinerea* (Langat et al. 2016), *O. goetzei* (Mgumia et al. 2017), *V. africana* and *C. molle* (Wilfred et al. 2006), which were reported to be used as charcoal and firewood, referred to as fuel wood in the present study context. Other species like *T. orientalis* (Moshi et al. 2010), *E. amoena* and *D. borbonica* (Luoga et al. 2000), *B. micrantha, A. versicolor, B. micrantha, A. senegalensis* and *B. rodognaphalon* (Amri and Kisangau 2012, Kacholi 2014a), *A. senegalensis*, *B. micrantha, C. molle, D. cinerea, E. amoena* and *V. infausta* (Augustino and Gillah 2005) and *D. borbonica* (Luoga et al. 2000) were also reported to have medicinal values. Species like *Markhamia zanzibarica* (Luoga et al. 2000, Kacholi 2014a) and *A. ulugurensis* (Wilfred et al. 2006) were reported to be used for construction and furniture purposes.

The findings revealed that citation index (CI) and tree species uses were directly related, signifying that species with multiple uses had high citation index (Table 3); for instance, *A. glaberrima* (CI of 3.58, 5 uses), *A. senegalensis* (CI of 3.38, 5 uses) and *S. fischeri* (CI of 3.16, 4 uses) had multiple uses. Among the trees species listed by the respondents, 76% of them had more than two uses, while 24% had only single use. This observation is different from the findings of other studies (Mndolwa et al. 2008, Maguzu et al. 2017) that reported at least 96% of the species to have multiple uses at Kizee village forest and Kitulangalo forest, respectively. The results revealed the majority of species were appropriate for medicinal uses, construction, fuel wood, crafts and food (Figure 5). This study shows that most of the ailments are treated by barks followed by roots leaves and seeds (Figure 7). The findings are somehow incomparable with Kacholi (2014a) and Kitula (2007) who observed roots being the commonly harvested parts followed by leaves. The collection of barks and roots for medicinal purposes was also reported to be commonest in Namibia (Chinsembu and Hedimbi 2010). The bark striping and root excavation are very disturbing and threaten plant survival (Amri and Kisangau 2012). For instance, continual bark stripping can eventually cause death of a tree due to disruption of phloem and xylem, which help flow of water, nutrients and sugars all over the tree. Thus, the process of obtaining barks need to be controlled, otherwise affected trees are likely to perish in the forest. Moreover, garnering of tree roots is risky as it can cause permanent harm and probably fatal to tree (Kacholi 2014a). To avoid this kind of damage to trees, it is advised to be aware of which roots are to be cut and cuts ought to be done to avoid adverse effects to trees. Moreover, in order to nurture sustainability, the locals should be fortified to use leaves whenever possible than roots and barks (Chinsembu and Hedimbi 2010).

Conclusion and Recommendation

Understanding tree species density and indigenous uses is imperative in providing baseline information on the values of the forest for management planning and monitoring as well as for meriting sustainable productivity in the ecosystem. In the present study, *X. parviflora, E. amoena* and *D.*

squarrosa were the most abundant species while the rest of the species were not well stocked. The locals living nearby the forest demonstrated good understanding of wild tree species and their aboriginal uses. Among the listed tree species with potential indigenous uses, majority had medicinal utility. Among the tree parts, bark was the most harvested part for medicinal purposes, followed by roots, leaves and seeds. The five species with high citation indices were *A. glaberrima*, *A. senegalensis*, *S. fischeri*, *A. versicolor* and *A. ulugurensis* while *D. borbonica* and *D. squarosa* had low citation indices. The study recommends that planting of the wild tree species, especially those with high citation indices and low density, should be prioritized for the purpose of guaranteeing sustainability of the forest reserve and viable supply of forest products and services. Moreover, it suggests for the development of pharmacopoeia of the area through partnership among stakeholders in ethnobotany, medicine, pharmaceutical sciences and herbal, and lastly, experienced herbal practitioners with many years of know-how should be encouraged to train the young generation on the practices in order to preserve the indigenous knowledge.

Conflict of Interests

The author declares that there is no conflict of interests regarding the publication of this paper.

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