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Availability, Preference, and Consumption of Indigenous Forest Foods in the Eastern Arc Mountains, Tanzania

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We investigated the availability, preference, and consumption of indigenous forest foods in Uluguru North (UNM) and West Usambara Mountains (WUM) of Tanzania. Data collection techniques involved focus group discussion, structured questionnaires, and botanical identification. Results revealed (1) there were 114 indigenous forest food plant species representing 57 families used by communities living adjacent to the two mountains; (2) sixty-seven species supplied edible fruits, nuts and seeds: 24 and 14 species came from WUM and UNM, respectively, while 29 came from both study areas; (3) of the 57 identified vegetable species, 22 were found in WUM only, 13 in UNM only, and 12 in both areas; (4) there were three species of edible mushrooms and five species of roots and tubers; (5) unlike the indigenous roots and tubers, the preference and consumption of indigenous vegetables, nuts, and seeds/oils was higher than exotic species in both study areas; and (6) UNM had more indigenous fruits compared to WUM, although preference and consumption was higher in WUM. We recommend increased research attention on forest foods to quantify their contribution to household food security and ensure their sustainability.

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KEYWORDS indigenous forest foods, household food security, Uluguru North Mountains, West Usambara Mountains, Eastern Arc Mountains, Tanzania

INTRODUCTION

Recently, there has been a growing research interest in forest foods as their nutritional and economic values are being recognized and promoted globally (Ogle 1996; Uiso and John 1996; Ruffo, Birnie, and Tengnäs 2002; Mapolu 2002; Msuya, Kideghesho, and Luoga 2004; Maharjani and Khatri-Chettri 2006; Kilonzo 2009). The forest foods are economically more affordable and have proved to be important sources of vitamins (e.g., vitamin A, vitamin C, and folic acid), minerals, proteins, carbohydrates, and fats. Often, these forest foods have comparable, and in some cases superior, nutritional quality to domesticated varieties. For example, indigenous vegetables such as *Amaranthus spinosus*, *Bidens pilosa*, *Corchorus olitorius*, and *Solanum nigrum* have higher levels of protein, fat, minerals (calcium and iron), and carotenes compared to exotic vegetables such as *Brassica chinensis* and other species of the cabbage family (Oomen and Grubben 1978; Ruffo et al. 2002). Wild vegetable leaves can be excellent sources of vitamins and minerals as exemplified by *Moringa oleifera* (vitamin A—11,300 μg/100 g), *Cassia obtusifolia* (vitamin C—120 mg/100 g), *Balanites aegyptiaca* (calcium—37,010 mg/100 g), *Adansonia digitata* (niacin—8.1 mg/100 g), and *Leptadenia hastata* (iron—95 mg/100 g) (Falconer and Arnold 1991). Leaves of *Adansonia digitata* are good sources of protein (13.4% of calories), energy (1180 kj/100 g), calcium (2600 mg/100 g), and vitamin A (1618 μg/100 g) (Falconer and Arnold 1988). Furthermore, indigenous vegetables supply roughage, which facilitates digestion and prevents constipation (Tindall 1965; Thompson 1972; Kochhar 1981). Analysis by Caldwell and Enoch (1972) revealed that, the average riboflavin concentrations in wild leaf vegetables (0.4–1.2 mg/100 g edible portion) were greater than those found in eggs, milk, nuts, and fish. Likewise, Becker's (1983) analysis of the *Geoffroea decorticans* seed protein indicated a chemical score that was comparable to that of groundnuts and millet.

Literature on indigenous fruits indicates that, vitamin C content is much higher in fruits of *Adansonia digitata, Ziziphus jujube* and *Ximenia caffra* than in exotic fruits such as mango (*Mangifera indica*) and orange (*Citrus sinensis*) (Nkana and Iddi 1991; Ruffo et al. 2002). The vitamin C content of an orange is 57 mg/100 g while that of *Adansonia digitata* is 360 mg/100 g and *Ziziphus jujube* var. *spinosus* is 1000 mg/100 g. The gum of *Sterculia* spp is a good source of vitamin C (52 mg/100 g) and vitamin A (396 ug/100 g) (Becker 1983). Indigenous fruits, such as *Syzygium guineensee* are very rich in iron (Saka 1994; Msuya, et al. 2004). Furthermore, indigenous fruits contain organic acids such as malic, citric and tartaric, which are good preservatives for soft drinks and sources of flavors and aroma (Kochhar 1981).

Mushrooms, another important forest food product, are favorites in many cultures. They serve as sauces and relishes to accompany the staple dishes and are often consumed as meat substitutes. Mushrooms are also good sources of protein and minerals. Parent's (1977) analysis of the nutritional value of 30 edible mushroom species from Upper Shaba, Democratic Republic of Congo revealed that, the mean protein content of mushrooms was 22.7 g/100 g dry weight and the mean calcium and iron concentrations were 349 mg/100 g and 1552 mg/100 g, respectively.

Indigenous Forest Food Products and Food Security

The 1996 World Food Summit defined food security as a situation existing "when all people at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy lifestyle" (WFS 1996). The term food insecurity will apply even in situations where there is enough food but the poor cannot access it. Indigenous forest food products play a crucial role in enhancing food security as they contribute to the food basket of the households directly in the form of edible fruits, flowers, gums, leaves, roots, tubers, and stems. Lack of economic alternatives for poor populations, increased human pressure on natural resources, and the frequency of extreme weather events have in turn increased dependency of rural households on forest resources for food security. Many families use forest resources to meet their subsistence needs for staple and supplemental foods (Ogle 1996; Arnold and Bird 1999; Cavendish 2000; Maharjani and Chettri 2006). Collection and use of forest food products is, therefore, becoming an essential strategy for coping and adapting to poverty, growing food demand and weather-induced food scarcity (Ruffo et al. 2002; Kilonzo 2009). In addition to enhancing food security, the indigenous forest foods are of great cultural significance to rural populations in developing countries (Kwesiga and Mwanza 1994; Msuya et al. 2003). In some areas, however, the forest foods are neglected and underutilized and, therefore, are branded as 'foods of last resort' (Ruffo et al. 2002; Hughes 2009). Furthermore, the forest foods have received little research attention, poor commercialization and marketing, with lack of effective policy frameworks for harnessing their potentials in rural communities (Idowu 2009).

During the lean agricultural seasons, rural people supplement their food requirements with the indigenous forest food products. For instance, in Zimbabwe wild fruits were collected and utilized mostly during the times of food shortage (Campbell, Luckert, and Scoones 1991). Vegetables are always available throughout the year because they can be dried and stored. These foodstuffs, not only guarantee the availability of food at the household level, but also contribute to the nutritional status within families. Furthermore, indigenous forest foods contribute to food security indirectly. Income generated from sale of surplus fruits, nuts, vegetables, juices, wines, and jams made from indigenous fruits such as *Strychnos coculoides*, *Vitex spp, Adansonia digitata,* and *Uapaka kirkiana* enables the poor families to purchase food (Ruffo et al. 2002). Indigenous forest food plants also play a vital role in ameliorating the soil fertility and water conservation conditions, which in turn enhance food production (Sène 2000).

By contributing to household food security, the indigenous forest foods have a great potential in alleviating poverty. Poor countries such as Tanzania, where the majority of the population live below the poverty line, can capitalize on this potential. Several studies conducted in Tanzania reported the wealth of indigenous forest food products (Temu and Msanga 1994; Härkönen and Vainio-Mattila 1998; Ruffo et al. 2002; Nyambo et al. 2005). However, only few of these studies have attempted to compare these forest products with exotic species in terms of availability, preference, and consumption (Kajembe et al. 2000). Furthermore, these few studies did not cover the Eastern Arc Mountains—one of the 34 world biodiversity hotspots (Myers et al. 2000; URT 2005; Okayasu 2008). This study therefore, seeks to address this knowledge gap by focusing on two mountains blocks—Uluguru North and the West Usambara Mountains. In order to understand the potential of the indigenous forest foods to local livelihoods, the following key issues were addressed: (1) identifying the forest food species found in the study sites and (2) assessing people's perceptions on availability, preference and consumption of indigenous forest foods in relation to exotic food species. This is important in deciding whether forest foods have contribution to household food security when compared to exotics. Knowledge on availability, preference and consumption may also stimulate some management actions, as one may forecast the future of these species depending on amount and the manner in which a particular species is being utilized. The findings of this study will add some useful information about the value and potential of the Eastern Arc Mountains in enhancing the livelihoods of the local communities and thus inspire support from the policy makers and the public to conserve the ecosystem. The findings will also be useful in planning for food and nutrition security for communities surrounding the Eastern Arc Mountains.

MATERIALS AND METHODS

Study Area

Eastern Arc Mountains

The Eastern Arc Mountains of East Africa comprise a chain of 13 mountain blocks stretching some 900 km from Taita Hills in Kenya through Tanzania's

North and South Pare, West and East Usambara, Nguu, Nguru, Ukaguru, Uluguru, Malundwe, Rubeho, Udzungwa, and Mahenge (CEPF 2005; Burgess et al. 2007). The Eastern Arc Mountains, declared as one of the 34 globally important biodiversity hotspots (Myers et al. 2000; URT 2005; Okayasu 2008) and one of the top eco-regions for biodiversity importance in Africa (Burgess et al. 2006), represent some of the oldest geological formations on the continent (Burgess et al. 2007; Okayasu 2008). Originally more than 23,000 square kilometers of the forest covered these mountains, but deforestation coupled with inappropriate farming practices and overgrazing has reduced the cover to as low as 2,000 square kilometers (CEPF 2005). Today, most of the remaining forests are found in some 150 government forest reserves, and some additional private and village forest reserves (Burgess et al. 2006; Okayasu 2008).

Despite the considerable reduction of the forest cover, the Eastern Arc Mountains have remained popular worldwide due to their terrific variety of endemic flora and fauna species. Over 25% of the 800 plant species found in the forests of Eastern Arc Mountains are endemic. These endemic species comprise about 60% of Tanzania's endemic plants (Hamilton and Mwasha 1989; Rodgers 1993). The forests are home to 20 out of 21 species of the African violet (*Saintpaulia* spp), which form the basis of a global houseplant trade (CEPF 2005). The forests are a part of the Endemic Bird Areas of the Tanzania-Malawi Mountains (BirdLife International 2003). In addition to unique biodiversity found in the forests of the Eastern Arc Mountains, the mountains play a vital life-supporting role to many Tanzanians. They are principal catchment areas for the constant water supply to major urban centers including Dar es Salaam, Tanga, Iringa, Mbeya, and Morogoro. Water flowing from the Eastern Arc forests is the source of 90% of the country's hydroelectric power generating systems, sustained by the year-round rainfall at high altitudes (Bjørndalen 1992; CEPF 2005; EAMCEF 2005). The Eastern Arc forests also provide a variety of wild food products ranging from fruits, vegetables, tubers to roots. The contribution of these products in enhancing food security has, however, received minimal recognition from the official policies. The focus of this study is on 2 of the 13 Eastern Arc Mountains: the Uluguru North and West Usambara Mountains.

Uluguru North Mountains

The Uluguru North Mountains is located southeast of Morogoro town between 6°52'–6°54'S and 37°40'–37°42'E (figure 1) at an altitude ranging from 700 to 2000 m above sea level. Rainfall in this area usually has two annual peaks (March–May and October–December) (Nummelin and Nshubemuki, 1998). The mountains receive about 3000 mm of rainfall per year on the eastern side, while the western parts receive about 500 mm

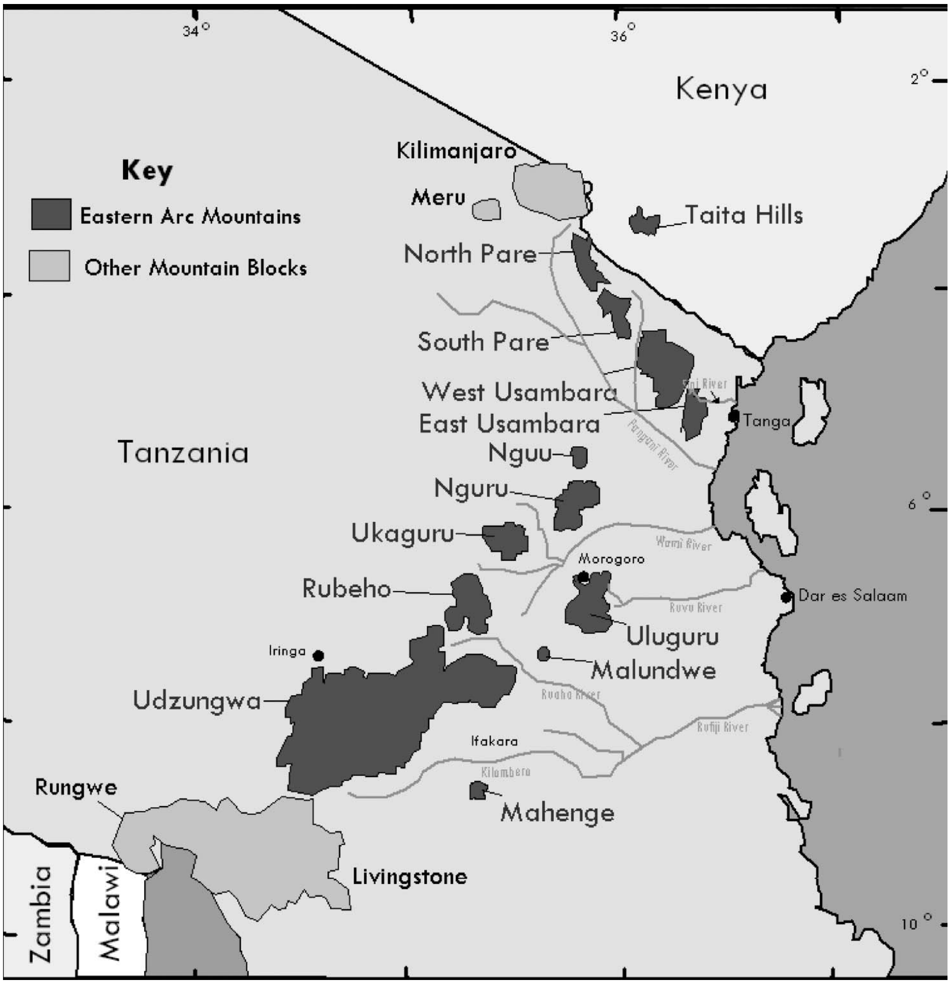


FIGURE 1 Location of the Uluguru North and West Usambara Mountains within the Eastern Arc Mountains, Tanzania.

per year (Ulvila 1993). The type of soils found in this area is sandy loam (Ulvila 1993).

The major ethnic tribe of the Ulugurus is the Luguru. They have been in these mountains for several hundred years, but came from other areas of Tanzania. The land ownership is matrilineal and women are powerful in village life, in contrast to most other tribes in Tanzania where men own the land and make most of the strategic decisions about its use and management. There is intensive land scarcity and the available land has remarkably lost fertility leading to poor crop yield. Main crops grown include cabbages (*Brassica oleracea*), maize (*Zea mays*), beans (*Phaseolus vulgaris*), peas (*Pisum sativum*), bananas (*Musa* spp.), cassava (*Manihot* *esculenta*) and cocoyam (*Colocasia esculenta*). Tree crops include deciduous fruits—peaches (*Prunus persica*), plums (*Prunus* spp), pears (*Pyrus communis*) and apple (*Malus domestica*), and forest trees like *Eucalyptus spp, Cupressus lusitanica, Grevillea robusta* and *Acacia mearnsii.* Animal husbandry is concentrated on keeping pigs and few goats for the main purpose of getting manure as well as raising the household income (Bhatia and Ringia 1999).

West Usambara Mountains

The West Usambara Mountains lie between 4°24'–5°00'S and 38°10'–38°36'E (figure 1) at an altitude varying from 400 to 2,400 m above sea level. The area receives rainfall in a bimodal pattern, with short rains in October–December and long rains in March–May. Average rainfall ranges from 600 mm to over 1,200 mm per annum. The temperatures vary with altitude. At 500 m, the mean monthly temperature ranges between 25 °C and 27 °C while on the plateau at 1500–2400 m, the range is 13–18 °C (Wiersum et al. 1985). Frosts occur above 1600 m above sea level. The soil types are humic ferralitic and humic ferrisols with red to yellowish color, but the top-soil (not more than 30 cm deep) is darker owing to the high organic matter content.

Ethnically, these mountains are habited by the Shambaa tribe (78%), followed by the Pare (16%), the Mbugu (5%), and other tribes forming 1% of the population (Moshi 1997; Msuya 1998). The Pare, Mbugu, and other tribes beside the Shambaa are immigrants to the study area. People's livelihood depends on subsistence farming of food crops, which include maize, beans, wheat (*Triticum aestivum),* Irish potatoes (*Solanum tuberosum*), sweet potatoes (*Ipomea batatas*), banana, and cassava. Coffee (*Coffea arabica*), tea (*Camellia sinensis*), cardamom (*Elettaria cardamomum*), sugarcane (*Saccharum officinarum*), fruits (plums, pears, and apples), and green vegetables are grown as cash crops.

DATA COLLECTION AND ANALYSIS

Primary data were collected through Focus Group Discussions (FGD), household interviews, participant observation, and botanical surveys. A double sampling method was employed in selecting the study villages and households for questionnaire administration. At first, six villages, three from the Uluguru North Mountains (Kibwe, Magadu and Towelo) and three others from the West Usambara Mountains (Irente, Kiluwai and Kwemakame) were purposively selected. Thereafter, 30 households were randomly selected from each village to make a total sample size of 180 households. For the purpose of this study, a household was defined as a group of one or more persons living together under the same roof or several roofs within the same dwelling and eating from the same pot or making common provisions of food and other living arrangements. None of the study villages had more than 350 households. Therefore, based on recommendation by Boyd, Westfall, and Stasch (1981), the 30 households picked from each village were representative enough. Boyd and colleagues recommend a sample size of at least 5% of the total populations. Mbeyale (2008), on the other hand, recommended that a sample size of at least 30 units is sufficient irrespective of the population size. Information on the types and names of forest foods were obtained through the FGD/key informants interviews, which involved 10 to 15 people from each study village. Selection of participants for FGDs was based on the depth of their knowledge on indigenous forest food plants. Village leaders assisted in identifying these participants. Formal interviews using open-ended questionnaires were used to understand people's perceptions on availability, preferences, and consumption of both indigenous and exotic forest foods. This was important for comparison purposes and in judging whether indigenous forest food species were more or less important than exotic species. For the purpose of this study, an indigenous species is defined as the species that occurs naturally in a particular geographic area and whose genetic material has adapted to that specific location while exotic species is the one that has been introduced from another geographic region to an area outside its natural range.

Botanical surveys were conducted in the forests, cultivated farms, and on fallow areas. Three local people in each village and two botanists from Tanzania Forest Research Institute (TAFORI) Herbarium in Lushoto and Tanzania Tree Seed Agency (TTSA) in Morogoro were involved in the identification and marking of edible plants in WUM and UNM, respectively. The role of local people was to show the plants, which were reported in the FGD/key informant interviews sessions, and the botanists had the role of assigning the scientific names. Although the botanists were highly skilled and experienced in plant identification, two field guides for identification of tropical plants (Blundell 1987; Dharani 2002) were used to verify the identified species. Specimens which could not be assigned scientific names in the fields were collected, pressed using the old newspapers and, those from UNM were taken to the TTSA while those from WUM were taken to the TAFORI Herbarium in Lushoto for identification to either species or genus level.

Data from the questionnaire and botanical identification were compiled and analyzed using Statistical Package for Social Sciences (SPSS) Version 12.5 (SPSS Inc., 2335 Wacker Drive, Chicago, IL 60606) and Microsoft Excel. Descriptive statistics such as means, percentages, frequencies, and variances were computed and used to describe the data.

RESULTS

Species Supplying Forest Food

A total of 124 indigenous forest food plant species representing 57 families were identified from the UNM and the WUM (tables 1 and 2). Sixty-nine species belonging to 31 families provide edible fruits, nuts, and seeds (table 1)

TABLE 1 The Indigenous Plant Species Supplying Wild Fruits, Seeds, and Nuts from the Uluguru North and West Usambara Mountains

	Scientific name	Local name (Sambaa)	Family
Species identified in West Usambara Mountains (14 species; 9 families)			
1	*Acokanthera oppositifolia*	Msunguti	Apocynaceae
2	*Allanblackia ulugurensis*	Mkani	Clusiaceae
3	*Ancylobothrys petersiana*	Vitoja	Apocynaceae
4	*Berchemia discolour*	Nyahumbu	Rhamnaceae
5	*Bridelia micrantha*	Msumba	Euphorbiaceae
6	*Diospyros mespiliformis*	Mkululu	Ebenaceae
7	*Dovyalis abyssinica*	Msambwa	Flacourtiaceae
8	*Flueggea virosa*	Mkwambekwambe	Euphorbiaceae
9	*Myrianthus arboreus*	Mdewerere	Cecropiaceae
10	*Myrianthus holstii*	Mlowelowe	Cecropiaceaea
11	*Rhus vulgaris*	Msulu	Anacardiaceae
12	*Saba comorensis (S. florida)*	Mbungo	Apocynaceae
13	*Sorindeia madagascariensis*	Mhilihili	Anacardiacea
14	*Synsepalum msolo*	Msambwa	Sapotaceae
Species identified in West Usambara Mountains (24 species; 15 families)			
1.	*Adansonia digitata*	Tebwe	Bombacaceae
2	*Annona senegalensis*	Mbokwe	Annonaceae
3	*Canthium shabanii*	Ntuavuha	Rubiaceae
4	*Deinbollia borbonica*	Mkunguma	Sapindaceae
5	*Carissa edulis*	Mfumba	Apocynaceae
6	*Cordyla Africana*	Mgwata	Caesalpiniaceae
7	*Englerophytum natalense*	Mdulu	Sapotaceae
8	*Grewia forbesii*	Mkongodeko	Tiliaceae
9	*Mammea usambarensis*	Mbuni	Clusiaceae
10	*Manilkara discolour*	Mghambo	Sapotaceae
11	*Mystroxylon aethiopicum*	Mtunda kunguru	Celastraceae
12	*Landolphia kilimanjarica*	Ugooto	Apocynaceae
13	*Osyris lanceolata*	Mzulu	Santalaceae
14	*Passiflora edulis*	Makakara	Passifloraceae
15	*Pyrostria bibracteata*	Mshizo	Rubiaceae
16	*Senna septenintrionalis*	Mkundekunde	Caesalpiniaceae
17	*Scolopia zeyheri*	Mtwampara	Flacourtiaceae
18	*Tamarindus indica*	Mkwazu	Caesalpiniaceae
19	*Thylachium africanum*	Shingaazi	Capparidaceae
20	*Trilepisium madagascariense*	Mzughu	Moraceae
21	*Tylosema fassoglense*	Mpwizopwizo	Caesalpiniaceae
22	*Uvaria acuminate*	Mshofu	Annonaceae
23	*Uvaria lucida subsp. Virens*	Mshofu	Annonaceae
24	*Oncoba spinosa*	Mtonga	Flacourtiaceae

(*Continued*)

TABLE 1 (*Continued*)

Scientific name		Local name (Lu = Luguru; Sa = Sambaa)	Family
Species identified in both study areas (31 species; 27 families)			
1.	*Allanblackia stuhlmannii*	Mkani (Lu), Mkanyi (Sa)	Clusiaceae
2	*Alsodeiopsis schumannii*	Mmavimavi (Sa)	Icacinaceae
3	*Ampelocissus africana*	Mzabibu pori (Lu), Ghoe (Sa)	Vitaceae
4	*Borassus aethiopum*	Mtapa (Lu), Vumo (Sa)	Arecaceae
5	*Deinbollia kilimandscharica*	Mmoyomoyo (Lu), Mkunguma (Sa)	Sapindaceae
6	*Euclea divinorum*	Mdaa (Lu), Mdala (Sa)	Ebenaceae
7	*Ficus sycomorus*	Mkuyu (Lu), (Sa)	Moraceae
8	*Flacourtia indica*	Mgora (Lu), Mgola (Sa)	Flacourtiaceae
9	*Grewia similes*	Mkole (Lu), Mnangu (Sa)	Tiliaceae
10	*Grewia villosa*	Mkole (Lu), Mnangu (Sa)	Tiliaceae
11	*Hoslundia opposita*	Mteremtere (Lu), Mshwee (Sa)	Lamiaceae (Labiatae)
12	*Landolphia kirkii*	Mlimbo (Lu), Ugooto (Sa)	Apocynaceae
13	*Opilia amentacea*	Mlende (Lu), Mwevumbulo (Sa)	Opiliaceae
14	*Parinari excelsa*	Mgama (Lu), Muula (Sa)	Chrysobalanaceae
15	*Zanha africana*	Mdaula (Lu), Mkwanga (Sa)	Sapindaceae
16	*Phoenix reclinata*	Mkindu (Lu), (Sa)	Arecaceae
17	*Physalis angulata*	Songwa (Lu), Msupu (Sa)	Solanaceae
18	*Rhus natalensis*	Msulu (Lu), Mhunguu (Sa)	Anacardiaceae
19	*Ricinodendron heudelotii*	Mkungonolo (Lu), Mtondoro (Sa)	Euphorbeaceae
20	*Rubus spp*	Fifi (Lu), Mshawa (Sa)	Rosaceae
21	*Slerocarya birrea sbsp. cafra*	Mng'ongo (Lu), (Sa)	Anacardiaceae
22	*Solanum anguivii*	Songwa (Lu), Njujui (Sa)	Solanaceae
23	*Sterculia appendiculata*	Mfune/mgude (Lu); Mfune (Sa)	Sterculiaceae
24	*Syzygium cordatum*	Msu (Lu), Mshihwi (Sa)	Myrtaceae
25	*Syzygium guineense*	Msu (Lu), Mshihwi (Sa)	Myrtaceae
26	*Telfairia pedata*	Ng'eme (Lu), Nkungu (Sa)	Cucurbitaceae
27	*Vangueria infausta*	Msada (Lu), Mvilu (Sa)	Rubiaceae
28	*Vangueria madagascariensis*	Msada (Lu), Mvilu (Sa)	Rubiaceae
29	*Vitex doniana*	Mfuru (Lu), Mgobe (Sa)	Verbenaceae
30	*Ximenia Americana*	Mhingi (Lu), Mtundwi (Sa)	Olacaceae
31	*Ximenia caffra*	Mhingi (Lu), Mtundwi (Sa)	Olacaceae

and 47 species from 25 families are used as green leafy vegetables (table 2). Three species of edible mushrooms (*Termitomyces eurrhizus, T. letestui,* and *Auricularia delicata*) and five species of roots and tubers (*Dioscorea quartiniana, Dioscorea minutiflora, Satyrium neglectum, Tacca leontopetaloides,* and *Thylachium africanum*) were also used as forest foods.

Twenty-four species supplying edible fruits, nuts and seeds, and 22 vegetable species were identified from the WUM, including 2 edible mushrooms (*Termitomyces eurrhizus* and *Auricularia delicata*) and 2 edible roots/tubers (*Tacca leontopetaloides* and *Diaoscorea minutiflora*). The UNMs had relatively low number of species with 13 vegetable species and 14 species providing edible fruits, nuts, and seeds. Only one edible tuber, namely *Satyrium neglectum* (orchid), was reported. Twelve vegetable species, 29 species supplying edible fruits, nuts and seeds and 1 edible

TABLE 2 The Indigenous Plant Species Supplying Vegetables from the Uluguru North and West Usambara Mountains

Scientific name		Local name (Luguru)	Family
Species identified in Uluguru North Mountains (13 species; 9 families)			
1.	*Amaranthus graecizans*	Mchicha pori	Amaranthaceae
2	*Amaranthus thunbergii*	Mchicha pori	Amaranthaceae
3	*Asystasia mysorensis*	Mkekomba	Acanthaceae
4	*Bidens schimperi*	Nyaweza	Compositae
5	*Capsicum frutescens*	Pilipili	Solanaceae
6	*Corchorus olitorius*	Mlenda mgunda	Tiliaceae
7	*Talinum sp. c.f. T. cafra*	Tere	Portulacaceae
8	*Corchorus tridens*	Msafa	Tiliaceae
9	*Gynandropsis gynandra*	Mgange	Capparaceae
10	*Justicia heterocarpa*	Mwidu	Acanthaceae
11	*Justicia sp*	Mwidu	Acanthaceae
12	*Mansonia angustifolia*	Hombo	Geraniaceae
13	*Ormocarpum kirkii*	Kilumbulumbu	Papilionaceae

Scientific name		Local name (Sambaa)	Family
Species identified in West Usambara Mountains (22 species; 18 families)			
1.	*Abutilon mauritianum*	Fiefie	Malvaceae
2	*Acalypha ornate*	Mfulwe	Euphorbiaceae
3	*Acanthopale laxiflora*	Hongoani	Acanthaceae
4	*Adansonia digitata*	Tebwe	Bombacaceae
5	*Aerva lanata*	Paramoyo	Amaranthaceae
6	*Cardamine trichocarpa*	Kisegeju	Brassicaceae
7	*Chenopodium opulifolium*	Thekizeu	Chenopodiaceae
8	*Combretum padoides*	Msangate	Combretaceae
9	*Dioscoreophyllum volkensii*	Msangani	Menispermaceae
10	*Drymaria cordata*	Lugulashili	Caryophyllaceae
11	*Emilia coccinea*	Limijang'ombe	Compositae
12	*Grewia tembensisi*	Mnangu	Tiliaceae
13	*Justicia striata*	Unkobo	Acanthaceae
14	*Momordica foetida*	Ushwe	Cucurbitacea
15	*Opilia amentacea*	Mwevumbulo	Opiliaceae
16	*Oxygonum sinuatum*	Mbigili	Polygonaceae
17	*Pouzolzia mixta*	Kanyandee	Urticaceae
18	*Pupalia lappacea*	Mamata	Amaranthaceae
19	*Rourea orientalis*	Kisogo	Connaraceae
20	*Sonchus luxurians*	Mshunga pwapwa	Compositae
21	*Sonchus oleraceus*	Mshunga kwake	Compositae
22	*Solanum anguivii*	Njujui	Solanaceae

Scientific name		Local name (Lu = Luguru; Sa = Sambaa)	Family
Species identified in both study areas (12 species; 7 families)			
1.	*Amaranthus spinosus*	Bwasi (Lu), Bwache (Sa)	Amaranthaceae
2	*Basella alba*	Delega (Lu), Ndelema (Sa)	Basellaceae
3	*Bidens pilosa*	Nyangudi (Lu), Mbwembwe (Sa)	Compositae
4	*Celosia trigyna*	Zaza (Lu), Bwache (Sa)	Amaranthaceae
5	*Commelina benghalensis*	Korogwa (Lu), Nkongo (Sa)	Commelinaceae

(*Continued*)

TABLE 2 (*Continued*)

Scientific name		Local name (Lu = Luguru; Sa = Sambaa)	Family
6	*Commelina africana*	Korogwa (Lu), Nkongo (Sa)	Commelinaceae
7	*Galinsoga parviflora*	Mamboleo (Lu), Mngereza(Sa)	Arecaceae
8	*Grewia similis*	Mkole (Lu), Mnangu (Sa)	Solanaceae
9	*Launaea cornuta*	Mshunga (Lu), (Sa)	Anacardiaceae
10	*Physalis peruviana*	Songwa (Lu), Msupu (Sa)	Rosaceae
11	*Solanum nigrum*	Mnavu (Lu), (Sa)	Anacardiaceae
12	*Zanthoxylum chalybeum*	Mlenda (Lu), Hombomuungu (Sa)	Solanaceae

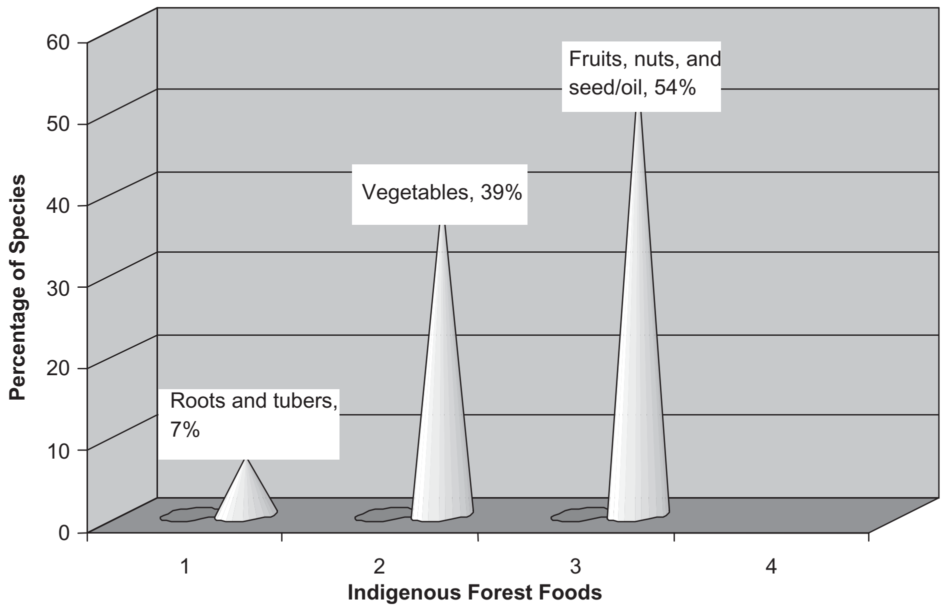


FIGURE 2 Proportions of different categories of indigenous forest foods recorded in Uluguru North and West Usambara Mountains.

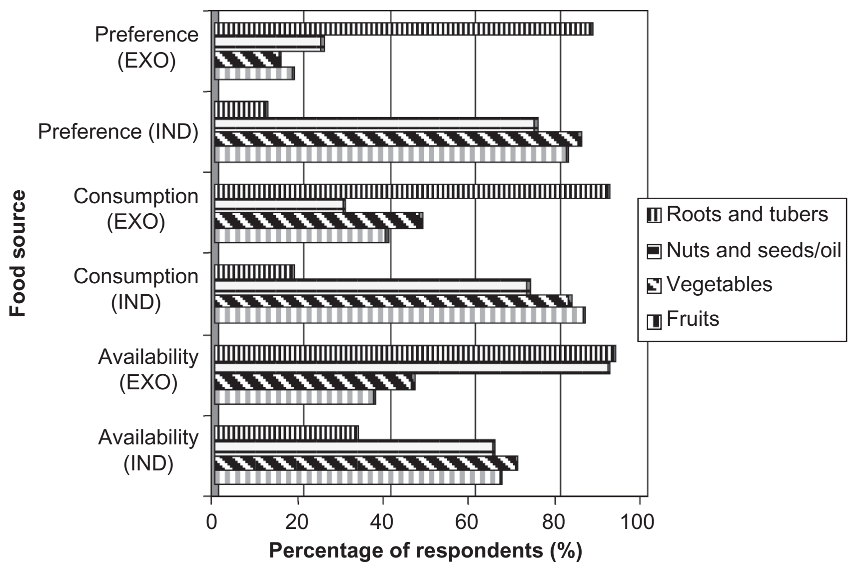
mushroom (*Termitomyces letestui*) along with 2 tubers/roots (*Thylachium africanum and Diaoscorea quartiniana*) were found in both study areas.

Indigenous forest plant species supplying edible fruits, nuts/seeds, and vegetables comprised 93% (n = 122) of all forest foods reported in the study areas (39% vegetables and 54% fruits, nuts/seeds) while mushrooms, roots/tubers contributed only 7% (figure 2).

Availability, Preference, and Consumption of Forest Foods

The WUM had higher proportions of both indigenous and exotic fruits reported by respondents compared to UNM (figure 3). However, while the

(a)



(b)

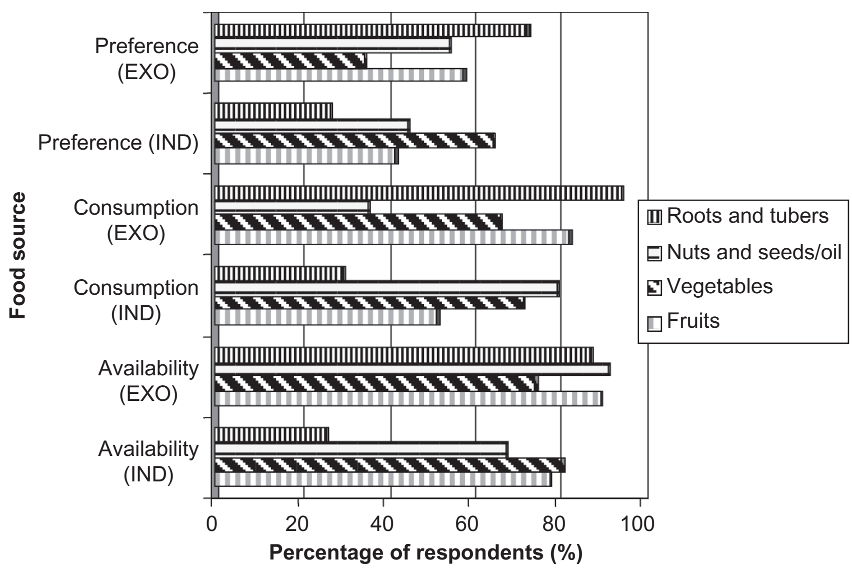


FIGURE 3 People's perceptions on availability, consumption, and their preference on the indigenous species (IND) and exotic species (EXO) in (a) Uluguru North Mountains and (b) West Usambara Mountains.

proportions of both types of fruits were equally reported to be higher in WUM, in UNM plant species reported as indigenous fruits were almost twice the number of those reported as exotics. The situation is similar for vegetables, nuts, and seeds. For the case of indigenous species of roots/tubers, the availability in both study areas was very low.

The number of indigenous fruits was low in the UNM compared to WUM. However, their consumption and preference was much higher in the former than in the latter (figure 3). The case is different for vegetables, indigenous nuts, and seeds/oil in both areas as their consumption and preference were higher than the exotic ones (figure 3). The consumption and preference of indigenous roots and tubers were reasonably low compared to the exotic ones (figure 3). Although on average the availability of indigenous forest foods was relatively low in the UNM (59%), their preference and consumption were higher compared to the situation in WUM (figure 3).

DISCUSSION

This study did not assess the contribution of forest foods in enhancing food security and household income. However, a large number of indigenous edible forest species reported here, their preference and consumption, compared to exotic species, signify the economic value of the forests in the Eastern Arc Mountains and the potential role of the indigenous forest foods to food security and household income. Although the market for indigenous forest foods is not well established, about 26 and 35% of the respondents from the UNMs and the WUMs, respectively, reported to have obtained some income from sales of indigenous forest foods such as *Tamarindus indica*, *Saba comorensis*, *Annona senegalensis*, nuts from *Telfairia pedata*, and indigenous vegetables. Sales of forest food products have potential to increase purchasing powers for households and, therefore, contribute indirectly to food security by providing more access to cultivated food products such as maize, rice etc. A recent valuation of non-timber forest products in Nyanganje Forest Reserve, one of the forests in the Eastern Arc Mountains, demonstrates the economic value of forest foods. The valuation revealed that non-timber forest products earned the adjacent communities an annual income of about US$347,500 (Kilonzo 2009). Of this, mushrooms, wild fruits, and wild vegetables contributed US$66,412, US$5,035, and US$26,055, respectively (Kilonzo 2009).

The indigenous trees and other plants producing edible products contribute indirectly to household food security by ameliorating the climate, improving soil fertility, and enhancing water conservation and, therefore, increasing land productivity (Falconer and Arnold 1988; Hoskins 1990; Séne 2000; Kajembe et al. 2000). In this regard, the same forest plants supplying edible fruits, nuts/seeds and vegetables found on farmlands can improve soil fertility by increasing soil organic matter through the dead plant materials such as leaves. Some plant species with food value such as *Tamarindus indica*, *Senna septenintrionalis*, *Cordyla africana,* and *Ormocarpum kirkii* have the potential of fixing nitrogen and hence increasing the fertility of the soils. Furthermore, *Ficus sycomorus* and *Vitex doniana*, which supply edible fruits, have the ability to retain soil moisture and hence improve crop production.

There is ample literature indicating that forests and wild places in different parts of Africa have historically been the potential sources of indigenous foods. Irvine (1952), for example, recorded over 100 species of wild plants exploited for their leaves and another 200 wild species valued for their fruits. Grivetti (1976) reported that, the Tswana (agro-pastoralists) regularly used 126 plant species as food sources while Okafor (1980) recorded over 150 species of edible woody plants in Nigeria. A literature survey by Becker (1986) revealed 800 edible plant species in the arid and semi-arid Sahelian belt. In Tanzania, Ruffo and colleagues (2002) documented over 320 edible wild plant species; Temu and Msanga (1994) found 83 species of indigenous fruit trees while 30 species of edible mushrooms were identified by Härkönen and colleagues (2003). Other researchers have worked in specific areas of the country (see e.g., Kilonzo 2009; Uiso and John 1996; Mapolu 2002; Msuya et al. 2004; Nyigili 2003).

In this study, availability, preference, and consumption of forest foods were quite high for indigenous fruits, nuts/seeds, and vegetables but low for tubers, roots, and mushrooms. One of the reasons could be the diversity of the species within each category of indigenous forest foods (i.e., vegetables, fruits, tubers/roots, and mushrooms). Categories with more diverse species are likely to be more accessed and consumed. It is apparent that availability and preference of the species have influence on the consumption level of the indigenous forest foods. For instance, indigenous edible tubers/roots are scarce in both the study areas. Their preference and consumption are, therefore, low compared to exotic species, which are more available. The level of knowledge on the categories may also influence preference and consumption levels—the higher the knowledge the higher the level of extraction and use of a particular category. For instance, the consumption of mushrooms in the plateau of the Miombo woodlands and Southern Tanzania is higher compared to the mountainous areas, including the Eastern Arc Mountains, because the knowledge on the use of this food category is well established in the former (Härkönen, Saaramaki, and Mwasumbi 1995; Missano et al. 1994; Kilonzo 2009). Furthermore, a large number of mushroom species in the mountainous areas are reported to be toxic and, therefore, inedible.

Differences in consumption and preference of indigenous forest foods observed between the Uluguru North and the West Usambara Mountains can be attributed to abundance of exotic food plants grown by the local people surrounding the West Usambara Mountains. The local economy of Shambaa people is largely sustained by cultivation and selling of exotic fruits and vegetables. This was explained by the inverse relationship between the cultivation of exotic species and the preference and uses of indigenous forest foods. Where exotic plant species were planted in large quantities, little preference and use were observed on the indigenous forest foods; likewise, where large number of indigenous foods were preferred and consumed, the variety of exotic food plants available was low (Msuya, Mndolwa, and Sabas 2002).

In West Usambara, whereas preference for all other food sources was higher for exotics relative to indigenous species, the situation was different for vegetables. Indigenous vegetables were more preferred than the exotic vegetables. This was the scenario observed in the past 30 years. A study of wild leaf plants in the study area by Fleuret (1979) found that, vegetable relishes were an essential element of the Shambaa people's diet. She found that, introduced exotic vegetables were not replacing wild leaf relishes because people preferred the taste of wild leaves and were traditionally important in the people's culture. Furthermore, wild leaves were valued because they were economically more affordable and accessible.

CONCLUSION

Although this study made no attempt to quantify the contribution of indigenous forest foods in enhancing food security; results on availability, preference, and consumption provide a hint of their potential in this role. The high diversity of indigenous food species found in the two studied forest areas affirms the importance of the Eastern Arc Mountains in sustaining the livelihoods of the adjacent communities. The availability of the forest food resources in these forests is fairly high. However, the high levels of preference and consumption of the forest foods may render contribution of these resources to food security unsustainable. This may be compounded by a rapid human population growth that increases deforestation (for agriculture and settlements) and overexploitation of forest resources. A rise in negative impacts associated with the climate change may equally complicate the situation. Sustainability of these resources will depend on proper management of these factors. The following recommendations are pertinent:

- Adequate research and improved technology should be invested in the forestry sector to ensure sustainable use of these resources. A combination of initiatives aimed at a better understanding of local and traditional practices, better management of resources, and integration of trees into farming systems can greatly enhance the contribution of forest foods to the household food security in the study areas.
- Future research should be conducted to quantify the contribution of indigenous forest foods in enhancing household food security and

income and to determine the nutritional value of different species. This can motivate conservation efforts towards these species.

- Unlike in other parts of the country such as in the Miombo woodlands of Tabora Region, the market for the indigenous forest foods is not well established in the study areas. Developing the market opportunities for these resources can motivate conservation of the indigenous species through domestication, although it is also true that it can pose a risk of depletion from the forests.

REFERENCES

Arnold, J. E. M., and P. Bird. 1999. *The forests and the poverty-environment nexus*. New York: UNDP Program on Forests.

Bhatia, Z., and O. Ringia. 1999. Socio-economic survey of selected villages in the Uluguru Mountains, Tanzania. Uluguru Slopes Planning Project. Report No. 3. A Joint Project between URT, European Union, and R.S.P.B.

Becker, B. 1986. Wild plants for human nutrition in the Sahelian zone. *Journal of Arid Environments* 11 (1): 61–64.

Becker, R. 1983. The nutritional quality of the fruit from the Chanar tree. (Geoffroea decorticans). *Ecology of Food and Nutrition* 13:91–97.

BirdLife International. 2003. *BirdLife's online world bird database: The site for bird conservation*. Cambridge, UK: BirdLife International.

Bjørndalen, J. E. 1992. Tanzania's vanishing rain forests—Assessment of nature conservation values, biodiversity and importance for water catchment. *Agriculture, Ecosystems & Environment* 40 (1–4): 313–334.

Blundell, M. 1987. *Collins photo guide to the wild flowers of East Africa*. London: Collins.

Boyd, H. W., R. Westfall, and S. Stasch. 1981. *Marketing research text and cases*. 6th ed. Chicago: Homewood.

Burgess, N. D., T. M. Butynski, N. J. Cordeiro, N. H. Doggart, J. Fjeldsa, K. M. Howell, F. B. Kilahama, et al. 2007. The biological importance of the Eastern Arc Mountains of Tanzania and Kenya. *Biological Conservation* 134:209–231.

Burgess, N. D., J. D. A. Hales, T. H. Ricketts, and E. Dinerstein. 2006. Factoring species, non-species values and threats into biodiversity prioritisation across the ecoregions of Africa and its islands. *Biological Conservation* 127:383–401.

Caldwell, M. J., and I. C. Enoch. 1972. Ascorbic acid content of Malaysian leaf vegetables. *Ecology of Food and Nutrition* 1:313–317.

Campbell, B. M., M. Luckert, and I. Scoones. 1991. Local-level valuation of savannah resources: A case study from Zimbabwe. Harare, Zimbabwe: Zim Publishers.

Cavendish, W. 2000. Empirical regularities in the poverty-environment relationship of African rural household. Working Paper Series 99–21, Centre for the Study of African Economics, University of London.

CEPF. 2005. Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya. Critical Ecosystem Partnership Fund. http://cepf.tfcg.org/ (accessed September 18, 2009).

Dharani, N. 2002. *Field guide to common trees and shrubs of. East Africa.*, Cape Town, South Africa: Struik Publishers.

EAMCEF. 2005. Eastern Arc Homepage. Eastern Arc Mountains Conservation Endowment Fund. http://www.easternarc.or.tz/ (accessed September 18, 2009).

Falconer, J., and J. E. M. Arnold. 1988. Forests, trees and household food security. Social Forestry Network Paper No. 7a, Overseas Development Institute, London.

Falconer J., and J. E. M. Arnold. 1991. Household food security and forestry an analysis of socio-economic issues. Community Forestry Notes Series 01.1991.

Fleuret, A. 1979. The role of wild foliage in the diet: A case study from Lushoto, Tanzania. *Ecology of Food and Nutrition* 8 (2): 87–93.

Grivetti, L. E. 1976. Dietary resources and social aspects of food use in a Tswana tribe. PhD diss., University of California.

Hamilton, A. C., and I. V. Mwasha. 1989. History of resource utilization and management after independence. In *Forest conservation in the East Usambara Mountains, Tanzania*, ed. A. C. Hamilton and R. Bensted-Smith, 45–56. Gland, Switzerland: IUCN.

Härkönen, M., and K. Vainio-Mattila. 1998. Some examples of natural products in the Eastern Arc Mountains. *Journal of East African Natural History* 87:265–278.

Härkönen, M., T. Saaramaki, and L. Mwasumbi. 1995. Edible mushrooms of Tanzania. *Karstenia* 35 (suppl. 92).

Härkönen, M., T. Saaramaki, and L. Mwasumbi. 2003. *Tanzanian mushrooms: Edible, harmful and other fungi.* Helsinki, Finland: Botanical Museum, Finnish Museum of Natural History.

Hoskins, M. 1990. The contribution of forestry to food security. *UNASYLVA* 41(160).

Hughes, J. 2009. Just famine foods? What contributions can underutilized plants make to food security? International symposium on underutilized plants for food security, nutrition, income and sustainable development. *ISHS Acta Horticulturae* 806:39–47.

Idowu, O. O. 2009. Contribution of neglected and underutilized crops to household food security and health among rural dwellers in Oyo State, Nigeria. International symposium on underutilized plants for food security, nutrition, income and sustainable development. *ISHS Acta Horticulturae* 806:48–56.

Irvine, F. R. 1952. Supplementary and emergency food plants of West Africa. *Economic Botany* 6 (1): 23–40.

Kajembe, G. C., M. I. Mwenduwa, J. S. Mgoo, and H. Ramadhani. 2000. Potentials of non-wood forest products in household food security in Tanzania: The role of gender based local knowledge. Report submitted to Gender, Biodiversity and Local knowledge Systems (LinKS) to Strengthen Agricultural and Rural Development.

Kilonzo, M. 2009. Valuation of non-timber forest products used by communities around Nyanganje Forest Reserve in Morogoro, Tanzania. MSc thesis, Sokoine University of Agriculture, Morogoro.

Kochhar, S. L. 1981. *Tropical crops.* London: Macmillan.

Kwesiga, F., and S. Mwanza. 1994. Under-exploited wild genetic resources: The case of indigenous fruit trees in Eastern Zambia. In *Proceedings of the regional conference on the indigenous fruit trees of the Miombo ecozone of Southern Africa, Mangochi, Malawi*, ed. ICRAF, 106–111. Nairobi.

Maharjani, K. L., and A. Khatri-Chettri. 2006. Role of forests in household food security: Evidence from rural areas in Nepal. *ANREG* 15:41–67.

Missano, H., C. W. Njebele, L. Kayombo and B. Ogle. 1994. Dependency of forests and trees for food security: A pilot study of Nanguruwe and Mbambakofi villages in Mtwara Region, Tanzania. TFNC Report No. 1614, Dar es Salaam.

Mapolu, M. 2002. Contribution of non-wood forest products to household food security: A case of Tabora District, Tanzania. MSc thesis, Sokoine University of Agriculture, Morogoro.

Mbeyale, G. E. 2008. The impact of institutional changes on the management of common pool resources in Pangani River Basin: A case study of Eastern Same, Kilimanjaro Tanzania. PhD diss., University of Dar es Salaam, Tanzania.

Moshi, E. R. F. 1997. Inventory of indigenous agroforestry systems in practice in the West Usambaras. MSc thesis, Sokoine University of Agriculture, Morogoro.

Msuya, T. S. 1998. Uses and indigenous conservation methods of wild plants: A case of West Usambara Mountains, Tanzania. MSc thesis, NORAGRIC, Agricultural University of Norway.

Msuya, T. S., J. R. Kideghesho and E. J. Luoga. 2004. Consumption of indigenous fruits in Uluguru North and Ruvu North Forest Reserves, Tanzania. *Tanzania Journal of Forestry and Nature Conservation* 75:65–73.

Msuya, T. S., M. A. Mndolwa, and E. Sabas. 2002. Comparison of indigenous and exotic fruits by number of species, consumption and preference: A case of communities around Ruvu North Forest Reserve, Tanzania. *TAFORI Newsletter* 2 (2): 19–24.

Msuya, T.S., and C. Kapinga. 2006. Tree products market chains and trade arrangements in the ECA Region: Case of Arsha and Kilimanjaro, Tanzania. Tree on Farmland Network (TOFNET) Project Report submitted to the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA).

Msuya, T. S., E. Shilogile, M. A. Mndolwa, and E. Sabas. 2003. Potentials of joint forest management embracing agroforestry in improving the livelihoods of communities adjacent to forest areas: observations from Ruvu Fuelwood Pilot Project, Tanzania. *TAFORI Newsletter* 3 (2): 32–39.

Myers, N., R. A. Mittermeier, C. G. Mittermeier, G. A. B. D. Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. *Nature* 405:853–858.

Nkana, Z. G., and S. Iddi. 1991. Utilization of Baobab (*Adansonia digitata*) in Kondoa District, Central Tanzania. Sokoine University of Agriculture Record No. 50.

Nummelin, M., and L. Nshubemuki. 1998. Seasonality and structure of the arthropod community in a forested valley in the Uluguru Mountains, eastern Tanzania. *Journal of East African Natural History* 87:205–212.

Nyambo, A., A. Nyomora, C. K. Ruffo, and B. Tengnas. 2005. Fruits and nuts: Species with potential for Tanzania. Regional Land Management Unit (RELMA in ICRAF), World Agroforetry Centre–Eastern and Central Africa Regional Programme. Nairobi.

Nyigili, B. R. 2003. Contribution of non-wood forest products to household food security: A case of Mbozi District, Tanzania. MSc thesis, Sokoine University of Agriculture, Morogoro.

Ogle, B. 1996. People's dependency on forest resources for food security: Some lessons learned from the programme of case studies. In *Current issues in non-timber forest products research*, ed. M. Ruiz Perez and J. E. M. Arnold. Bogor, Indonesia: CIFOR-ODA.

Okafor, J. C. 1980. Edible indigenous woody plants in the rural economy of the Nigerian forest zone. *Forest Ecology and Management* 3:45–55.

Okayasu, S. 2008. The status of eco-tourism in the Eastern Arc Mountains of Tanzania. MSc thesis, Imperial College, London.

Oomen, H. A. P., and G. J. H. Grubben. 1978. *Tropical leaf vegetables in human nutrition*. Amsterdam: Konikhjk Institute Voor de Tropen.

Parent, G. 1977. Food value of edible mushrooms from Upper Shaba. *Economic Botany* 31:436–445.

Rodgers, W. A. 1993. The conservation of the forest resources of the Eastern Africa: Past influences, present practices and future needs. In *Biogeography and ecology of the rainforest of Eastern Africa*, ed. J. C. Lovettand and S. K. Wasser, 283–332. Cambridge: Cambridge University Press.

Ruffo, C. K., A. Birnie, and B. Tengnäs. 2002. *Edible wild plants of Tanzania. Regional land management unit (RELMA)*. Nairobi, Kenya: Swedish International Development Cooperation Agency (Sida).

Saka, J. D. K. 1994. Nutritional value of edible indigenous fruits: Present research status and future direction. In *Proceedings of the regional conference on the indigenous fruit trees of the Miombo ecozone of Southern Africa, Mangochi, Malawi*, ed. ICRAF, 106–111. Nairobi.

Sène, E. H. 2000. Forests and food security in Africa: The place of forestry in FAO's Special Programme for Food Security. *UNASYLVA* 51 (3): 13–18.

Temu, R. P. C., and H. P. Msanga. 1994. Available information and research priorities for indigenous fruit trees in Tanzania. In *Proceedings of the regional conference on the indigenous fruit trees of the Miombo ecozone of Southern Africa, Mangochi, Malawi*, ed. ICRAF. 106–111. Nairobi.

Thompson, H. C. 1972. *Vegetable crops*. New Delhi: Tata MacGraw-Hill.

Tindall, H. D. 1965. *Fruits and vegetables in West Africa*. Rome: FAO.

Uiso, F. C., and T. Johns. 1996. Consumption patterns and nutritional contribution of *Crotalaria brevidens* (Mitoo) in Tarime District, Tanzania. *Ecology of Food and Nutrition* 35:50–69.

Ulvila, M. 1993. People, history and environment of the Uluguru Mountains. Working Paper. Wurzburg Germany.

The United Republic of Tanzania (URT). 2005. *Conservation and management of the Eastern Arc Mountains Forests Project: Forest condition assessment in the Eastern Arc Mountain Forests of Tanzania*. Dar es Salaam, Tanzania: Ministry of Natural Resources and Tourism, Forest and Beekeeping Division.

World Food Summit (WFS). 1996. Rome Declaration on World Food Security and World Food Summit Plan of Action. ftp://ftp.fao.org/fi/document/eifac/SubComII/europe/Chapter5.pdf (accessed January 20, 2010).

Wiersum, K. F., C. L. Anspach, J. H. A. Boerboom, A. Rouwand, and C. P. Veer. 1985. Development of ecological methods of upland farming in West Usambara Mountains, Tanzania. FAO Forestry Paper No. 5. 55–82, FAO, Rome.