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Full Length Research Article

Disappearing medicinal plants in mt. kenya forests, kenya: a case study of east african green heart (*Warburgia ugandensis* sprague)

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ABSTRACT

Natural disturbances and human activities are significantly affecting indigenous trees species in forests. *Warburgia ugandensis* is a plant highly valued for its medicinal properties, timber and fuel among other uses. Many rural communities use it as a remedy for a number of ailments. Investigations into the value of its chemical content reveal that it has antibiotic, antifungal, anti inflammatory and antiseptic effects. *W. ugandensis* has been rated as the second highest medicinal plant after *Prunus africana.* However its population has been affected by human activities, climatic effects and pests. The objective of this study is to investigate the threats of *W. ugandensis* in Mt. Kenya forests. The study was conducted in dry montane potential natural vegetation type forests in the North West of Mt. Kenya forest. Eighteen subplots of 625 m^2 each were used to sample number of debarked trees, stumps and other types of damages. Causes of threat were identified as human, wildlife, livestock and pests. Data was analyzed by general linear models (GLM) using SPSS 11.0 (2001) statistical software and Student Newman Keuls (S-N-K) at 5% significance level. Human activities caused the highest amount of threats while debarking was the most damaging form of threat. The findings of this study are important for sustainable utilization, management and conservation of the remnants of *W. ugandensis* in the forest and farm lands.

Key words: Debarking, threats, *Warburgia ugandensis*, stumps, animals, human

INTRODUCTION

Forests play a vital role in water catchment, soil fertility, regulation of local climate and are vital carbon sinks and reservoirs. They are a source of food, a habitat for wildlife and a source of income to the country (Muthike, 2004). Over the years, forests have been degraded due to poor legislative framework, politics, encroachment, illegal cultivation, logging, charcoal burning and poor understanding of the benefits of forests by local communities. As at the year 2008,

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forest cover in Kenya was 2-3% of the land area (Muthike, 2004). Assessing the structure of a particular forest type forms an important part of forest conservation. Tropical montane and tropical dry forests are considered as threatened and are therefore a high priority for conservation (Newton, 2007). One of the indicators of forest degradation is the removal of key important plant species. *W. ugandensis* is an important indigenous species in Mt. Kenya forests. It belongs to the family Canellaceae which is restricted mainly to the South and Eastern regions of Africa. The species occurs in Kenya, Uganda, Ethiopia, Tanzania, Zaire and parts of South Africa (Iwu, 1993).

W. ugandensis is an erect tree or a prostrate shrub, evergreen, single stem aromatic perennial plant whose height ranges between 4.5 and 30 m with diameter of up to 70 cm or more. The bark is smooth pale green or brown when young but becomes scaly black when matured (Orwa *et al*., 2009). The plant has simple leaves which are glossy dark green, paler green to dull green with entire margin and a midrib off the centre. The tree is one of priority species with multifunctions; used in extraction of herbal medicine, as timber, poles and charcoal burning (Bekele-Tesemma *et al*., 1993; Hamilton, 2008). Besides the medicinal value, it is also used as firewood, tool handles, food seasoning, mulch for soil conservation, ornaments, shade and resin (Maundu and Tengnas, 2005). The fruit is inedible, all parts have a hot peppery taste, leaves and seeds are used to add flavour to curries (Dharani, 2002). The leaves, pods and seeds are fed to livestock.

The wood is yellow or greenish, becoming brown on exposure; very fragrant when freshly cut, the scent somewhat resembling that of sandalwood. The wood also has high oil content and burns well with an incense-like smell. The tree has good timber for building and furniture, but not termite resistant (Dharani, 2002). The tree also produces resin that is used locally as glue to fix tools (Orwa *et al*., 2009). Currently, there is a growing demand for the products from *W. ugandensis* and there are fears that this may lead to its over-exploitation. With such growing attention, experts are sounding the alarm, that the tree could become extinct soon unless measures are taken to stem its exploitation. Unsustainable harvesting for medicinal purposes through ring barking and indiscriminate felling is threatening the wild populations of *W. ugandensis* (Muchugi *et al.,* 2008).

Though a lot of research has been done on genetic diversity (Muchugi *et al.,* 2007, 2008), genomics (Muge *et al*., 2009), phytochemical activities (Kioy *et al.,* 1990; Olila *et al*., 2001) and survey on uses (Kariuki and Simiyu, 2005; Maundu and Tengnas, 2005), none has focused on *W. ugandensis* current distribution and population structure in Mt. Kenya forests to find out if its distribution and structure has changed due to environmental and anthropogenic pressures. . Effective management of this threatened tree species requires updated data and information presented in a user-friendly database that can support *in-situ* and *ex-situ* conservation of the species (Martin *et al.,* 2001) in Mount Kenya region, where the species was abundant.

A research conducted by Kariuki and Simiyu, (2005) show that the species is rated second highest priority medicinal plant in Kenya after *Prunus africana*. Its extracts have been established to elicit anti-bacterial activities against both *Escherichia coli* and *Staphylococcus aureus* (Olila *et al.*, 2001). The extract also has anti-fungal activity against *Candida albicans* (Wube *et al.,* 2005). Further studies have shown microbial activity against *Mycobacterium aurum*, *M. fortuitum*, *M. phlei* and *M. smegmatus* and the active constituents showed minimum inhibitory concentration (MIC) values ranging from 4 to 128 µg/ml compared to antibiotic drugs (Wube *et al.,* 2005). A study by Stampf *et al.,* (1982) showed that sesquiterpene (turpenes consisting of three isoprenes $C_{15}H_{24}$) is used as antiseptic, antibacterial and anti-inflammatory. *W. ugandensis* new sesquiterpenoids. Though Kenya is yet to set up its own factory to manufacture the tree products, trees from Mount Elgon are used to provide raw materials for processors in nearby Uganda. Some of the products manufactured from the species according to Muchugi (http://allafrica.com/stories/201008300329.html) research include herbal chicken product in Trans-Nzoia, Kenya, Warburgia tea in Ruiri Meru, Bioharmony products in South Africa and Africa Red Tea imports in South Africa. In Kenya, there is a growing interest in commercial exploitation of this tree in addition to threats from stripping its bark for sale to herbalists and processors. This has put pressure on *W. ugandensis* populations in the natural forests.

This study aimed at determining anthropogenic activities that are threatening *W. ugandensis* in Mt. Kenya forests. The results can be used to plan how species levels can be increased by reintroducing suitable indigenous tree species in anthropogenic landscapes using Potential Natural Vegetation Types as a criterion for ecological suitability (Mueller-Dombois and Ellenberg, 1974).

Study area

This study was conducted in forests around Mount (Mt.) Kenya. The mountain is 5.199 m above sea level and lies on latitude 0^{o} 9' 00'' S and longitude 37^{o} 18' $00^{''}$ E. It is in the Central Kenya, South of equator about 150 km North East of Nairobi. Mt. Kenya forest which is 2800 square kilometres is a composite of many forests among which the following were selected for study: Mount Kenya consists of several separate forest blocks of different sizes and varying in altitude. This research was conducted within an altitude range of 2056 m to 2275 m asl. Kangaita forest had the highest altitudinal range of

Table 1. Percentage damages in different forests

Site	Stump (%)	Debarked (%)	Other indicators (broken twigs(%)	Total
angaita	8	10	10	28
Kahurura	8	7	10	25
Ontulili	5	13	9	34
Gathioro	3	2	8	13
Total	24	32	37	100

2080 m to 2275 m asl. Of the four forests with *W. ugandensis,* Gathioro forest was the largest covering 66.9% of the total area covered by the four forest blocks. Kangaita forest covered 21.2% while Ontulili forest and Kahurura forest covered 6.9% and 4.9% respectively. Gathioro forest had the highest density of 25.6 trees per hectare. Kangaita forest had 14.7 trees per hectare; Ontulili forest had 18.8 while Kahurura forest had 13 trees per hectare.

METHODOLOGY

Four forest blocks selected for this study were; Kangaita, Kahurura, Ontulili and Gathioro forests. Mapping of all the roads, foot paths and altitude used within Mt. Kenya forests was done by use of Global Positioning System (GPS) together with vegetation and climatic maps (Trapnell *et al.,* 1966). In each forest, a base transect was selected parallel to another base transect in the other forest with similar environmental conditions. Base transects were either an established road, foot path or animal track cutting across altitudinal gradient as described by Caratti *et al*., (2006). There were nine sampling sites in the four forests with a total of 36 subplots. At each sampling site, sampling of *W. ugandensis* started at a distance of 50 m from the forest edge into the forest to reduce edge effects from neighbouring farms and roads.

Belt transects measuring 25 m wide and 500 m long were marked with the starting points being 50 m from the base transect. Direction of the first belt transect was determined randomly by tossing a coin. The rest of the belts were selected systematically by alternating left and right sides of base transects spaced at an altitudinal interval of 100 m above sea level. Belt transects were subdivided into twenty plots of 25 m by 25 m from which four sub-plots were systematically selected for sampling starting from the second sub-plot and others followed after a distance of every 100 m.

Within the sub-plot, damages to *W. ugandensis* were recorded*.* The tree stumps, debarked and uprooted plants were enumerated. Human debarking had signs of matchet cuttings, sometimes extending into the woody part of the tree which differentiated it from any other cause of debarking. Other forms of damage recorded include, plucking of leaves and branches and twigs cut off.

Data was analyzed by general linear models (GLM) using SPSS 11.0 (2001) statistical software. Mean differences were tested using Student Newman Keuls (S-N-K) at 5% significance level.

RESULTS

Damages on *W. ugandensis* in the four forests

The study showed that the most frequent damages were on non-pronounced plant parts such as the cut off branches and twigs, removal of terminal twigs in seedlings, saplings and defoliation of leaves all these are hereby referred to as 'other types of damage' and comprised 37%. This was followed by debarking (32 %), stumps (24%) and fallen and uprooted plants comprising 7%. There was significant difference among various damages on *W. ugandensis* ($F_{[3, 99]} = 5.97$, $p < 0.05$)

Damages to *W. ugandensis* in different forests

Damages were detected in all the forests with Ontulili forest recording 34% of the total damages. Kangaita forest had 28% while Kahurura and Gathioro forests had 25% and 13% respectively (Table 1). There was no significant difference among damages in various forest reserves sampled ($F_{[3, 99]} = 2.7$, $p > 0.05$).

Stumps

Tree stumps constituted 24% of all the damages and were caused by cutting down of trees. Kangaita had 33% of stumps and Kahurura forests also had 33% stumps. Ontulili and Gathioro forests stumps constituted 20% and 14% respectively. There was no significant difference between number of stumps in different forests ($F_{[3, 8]} = 0.41$, $p > 0.05$).

Debarking

Incidences of debarking were common in all the four forest blocks with Ontulili forest having the highest number of debarked trees (40.6%). Kangaita forest had 31.25%, while Kahurura and Gathioro forests had 21.9% and 6.25% respectively (Figure 1). It is evident that Ontulili had the highest number of debarked trees and this is the same place where dry trees were common due to complete debarking.

Uprooting of seedlings from the forests

Various forms of regeneration were recorded in different forests where the species was found. The regenerates

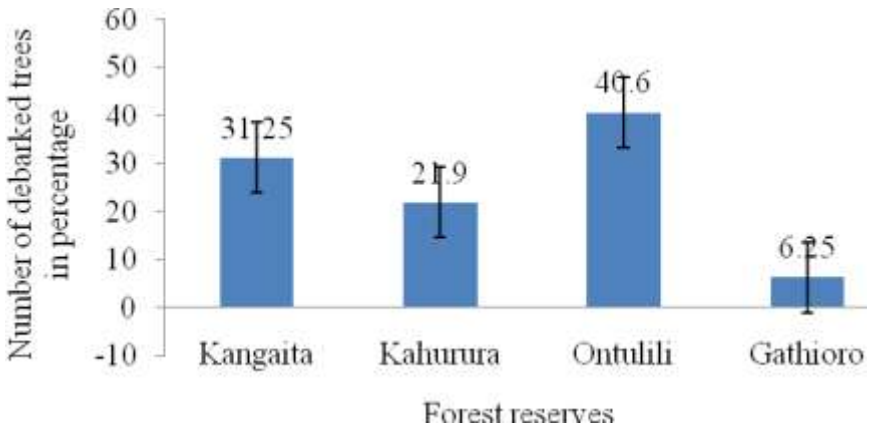

Figure 1. Percentage of debarked trees by human beings in different forests

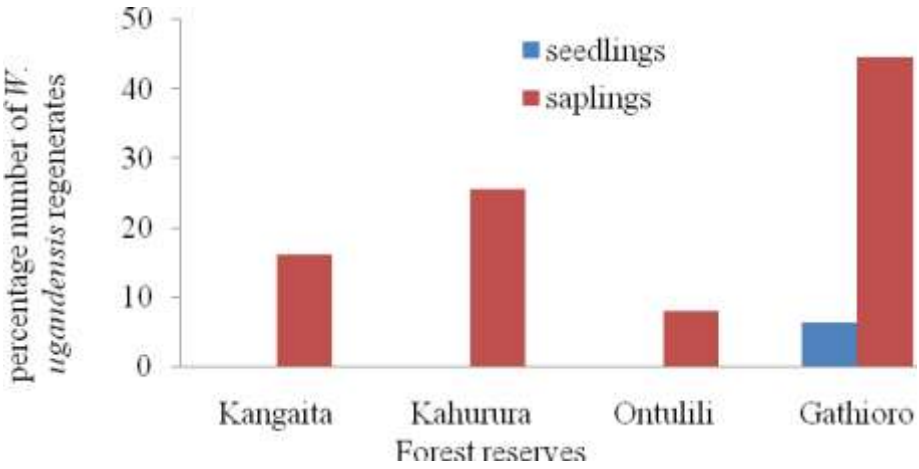

Figure 2. Percentage regenerates of *W. ugandensis* in the forest reserves

included seedlings, saplings and sprouts. *W. ugandensis* produces enormous amount of fruits with a lot of seeds. However while saplings were found in all the sampled forests totalling 93.7%, seedlings were only 6.3% (Figure 2) and only present in Gathioro forest. Evidence of seeds being uprooted in the forest and planted in the nursery beds (Plate 1) belonging to women groups for sale was confirmed by a resource person. The nursery had more than four hundred seedlings collected from Kangaita and neighbouring forests.

Grazing livestock in the forest

Grazing livestock in the forests contributed to damaging *W. ugandensis* through defoliation and breaking off the twigs. Though it was the lowest form of damage compared to the other forms of damage (human mean of 3.16, wild animals mean 0.80 and livestock 0.13) animal grazing and browsing removed off the apical buds and leaves negatively affecting its growth form and rate.

Plantation establishment for livelihood scheme (PELIS)

In all the forests visited during this study each one of them had a PELIS program being carried out, where local communities were given portions of land cleared off the indigenous forests for planting exotic tree seedlings together with food crops (Plate 2) until they have established themselves.

W. ugandensis performs well in altitude of up to 2150m above sea level and below (Figure 3). Majority of shamba system existed within the same altitude or below. Clearing the forest for this program does not spare indigenous species like this one. Shamba system is a major threat to this species.

Plate 1. Nursery bed planted with seedlings of *W. ugandensis* in a farm at Kangaita

Plate 2. Pelis program with food crop plantations in Gathioro forest

DISCUSSION

Investigations in different forests revealed that *W. ugandensis* is heavily exploited. The principle threats were utilization of forest land or over-exploitation for its medicinal value. The objective of this study is to investigate the anthropogenic activities that impacts on *W. ugandensis.* The study found that human activities are the major threat to *W*. *ugandensis* through debarking, cutting it down, removal of branches and twigs and forest clearing. Several trees were found dry as a result of debarking. The results are in line with results of work done by Cunningham and Davis (1997), which indicated that debarking of tree may kill a plant irrespective of the size. Debarking removes phloem vessels in the bark which are involved in the movements of photosynthetic products to the roots. This starves the roots until they die, causing the death of the entire plant.

Some of the trees had full debarking all round the trunk and most were in the process of regenerating a new bark. *W. ugandensis* is a valuable plant for humans, livestock and wildlife use and the greatest threat to it was humans. This threat is attributed to the high value of its medicinal properties for treating human and livestock diseases. The

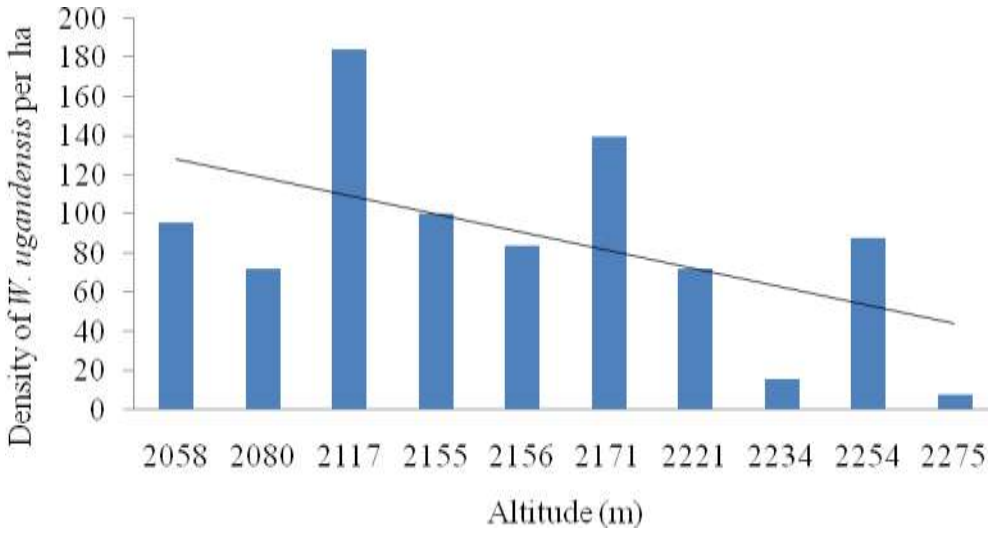

Figure 3. Change in density of *W. ugandensis* per hectares with altitude

damages were actualized through breaking off twigs, branches and debarking for use in herbal medicine. Bark stripping was also highlighted by Wass (1995) in his book on Kenya's indigenous forests as a threat to the species. Today many people are shifting away from over the counter medicine due to their high cost and side effects to herbal remedies as reported by Cunningham (1988), who stated that massive trade was in existence in South Africa for herbal medicine.

Elephants are also a threat to *W. ugandensis* in that they cause debarking by ripping off the bark and feeding on it. They also peak the twigs, leaves and soft branches and feed on them. This finding is confirmed by research conducted by Joshi and Singh (2008) which found that elephants feed on soft twigs and has a debarking feeding behaviour. Reasons for debarking may be to extract some of the nutrients and medicinal substances from the plant.

CONCLUSION

Though the tree is exploited by humans through debarking, cutting down and removal of twigs, PELIS program could be the real threat which need to be addressed. It was found that some farmers grow the species in their farms. This will reduce the exploitation pressure of the species in the forest. The findings of this study are important for management and conservation of the remnants of *W. ugandensis* in the forest and farm lands. A study need to be carried out on regeneration rate and survival of saplings and seedlings. Community groups should be supported in the production of *W. ugandensis* seedlings from seeds to enhance conservation of those growing naturally in the forest. Analysis of the active ingredients of the different parts of the plant should be done to reduce the reliance on tree bark. Usage of other plant parts other than the bark should be encouraged.

There should be breeding of the species to make it shorter for ease of harvesting and faster growth. More factories for processing the products should be constructed to enhance easy marketing of the species' products. Due to the high demand of the species products, all *W. ugandensis* in the forest should be identified and located so that they are monitored by the Kenya Forest Service (KFS). Such areas should be restricted from the public to enhance regeneration. Studies should be conducted to investigate the role of fruit eating animals in the dispersal of the species.

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