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Diversity and utilization of indigenous wild edible plants and their contribution to food security in Turkana County, Kenya

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Introduction: Indigenous Wild edible plants (IWEPs) are consumed daily in some form by at least one in seven people worldwide. Many of them are rich in essential nutrients with the potential for dietary and nutrition improvement particularly for poor households. They are, however, often overlooked. This study investigated diversity, consumption frequency, and perceptions of IWEPs and the contribution they make to the food security of communities in Turkana County, northern Kenya. Our findings are aimed at stimulating targeted discussions among stakeholders involved in food security programs on best way to overcome the poverty stigma associated with IWEPs consumption and to promote their utilization for food security, nutritional and dietary improvement, and enhanced community resilience.

Methods: Applying a mixed-methods approach, we collected data using 12 gender-disaggregated focus group discussions and a questionnaire applied to a random sample of 360 households.

Results and Discussion: Participants identified 73 IWEPs, of which 24 were consumed in the preceding six months by 48.5% of households. Almost all surveyed households (96%) were classified as severely food insecure, and food insecurity did not differ significantly between households that consumed IWEPs and those that did not. Our results indicate that more IWEPs consumers than non-consumers reported eating foods they had not wanted to consume to cope with food scarcity, as well as having to eat fewer meals than normal. Just over half of the respondents (57.1%) held positive attitudes towards IWEPs, which was positively associated with a higher likelihood of IWEPs consumption. Long distances to harvest sites, lack of knowledge about the plants, their seasonality, and how to cook them appetizingly, coupled with overall unfavorable perceptions, are probable reasons for non-consumption of IWEPs among the survey respondents. In line with other studies cited on wild foods, we conclude that IWEPs have the potential to bridge food and nutritional deficits in food insecure households in the study area, although currently their consumption remains limited. Given this potential, further analysis of IWEPs' nutritional composition and restoration of wild edible foods to local areas should be given priority, as well as interventions that help to overcome the challenges to their consumption and promote their wider use.

KEYWORDS

indigenous wild edible plants, perceptions, diversity, food security, Turkana

1. Background

Indigenous Wild Edible Plants (IWEPs) have been part of diets in traditional food systems since ancient times (Carvalho and Barata, 2016; Shaheen et al., 2017). These foods were well known to indigenous peoples and formed their main source of energy and nutrients (Carvalho and Barata, 2016; Shaheen et al., 2017). Their importance should not be underestimated—they are consumed daily in some form by at least one in seven people worldwide (FAO, 2019). Often, wild foods are harvested in the lean seasons when household staple stocks are low or depleted and new crops are still in the field (Ogoye-Ndegwa, 2003; Teklehaymanot and Giday, 2010; Feyssa et al., 2011a), a period which in many cases coincides with increased food prices in the markets (De Beurs and Brown, 2013). Even though wild food resources make up less than 1% of global caloric intake, these food resources are rich in essential nutrients (Durst and Bayasgalanbat, 2014; Achaglinkame et al., 2019) and have been positively linked with improved dietary diversity (Jones et al., 2014; Powell et al., 2015; Sibhatu and Qaim, 2018) and a lower cost of nutritious diets (Termote et al., 2014; Sarfo et al., 2020). In other times, an overlap in fruiting pattern of the wild plants result in a year round availability thus providing stable food sources that supplement the conventional foods available to the communities (Fentahun and Hager, 2009; Feyssa et al., 2011a).

Other health benefits other than their nutrients have also been reported in wild foods. IWEPs are rich in in many natural antioxidant compounds such as carotenoids, vitamins, phenols, tannins, flavonoids, and many secondary metabolites (Hegazy et al., 2013; Morales et al., 2013; Datta et al., 2019). For example, fruits pulps of duom (*Hyphaene thebaica L.* Mart.), baobab (*Adansonia digitata L.*), tamarind (*Tamarindus indica L.*), and jujube (*Ziziphus spina-christi L.* Willd.) were found to possess high phenolic compounds and antioxidant capacity and good amount of minerals (Salih and Yahia, 2015). Increased antioxidant intake through consumption of antioxidant rich foods has been shown to be associated with reduced risk of cardiovascular disease (Tribble, 1999; Johnston, 2009; Pellegrino, 2016). Antioxidants act as radical scavenger, hydrogen donor, electron donor, peroxide decomposer, singlet oxygen quencher, enzyme inhibitor, synergist, and metal-chelating agents (Lobo et al., 2010). Besides, IWEPs are used regularly across many communities in the world for their medicinal value (Chauhan et al., 2018; Tharmabalan, 2023).

Apart from their nutritional and health benefits, many IWEPs are used as source of income generation by rural inhabitants — mostly women (Feyssa et al., 2011a), youth (Tebkew et al., 2014) and, for some species, all age groups (Sina and Degu, 2015). Published literature on the contribution of IWEPs to income generation in Kenya is scant or nonexistent; however, press articles have reported the usefulness of these plants as a source of income (Koigi, 2011; Mugo, 2017). The Food and Agriculture Organization of the United Nations (FAO) estimates that up to 1.6 billion people—almost 25% of the world's population—rely on these resources every day for their livelihoods (FAO, 2015). For example, in Tanzania, Mwajombe et al. (2022) found that IWEPs provided income in about one in ten households in the study accounting for 10% of the total household income.

There is evidence that more than 7,000 wild edible plant species have been used for human food at point throughout human history (Carvalho and Barata, 2016). In Kenya, 800 IWEPs have been documented, of which about 400 are used as fruits, 200 as vegetables, 100 as tubers or roots, 30 as edible gums or resins, and 30 as spices or flavorings, with the rest providing other kinds of food uses (Heywood, 1999; Maundu et al., 1999). What is alarming is that many of the IWEPs that were previously highly valued are today neglected or underutilized for many reasons (FAO, 1995; FAO, 2004; Khoury et al., 2014).

Many factors influence the harvesting and consumption of wild foods, including their seasonal availability, user knowledge and perceptions (Fentahun and Hager, 2009; Bahir Dar University, 2016). Shumsky and colleagues noted that taste and enjoyment are major drivers of wild food harvest in food-insecure rural households in eastern Kenya, but also that significant portions of these resources are consumed specifically to supplement diets lacking in calories and micronutrients (Shumsky et al., 2014). Lack of awareness of the nutritional and health benefits of these plant species, as well as a lack of clear recipes, culinary skills, and knowledge of how to prepare them adequately or appetizingly are listed among the main factors discouraging and negatively affecting their use (Bahir Dar University, 2016). This is exacerbated by a continuing erosion of traditional knowledge of nutritious local and wild foods due to increasing globalization and negative perceptions associated with these non-commercial foods (Brosi et al., 2007; Ramirez, 2007; Bahir Dar University, 2016; Bender, 2017; Achaglinkame et al., 2019). Furthermore, IWEPs receive very little attention in national and local policy discussion forums (Shaheen et al., 2017).

Turkana County, in Northern Kenya, in the arid and semi-arid region, is one of the counties with the highest levels of food insecurity and malnutrition in the country. Our hypothesis is that IWEPs could potentially contribute to improving food and nutrition security in Turkana—and, by extension, similar agroecologically challenging contexts—if only the plants were more available and better known, appreciated, and used by the local populations.

As a starting point for the promotion of these resources for improvement of food and nutritional security, the present study sought to describe the diversity and consumption of IWEPs available in Turkana County. Specifically, the study aimed to answer the following research questions: (1) What IWEPs are available? (2) What are the community's perceptions about IWEPs consumption? (3) What is the frequency of IWEP consumption in the study area? (4) What contribution do IWEPs make to the food security of the local community? Such knowledge is needed to inform and stimulate a targeted discussion by policy analysts, researchers, food and nutrition security experts, and others involved in food security program design on the best way to overcome the poverty stigma associated with IWEPs consumption and to promote their utilization for food security, nutritional and dietary improvement, and enhanced community resilience. This would be a step towards the realization of goal number two of the UN's Sustainable Development Goals, to which Kenya is a signatory.

2. Materials and methods

2.1. Study area

Our study was conducted in two sub-counties of Turkana County: Loima and Turkana South, located in the northwestern part of the

country. Both are characterized by a harsh climate with high average daytime temperatures ranging from 20°C to 41°C, erratic and unreliable rainfall (both in time and space), and by high poverty levels, remoteness, poor infrastructure, safety issues, and limited access to essential services. The long rains usually occur between April and July and the short rains between October and November; the annual total ranges between 52 mm and 480 mm, with a mean of 200 mm (Turkana County Government, 2018).

The area's vegetation cover is varied, ranging from patchy annual grassland and herbaceous plants interspersed with woody shrubs to riverine woody tree species. Most parts of the study area have dwarf shrubs and bush species. Within the sweltering, arid areas, traditional nomadic animal husbandry is the dominant livelihood activity, whereas in the riverine areas agropastoralism—keeping livestock and growing crops—is practiced, in addition to pursuing other income-generating activities, such as charcoal burning, handicraft making, and petty trading. The livestock species reared include camels, cattle, sheep, goats, and donkeys. The camels, cattle, and goats provide milk for household consumption. The small livestock is sold when cash is required to meet other domestic requirements, such as food purchases. The main crops are maize, sorghum, cowpea, green gram, and some horticultural crops. Fishing is also practiced by households living along the shores of Lake Turkana.

Generally, food production in the county falls far short of demand. At least 66% of the population, or more than 611,804 of the 926,976 people residing in the county are classified as food poor compared with only 32% nationally. At the same time up to 90% of the population rely on relief food every year from the government, private sector, and NGOs (Mbuge et al., 2012; KNBS, 2018). Hunger and malnutrition remain big challenges in the county; at least 20% of children under 5 years old are stunted, while 7.4% suffer from acute malnutrition (Ministry of Health/Kenya, 2019). A staggering 79.4% of the population lives below the poverty line, compared to 36.1% nationally (KNBS, 2020).

2.1.1. Study design and data collection methods

This descriptive study was implemented within the framework of a larger phased research with a qualitative phase and an experimental study phase with treatment and control arms designed to test the use of participatory community approach to promote consumption of locally available agrobiodiversity for dietary improvement for women and children. The current study applied a mixed methods approach, including focus group discussions (FGDs) and a household survey implemented in the two phases. The study protocols were reviewed and approved by the AMREF Ethics and Scientific Review Committee (ESRC P276/2016 and ESRC P688/2019). Participants' informed consent was sought prior to their involvement in the study.

The first phase of the study, implemented in 2016, aimed at documenting and describing all the available wild edible plants in the study area. During this phase, 12 FGDs were held in six villages, separately, but concurrently, with men and women (six per gender) to create an inventory of all available wild, edible, and cultivated foods used by in the community. With the help of community health volunteers, participants were selected from six villages in Loima sub-county, based on their availability and willingness to participate, as well as their knowledge of the study topic, and their having resided for at least a year in the respective villages. The six villages were stratified by livelihood type: from an initial list of 15 villages identified as pastoral, three villages were randomly selected after two were excluded due to inaccessibility and safety issues, while three villages were randomly selected from a list of six agropastoral villages, after one was also excluded due to inaccessibility.

Each discussion was guided by a trained facilitator and a note taker, who were both trained native Turkana speakers. The first exercise involved a free listing of the plant and animal species used for food within each food group: staples, legumes and nuts, fish and water-sourced foods, animals, vegetables, fruits, and other foods. Subsequently, for each species cited within a food group, the participants discussed the plant or animal parts used, preparation and consumption methods, and their seasonal availability. Each FGD lasted 3 days for the free listing exercise, followed by the details for staples and fruits on day one, the details for vegetables, legumes and nuts, and other food categories on day two, while fish, water-sourced foods and animal food species were discussed on day three.

Upon completion of the discussions a list with local names of all IWEPs mentioned was prepared, followed by forest walks with knowledgeable people from the communities where the species were cited to collect specimens, following standard collection procedures (Bridson and Forman, 1992). Taxonomic identification was conducted by the Botany Department of the East African Herbarium of the National Museums of Kenya. Reference was also made to relevant literature about the area. All scientific plant names were verified using The World Flora Online (WFO, 2022).

The second phase of the study was implemented in August 2020 as part of baseline data collection for the larger experimental study. In the experimental study a minimum sample of 360 households with at least one child aged 6–36 months and a woman of reproductive age, determined using the G*Power software (Wang and Chow, 2007), was sufficient to detect change due to the treatment. The households were randomly selected from 17 community health units (CHUs) in the study area (ten in Loima and seven in Turkana South). A community health unit comprises 20 or fewer villages, with a village having at most 100 households. Of the 17 CHUs, pastoralism is the dominant livelihood activity in 9 CHUs, while the other eight are dominated by agro-pastoralists. Initially, 20 community units were selected, but two were dropped due to safety issues and one due to inaccessibility as a result of poor road and communication infrastructure. Turkana County has a total of 196 community health units and 2,268 villages (GoK, 2018).

During this second study phase an interviewer completed a semi-structured survey questionnaire with the head of the household or, in his/her absence, their spouse. This exercise was designed to collect data on various aspects, including household socio-demographic characteristics, consumption of IWEPs, food security, perceptions regarding IWEPs consumption, the agrobiodiversity in general, including crop and livestock biodiversity, and market participation. Household consumption of any IWEPs by any member of the household was assessed over a six-month recall period. For households that responded affirmatively, a list of all the IWEPs consumed, the frequency of consumption when in season, and the contribution of the IWEPs to household food consumption were recorded. The interviews were conducted in the local Turkana language by 15 enumerators recruited from within the surveyed communities and trained for 1 week, including 1 day for pre-testing.

Household perceptions of IWEPs were assessed through 10 evaluative statements rated according to a five-point Likert scale:

strongly disagree, disagree, neutral, agree, and strongly agree. To enhance the understanding and rating of the participants, five different emojis representing the five different levels of agreement or disagreement were shown to them. The statements were then read to the respondents in the local language, and they selected the emoji that represented their rating of the statement. The ten statements were as follows: IWEPs are difficult to obtain in this area; including IWEPs in the diets of women can improve the quality of the diet; including IWEPs in the diets of children can improve the quality of the diet; IWEPs are safe for consumption by women from this community; IWEPs are safe for consumption by children from this community; IWEPs are only important in times of famine when food is scarce; harvesting IWEPs for sale can serve as an alternative or additional source of income for my household; some IWEPs are important in this community because they are part of our cultural identity; if I had enough of other foods, I would never eat or allow my child to eat IWEPs; the only reason I eat IWEPs is because I am poor.

In assessing the overall balance of the perceptions, a positive attitude was scored as 1 and a negative attitude as −1, regardless of the strength of agreement or disagreement with the statement. A neutral attitude was scored as zero and the overall perception was calculated by summing the scores for each household. Households where the total was negative were regarded as having an overall negative perception and those where the sum was positive were considered to have a positive perception. Households where the sum was zero were considered to hold a neutral attitude towards IWEPs.

Household food security was assessed using the Household Food Insecurity Access Scale (HFIAS) (Coates et al., 2007). The scale comprises nine questions (worry about food, unable to eat preferred foods, eat just a few kinds of foods, eat foods they really do not want to eat, eat a smaller meal, eat fewer meals in a day, no food of any kind in the household, go to sleep hungry, go a whole day and night without eating). The standard procedure for scoring HFIAS used by Coates et al. (2007) was followed: zero is attributed if the event described by the question never occurred; 1 point is given if it occurred once or twice during the previous 30 days (rarely); 2 points if it occurred 3–10 times (sometimes); and 3 points if it occurred >10 times (often). For each household, the HFIAS score corresponds to the sum of these points and could range from zero (food secure) to a maximum score of 27 (severe food insecurity). A household is considered food secure when none of the nine scenarios are experienced, or only sporadic "concern about food" is reported (first scenario) and considered food insecure if the responses were "sometimes" or "always" to one or more of the nine occurrence questions. A severely food-insecure household experiences at least one of the last three scenarios (running out of food, going to bed hungry, or going a whole day and night without eating).

2.2. Statistical analysis

The data from the FGDs were entered in MS Excel for analysis. Household data collected using the KOBO toolbox server were exported to MS Excel for cleaning. Statistical analysis of the data was done using SPSS version 22. Frequencies, measures of central tendency, and dispersion were used to summarize and describe the households' socio-demographic data. Chi-square tests of proportion were used to establish associations between consumption of IWEPs, household food security, and perceptions of IWEPs. Comparisons of means were performed using independent sample T-tests and correlations between household food insecurity access scores and other variables were calculated using a Pearson product–moment correlation analysis.

3. Results

3.1. Diversity of indigenous wild edible plants of Turkana

Supplementary Table S1 describes the IWEPs listed by the participants. A total of 73 wild plants were known to be edible by the participants. We noted that some plant species were referred to by different names by the community. Fifteen of the plants cited could not be fully identified because of unavailability of specimen and are thus reported in vernacular language, as stated by the study participants. Because it is not possible verify whether the names were for different species or duplicates of the already identified species they have been excluded from the study going forward. The 58 fully identified are listed following the order of the Angiosperm Phylogeny Group (APG) IV. The IWEPs belong to 30 different plant families and one fungus. Fifty-three of the species were listed by the pastoral communities compared to 44 by the agropastoral communities. More than 67% (39 species) were mentioned in both pastoral and agropastoral communities. Fourteen of the identified species were mentioned only by the pastoral communities, compared to five in the agropastoral communities.

Differentiating the participants' responses by gender, the men mentioned 47 species, while the women mentioned 34 species. Twenty-three common species were cited by both men and women. Twenty-four of the species were only cited by the men and 11 were listed only by the women.

Seven different harvestable plant parts were mentioned, with fruits being the most-harvested part recorded for 30 of the IWEPs, followed by leaves (21 species), seeds (15 species), bark (8 species), tubers/roots (3 species), pods (2 species), and a flower in one species. The one edible fungus (mushroom) also mentioned was consumed whole. Almost one-third of the species (29.3%) had more than one harvestable part. The species *Vatovaea pseudolablab* (Harms) J.B. Gillett was cited as having six harvestable parts used for human food: flowers, fruits, leaves, pods, seeds, and tubers.

Figure 1 presents the distribution of the plant parts harvested across the food group classifications cited. The most diverse food group was the fruits, with 31 species (note: one species part contributes to more than one group), followed by the vegetables group (22 species) and the spices, condiments, and beverages group (14 species). The seeds were mainly cooked and eaten alone, or sometimes mixed with grains such as maize or sorghum. Three species of tubers (*Commiphora africana* Endl., *Hydnora abyssinica* A. Br., and *Vatovaea pseudolablab* J.B. Gillett) were harvested for consumption either raw, roasted, or boiled as a snack, or as a staple food.

3.2. Socio-demographic characterization of the surveyed households

Of the 360 households sampled, 357 completed the survey, representing a 99% response rate. Table 1 presents the characteristics

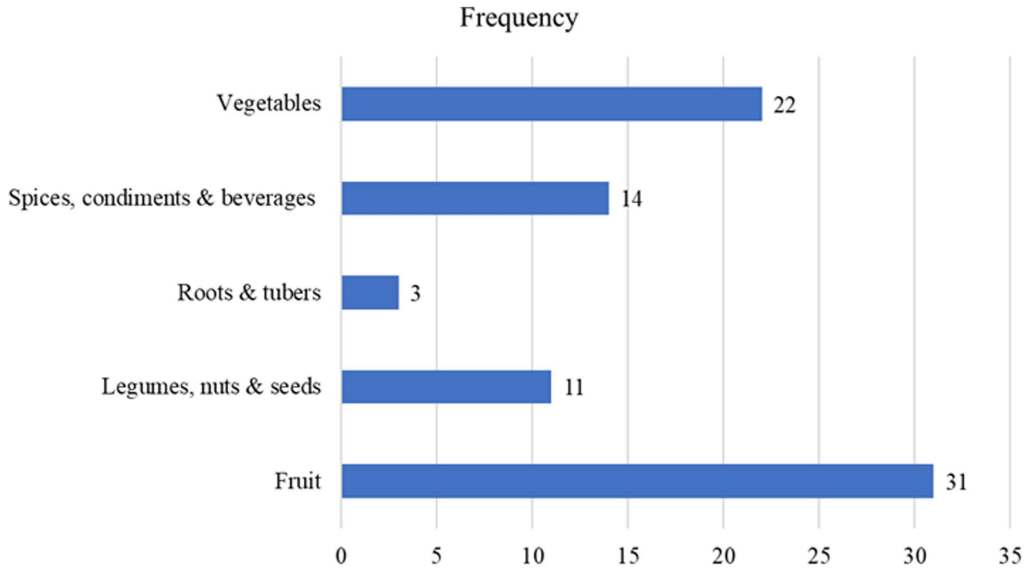

FIGURE 1
Food group classification of species cited by focus group discussion participants. Some species contribute parts to more than one group.

of the respondents and the study sample. Pastoral communities accounted for 22.7% of the sampled households, agropastoral communities represented 37%, and the rest (40.3%) were peri-urban communities. The average age of the respondents, mostly women (94.1%), was 28.8 ± 6.8 years (minimum age 17 years, maximum age 65 years).

The socio-demographic characterization of the surveyed households showed that the mean age of the heads of households was 31.8 ± 8.8 years, 60.8% of households were male-headed, 53.8% were in a monogamous marriage, 45.9% in a polygamous marriage, and 0.3% were not married at the time of survey. Only 36.1% of the household heads had some education, of whom 48.8% only primary-level education, 33.3% secondary education, and 17.8% post-secondary education. The proportion of household heads with some education was significantly higher among those from peri-urban (47.9%) areas compared with pastoral (25.0%), and agropastoral areas (30.8%), ($\chi = 14.371$, df = 2, $p = 0.001$).

A majority of the households (61%) kept livestock, but only 27% had access to land for crop farming. Over a 12 month period, a plurality of the surveyed households (48.7%) earned their income through the sale of homemade handicrafts or goods such as mats, firewood, charcoal, etc., followed by casual labor (17%) and sale of livestock or their products (14%).

3.3. Indigenous wild edible plant consumption

In the 6 month reference period, 48.5% of households reported harvesting and consuming IWEPs. The proportion of peri-urban households that consumed IWEPs (39.4%) differed significantly from that of the agropastoral (56.2%), and pastoral (51.2%) communities ($\chi = 7.957$, df = 2, $p = 0.019$). A total of 24 IWEPs, representing 37.5% of the wild plants listed during the FGDs, were consumed by households in the survey period. Among the IWEPs consumers, individual households reported consuming one to ten different species, with an average of 2.8 per household. Participants from households where IWEPs were not consumed cited various reasons: distance from harvesting sites (67.0%), lack of knowledge about when plants were in season (61.6%), lack of knowledge on how to prepare them (4.3%), complicated to prepare (2.0%), and bad taste and texture (2.0%). Table 2 describes the frequency of use and the contribution of the species as reported by the households consuming IWEPs in our sample. The species *Ziziphus jujuba*, *Hyphaene compressa* and *Boscia coriacea* were the three most frequently consumed (respectively by 53.5, 51.8, and 29.4% of the IWEPs-consuming households). These were followed by *Dobera glabra* (24.1% of IWEP-consuming households), *Balanites rotundifolia* (22.9%), *Balanites pedicellaris* (18.2%), *Vachellia tortilis* (15.9%), *Salvadora persica* (13.5%), *Cordia sinensis* (12.4%), and 15 other species reported by less than 10% of households.

Regardless of the species collected, 18% of households reported harvesting IWEPs almost daily to supplement their diets, 36.8% consumed IWEPs at least three to four times a week and 45.4% consumed IWEPs rarely. Some 27.8% of households that consumed IWEPs reported that this made a major contribution to diets and household food consumption. The contribution of IWEPs varied from species to species, as well as from one household to another. The species *Ziziphus jujuba*, for example, collected by 91 households, provided a major contribution to the diets of 31.9% of households and only minor contributions to the diets of the remaining 68.1%.

Consumption rates varied from species to species and from household to household. For instance, of the 91 households that consumed *Ziziphus jujuba*, 15.4% consumed it at least five times a week, 38.5% at least four times a week, and 46.2% at least once a week. Of the 39 households that reported consumption of species *Balanites rotundifolia*, 43.6% consumed it more than five times per week, 23.1% consumed it three to four times a week, and 33.3% once or twice every week.

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TABLE 1 Summary statistics for the socio-demographic characteristics of the sample.

Characteristics	Frequency	Percent	
Dominant livelihood grouping			
	Pastoral	81	22.7
	Agropastoral	132	37.0
	Peri-urban	144	40.3
Respondent status (relationship with household head)			
	Household head	154	43.1
	Spouse	169	47.3
	Parent	24	6.7
	Other	9	2.5
Age of respondent (mean ± SD)	28.8 ± 6.7		
Respondent went to school			
	Yes	115	32.2
	No	242	67.8
Highest level of education of respondent (*n* =115)*			
	Primary school	75	65.2
	Secondary school	29	25.2
	Post-secondary	11	9.6
Sex of respondent			
	Male	21	5.9
	Female	336	94.1
Household size (mean ± SD)	6.1 ± 2.3		
Age of household head (mean ± SD)	31.9 ± 8.8		
Sex of household head			
	Male	217	60.8
	Female	140	39.2
Household head went to school			
	Yes	129	36.1
	No	228	63.9
Highest level of education of household head (*n* =129)*			
	Primary school	63	48.8
	Secondary school	43	33.3
	Post-secondary	23	17.8
Occupation of household head			
	Salaried employee	23	6.4
	Casual laborer	53	14.8
	Farmer/pastoralist	35	9.8
	Self-operated business	122	34.2
	Student	2	0.6
	Basketry/pottery/ charcoal making	24	6.7
	Unemployed	98	27.5
Household sources of income in the past 12months			
	Cash transfers/ remittance	9	2.5
	Casual labor	61	17.1
	Salaried employment	22	6.2
	Retail trading	36	10.1
	Juakali service (carpentry, masonry, saloon)	11	3.1
	Sale of wild gathered fruits/vegetables	4	1.1
	Sale of homegrown crops	37	10.4
	Sale of home-raised livestock or their products	50	14.0
	Sale of gathered crafts/goods, e.g., charcoal, stones, firewood, baskets	174	48.7
Household has access to agricultural land for farming			
	Yes	97	27.2
	No	260	72.8
Household has livestock			
	Yes	220	61.6
	No	137	38.4

3.4. Household food security

The overall mean HFIAS score was 14.14 ± 5.8 (minimum 0, maximum 27) and 14.4 ± 5.4 for the IWEP-consuming households, compared to 13.8 ± 6.2 for the non-IWEPs consuming households, with a higher HFIAS score indicating a more food-insecure household. The difference in the means was not significant ($p > 0.05$). The Pearson product–moment correlation of HFIAS score with household socio-demographic variables showed significant positive correlations with the age of household heads ($r = 0.147$, $p = 0.006$) and the share of household income spent on purchase of staple foods ($r = 0.194$, $p < 0.001$), but a significant negative correlation with the share of household income spent on education ($r = -0.168$, $p = 0.002$). Households whose head did not have any form of education had higher HFIAS scores (14.9 ± 5.9) than those where the heads had some education (12.8 ± 5.5, $p = 0.001$), indicating that a lack of education was associated with an increased risk of household food insecurity. Nearly all the sample households (96%) were food insecure, with 88% experiencing severe food insecurity, 7.1% moderate food insecurity, 0.9% mild food insecurity, and only 4.0% being food secure.

A comparative analysis of the food insecurity-related domains by IWEPs consumers and non-IWEPs consumers is presented in Table 3. Nearly all (86.4%) of the sampled households experienced anxiety and uncertainty related to food availability in the 4 weeks prior to the data

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TABLE 2 Consumption frequency and perceived contribution of IWEP to household food consumption.

Wild edible species	IWEPs consumers (n=173)		Consumption prevalence when in season††			Perceived contribution to household food consumption††	
	Frequency	Percent	Often (%)	Sometimes (%)	Rarely (%)	Major (%)	Minor (%)
Ziziphus jujuba Mill.	91	52.6	15.4	38.5	46.2	31.9	68.1
Hyphaene compressa H. Wendi	88	50.1	13.6	36.4	50.0	28.4	71.6
Boscia coriacea Graells	50	28.9	8.0	24.0	68.0	38.0	62.0
Dobera glabra (Forssk.) Juss. ex Poir	41	23.7	4.9	46.3	48.8	24.4	75.6
Balanites rotundifolia (Tiegh.) Blatt.	39	22.5	43.6	23.1	33.3	25.6	74.4
Balanites pedicellaris Mildbr. & Schltr.	31	17.9	9.7	38.7	51.6	29.0	71.0
Vachellia tortilis (Forssk.) Galasso & Banfi	27	12.7	44.4	37.0	18.5	7.4	92.6
Salvadora persica L.	23	13.3	26.1	43.5	30.4	26.1	73.9
Cordia sinensis Lam.	21	12.1	–	42.9	57.1	19.0	81.0
Grewia tenax (Forssk.) Fiori	14	8.1	25.0	–	75.0	75.0	25.0
Leptadenia lanceolata subsp. lanceolata	13	7.5	30.8	46.2	23.1	30.8	69.2
Amaranthus hybridus L.	6	0.3	33.3	50.0	16.7	33.3	66.7
Corchorus olitorius L.	5	2.9	40.0	40.0	20.0	40.0	60.0
Maerua decumbens (Brongn.) DeWolf	5	2.9	–	60.0	40.0	–	100.0
Coccinia grandis (L.) Voigt	4	2.3	25.0	50.0	25.0	–	100.0
Grewia arborea (Forssk.) Lam.	4	2.3	14.3	21.4	64.3	35.7	64.3
Cleome gynandra L.	3	1.7	–	66.7	33.3	–	100.0
Amaranthus graecizans L.	2	1.2	100.0	–	–	50.0	50.0
Berchemia discolor Hemsl.	2	1.2	50.0	–	50.0	50.0	50.0
Tamarindus indica L.	2	1.2	–	100.0	–	–	100.0
Vatovaea pseudolablab (Harms) J.B.Gillett	2	1.2	–	100.0	–	–	100.0
Combretum aculeatum Vent.	1	0.6	–	–	100.0	100.0	–
Ficus sycomorus L.	1	0.6	–	100.0	–	–	100.0
Ximenia americana L.	1	0.6	–	100.0	–	–	100.0

Often, more than 5 times a week; Sometimes, 3–4 times a week; Rarely, 1–2 times a week. ††The column percentages represent prevalence among those who reported consuming the species while on season. The percentages were computed from the n-values (Frequency) in column 2 of the table.

collection. The proportion of households that reported anxiety and uncertainty about food availability did not significantly differ between IWEPs-consuming (90%) and non-IWEPs consuming households (83.0%, $p > 0.05$). Similarly, in nearly all sampled households, diets limited in quality (88.1%) and quantity (88.4%) were documented, as well as a reduction in the number of meals consumed (93.5%). The proportion of households that consumed foods they did not really want to eat was significantly higher among IWEPs-consuming households (92.4%) than non-IWEPs consuming households (88.4%, $p < 0.05$) and the proportion not able to eat their preferred food was

86%, while 88% had to eat a diet with limited variety due to a lack of resources. A significantly larger proportion of IWEPs-consuming (96.5%) than non-IWEPs consuming households (90.7%) ate fewer meals during the recall period ($p < 0.05$).

3.5. Participants' perceptions of IWEPs consumption

Participants' responses to the Likert scale questions assessing their perceptions of IWEPs are presented in Table 4. Using a simplified 3-option scale, the study shows that 57.1% overall had favorable attitudes towards IWEPs, 14.2% held a neutral attitude, while 28.7% had an overall negative attitude. Among the IWEP-consuming households, 56.7% showed positive attitudes, 27.1% had a negative attitude, and 15.3% a neutral attitude. On the other hand, 56.6% of non-IWEP consuming households held positive attitudes, 30.2% negative attitudes, and 13.2% a neutral attitude. The difference in proportions between the IWEP-consuming households and non-consuming households did not reach significant levels ($\chi = 0.598$, $p = 0.742$).

Nearly half of the participants (44.9%) disagreed with the statement that IWEP are difficult to find in their respective community, with a quarter (25.6%) showing strong disagreement. Significantly higher proportions of the IWEP-consuming households (55.9%) than the non-IWEP consumers (34.6%) disagreed with this statement ($\chi = 17.068$, $p = 0.002$).

More than three-quarters (76.4%) of the participants believed that some IWEPs are important because they are part of the community's cultural identity, with 22.6% strongly agreeing. The proportion of those who strongly believe that IWEPs have cultural significance was significantly higher for IWEP-consuming households (28.2%) than for non-IWEP consuming households (17%) ($\chi = 20.388$, $p = 0.000$).

As for the question of whether including IWEPs in the diets of women and children could improve their diets, health, and nutrition status, more than half (58.3%) of the IWEP consumers, compared with 45% of the non-IWEP consumers, believed that IWEPs can improve women's dietary quality ($\chi = 25.054$, $p = 0.000$), with a similar pattern regarding children's diets in both the IWEP consuming households (54.1%) and non-IWEP consuming households (46.2%).

A majority of both IWEP-consuming (58.8%) and non-IWEP consuming households (51.1%) agreed that they consume IWEPs because they are poor. However, 45.9% of IWEP-consuming households and 33.5% of non-IWEP consuming households indicated that they would still eat or feed their children with IWEPs even if when other foods were sufficient.

4. Discussion

4.1. Diversity of indigenous wild edible foods

Our study shows that Turkana County is rich in IWEPs that can contribute to the food security and nutritional improvement of the community. The participants listed 73 IWEPs, of which 58 species were fully identified. Previous studies conducted in the Turkana area have also reported a high diversity of IWEPs: an earlier work by Morgan (1981) on the ethnobotany of wild plants used by Turkana pastoralists recorded 53 IWEPs. In a study of the Turkana people's knowledge of IWEPs, Watkins (2010) recorded a total of 149 names, of which 50 were identified to species level.

Pastoral communities and male participants were able to cite many more plants than agropastoral communities and the female participants, respectively. Pastoralists in Turkana are known to move with their livestock, season after season, in search of water and pasture. During this movement women are left behind to look after the children and tend to the young and weak animals at home. As they move from place to place, the pastoralists often depend on IWEPs for food, in addition to the blood, meat, and milk they obtain from their animals. For this reason, the men can be expected to know more about IWEPs than the women. The nomadic pastoralist communities may also be more knowledgeable about IWEPs than the agro-pastoralists due to their greater reliance on IWEPs for food/sustenance far from home, and their opportunity

TABLE 3 Prevalence of food insecurity-access-related events in the sample.

HFIAS events	IWEPs consuming households (%, n=173)	Non-IWEPs consuming households (%, n=184)	Overall (N=357)
Worry about food	90.2	83.2	86.6
Unable to eat preferred foods	89.6	84.8	87.1
Eat a limited variety of foods	91.3	85.3	88.2
Eat foods that you really did not want to eat	**92.5***	84.8	88.5
Eat a smaller meal	94.2	90.2	92.2
Eat fewer meals in a day	**96.5***	90.8	93.6
No food to eat of any kind in the household	86.1	85.9	86.0
Go to sleep at night hungry	82.7	77.7	80.1
Go a whole day and night without eating anything	77.5	68.5	72.8

*The proportion is significantly different (at 0.05) between household groups.

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TABLE 4 Participants' responses to the Likert scale questions assessing their perceptions of IWEPs.

Statements	IWEP-consuming households (n=173)	Non-IWEP consuming households (n=184)	Overall (N=357)	χ-value Sig.	
IWEPs are difficult to obtain in this area					
	Strongly disagree	**25.3***	13.7	19.3	17.068,**0.002**
	Disagree	**30.6***	20.9	25.6	
	Neutral	10.0	15.4	12.8	
	Agree	25.9	35.2	30.7	
	Strongly agree	8.2	14.8	11.6	
Including IWEPs in the diets of women can improve the quality of the diet					
	Strongly disagree	**18.2***	9.3	13.6	25.054,**0.000**
	Disagree	10.6	11.5	11.1	
	Neutral	12.9	**34.1***	23.9	
	Agree	**52.4***	39.0	45.5	
	Strongly agree	5.9	6.0	6.0	
Including IWEPs in the diets of children can improve the quality of the diet					
	Strongly disagree	**15.3***	6.6	10.8	19.859,**0.001**
	Disagree	13.5	11.5	12.5	
	Neutral	17.1	**35.7***	26.7	
	Agree	48.8	39.6	44.0	
	Strongly agree	5.3	6.6	6.0	
IWEP are safe for consumption by women from this community					
	Strongly disagree	**13.5***	4.4	8.8	23.242,**0.000**
	Disagree	10.0	12.1	11.1	
	Neutral	11.8	**29.1***	20.7	
	Agree	54.7	47.3	50.9	
	Strongly agree	10.0	7.1	8.5	
IWEPs are safe for consumption by children from this community					
	Strongly disagree	7.1	4.4	5.7	25.183,**0.000**
	Disagree	14.1	8.2	11.1	
	Neutral	17.1	**41.2***	29.5	
	Agree	**48.2***	36.3	42	
	Strongly agree	13.5	9.9	11.6	
IWEPs are only important in times of famine when food is scarce					
	Strongly disagree	**9.4***	3.8	6.5	20.372,**0.000**
	Disagree	15.9	12.1	13.9	
	Neutral	8.8	**25.8***	17.6	
	Agree	47.6	42.9	45.2	
	Strongly agree	18.2	15.4	16.8	
Harvesting IWEPs for sale can serve as an alternative or additional source of income for my household					
	Strongly disagree	6.5	5.50	6.0	10.833,**0.029**
	Disagree	18.2	15.9	17.0	
	Neutral	14.7	**26.9***	21.0	
	Agree	44.1	42.9	43.5	
	Strongly agree	**16.5***	8.8	12.5	

(Continued)

TABLE 4 (Continued)

Statements	IWEP-consuming households (n=173)	Non-IWEP consuming households (n=184)	Overall (N=357)	χ-value Sig.	
Some IWEPs are important in this community because they are part of our cultural identity					
	Strongly disagree	3.5	1.6	2.6	20.388,**0.000**
	Disagree	7.1	10.4	8.8	
	Neutral	5.3	**18.7***	12.2	
	Agree	55.9	52.2	54.0	
	Strongly agree	**28.2***	17.0	22.4	
If I had enough of other foods, I would never eat or allow my child to eat IWEPs					
	Strongly disagree	**12.9***	5.5	9.1	13.059,**0.011**
	Disagree	32.4	28.0	30.1	
	Neutral	10.6	**22.0***	16.5	
	Agree	31.2	33.0	32.1	
	Strongly agree	12.9	11.5	12.2	
The only reason I eat IWEPs is because I am poor					
	Strongly disagree	**11.8***	4.9	8.2	19.007,**0.001**
	Disagree	21.8	21.4	21.6	
	Neutral	7.6	**22.5***	15.3	
	Agree	40.6	37.4	38.9	
	Strongly agree	18.2	13.7	15.9	

Bold values: Difference in proportions between IWEPs consumers and non-consumers is significant at 95% confidence level.

to explore new territories. This would also explain the IWEPs cited only by the pastoralists compared to the agro-pastoralists and by the men respondents compared to the women.

Although the nutrient composition of IWEPs is not often documented, their importance in supplementing diets, especially among smallholder or marginal rural farmers, has been described in many studies (Feyssa et al., 2011b; FAO, 2018). In addition to providing calories during seasonal food shortages or droughts, some IWEPs have been reported to have comparable or even higher quantities of micronutrients and calories than conventional crops (Fentahun and Hager, 2009; Feyssa et al., 2011a; Addis, 2013; Bahir Dar University, 2016). In his analysis of the nutritive composition of the fruits of *Hyphaene coriacea* (Lokuruka, 2007), for example, reported that freshly cut slices of the fruit mesocarp are an excellent source of iron (28.9 mg/100 g), a fairly good source of zinc (3.4 mg/100 g), fairly rich in essential amino acids and a good source of dietary fiber (27%). Our study showed that fruits and leaves were among the most frequently used plant parts, but the diversity of the plants' uses also included consumption of ripe fruits, leaves that are often cooked and eaten as vegetables, seeds that are cooked—often for many hours to remove bitterness—and eaten either alone or mixed with maize or sorghum, and roots or tubers that are eaten raw, cooked, or roasted as a snack or staple to provide energy for the family. This diversity in harvested plant parts and in their food group classification means that IWEPs can be used to increase diversity in the foods and diets of consumers. Other studies have also reported similar results (Maseko, 2015; Fungo et al., 2016a; Berihun and Molla, 2017; Mutie et al., 2020). These plants can therefore contribute to bridging the food security and dietary diversity gaps of many millions of smallholder farmers within the arid and semi-arid areas, besides lowering the cost of their diets (Sarfo et al., 2020).

4.2. Indigenous wild edible plant consumption and household food security

IWEPs are widespread in many parts of the world and have been part of human diets since time immemorial. However, the extent to which they contribute to household food consumption and diets is still neither fully understood, or documented. As is the case in many arid and semi-arid areas in sub-Saharan Africa, our study revealed a high prevalence of severe food insecurity in the study area, despite the diversity of IWEPs reported. The high levels of food insecurity in Turkana County are attributable to environmental factors such as unreliable seasonal rains, frequent droughts, and flooding, which make both crop farming and livestock raising unproductive, as well as to social factors such as safety issues due to frequent ethnic clashes and livestock raiding. These, together with poor road networks, a lack of other infrastructure development, and high poverty rates, are the greatest contributors to food insecurity in Turkana. In 2021, an estimated 2.1 million people, representing 14% of the population of Kenya's arid and semi-arid regions, experienced acute food insecurity, a 34% increase from the rates reported for the same period in 2020 (IPC Global Partners, n.d.).

Our study shows that these households' food insecurity tends to increase with the age of the head of the household, meaning that younger households were likely to be more food secure than older households. This is consistent with other studies that reported a

positive association between the age of the household head and the likelihood of food insecurity (Mutisya et al., 2016). Older households may also lack access to advanced production techniques and technologies, as more and more empowerment opportunities target younger people. Older population members also tend to be less educated, a fact that has been reported in other studies (Mutisya et al., 2016; Abdullah et al., 2019). While our study did not closely examine the impact of years of education, the study by Mutisya et al. (2016) found that household food security increased with higher educational attainment. This is possible through a number of mechanisms, for example better access to agricultural information and technology by farming households, leading to higher productivity, and through better employment among non-farming households. Although Turkana community members are traditionally pastoralists, younger generations have embraced other livelihood options, including formal employment with higher and more stable income, leading to greater purchasing power. Our observation that younger households had better food security is, however, in contrast with the study by Abdullah et al. (2019). Our study also found that household spending on staple food was correlated with household food insecurity. This could therefore be an indication of poverty in the household: poorer families are more vulnerable to nutrition insecurity as little money is left to purchase other more nutrient-rich foods, as well as to meet other expenses, such as children's education.

Despite the high levels of food insecurity, slightly fewer than half the surveyed households reported consuming IWEPs in the 6 months prior to the survey. This was in contrast with our expectations and can best be attributed, among other probable reasons, to seasonal differences in fruiting, the long droughts, as well as the value the community attaches to IWEPs in meeting their food security and nutrition needs. While there was no significant difference in food insecurity between IWEPs-consuming and non-IWEPs consuming households, the IWEPs-consuming households were somewhat more food insecure than the non-IWEPs consumers, indicating that consumption of IWEPs may only become vital in times of food scarcity, by acting as a safety net for these households. That the IWEPs-consuming households were somewhat more food insecure that non-consuming households is a likely indicator that the situation would have been worse were it not for the IWEPs. These observations corroborate the results of studies by Chakona and Shackleton (2019) in South Africa and Shumsky et al. (2014) in the semi-arid areas of Tharaka constituency in Kenya, which found a strong relationship between self-reported food insecurity and increased IWEPs consumption. Other studies have determined that IWEPs are of greatest importance to poor risk-prone households than wealthier food-secure households, confirming that IWEP consumers are likely to be more food insecure (Bharucha and Pretty, 2010; Erskine et al., 2020). In Cameroon, a study revealed that greater forest food consumption was significantly and positively related to increased dietary diversity among the forest food consumers (Fungo et al., 2016a). The same study reported that more non-forest food consumers (20.5%) suffered severe food insecurity than did forest food consumers (5.8%) suggesting that IWEPs served to cushion the households from experiencing severe food insecurity. Similar observations have been made recently in Gabon, DR Congo and Cameroon where forest food consumers were reported to be 90% more likely to be food secure compared with non-forest food consumers (Fungo et al., 2020).

The contribution of wild edible foods to food consumption among the studied households varied according to the households and the specific plants consumed. The number of IWEPs consumed over the reference period varied from one to ten species per household. These varying patterns could be for similar reasons to those cited by non-IWEP consuming households, namely long distances to the collection sites and lack of knowledge about the species, their seasonality, or how to prepare them. Another reason could be negative attitudes and perceptions about some IWEPs. A study by Shumsky et al. (2014) in the semi-arid areas of Kenya showed that longer travel times significantly reduced the consumption frequency of IWEPs. A review of the nutritional contribution of IWEPs in Ethiopia revealed similar variations in their harvesting and consumption, with some being consumed regularly, even in the presence of adequate food stocks, while others are consumed only at times of acute food shortage and scarcity (Duguma, 2020). Households that are more food insecure seem to depend more on IWEPs than those that are less food insecure, thereby supplementing what is available from other sources. As the study only covered a six-month reference period, it is possible that the number of wild plants reported by the households could have been higher or even more households would have reported consumption of IWEPs had the study considered a longer period. The 6 month reference period means, for example, that not all fruiting species have been considered in the study (Food Economy Group, 2016; Erskine et al., 2020).

IWEPs remain important sources of essential micronutrients. It is estimated that while IWEPs contribute only about 0.6% to the global supply of dietary energy, they are eaten regularly by close to 80% of households living in or close to forests (FAO, 2019). Particularly among food-insecure, marginalized communities such as in Turkana, promoting the use of locally available indigenous foods like IWEPs could be an important step towards addressing the pressing food security and nutritional needs of the communities. However, a critical first step to determine their nutritional contribution is the compilation of comprehensive food composition data for the wild foods available within these communities (Shaheen et al., 2017). The nutrient composition analysis of some IWEPs has been conducted, demonstrating a huge potential for their utilization as source of micronutrients, proteins, energy, and fiber (FAO, 2019). For example, *Hyphaene coriacea*, a widely-distributed species in Turkana, has been confirmed as an excellent dietary source of iron and a good source of zinc (Lokuruka, 2007), both of which are among the most limiting micronutrients deficits in the diets of Kenyan women and children (Bwibo and Neumann, 2003; Oduor et al., 2018; Sarfo et al., 2020). Furthermore, knowledge of the IWEPs' nutrient composition IWEPs is vital so that it can be used to educate community members on their nutritional value and to promote their utilization for nutritional improvement, and to promote their conservation and restoration.

4.3. Local perceptions of indigenous wild edible foods

Local perceptions and attitudes are important determinants of IWEPs consumption (Cruz et al., 2014; Hanemaayer et al., 2020). In this study, most participants (57.1%) showed a favorable attitude towards IWEPs, in line with other studies. In Cameroon, for example, Fungo et al. (2018) found that a >50% of respondents expressed

positive opinions about specific benefits resulting from consuming forest foods.

The general perception about IWEPs did not differ between consuming and non-IWEPs consuming households in our study. However, participants' perceptions linked to some of the IWEPs-related statements differed significantly between these two groups. For example, larger proportions of IWEPs-consuming than non-IWEPs consuming households agree that IWEPs can improve children's diets, that IWEPs are safe for consumption by children, and that IWEPs can be an alternative source of income for the households; this demonstrates a positive association between consumption and attitude. Nevertheless, given that one in three households surveyed held an overall negative attitude towards IWEPs, we deduce that negative perceptions and attitudes are among the many reasons for low IWEPs consumption in the surveyed communities. This conclusion supports the findings of Fungo et al. (2016b) that respondents who expressed positive attitudes towards the consumption of forest foods were up to 13 times more likely to prepare and consume them.

In agreement with other reports (Bharucha and Pretty, 2010; Cruz et al., 2014; Hanemaayer et al., 2020), our study revealed that IWEPs are considered more important during times of food scarcity and are associated with poverty. This was demonstrated by the analysis of the coping strategies adopted by households, which showed that a significantly higher proportion of IWEP-consuming than non-IWEPs consuming households resorted to eating foods that they did not actually want to eat. Significantly more IWEPs consumers compared to non-consumers strongly agreed with the statement "if they had enough of other foods I would never eat or allow my child to eat IWEPs." This clearly demonstrates that many IWEPs are among the foods that households consume when they do not have anything else to eat. The results also show that a majority of respondents agree that IWEPs are only important during times of famine and food scarcity. The association of IWEP consumption with poverty has also been reported in other studies as one of the factors limiting their consumption (Cruz et al., 2014).

Our results show that although IWEPs did not feature in the diets of all participants, they remain important to the community, as more than 80% of respondents agreed that IWEPs are important as part of the community's cultural identity. IWEPs are part of the history of the Turkana people: For example, the name "Lodwar," the capital of Turkana County—the original name of the town was "Namorkirinok," which means a place with many black stones—is said to have stemmed from a miscommunication between Turkana women preparing the wild species *Dobera glabra* for food and an English explorer. The explorer, it is claimed, asked the women for the name of the village but, because they did not understand the question, the women thought the explorer wanted to be served some of the food, thus responding "edwar" meaning "it is still bitter." In turn, the explorer did not understand the meaning of the answer "edwar" and so recorded it as the name of the village. The species *Dobera glabra* is one of the IWEPs found in almost all Turkana's sub-counties; its bitterness requires it to be cooked for a long time, discarding the water to remove the bitter taste. In this study the species was consumed by 24% of surveyed households.

The findings of this study must be seen considering three main limitations. First, the study relies on two kinds of data collected 4 years apart to draw conclusions. This time difference is large enough for some changes to occur at the level of the local agrobiodiversity given the metamorphosizing socio-economic, socio-political, and environmental ecosystems in the study location. The changing climate and the resulting long droughts mean that the sprouting and fruiting patterns and the general availability of the IWEPs are affected in a way. Second is on the use of the 6 months recall period used to derive the data on consumption frequency of the IWEPs. As this relies on the memory of the respondent, it may lead to underestimation of the actual consumption of the wild edible plants. Lastly, the study did not inquire about the forms in which the IWEPs were consumed as well as who consumed the food items during the reference period.

5. Conclusion

Our results reveal that Turkana County is rich in a wide diversity of IWEPs that are harvested for use as fruits, vegetables, spices, condiments, and beverages, or as a staple food. The diversity in plant parts used and their food group classification demonstrates that IWEPs can contribute to improving the dietary diversity of the communities living in these areas. The study also revealed extremely high levels of severe food insecurity among almost all households sampled, yet only about half of the households reported consuming IWEPs. Long distances to harvest sites, a lack of knowledge about IWEPs seasonality and how to prepare them, coupled with unfavorable attitudes and perceptions, are all probable reasons for not consuming IWEPs. Interventions to improve and promote wider IWEPs utilization should therefore focus on food composition analysis and restoration of the wild edible foods so that they are easily accessible by the consumers. The information on the nutrient composition can be used for educational purposes to promote their use to fill the food security gap that exists.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The study protocols were reviewed and approved by AMREF Ethics and Scientific Review Committee (ESRC P276/2016 and ESRC P688/2019). Written informed consent to participate in this study was provided by the participants or their parents or legal guardian/next of kin in the case of children.

Author contributions

FO conceptualized the scope, framework of the study, analyzed the data, and wrote the first draft of the manuscript. CT, GA, DK, and FT contributed to writing the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2023.1113771/full#supplementary-material

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