Ethnobotany of Wild and Semi-Wild Edible Fruit Species used by Maale and Ari Ethnic Communities in Southern Ethiopia

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Research

Abstract

Wild and semi-wild tree fruit species are important resources in combating food insecurity and providing supplementary diet to rural people. We studied wild and semi-wild fruit species used by the Maale and Ari communities in southern Ethiopia and the conservation status of these resources. We used focus group discussions (n = 18) and individual interviews (n = 144) in three rural **kebeles**. In total, the two communities used 52 species of wild and semi-wild fruit species which were especially important for their diet in times of food shortage. The most important species were, for the Maale community, *Balanites rotundifolia* (Tiegh.) Blatt. and *Dobera glabra* (Forssk.) Juss. ex Poir. and, for the Ari community, *Carissa spinarum* L. and *Vitex doniana* Sweet. No significant variation in ethnobotanical knowledge regarding fruit species existed among gender and age groups. The main traded fruit species were *B. rotundifolia*, *Ximenia caffra* Sond., and *Vangueria madagascariensis* J.F.Gmel. The major threats reported by informants to the availability of wild and semi-wild fruit species were tree felling and conversion of forest to agricultural land. In addition to preserving the local knowledge and implementing conservation strategies that protect the remaining fruit trees, maintenance and enrichment planting of the most important species are plausible management interventions.

Introduction

Ethiopia is an ecologically diverse country that not only harbors an exceptionally rich botanical diversity (Friis *et al.* 2005), but is also known for its extraordinary agro-biodiversity resulting from its varied geography, climate, ethnic diversity, and strong food culture (Edwards 1991, Kahsay 2004, Wiersinga & de Jager 2009). In Ethiopia, a large number of fruiting species are used for human consumption, and most come under the broad category of wild or semi-wild edible plants (Asfaw & Tadesse 2001). Edible fruit species refer to a subset of this broad category to pinpoint the plants in which the fleshy parts of the fruit (and sometimes seeds) are eaten raw, boiled, or roasted. There have been several attempts to define the term "wild" (e.g., FAO 1999, Mengistu 2008). The term "wild" in this paper, however, refers to indigenous plants that are growing only in natural environments, while "semi-wild" applies to those plants that are indigenous or introduced and naturalized to the region while nurtured also through encouragement or tolerance by people in their crop fields, home gardens, or borders.

Millions of rural people in developing countries, including Ethiopia, are unable to obtain or produce enough food through currently conventional means. Thus, they often depend on wild and semi-wild fruit to complement and enrich their diet, especially in periods of food shortage (Akin-

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nifesi 2006, Balemie & Kebebew 2006, Campbell 1987, CTA 2007, Effiong & Udo 2010). These fruit species play a crucial role in combating food insecurity, especially the so-called "hidden hunger" caused by deficiencies of micronutrients, vitamins, and minerals (Deshmukh & Waghmode 2011, Motlhanka & Makhabu 2011). They also serve as a safety net for filling the gaps when cultivated fruit are scarce (CTA 2007, Valvi & Rathod 2011).

Wild and semi-wild fruit species are not only consumed directly, but also serve to make beverages (Falconer & Arnold 1991) or are used for other specific purposes, such as to detoxify poisonous yams (*Dioscorea* spp.) during cooking in the case of tamarind pods in Ghana (CTA 2007). Furthermore, by collecting and marketing them, fruit provide an additional source of income, especially for rural women and children (Effiong & Udo 2010, Kalaba *et al.* 2009). Although in sub-Saharan Africa the benefits of wild and semi-wild fruit species are acknowledged by rural communities, their importance remains understudied and undervalued by outsiders (CTA 2007). Some of these edible fruit resources, however, may also have harmful effects if consumed in large amounts (Samson 2003). Thus, understanding which wild fruit species have adverse health effects will help to design future research on anti-nutritional factors and to devise solutions for possible consequences of long term consumption (Mengistu & Hager 2009).

Wild and semi-wild fruit resources are not only important as food but may also have several other functions and services (Motlhanka *et al.* 2008, Tabuti *et al.* 2004), such as medicinal applications or bee forage, although their relative importance depends on local circumstances. Due to their diverse functions, these resources may be exposed to overexploitation or otherwise threatened, especially in periods of food scarcity. These threatening factors may vary from region to region, depending up on the local socio-economic and ecological circumstances.

Thapa (2005) stressed the important role of women in natural resource utilization and suggested that any study on natural resource utilization should begin with a gender analysis for the purpose of maintaining and improving the resource's management. Moreover, Idowu *et al.* (2012) highlighted the importance of gender studies for a sound conservation policy analysis and for designing effective development options. Ethiopia is sometimes called a museum of diverse ethnic communities (Yintiso 1995) as it is home to about 70 ethnic communities. Although many of these communities regularly consume wild and semi-wild fruit and consider them part of their diet, little research has been undertaken on this valuable resource (Addis 2009, Balemie & Kebebew 2006, Mengistu & Hager 2008). A recent review by Lulekal *et al.* (2011) indicated that only a small number of communities were addressed and most studies poorly dealt with issues surrounding the different gender and age groups (Balemie & Kebebew 2006). Information on seasonal fruit availability in different parts of the country is largely lacking (Feyssa *et al.* 2011). To fill part of this knowledge gap, we present evidence on wild and semi-wild fruit consumption by two ethnic communities (Maale and Ari) for whom no previous information exists.

The objectives of this study are to describe and analyze the consumption, preference, and marketing of wild and semi-wild edible fruit in Maale and Ari communities. We expect that wild and semi-wild fruit species play an important role in the local diet and contribute to the nutrient intake of Maale and Ari people. Our null hypothesis is that all gender and age groups have a similar knowledge and familiarity of wild and semi-wild fruits. If differences exist in traditional knowledge among these groups, this will have an impact on the long-term availability of this food source, which should be addressed separately in any conservation strategy.

To test our hypothesis, we need to answer the following major research questions: 1) Which wild and semi-wild edible fruit species are harvested by Maale and Ari communities, in which quantities, and what is their seasonal availability? 2) Are there differences in familiarity, preference, and trade of these fruit species among age and gender groups? 3) Which criteria are important to farmers for the possible transition of wild fruit to semi-wild or even cultivated conditions? 4) Which elements affect wild and semi-wild fruit availability and trade?

Materials and Methods

Study area

The study was conducted in two communities (Maale and Ari) in the Maale and Debub Ari districts of southern Ethiopia, some 750 km from the capital Addis Ababa (Figure 1).

Among the other nine regions and two city administrations in the country, the Southern Nations, Nationalities and People's Regional State (SNNPR) comprises the highest number of ethnic communities (ca. 55), among which are the Maale and Ari. The language of the Maale people is called Malló mucci (Amha 2001), while the Ari speak the Araf language (Kebede 2009, Yintiso 1995).

Field work

We used combined reconnaissance surveys, field observations, discussions with individual farmers and focus groups, semi-structured key informant interviews, and preference ranking comparisons as described by Martin (1995), Alexiades (1996), and Cotton (1996). In ranking exercises, usually the highest value is given for the most preferred species and the lowest value is given for the least preferred ones. However, as this was difficult for our informants, we modified the procedure and used rank one

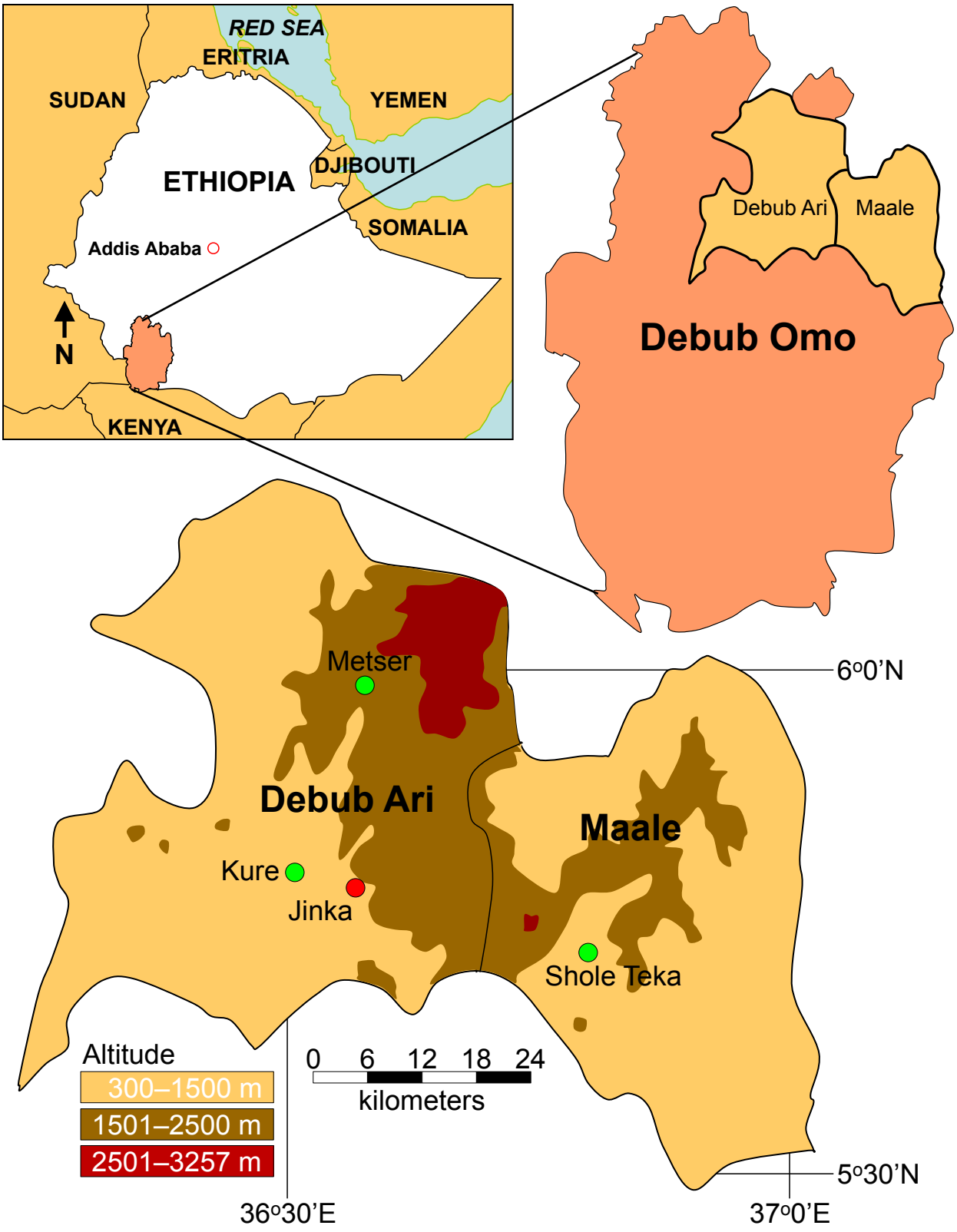

Figure 1. Study site **kebeles** (Kure, Metser, and Shole Teka) in Debub Ari and Maale, Debub Omo Zone, Ethiopia.

for the most preferred ones and higher values (six or seven) for less preferred items to enable respondents to express their preference more easily.

Reconnaissance surveys were conducted in July and August 2010 in the two districts. They encompassed transect drives, walks, and discussions with administrative officials from the zone, district, and **kebeles** (the lowest formal administrative unit in rural Ethiopia) in the two districts. Field observations were made in the same period during village walks with key informants and local community members. Individual formal and informal discussions were carried out to compile lists of wild and semi-wild fruit species and to understand their general importance. Focus group discussions (n = 18) were also carried out. At each study site about 10–12 informants from different socio-demographic groups were involved in the focus group discussions.

Generally, a stratified simple random sampling procedure was used in selection of study sites and study participants (Alexiades 1996). Based on altitude and ethnicity, the study areas were divided into three strata. Finally, three study **kebeles** (one from each stratum) were randomly selected for a more detailed, formal survey. Two **kebeles** (Kure and Metser) were selected in Debub Ari district, which represent the midland (1500–2500 masl) and lowland (500–1500 masl) climatic zones respectively. One **kebele** (Shole Teka) was selected from the Maale district, which is located in the lowland climatic zone. The respective **kebele** offices supplied us with lists of households and household members of the study areas from which males and females were randomly selected. We used two age groups because in both communities an individual above forty was considered matured adult. Similar groupings were used by Mengistu & Hager (2008) in their study in northern Ethiopia.

Voucher specimens were collected for wild and semi-wild fruit species used by the two ethnic communities in the presence of study participants and key informants. Preliminary identification was carried out in the field. Further, specimens were identified using taxonomic keys and floras (Edwards *et al.* 1997, Edwards *et al.* 2000, Edwards *et al.* 1995, Hedberg & Edwards 1989, Hedberg *et al.* 2003, Hedberg *et al.* 2006) and compared with earlier identified specimens. Finally the specimens were deposited at the National Herbarium (ETH) of Addis Ababa University. Plant names were also checked for accuracy by means of The Plant List (www.theplantlist.org).

Market surveys were carried out from February 2011 up to February 2012 at Beneta market in the Maale area and Jinka market for Debub Ari. Markets were visited every fifteen days. All wild and semi-wild edible fruit species that were sold at these two markets were documented with their price, source, and additional trade information.

Data analysis

Data were analysed with the statistical program SPSS 16.0 (SPSS 2007). Descriptive statistics were used to illustrate averages, percentages, and market survey results. Similarities and differences in fruit consumption between sites and ethnic communities were compared by means of the Jaccard similarity index (Höft *et al.* 1999). This index uses positive reply (plant used as edible fruit) and negative reply (plant not used) data sets and is expressed as:

$$JI = c / (a + b + c)$$

Where JI is the Jaccard similarity index, c is the number of species used by the two sites, a is the number of species used by the community in site A only, and b is the number of species by the community in site B only (Höft *et al.* 1999).

We used a familiarity index (FI) as a relative indicator of the popularity of the wild and semi-wild fruits within the communities (Tabuti *et al.* 2004), which was computed using:

FI = Frequency of a given species mentioned as food / Total number of respondents

The total figure of use value (UV) and the cultural importance index is the same, although defined in different ways (Tardío & Pardo-De-Santayana 2008). We considered the use value applied by Albuquerque *et al.* (2006) and Rossato *et al.* (1999), modified from Phillips and Gentry (1993), to estimate the total cultural significance of each species. Use value was calculated using:

$$UV = \sum Ui/n$$

Species use values (UV) were obtained by adding the number of uses mentioned by each informant for a given species (Ui) and dividing them by the number of informants in the survey (n). The value for each specific use category was also considered and obtained by adding the number of informants mentioning a given species for a specific use and dividing this by the total number of informants (Tardío & Pardo-De-Santayana 2008).

One-way analysis of variance (ANOVA) was performed to compare responses among different age and gender groups with regard to the familiarity and numbers of wild and semi-wild edible fruit species listed.

Results

Informants

The field study was carried out by multiple trips to the study sites from July 2010–November 2012. We random-

Table 1. Site and socio-demographic characteristics of the participants in the formal surveys in three study site **kebeles** in Debub Ari and Maale, Debub Omo Zone, Ethiopia.

Characteristics	**Site characteristics and number of individuals**				
Study sites	Shole Teka	Kure	Metser	Total	(%)
District	Maale	Debub Ari	Debub Ari		
Ethnicity	Maale	Ari	Ari		
Vegetation	*Acacia-Commiphora* and *Combretum - Terminanlia* woodland	Moist evergreen Afromontane forest and *Combretum - Terminalia* woodland	Forest converted to agricultural land; scattered trees in fields and home gardens		
Rainfall	Bimodal	Bimodal	Bimodal		
Male	24	24	24	72	50
Female	24	24	24	72	50
<40 years old	24	24	24	72	50
>40 years old	24	24	24	72	50
Educational status					
Illiterate	36	32	20	88	61
Read and write	1	2	7	10	6.9
Grade 1–6	9	6	9	24	17
Grade 7–8	2	5	5	12	8.3
Grade 9–12	0	3	7	10	6.9

ly selected a total of 144 individuals (72 male, 72 female) from households in three **kebeles**. Socio-demographic characteristics of the participants are listed in Table 1.

Diversity of wild and semi-wild fruits used

A total of 52 wild and semi-wild fruit-bearing species from 37 genera and 22 families were recorded among Maale and Ari communities (Appendix 1). The family Moraceae was most important (8 species), followed by the Rubiaceae (6 spp.), Fabaceae and Malvaceae (4 spp. each), and Anacardiaceae (3 spp.). Ten wild and semi-wild edible fruit species were common to both ethnic communities, while 36 species were used exclusively by the Maale and six species were consumed only by the Ari. The Jaccard's similarity indices for fruit use among the two study sites are given in Table 2. The two Ari **kebeles** (Kure, Metser) were more similar to each other than to the Maale **kebele** (Shole Teka), which could be attributed to geographical proximity and shared cultural preferences for fruit species. In all three study sites, knowledge on wild and semi-wild fruits was primarily acquired or transferred from parents, followed by friends, neighbors, and accidentally encountered individuals (Table 3).

Table 2. Similarity in wild and semi-wild fruit knowledge among the three study sites in Debub Ari and Maale, Debub Omo Zone, Ethiopia. * JI values ranges from 0–1; higher values indicate a greater similarity.

Study site (ethnic group)	Jaccard Index*	
	Shole Teka (Maale)	Kure (Ari)
Kure (Ari)	0.1923	-
Metser (Ari)	0.0588	0.5000

Table 3. Knowledge transfer means and ranking in Debub Ari and Maale, Debub Omo Zone, Ethiopia.

Transfer means (source)	Sum of ranking per study site			Mean rank			Mean ranks sum for all study sites	Overall rank
	Shole Teka	Kure	Metser	Shole Teka	Kure	Metser		
Parents	53	48	49	1.1	1.0	1.0	3.1	1
Friends	103	117	130	2.2	2.4	2.7	7.3	2
Neighbors	133	123	112	2.8	2.6	2.3	7.7	3
Accidental	191	192	189	4.0	4.0	3.9	12	4

The average numbers of wild and semi-wild fruit species listed by different age and gender groups and the result of the one-way ANOVA test are summarized in Table 4. The ANOVA results showed no significant difference in knowledge among different age and gender groups as all *P*-values were greater than 0.05.

The results of familiarity index for preferred species based on taste at each site are shown in Table 5. *Balanites rotundifolia* (Tiegh.) Blatt., *Vitex doniana* Sweet, and *Garcinia livingstonei* T.Anderson were the most familiar species in Shole Teka, Kure, and Metser study sites, respectively. Our ANOVA test showed no significant differences in familiarity among the gender and age groups for all sites at $P > 0.05$ ($P = 0.953$ in Shole Teka, $P = 0.895$ in Kure, and $P = 0.847$ in Metser).

Table 4. Average number of fruit species listed by males and females in study sites in Debub Ari and Maale, Debub Omo Zone, Ethiopia.

	Study sites					
	Shole Teka		Kure		Metser	
Age	Male	Female	Male	Female	Male	Female
>40	11.67	11.42	4.08	3.50	2.17	2.25
<40	12.75	12.17	3.17	3.42	2.08	2.83
ANOVAs (*P*-value) for gender & age groups for each site	0.524		0.506		0.635	
ANOVA (*P*-value) for gender & age groups in all sites	0.991					

Table 5. Selected wild and semi-wild fruit species and their familiarity indices (in %-age) in Shole Teka, Kure, and Metser study sites in Debub Ari and Maale, Debub Omo Zone, Ethiopia. n = 48 in each site.

Fruit species	% in each study site											
	Shole Teka				Kure				Metser			
	Male		Female		Male		Female		Male		Female	
Age	>40	<40	>40	<40	>40	<40	>40	<40	>40	<40	>40	<40
Balanites rotundifolia (Tiegh.) Blatt.	67	83	92	92								
Diospyros mespiliformis Hochst. ex A.DC.	67	67	58	92								
Uvaria leptocladon Oliv.	42	50	50	75								
Bullockia pseudosetiflora (Bridson) Razafim., Lantz & B.Bremer	50	25	50	58								
Carissa spinarum L.	75	8.3	50	50					33	25	83	50
Meyna tetraphylla (Schweinf. ex Hiern) Robyns	42	25	42	67								
Flacourtia indica (Burm.f.) Merr.	58	42	25	25								
Vitex doniana Sweet	33	33	42	33	67	100	92	92				
Grewia schweinfurthii Burret	25	42	33	25								
Vangueria madagascariensis J.F.Gmel.	0	0	33	0								
Ximenia americana L.					67	42	75	50				
Garcinia livingstonei T.Anderson					75	17	50	58	58	67	83	83
Manilkara butugi Chiov.					67	25	25	50	58	67	83	75
Ficus vasta Forssk.					33	25	25	33				
Ficus sycomorus L.					17	17	42	25				
Rubus steudneri Schweinf.					25	17	8.3	17	50	42	50	67
Syzygium guineense (Willd.) DC.					25	25	17	0				
Rubus apetalus Poir.									17	8.3	0	8.3

Seasonal fruit availability

Wild and semi-wild fruit species appear to be important food resources in the dry season and at the beginning of the rainy season, when there is a shortage in cultivated food in the study areas. The critical food scarcity starts in February and extends up to April or May. Food is generally in short supply during the dry period and at the beginning of the rainy season, but shortages can also occur throughout the year if there was no crop harvest in the preceding seasons. The most commonly cited fruit harvested during food shortage periods were *B. rotundifolia* and *Dobera glabra* (Forssk.) Juss. ex Poir. in Shole Teka, *Carissa spinarum* L., *V. doniana*, and *Ximenia americana* L. in Kure, and *Manilkara butugi* Chiov. and *G. livingstonei* in Metser (Table 6).

The seasonal availability of selected fruit-bearing species, especially those that are important during food shortage periods is indicated in Table 7. Wild and semi-wild fruit species are not only important to fill the stomach during different seasons, but they also contribute essential nutrients to the local diet. Mengistu and Hager (2009) studied the nutrient contents of *Ziziphus spina-christi* (L.) Desf. and *Diospyros mespiliformis* Hochst. ex A.DC. and showed that these wild species contained higher quantities of important nutrients than cultivated ones. Thus, wild and semi-wild fruit can play an important role in the local nutrient intake, provided their availability is guaranteed.

During group discussions, farmers mentioned several trees that bore fruit even in periods of severe drought: *D. mespiliformis*, *Tamarindus indica* L., *B. rotundifolia*, *Ximenia caffra* Sond., *Sterculia africana* (Lour.) Fiori, *Ficus sur* Forssk. (Figure 2), *Grewia schweinfurthii* Burret, and *Ficus vasta* Forssk.

Figure 2. *Ficus sur* Forssk., an important wild fruit resource during drought periods in Debub Omo Zone, Ethiopia.

Table 6. Most important fruit species harvested during food shortage periods in Shole Teka, Kure, and Metser study sites in Debub Ari and Maale, Debub Omo Zone, Ethiopia. n = 48 in each site.

Fruit species	**% citation**		
	Shole Teka (Maale)	**Kure (Ari)**	**Metser (Ari)**
Balanites rotundifolia (Tiegh.) Blatt.	35.4		
Dobera glabra (Forssk.) Juss. ex Poir.	20.8		
Diospyros mespiliformis Hochst. ex A.DC.	14.6		
Tamarindus indica L.	8.3		
Vangueria apiculata K.Schum.	6.3		
Uvaria leptocladon Oliv.	6.3		
Ficus vasta Forssk.	6.3	8.3	
Ficus platyphylla Delile	6.3		
Ficus sycomorus L.	4.2	8.3	2.1
Vangueria madagascariensis J.F.Gmel.	4.2		
Carissa spinarum L.		43.8	
Vitex doniana Sweet		37.5	
Ximenia americana L.		33.3	
Mussaenda arcuata Poir.		14.6	
Garcinia livingstonei T.Anderson		14.6	31.3
Manilkara butugi Chiov.		12.5	33.3
Syzygium guineense (Willd.) DC.		8.3	
Rubus steudneri Schweinf.		4.2	12.5
Meyna tetraphylla (Schweinf. ex Hiern) Robyns	2.1		

Table 7. Seasonal availability of selected wild and semi-wild fruit species as reported by informants in Shole Teka, Kure, and Metser in Debub Ari and Maale, Debub Omo Zone, Ethiopia. Seasons: Dry season (D), Rainy season (R).

Months	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Season	D	R	R	R	D	D	R	R	D	D	D	D
Species												
Balanites rotundifolia (Tiegh.) Blatt.			X	X			X	X				
Carissa spinarum L.						X	X	X	X			
Diospyros mespiliformis Hochst. ex A.DC.	X	X										X
Dobera glabra (Forssk.) Juss. ex Poir.		X	X	X								
Ficus platyphylla Delile	X	X										X
Ficus sur Forssk.	X	X										X
Ficus vasta Forssk.	X	X										X
Garcinia livingstonei T.Anderson	X									X	X	X
Manilkara butugi Chiov.			X	X	X							
Mussaenda arcuata Poir.			X	X								
Tamarindus indica L.	X	X				X	X					X
Vitex doniana Sweet	X	X										
Ximenia americana L.				X	X							

Farmers' criteria and preferences for future cultivation of fruits

Participants from both cultures distinguished seven preference criteria for the (future) cultivation of wild fruits. The most important were taste and marketability, followed by fast growth and high yield of the species (Table 8).

Maale and Ari farmers did not plant wild and semi-wild fruit trees as actively as they did with exotic domesticated fruit species, due to the better price and higher market demand of the latter. In Maale, *B. rotundifolia* was the only species actively grown for its fruit. *Cordia africana* Lam. (in Maale) and *F. vasta* and *Ficus sycomorus* L. (in Ari) were also cultivated, but mainly as shade trees in coffee plantations. Spontaneously growing fruit trees or shrubs in farms and home gardens were managed and protected to a certain extent. However, the increased demand for agricultural land made it difficult for farmers to save the remaining wild fruit species. Respondents of all three groups did not suggest enrichment planting of wild fruits in the remaining forest, but they did protect trees that al-

Table 8. Preference criteria for wild and semi-wild fruit species as reported by informants in Shole Teka, Kure, and Metser in Debub Ari and Maale, Debub Omo Zone, Ethiopia. Rank value 1 is given for the most preferred and rank value 7 given for the least preferred critera. n = 48 in each site.

Study sites	**Shole Teka (Maale)**		**Kure (Ari)**		**Metser (Ari)**		**Overall**	
Criteria	**Mean rank**	**Rank**	**Mean rank**	**Rank**	**Mean rank**	**Rank**	**Sum of rank**	**Overall rank**
Taste	1.7	1	2.1	2	1.3	1	4	1
Marketability	2.2	2	1.5	1	2.1	2	5	2
Fast growth and high yield	2.8	3	3.5	3	3.0	3	9	3
Ease of collection	5.0	6	3.8	4	4.8	4	14	4
Low shade effect on undergrowth	4.5	4	5.3	5	5.7	6	15	5
Ease of preparation	4.9	5	5.4	6	5.0	5	16	6
Specific cultural application	6.6	7	6.5	7	6.1	7	21	7

Table 9. Pair-wise mean value and rank of wild and semi-wild fruits based on taste in Shole Teka, Kure, and Metser Debub Ari and Maale, Debub Omo Zone, Ethiopia.

Study sites	Shole Teka (Maale)		Kure (Debub Ari)		Metser (Debub Ari)	
Species	**Mean**	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**
Balanites rotundifolia (Tiegh.) Blatt.	7.9	1	-	-	-	-
Meyna tetraphylla (Schweinf. ex Hiern) Robyns	5.8	2	-	-	-	-
Diospyros mespiliformis Hochst. ex A.DC.	5.2	3	-	-	-	-
Uvaria leptocladon Oliv.	4.7	4	-	-	-	-
Bullockia pseudosetiflora (Bridson) Razafim., Lantz & B.Bremer	4.2	5	-	-	-	-
Grewia schweinfurthii Burret	4.0	6	-	-	-	-
Vangueria madagascariensis J.F.Gmel.	3.5	8	-	-	-	-
Flacourtia indica (Burm.f.) Merr.	3.2	9	-	-	-	-
Manilkara butugi Chiov.	-	-	8.2	1	6.2	1
Vitex doniana Sweet	3.8	7	6.1	2	-	-
Carissa spinarum L.	2.8	10	5.5	3	2.9	5
Garcinia livingstonei T.Anderson	-	-	4.9	4	4.1	2
Rubus steudneri Schweinf.	-	-	4.7	5	3.9	3
Ximenia americana L.	-	-	3.8	6	-	-
Ficus vasta Forssk.	-	-	3.4	7	-	-
Syzygium guineense (Willd.) DC.	-	-	2.1	8	-	-
Ficus sycomorus L.	-	-	1.5	9	0.27	6
Rubus apetalus Poir.	-	-	-	-	3.9	4

ready grew there as these were highly appreciated. The lack of motivation for enrichment planting was associated with the problem of ownership rights, individual benefit sharing, and difficulty of close supervision. The taste preference ranking of fruit species depended on availability and knowledge based on practices. The most preferred species with regard to taste are listed in Table 9.

Figure 3. A young Maale girl in Shole Teka, Debub Omo Zone, Ethiopia, eating fresh *Uvaria leptocladon* Oliv. fruit.

Wild and semi-wild fruit harvesting and consumption

Harvesting of wild fruit was done either by shaking the plant, loosening the fruit with long sticks, or by climbing the tree. Harvesting for household consumption was usually done by all groups of people. Most fruit were consumed raw and fresh (Figure 3), but some were cooked with maize and sorghum flour (*B. rotundifolia* and *D. mespiliformis*), roasted (*S. africana* and *T. indica*), or boiled (*Vangueria apiculata* K.Schum. and *D. glabra*). Few species were processed into juice. Table 10 lists the farmer's preference of species used to prepare juice.

Table 10. Farmer's preference rank order for taste of fruit juice in Shole Teka, Maale, Debub Omo Zone, Ethiopia.

Scientific name	Mean Rank	Rank
Senna singueana (Delile) Lock	1.3	1
Rhus natalensis Bernh. ex C.Krauss	1.7	2
Rhus ruspolii Engl.	3.3	3
Tamarindus indica L.	3.7	4
Grewia villosa Willd.	5.1	5
Carissa spinarum L.	6.1	6
Bridelia micrantha (Hochst.) Baill.	6.8	7

Table 11. Fruit with undesirable effects and farmers' control strategy in Shole Teka, Kure, and Metser in Debub Ari and Maale, Debub Omo Zone, Ethiopia.

Species	Undesirable effect	Causes	Farmers' control strategy
Balanites rotundifolia (Tiegh.) Blatt.	Diarrhea, stomach ache	Eating meat after fruit	Avoid eating meat after fruit consumption
Carissa spinarum L.			
Flacourtia indica (Burm.f.) Merr.			
Ximenia caffra Sond.			
Cordia africana Lam.	Diarrhea, stomach ache	Excessive consumption	Drinking lime juice
Ficus platyphylla Delile	Diarrhea, stomach ache, vomiting	Excessive consumption	Drinking hot coffee
Ficus sur Forssk.			
Ficus sycomorus L.			
Ficus vallis-choudae Delile			
Ficus vasta Forssk.			
Manilkara butugi Chiov.	Aggravate and widen wounds	Eating the fruit or drinking the juice	Avoid drinking if one has wounds
Tamarindus indica L.	Diarrhea, stomach ache, vomiting	Excessive consumption	Drinking ash mixed with water
		Eating meat after fruit	Drinking the decoction of *Rhus natalensis* Bernh. ex C.Krauss leaves

Making juice from wild fruit was not a regular practice by the Ari communities, but they occasionally did this with *X. americana*, *G. livingstonei*, *C. spinarum*, and *M. butugi*. Moreover, the Ari boiled unripe fruits of *C. spinarum* to prepare soup during critical periods of the year. In some cases, the Maale also stored *B. rotundifolia* and *D. glabra* seeds for later use in traditional dishes. *Balanites rotundifolia* seeds can be stored for a year under dry conditions. Long storability was considered as one of the important characteristics of the fruit that were used during food shortage.

Side effects of wild fruit consumption and farmers' control strategies

Knowledge of wild fruit characteristics and farmers' control strategy is crucial, not only for dietary purposes, but also to prevent or treat the side effects of overconsumption. Experiences from Maale and Ari farmers and their remedies are indicated in Table 11. Excessive consumption of certain fruit species was mentioned to cause stomach and bowel problems. The use of wood ash as a possible remedy should be studied further to understand possible health effects. Moreover, the reported side effects caused by eating meat immediately after consuming certain fruit species requires further research attention.

Other uses of wild and semi-wild fruits

Several wild and semi-wild fruit species with important cultural meaning are listed in Table 12. *Balanites rotundifolia*, *V. doniana*, and *G. livingstonei* had the highest use value or cultural significance in Shole Teka, Kure, and Metser sites, respectively.

Major threats to wild and semi-wild fruits

According to the Maale and Ari participants, agricultural expansion was the main threat to wild fruit availability (Table 13). Population pressure, combined with declining productivity of agricultural land, forced the communities to expand their fields to the remaining patches of forest, resulting in increased deforestation and a decline in wild fruit trees. The recent increased value of land contributed to further expansion to the remaining forested patches. The threats were similar in all study sites, but respondents ranked it differently. In Kure the selective harvesting for other uses was ranked as a major threat next to agricultural expansion.

Trade in wild and semi-wild fruits

Collecting wild and semi-wild fruit to sell in the market was said to be a common practice by the rural communities during different seasons. Unlike cultivated species, which were sold along road sides, marketing of wild and semi-wild fruit only took place at the main markets. The fruit were main-

Table 12. Use value (UV) of species in Shole Teka (S), Kure (K), and Metser (M), in Debub Ari and Maale, Debub Omo Zone, Ethiopia.

Species	Study sites	Medicine	Construction	Fencing	Agri. tools	Fuel wood	Fodder	Bee forage	Furniture	Market	Edibility	Sum (UV)
Garcinia livingstonei T.Anderson	M	0.3	1.0	1.0	1.0	1.0	0	1.0	1.0	0.9	1.0	8.2
Manilkara butugi Chiov.	M	0	0.8	1.0	1.0	1.0	0	1.0	0.8	1.0	1.0	7.6
Balanites rotundifolia (Tiegh.) Blatt.	S	1.0	0.3	1.0	0.5	0.9	0.6	0.8	0.1	1.0	1.0	7.2
Ficus sycomorus L.	M	0	1.0	1.0	0.6	1.0	0	0.4	0.9	0.4	1.0	6.3
Meyna tetraphylla (Schweinf. ex Hiern) Robyns	S	1.0	0.2	1.0	0	1.0	1.0	0.8	0	0	1.0	6.0
Diospyros mespiliformis Hochst. ex A.DC.	S	0	0.9	0.9	0.9	1.0	0.1	0.6	0.6	0	1.0	6.0
Vitex doniana Sweet	K	0	0.2	0.8	0.2	1.0	0	0.9	0.8	0.9	1.0	5.8
Vitex doniana Sweet	S	0	0.5	0.5	0.1	1.0	0.2	0.7	0.8	0.2	1.0	5.0
Syzygium guineense (Willd.) DC.	K	0	0.1	1.0	0.1	1.0	0	0.3	1.0	0.3	1.0	4.8
Carissa spinarum L.	S	0.2	0.1	1.0	0	0.8	0.8	0.8	0	0	1.0	4.7
Manilkara butugi Chiov.	K	0	0.6	0.8	0.3	1.0	0	0.3	0.4	0.2	1.0	4.6
Flacourtia indica (Burm.f.) Merr.	S	0	0.1	1.0	0.2	1.0	0.6	0.5	0.1	0	1.0	4.5
Grewia schweinfurthii Burret	S	0	0.1	0.6	0	1.0	0.8	0.8	0.1	0	1.0	4.4
Ficus vasta Forssk.	K	0	0.1	0.8	0.1	1.0	0.2	0.1	0.9	0	1.0	4.2
Ficus sycomorus L.	K	0	0	0.9	0	1.0	0.3	0.2	0.6	0	1.0	4.0
Rubus steudneri Schweinf.	M	0.1	0	0.9	0	0.9	0.1	0.2	0	0.8	1.0	4.0
Uvaria leptocladon Oliv.	S	0.1	0.3	0.8	0	0.7	0.1	0.9	0.1	0	1.0	4.0
Garcinia livingstonei T.Anderson	K	0.1	0.2	0.9	0.2	1.0	0	0.1	0	0.3	1.0	3.8
Carissa spinarum L.	K	0.1	0	0	0	0.9	0	0.8	0	0.8	1.0	3.6
Rubus apetalus Poir.	M	0	0.2	0.8	0	0.8	0	0.5	0	0.2	1.0	3.5
Vangueria madagascariensis J.F.Gmel.	S	0	0	0.7	0	0.8	0	0.7	0	0	1.0	3.2
Ximenia americana L.	K	0.9	0	0	0	0.9	0	0	0	0.2	1.0	3.0
Rubus steudneri Schweinf.	K	0	0	0.2	0	1.0	0.1	0	0	0.4	1.0	2.7
Bullockia pseudosetiflora (Bridson) Razafim., Lantz & B.Bremer	S	0	0	0.3	0	0.4	0.7	0.1	0	0	1.0	2.5
Carissa spinarum L.	M	0	0	0.5	0	0.7	0.1	0	0	0	1.0	2.3

Table 13. Major threats to fruit species according to respondents (n = 144) in Shole Teka, Kure, and Metser, in Debub Ari and Maale, Debub Omo Zone, Ethiopia. 0 - not mentioned as a threat.

Threats	Shole Teka		Kure		Metser	
	Mean	Rank	Mean	Rank	Mean	Rank
Agricultural land expansion	1.6	1	2.8	1	1.5	1
Fuel wood collection	3.3	3	3.0	3	2.7	2
Selective harvesting for construction, farm tools, etc.	4.6	5	2.9	2	4.1	4
No enrichment planting in crop fields or home gardens	2.8	2	4.7	6	2.9	3
Wild fire	5.5	6	3.0	4	5.7	6
Drought/shortage of rainfall	5.7	7	4.	5	4.2	5
Grazing	4.6	4	0	0	0	0

ly harvested from the remaining forest patches, although farmers mentioned they were occasionally harvested from home gardens and crop fields. The main actors in the wild and semi-wild fruit market chain were farmers (collectors) and customers (buyers). The market chain was very short; no middlemen were involved. During our survey at Jinka market, we only noticed *Vangueria madagascariensis* J.F.Gmel for sale, but according to consumers, fruit of *M. butugi*, *Syzygium guineense* (Willd.) DC., *V. doniana*, and *C. spinarum* were also marketed. At Beneta market, we only saw the seeds of *B. rotundifolia* and *X. caffra* being offered for sale.

Prices of wild and semi-wild fruit species were very low compared to cultivated species such as mango (*Mangifera indica* L.), avocado (*Persea americana* Mill.), or banana (*Musa acuminata* × *balbisiana* Colla). Study results showed that on average 1 kg of banana was sold for ca. 4 Birr (0.2 USD), whereas 1 kg of *V. madagascariensis* fruit was sold for ca. 1 Birr (0.05 USD). Traders purchased cultivated fruits either from the farmers' fields or bought them at the local market and sold them again. However, we did not encounter any trader that was involved in the marketing of wild and semi-wild fruits in the area during our fieldwork. The major reasons why traders were not buying and selling wild and semi-wild fruits were the lack of supply and the low prices. Lack of fruit stalls, short shelf life, and lack of storage facilities were also mentioned by traders as the major constraints in the marketing of cultivated species. Value additions by partial processing or packaging were practices with which our informants were not familiar.

Discussion

The higher consumption of wild and semi-wild fruit species by the Maale can be explained by the presence of higher numbers of fruit trees in the local vegetation and good experiences with their use by the community. Mengistu and Hager (2008) also argued that the various Ethiopian communities may utilize different species, and species importance depends on local practices. Jin *et al.* (1999) reported similar observations for Yunnan (China). These authors also emphasized that the extent of wild and semi-wild fruit use depended on the level of agricultural productivity and the environment.

No significant variation in the knowledge of wild and semi-wild fruits was found for the different age and gender groups. This indicates an open knowledge transfer in the communities, which is important for knowledge continuity and future participatory development and conservation plans. Our results differed from those reported by Mengistu and Hager (2008), who found that Amhara youngsters were more knowledgeable on edible fruit than elders because some species that were not considered edible in earlier days were discovered as edible by a younger generation during times of (extreme) food scarcity.

The wild and semi-wild fruit species in our study sites were available throughout the seasons, including during food shortages, which indicates that they play a supplementary role during nutrition crises. In this regard, our results are in line with those of Mengistu and Hager (2009) and Pinstrup-Andersen (2009), who emphasized the importance of wild fruit in periods of food shortage to assure a healthy and nutritionally balanced diet. However, when wild fruit are consumed in low amounts, they have little influence on dietary intake and nutritional security, as Termote *et al.* (2012) recorded for Congo. Just as in Central Africa, the consumption of wild fruit in Ethiopia should be stimulated to increase their role in the balanced diet of rural people while giving due attention to sustainable management of resources. Feyssa *et al.* (2011) reported that many people in the Boosat and Fantalle districts of east Shewa, Ethiopia, survived by partly eating *D. glabra* fruit during severe hunger periods some 50 years ago. The tree requires little rain to bear fruit. *Dobera glabra* was also listed by the Maale as an important species during food shortage periods.

Just as in South Africa (Shackleton *et al.* 2000), taste was an important criterion for wild fruit preference. Such preferences, however, may vary from one study site to another (Mengistu & Hager 2008). Preference criteria set by the communities should be taken into consideration in any research development program in order to optimize community acceptance or adoption of wild fruit species.

According to our data, the availability of fruit was mainly affected by agricultural land expansion, which is a common phenomenon in different parts of Ethiopia, such as Derashe and Kucha in southern Ethiopia (Balemie & Kebebew 2006). Agricultural expansion affects resource availability in rural areas thereby decreasing the volume of fruit harvestable for private consumption and sale.

The low price and inadequate market supply of wild and semi-wild fruit species discouraged traders from marketing this resource and also hampered the promotion of trade. Thus, it is important to work towards the maintenance or improvement of this resource to increase its supply. Moreover, market opportunities for rural farmers and traders should be improved to increase the current revenues obtained from wild and semi-wild fruit species.

Conclusions

Rural Ethiopian communities such as the Maale and Ari consume a wide variety of wild and semi-wild fruit species. Their availability during food shortage periods makes them important dietary supplements in rural areas. Moreover, the consumption of species with a relatively high

level of essential nutrients showed their role in food security. Both communities have a broad knowledge of wild and semi-wild edible fruit species, which offers opportunities for future conservation of plant resources as it will be relatively easy to implement conservation strategies compared to communities with limited knowledge. No significant variation on wild and semi-wild edible fruit knowledge was found between gender and age groups.

Agricultural expansion was mentioned as the major threat for the survival of wild fruit species. Beside alternative conservation strategies (*in*- and *ex-situ*) to protect the remaining forests, cultivation aims at gradual domestication, hence maintenance and enrichment planting of the most preferred species such as *Balanites rotundifolia*, *Vitex doniana*, and *Garcinia livingstonei* is recommended. The focus should be on enrichment planting in home gardens and nearby crop fields because these are easily supervised and do not involve ownership disputes. Moreover, it is important to take away the pressure from the natural forest.

Species with a high market value, good taste, fast growth, and high yield should be considered for promotion, but species that bear fruit during food shortage periods should not be overlooked. Consideration of local farmers' preferences is crucial for development programs. Low prices and poor market and outlet opportunities hamper the trade in wild fruits. Creating demand and facilitating better market outlets will encourage communities to cultivate wild and semi-wild fruit species. For example, for fruit that are harvested in bulk, value addition by making jams, jellies, or canned juice, as is done with *Opuntia ficus-indica* (L.) Mill. in northern Ethiopia, could be an option.

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Appendix 1. Wild and semi-wild tree fruit species in Shole Teka, Kure, and Metser **kebeles**, in Debub Ari and Maale, Debub Omo Zone, Ethiopia. Local languages: Malló mucci (M), Araf (A).

Plant names			**Study sites**		
Scientific names		**Local names**	**Shole Teka**	**Kure**	**Metser**
Anacardiaceae	*Rhus natalensis* Bernh. ex C.Krauss	**kubri** (M)	X		
	Rhus ruspolii Engl.	**shawshini** (M)	X		
	Sclerocarya birrea (A.Rich.) Hochst.	**tunkelo** (M)	X		
Annonaceae	*Annona senegalensis* Pers.	**dangarasho** (M)	X		
	Uvaria leptocladon Oliv.	**muralatse** (M)	X		
Apocynaceae	*Carissa spinarum* L.	**ambelto** (M), **almi** (A)	X	X	X
	Saba comorensis (Bojer ex A.DC.) Pichon	**kalikedo** (M)	X		
Arecaceae	*Phoenix reclinata* Jacq.	**zembaba** (A)		X	X
Boraginaceae	*Cordia africana* Lam.	**galmi** (M)	X		
	Cordia sinensis Lam.	**shengolochi** (M)	X		
Clusiaceae	*Garcinia livingstonei* T.Anderson	**chedi** (A)		X	X
Ebenaceae	*Diospyros mespiliformis* Hochst. ex A.DC.	**goroki** (M)	X		
	Euclea divinorum Hiern	**ounsi** (M)	X		
Fabaceae	*Bauhinia thonningii* Schum.	**dawrake** (M), **lol** (A)	X	X	
	Senna singueana (Delile) Lock	**karahaleko** (M)	X		
	Tamarindus indica L.	**rokee** (M),	X		
	Tylosema fassoglensis (Schweinf.) Torre & Hillc.	**dankilo** (M)	X		
Lamiaceae	*Hoslundia opposita* Vahl	**lisho** (M)	X		
	Vitex doniana Sweet	**woro goroki** (M), **gorka** (A)	X	X	
Loganiaceae	*Strychnos innocua* Delile	**jalijecho** (M)	X		
Malvaceae	*Grewia damine* Gaertn.	**beriaa** (M)	X		
	Grewia schweinfurthii Burret	**damage** (M),	X		
	Grewia villosa Willd.	**bonkako** (M)	X		
	Sterculia africana (Lour.) Fiori	**kautsee** (M)	X		
Moraceae	*Ficus glumosa* Delile	**kuntsee** (M)	X		
	Ficus ingens (Miq.) Miq.	**laze** (M)	X		
	Ficus platyphylla Delile	**titee** (M)	X		
	Ficus sur Forssk.	**semo** (M), **sema** (A)	X	X	X
	Ficus sycomorus L.	**bobi** (M), **shafa** (A)	X	X	X
	Ficus sycomorus subsp. *gnaphalocarpa* (Miq.) C.C.Berg	**dawitchi** (M), **tomiri** (A)	X	X	
	Ficus vallis-choudae Delile	**obori** (M)	X		
	Ficus vasta Forssk.	**shabi** (M), **wompa** (A)	X	X	
Myrtaceae	*Syzygium guineense* (Willd.) DC.	**ochi** (M), **shiringi** (A)	X	X	
Olacaceae	*Ximenia americana* L.	**mukla** (A)		X	
	Ximenia caffra Sond.	**mukalee** (M)	X		

Plant names			Study sites		
Scientific names		Local names	Shole Teka	Kure	Metser
Phyllanthaceae	*Bridelia micrantha* (Hochst.) Baill.	**aericho** (M)	X		
Rhamnaceae	*Ziziphus spina-christi* (L.) Desf.	**gaudii** (M)	X		
Rosaceae	*Rubus steudneri* Schweinf.	**sak** “a” (A)		X	X
	Rubus apetalus Poir.	**sak** “b” (A)		X	X
Rubiaceae	*Bullockia pseudosetiflora* (Bridson) Razafim., Lantz & B.Bremer	**meddale** (M)	X		
	Meyna tetraphylla (Schweinf. ex Hiern) Robyns	**onakii** (M)	X		
	Vangueria apiculata K.Schum.	**garo** (M)	X		
	Vangueria madagascariensis J.F.Gmel.	**surangaro** (M), **gara** (A)	X	X	
	Mussaenda arcuata Poir.	**murtsetse** (M), **sertsegela** (A)	X	X	
	Psydrax schimperiana (A.Rich.) Bridson	**gali** (M)	X		
Salicaceae	*Flacourtia indica* (Burm.f.) Merr.	**gurchinchi** (M)	X		
	Oncoba spinosa Forssk.	**sewembulko** (M)	X		
Salvadoraceae	*Dobera glabra* (Forssk.) Juss. ex Poir.	**bekee** (M)	X		
Sapotaceae	*Manilkara butugi* Chiov.	**koshimi** (A)		X	X
	Mimusops kummel Bruce ex A.DC.	**gosho** (M)	X		
Zygophyllaceae	*Balanites aegyptiaca* (L.) Delile	**donkey** (M)	X		
	Balanites rotundifolia (Tiegh.) Blatt.	**kuze** (M)	X		