South African Journal of Botany 145 (2022) 501–511

Contents lists available at ScienceDirect

South African Journal of Botany

journal homepage: www.elsevier.com/locate/sajb

Ethnobotanical use-pattern for indigenous fruits and vegetables among selected communities in Ondo State, Nigeria

Similoluwa Felicia Olowo[1], Abiodun Olusola Omotayo[2], Ibraheem Oduola Lawal[3], Peter Tshepiso Ndhlovu[1,4], Adeyemi Oladapo Aremu[1,2,*]

[1] *Indigenous Knowledge Systems (IKS) Centre, Faculty of Natural and Agricultural Sciences, North-West University, Private Bag X2046, Mmabatho 2745, South Africa*
[2] *Food Security and Safety Niche Area, Faculty of Natural and Agricultural Sciences, North-West University, Private Bag X2046, Mmabatho 2745, North West Province, South Africa*
[3] *Biomedicinal Research Centre, Forestry Research Institute of Nigeria, Private Bag 5054 Forest hill, Ibadan 200272, Oyo State, Nigeria*
[4] *School of Biology and Environmental Sciences, Faculty of Agriculture and Natural Sciences, University of Mpumalanga, Private Bag X11283, Mbombela 1200, Mpumalanga Province, South Africa*

ARTICLE INFO

Article History:
Received 21 January 2022
Revised 20 March 2022
Accepted 22 March 2022

Edited by A. Ndhlala

Keywords:
Amaranthus
Asteraceae
Biodiversity
Food security
Indigenous knowledge
Traditional medicine

ABSTRACT

Plants including indigenous/naturalised fruits and vegetables (IFVs) have the potential towards meeting the food and nutrition needs of humans. Currently, IFVs are threatened by human activities such as deforestation, environmental degradation and acculturation. As a result, the need for ethnobotanical surveys that focuses on the documentation of IFVs remains pertinent. This study explored the utilisation pattern of IFVs among participants in 40 rural communities of Ondo state, Nigeria. Ethnobotanical information was collected among 400 participants using semi-structured questionnaires. Thereafter, the frequency of citation (FC, %) was calculated. An inventory of 46 indigenous and naturalised plant species from 19 families were identified as a source of food, nutritional and therapeutic purposes as well as energy source (fuel) in the study area. The FC ranged from approximately 32-90% and IFVs such as *Ageratum conyzoides* (L.) L. (89.5%), *Citrus aurantiifolia* (Christm.) Swingle (89.5%), *Talinum fruticosum* (L.) Juss. (88.8%), *Amaranthus hybridus* L. (87.8%), *Vernonia adoensis* var. *adoensis* (86.8%) and *Vernonia amygdalina* Delile (86.8%) were the most commonly cited plants. The dominant plant families were Asteraceae (8 IFVs) and Malvaceae (6 IFVs) while the leaves (35%) and fruit (21%) were the most frequently used plant parts. In terms of use-categories, the IFVs served as food (53%), medicine/health benefits (46%) and fuel/energy source (1%), which is an indication of their diverse potential in the study area. *Elaeis guineensis* Jacq. was recorded as a highly diverse IFV with applications in the three aforementioned use-categories. Overall, the current findings contribute to the on-going global research efforts aimed at the documentation of indigenous plants. However, the determination of the nutritional and phytochemical content of identified IFVs collected from the study area will be essential for their characterisation which may enhance their acceptance among the local and wider populations.

1. Introduction

The prevalence of food insecurity has been of great concern globally and is one of the key challenges in Sub-Saharan Africa (Crush and Frayne 2010; Aworh 2015; Anderson et al. 2021). High levels of under-nutrition persist along with high rates of overweight, obesity and non-communicable diseases (Nkambule et al. 2021). In addition, the public health crisis triggered by SARS-CoV-2, the cause of the COVID-19 disease, has exacerbated food insecurity among local communities (Ayanlade and Radeny 2020). Since the Green Revolution in the 1960s, agriculture has mainly focused on developing conventional cereal and horticultural crops. As a result, exotic foods displaced many locally produced crops resulting in the severe neglect of indigenous and naturalised plants (Conway and Barbier 2013). The neglect of indigenous and naturalised plants in preference for a few exotic crops has partly affected the achievements of food policies globally, particularly in developing countries (Aworh 2015; Mabhaudhi et al. 2019; Akinola et al. 2020). Indigenous fruits and vegetables (IFVs) often have multiple uses within the society, especially for diversifying the food-types to meet food and nutrition security (Chivenge et al. 2015; De Vynck et al. 2016; Jones 2020). Despite the diverse uses of IFVs, they are often neglected and associated with negative perceptions which has contributed to their low consumption and utilisation in Africa (Van der Hoeven et al. 2013; Bvenura and Sivakumar 2017).

* Corresponding author; Tel: +27 18 389 2573
E-mail address: Oladapo.Aremu@nwu.ac.za (A.O. Aremu).

https://doi.org/10.1016/j.sajb.2022.03.040
0254-6299/

The World Health Organisation (WHO) recommends a daily consumption of at least five portions or 400 g, of fruits and vegetables in order to reduce the risk of non-communicable diseases (FAO/WFP 2014; Mishra et al. 2022). Intriguingly, IFVs are readily available plants with the potential to provide the dual benefits of nutritional and medicinal needs (Oseni and Olawoye 2015; Moyo et al. 2018; Omotayo and Aremu 2020). Increasing evidence has indicated that IFVs are rich in antioxidants which act as scavengers against reactive oxygen species that are linked to many diseases in humans (Moyo et al. 2018; Jideani et al. 2021). Particularly, IFVs have been linked with reduced risk of many non-communicable diseases such as cancer, cardiovascular disease, type 2 diabetes and obesity (Matos et al. 2021).

Nigeria is rich in plant biodiversity and culture, with many people still using plants to fulfil their food, shelter, water, fuel, and medicinal needs (Oseni and Olawoye 2015; Erinoso and Aworinde 2018; Ajao et al. 2022). However, in the last few decades, several changes have taken place in Nigeria. As indicated by Huang et al. (2018), changes such as urbanisation, farmers shifting from subsistence to cash cropping, increased population pressures, and environmental degradation have impacted the socio-cultural practices of many people and their biodiversity. These changes are an indication of the urgent need to document indigenous plants among local communities (Crane et al. 2019). In addition, the potential to contribute to the sustainable utilisation and associated knowledge of local floras as well as their conservation for current and future generations cannot be overemphasized (Erinoso and Aworinde 2018; Crane et al. 2019; Ajao et al. 2022). Hence, this study explored the utilisation patterns, common indigenous practices, and knowledge of IFVs among selected rural communities in Ondo State, Nigeria.

2. Materials and method

2.1. Study Area

The study was conducted in 40 out of 320 communities in Akure South local government area of Ondo State. The Akure South local government area is located in the south-western Nigeria (N 9° 4′ 55.1964'', E 8° 40′ 30.9972'') and serves as the capital city of Ondo State (Figure 1). Furthermore, it is approximately 900 km south-west of Abuja and 311 km north of Lagos State. The city has an estimated population of 665,524 people and a land area of 332 km^2 (Buettner 2015). Ondo State is divided into 11 wards and approximately 320 communities, many of which are largely rural and are in the tropical rainforest zone of Nigeria (Ogunrayi et al. 2016).

2.2. Ethnobotanical survey

A semi–structured questionnaire was used to collect the data, and this was supplemented with a photo album of 46 common IFVs (Supplementary Table S1 and Appendix 1). Some of these fruits and vegetables are known as naturalised in the study area. Information such as local names, uses, plant parts commonly eaten for the selected IFVs were collected from the participants. The use of a photo album for collecting ethnobotanical data is often effective among local communities (Thomas et al. 2007; De Vynck et al. 2016; Omotayo et al. 2020). During the fieldwork, a total of 46 IFVs were collected with the assistance of the participants. Voucher specimens of the IFVs were prepared and identified at the herbarium of the Forestry Research Institute of Nigeria (FRIN), Ibadan, Oyo State, Nigeria.

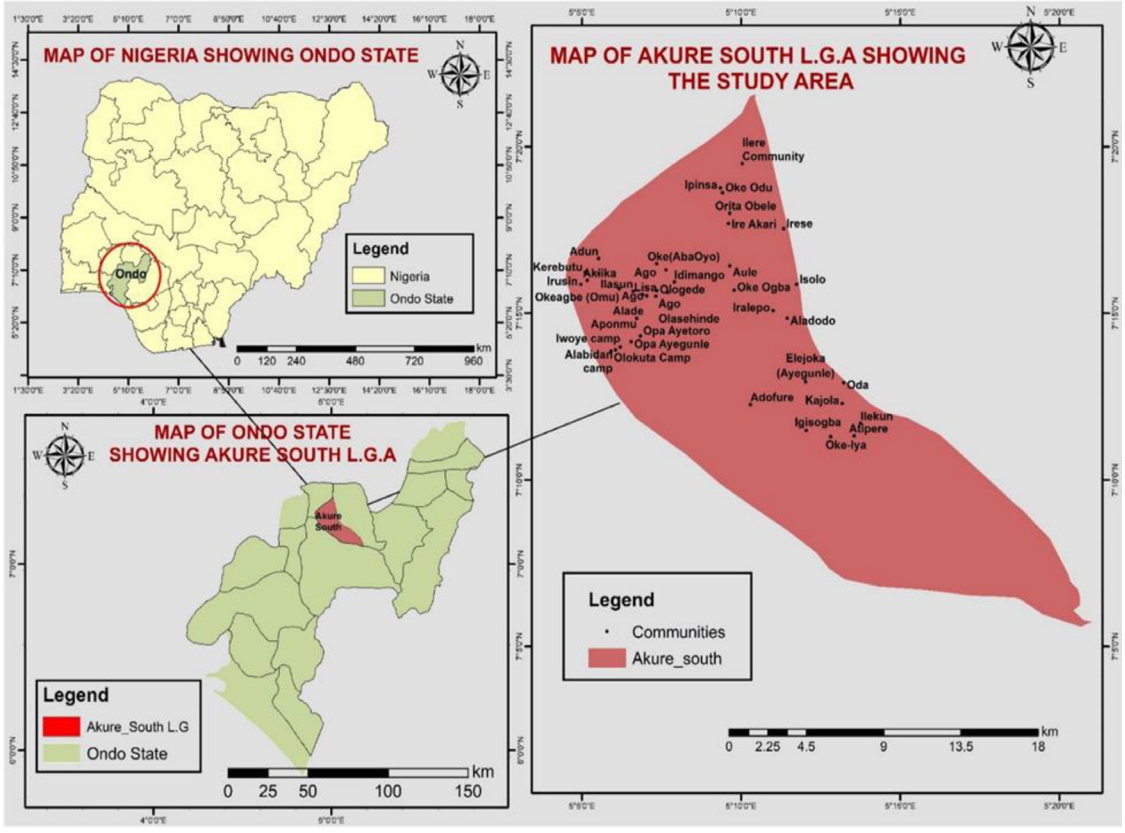

Figure 1. Geographical location of the 40 selected communities in Akure South local government area Ondo State, Nigeria. Modified from Olowo et al. (2022)

2.3. Data analysis

The collected data was analysed using SPSS and SATA 16 software. In terms of the ethnobotanical index, we calculated the frequency of citation (FC, %) as described by Tardío and Pardo-de-Santayana (2008).

$$FC = \frac{Np}{N} x100$$

Where Np = number of citations for a particular IFV, and N is the total number of participants in the study.

Thematic data analysis was used to develop the themes in the study (Bless et al. 2006). Thematic analysis is an accessible, flexible, and increasingly popular method of qualitative data analysis. Several authors argued that thematic analysis moved beyond counting explicit phrases and words to focusing on the identification and describing both the implicit and explicit ideas within the data (Braun and Clarke 2006).

2.4. Ethical approval

The research was approved (ethics certificate no: NWU-01771–20-A9) as low-risk by the Faculty of Natural and Agricultural Sciences Research Ethics Committee (FNASREC), North-West University, South Africa. The permission to access the study area was granted by the Osolo of Isolo Oba Edward Kolawole Adejoyegbe Adewole (Osalade 11) who is one of the paramount rulers in Akure South local government area. The ethnobotanical survey was conducted with the full consent of the participants. This included voluntary participation before the administration of semi-structured questionnaires in the study area. During the course of this study, the principle of privacy, autonomy, dignity, and respect was handled with high diligence.

3. Results and discussion

3.1. Demographic overview of the participants

The study included 400 participants aged from 18 to 73 years (Table 1). The mean age of the participants was 49 years which is an active labour force available in the rural communities of the state. Male participants were higher (60.5%) than females (39.5%). Similar findings were evident from previous studies (Mbavai 2013; Okonji and Awolu 2021), hereby suggesting the dominance of males in agricultural enterprise in Nigeria. In this study, most of the participants acquired formal education i.e., primary (36.8%), secondary (42.3%), and tertiary (7.3%) level, while 7.5% of the participants had no formal education. The household size variable revealed that the majority (52%) of households had 6-10 individuals. In terms of occupation, the majority (72%) of the participants were farmers. The ethnicity distribution of the participants indicated that Yoruba (88.3%), Igbo (8.0%), Hausa (2%) and others (1.8%) were engaged in the survey. Based on the years of experience, the majority (35%) of the participants had 11-20 years' experience in the production of indigenous fruits and vegetables in the study area (Table 1).

Table 1
Socio-economic characteristics of the participants in 40 selected rural communities in Akure South local government area of Ondo State, Nigeria

Characteristic	Frequency	Percentage (%)
Gender		
Male	242	60.5
Female	158	39.5
Age		
18-27	8	2
28-37	23	5.8
38-47	108	27
48-57	167	41.8
58-67	79	19.8
68-77	15	3.8
Marital status		
Single	22	5.5
Married	344	86
Divorced	17	4.3
Widow/Widower	17	4.3
Educational level		
Primary School	147	36.8
Secondary	169	42.3
Diploma	25	6.3
Degree	23	5.8
Postgraduate degree	6	1.5
No formal education	30	7.5
Household Size		
1-5	168	42
6-10	224	56
11-15	8	2
Occupation		
Civil Servant	30	7.5
Farming	291	72.8
Self-employed	48	12
Entrepreneur	22	5.5
Others	9	2.3
Ethnic groups		
Yoruba	353	88.3
Igbo	32	8
Hausa	8	2
Ijaw	6	1.5
Others	1	0.3
Years of experience		
1-10	113	28.3
11-20	141	35.3
21-30	98	24.5
31-40	37	9.3
41-50	10	2.5
51-60	1	0.3

3.2. Diversity of indigenous fruits and vegetables in the study area

An inventory of 46 IFVs that were considered as a source of food security, nutrition and medicinal/health benefits as well as fuel/energy source among the participants was generated (Table 2). Asteraceae (8), Malvaceae (6), Solanaceae (5) and Amaranthaceae (4) were the most frequently mentioned families (Figure 2), which accounted for 50% of the documented 46 IFVs. The significance of Asteraceae as being highly cited in the study, may be associated with their wider distribution and abundance in the selected communities. Similar patterns and popularity of members of the Asteraceae are well-documented in ethnobotanical surveys for edible and medicinal plants (Welcome and Van Wyk 2020; Rolnik and Olas 2021). Asteraceae is distributed worldwide in a range of environments such as forests, high-altitude grasslands, and even urban green spaces, but they are far less prevalent in tropical conditions. The morphology of members of the Asteraceae is highly diverse which likely account for their success in several environments (Bohm and Stuessy 2001). As one of the other dominant plant family in the current study, Malvaceae is generally recognised for producing a variety of fruit crops (Ogbu and Umeokechukwu 2014; Welcome and Van Wyk 2020).

Based on their FC values that ranged from approximately 32-90%, the most popular IFVs used by the participants were *Ageratum conyzoides* (L.) L. (89.5%), *Citrus aurantiifolia* (Christm.) Swingle (89.5%), *Talinum fruticosum* (L.) Juss. (88.8%), *Amaranthus hybridus* L. (87.8%), *Vernonia adoensis* var. *adoensis* (86.8%) and *Vernonia amygdalina* Delile (86.8%) (Table 2). The result is an indication that the participants have a broad understanding of the potential of these indigenous and naturalised plants. Increasing evidence suggest that the population living in rural areas are often aware of the medicinal properties and nutritional value of their local plants (Ogle and Grivetti 1985; Thomas et al. 2009; Mashile et al. 2019).

Table 2
Ethnobotanical information on indigenous (and naturalized) fruits and vegetables (IFVs) documented among participants in 40 selected rural communities in Akure South local government area of Ondo State, Nigeria. The botanical names of the plants were verified using the World flora online (http://www.worldfloraonline.org/). #Vernacular name: E - English and Y - Yoruba; ^ = naturalized plants in the study area; *O = Occurrence = (D - domesticated and W - wild). N = Number of mentions among the participants; FC (%) = frequency of citation.

Scientific name, Family, Voucher specimen number	#Vernacular name	Recorded use(s)	Plant part(s) used	*O	N	FC (%)
^*Ageratum conyzoides* (L.) L. Asteraceae OSF 113112	Billy goat weed (E), Imiesu (Y)	Food and medicine (tumours, boils, pneumonia, fever, rheumatism, headache, constipation, typhoid and diarrhoea)	Fruit, leaves, seeds, roots and whole plant	W	358	89.5
^*Amaranthus hybridus* L. Amaranthaceae OSF 113074	Africa spinach (E), Tete (Y)	Food	Leaves and stem	D	351	87.8
^*Amaranthus spinosus* L. Amaranthaceae OSF 113054	Spiny amaranthus (E), Tete-elegun (Y)	Food and medicine (dysentery, fever and malaria)	Fruit, leaves and stem	W	296	74
^*Amaranthus viridis* L. Amaranthaceae OFS 113073	Green amaranth (E), Tete-abalaye (Y)	Food	Leaves and stem	D	247	61.7
^*Andrographis paniculata* (Burm.f.) Nees Acanthaceae OSF 113121	King of bitter (E), Mejemeje (Y)	Medicine (cancer, heart attack, ulcer, leprosy, malaria, diarrhoea, fever, gonorrhoea, scabies, diabetes, lowers high blood pressure)	Leaves, stem and roots	D	287	71.8
^*Artocarpus altilis* (Parkinson ex F.A. Zorn) Fosberg Moraceae OSF 113053	Breadfruit (E), Berefuutu (Y)	Food and medicine (hypertension, diabetes, malaria, fever and diarrhoea)	Fruit, leaves, stem, seeds and roots	D	324	81
^*Basella alba* L. Basellaceae OSF 113030	Malabar spinach (E), Amunututu (Y)	Food and medicine (wound healing, ulcer, dysentery, cancer, diabetes, anaemia, diarrhoea, boils, sores, conjunctivitis), boosts libido, promotes labour and used as a laxative	Leaves and stem	D	314	78.5
Blighia sapida K.D.Koenig Sapindaceae OSF 113060	Ackee (E), Ishin (Y)	Food and medicine (epilepsy, fever, malaria, dysentery, constipation), use as a laxative	Fruit, bark, seeds and roots	W	240	60
^*Boerhavia diffusa* L. Nyctaginaceae OSF 113176	Hog weed (E), Eemo/Olowojeja (Y)	Food and medicine (pain reliever, cancer, epilepsy, lowers blood sugar, blood tonic)	Leaves and stem	W	240	60
^*Bryophyllum pinnatum* (Lam.) Oken Crassulaceae OSF 113122	Miracle leave (E), Abamoda (Y)	Food and medicine (convulsions, measles, headache, coughs, rheumatism, asthma, body pains, diabetes and arthritis)	Leaves and roots	D	146	36.5
^*Ceiba pentandra* (L.) Gaertn. Malvaceae OSF 113075	Baobao (E), Eegungun (Y)	Food and medicine (headache, diabetes, pain relievers, cancer, diarrhoea, ulcers, leprosy, dizziness, hypertension, fever and skin infection)	Leaves and seeds	W	129	32.3
Celosia argentea L. Amaranthaceae OSF 113072	Lagos spinach (E), Shokoyokoto (Y)	Food and medicine (stops vomiting, increases blood flow, colds, arthritis, diabetes, gonorrhea, eczema, rheumatism and snake bite antidote)	Leaves and stem	D	196	49
^*Chromolaena odorata* (L). R.M.King & H.Rob Asteraceae OSF 113113	Siam weed (E), Akintola (Y)	Medicine (skin-related diseases such as infections and wounds)	Leaves and roots	W	321	80.3
Chrysophyllum albidum G.Don Sapotaceae OSF 113057	Africa star apple (E), Agbalumo (Y)	Food and medicine (yellow fever, fibroids, malaria, and anemia)	Fruit, bark and roots	D	269	67.3
^*Citrus aurantiifolia* (Christm.) Swingle Rutaceae OSF 113051	Lime (E), Oronbowewe (Y)	Food	Fruit	D	358	89.5
Citrus aurantium L. Rutaceae OSF 113050	Orange (E), Ganinganin (Y)	Medicine (improves digestion, lowers blood sugar, cleanses liver, enhances immunity, cancer, diabetes and hypertension)	Fruit, bark and seeds	W	287	71.8
Clerodendrum volubile P.Beauv. Lamiaceae OSF 113118	White butterfly (E), Dagba(eweata) (Y)	Food and medicine (arthritis, diabetes, rheumatism, oedema and hypertension)	Leaves and roots	D	176	44
^*Cnidoscolus aconitifolius* (Mill.) I.M. Johnst. Euphorbiaceae OSF 113123	Chaya (E), Iyanapaja (Y)	Food and medicine (Leaf sap applied to irritated eyes and used for earaches)	Leaves and stem	D	199	49.8
Crassocephalum rubens (Juss. ex Jacq.) S.More	Coriander (E), Ebolo (Y)		Leaves, stem and seeds	D	313	78.3

(*continued*)

Table 2 (*Continued*)

Scientific name, Family, Voucher specimen number	#Vernacular name	Recorded use(s)	Plant part(s) used	*O	N	FC (%)
Asteraceae OSF 113057		Food and medicine (diabetes, stomach-ache, fevers, postpartum constipation, eye sores, and earaches)				
^*Corchorus olitorius* L. Malvaceae OSF 113049	Jute leaves (E), Ewedu (Y)	Food and medicine (pain relief, piles, tumors, fever, gonorrhea, typhoid, ulcer, malaria, and immune booster), treating infertility	Leaves and roots	D	322	80.5
^*Cocos nucifera* L. Arecaceae OFS 113047	Coconut (E), Agbon (Y)	Food and medicine (diarrhoea, diabetes, and cholera)	Fruit and seeds	D	251	62.8
Dialium guineense Willd. Fabaceae OSF 113120	Black velvet tamarind (E), Awin (Y)	Food and medicine (toothache, diarrhoea, hypertension)	Fruit	W	219	54.8
^*Eclipta prostrata* (L.) L. Asteraceae OSF 113128	False daisy (E), Abikole (Y)	Food and medicine (snake bites, pimples, wounds, cuts, eczema, sores and cancer)	Leaves and stem	W	140	35
Elaeis guineensis Jacq. Arecaceae OSF 113067	Palm oil (E), Eyin (Y)	Food, medicine (headache, pains, rheumatism, gonorrhea, cancer, measles, diabetes, and anemia) enhances lactation and as fuel	Fruit and seeds	D	323	80.8
^*Gossypium barbadense* L. Malvaceae OSF 113058	Cotton seed (E), Owu (Y)	Food and medicine (diarrhoea, fever, headache), enhancing lactation	Fruit and seeds	D	243	60.8
Hibiscus asper Hook.f. Malvaceae OSF 113078	Hibiscus (E), Isapa (Y)	Food and medicine (immune booster and general well-being)	Leaves, seeds and flowers	D	295	73.8
Irvingia gabonensis (Aubry-Lecomte ex O'Rorke) Baill. Irvingiaceae OSF 113055	Bush mango (E), Oro (Y)	Food and medicine (dysentery, toothache and diabetes)	Fruit, bark, seeds and roots	D	266	66.5
Irvingia tenuinucleata Tiegh. Irvingiaceae OSF 113079	Bitter bush mango (E), Oro (Y)	Food and medicine (diarrhoea, scabies, toothache, yellow fever, inflammation and diabetes)	Fruit and bark	D	170	42.5
Launaea taraxacifolia (Willd.) Amin ex C.Jeffrey Asteraceae OSF 113066	Wild lettuce (E), Yanrin (Y)	Food and medicine (stops vomiting, toothache, diabetes, wounds)	Leaves and stem	W/D	168	42
Manihot esculenta Crantz Euphorbiaceae OSF 113068	Cassava leaves (E), Ege (Y)	Food	Leaves	D	248	62
Mucuna pruriens (L.) DC. Fabaceae OSF 113118	Mucuna leaves (E), Esisi/Iwerepe (Y)	Food and medicine (blood tonic, bone fractures, coughs, dog bites, madness, ringworm, scorpion bites and snake bites), to manage male fertility	Leaves and roots	W	153	38.3
Ocimum gratissimum L. Lamiaceae OSF 113069	Scent leaves (E), Efirin (Y)	Food and medicine (blood tonic, headache, fevers, malaria, stomach-ache, promotes good eyesight, lowers blood sugar, stops vomiting and dysentery)	Leaves, seeds and roots	D	292	73
Parkia biglobosa (Jacq.) G.Don Fabaceae OSF 113076	Locust beans (E), Iru (Y)	Food and medicine (prevents stroke, lowers blood sugar, promotes good eyesight, coughs, diarrhoea, and hypertension)	Fruit and seeds	W	320	80
Plukenetia conophora Müll.Arg. Euphorbiaceae OSF 113059	Walnut (E), Awusa (Y)	Food and medicine (alleviates indigestion, constipation, hiccups, eyesight) cosmetic purposes including its use as soap	Fruit, seeds and roots	D	265	66.3
*Senecio biafra*e Oliv. & Hiern C.Jeffrey Asteraceae OSF 113117	Bologi (E), Woorowo (Y)	Food and medicine (diabetes, sore eyes, coughs and rheumatism), to manage female infertility	Leaves and stem	D	257	64.3
^*Sida acuta* Burm.f. Malvaceae OSF 113114	Wire weed (E), Iseketu (Y)	Medicine (urinary disease, headache, tuberculosis, asthma, diabetes, fever, ulcer, tuberculosis, rheumatism, and stops bleeding, blood tonic, measles and abdominal pain), to manage infertility and weight loss	Leaves, stem, roots and whole plant	W	255	63.8
Solanum aethiopicum L. Solanaceae OSF 113116	Garden egg (E), Igba (Y)	Food	Fruit	D	281	70.3
Solanum erianthum D.Don Solanaceae OSF 113070	Big eggplant (E), Ewuro Ijebu (Y)	Food and medicine (headache, dysentery, fever, diarrhoea, arthritis)	Leaves, stem and roots	W	171	42.8

(*continued*)

Table 2 (*Continued*)

Scientific name, Family, Voucher specimen number	#Vernacular name	Recorded use(s)	Plant part(s) used	*O	N	FC (%)
Solanum macrocarpon L. Dunal Solanaceae OSF 113056	Africa eggplant (E), Igbagba (Y)	Food and medicine (stomach worms, asthma, and wounds), used as a laxative and teeth cleanser	Leaves, stem, bark and roots	D	244	61
Solanum nigrum L. Solanaceae OSF 113115	Black nightshade (E), Efoodu (Y)	Food and medicine (pneumonia, toothache, stomach-ache, pain reliever, fever, tumour, dysentery, tuberculosis and ulcer)	Leaves, stem and whole plant	D	197	49.3
^*Solanum violaceum* Ortega. Solanaceae OSF 113048	African eggplant (E), Ajegun Were (Y)	Food	Fruit	D	169	42.3
^*Spondias mombin* L. Anacardiaceae OSF 113071	Hog Plum (E), Iyeye (Y)	Food and medicine (stomach-ache, diarrhoea, dysentery, gonorrhoea, inflammation)	Fruit	W	187	46.8
Talinum fruticosum (L.) Juss. Talinaceae OSF 113111	Waterleaf (E), Gbure (Y)	Food and medicine (scabies, ulcer, high blood pressure and anemia)	Leaves and stem	D	355	88.8
^*Theobroma cacao* L. Malvaceae OSF 113052	Cocoa (E), Koko (Y)	Food	Fruit and seeds	D	225	63.8
Vernonia adoensis var. *adoensis* Asteraceae OSF 113065	Bitter leaf (E), Ewuroodo (Y)	Food and medicine (gonorrhoea, tuberculosis, stomach-ache)	Leaves, stem and whole plant	W, D	347	86.8
Vernonia amygdalina Delile Asteraceae OSF 113065	Bitter leaf (E), Ewuro (Y)	Food and medicine (fever, malaria, dysentery, hepatitis, cough, head-ache, stomach-ache, diabetes, hypertension and high blood pres-sure), used as fertility inducer	Leaves, stem and whole plant	W, D	347	86.8

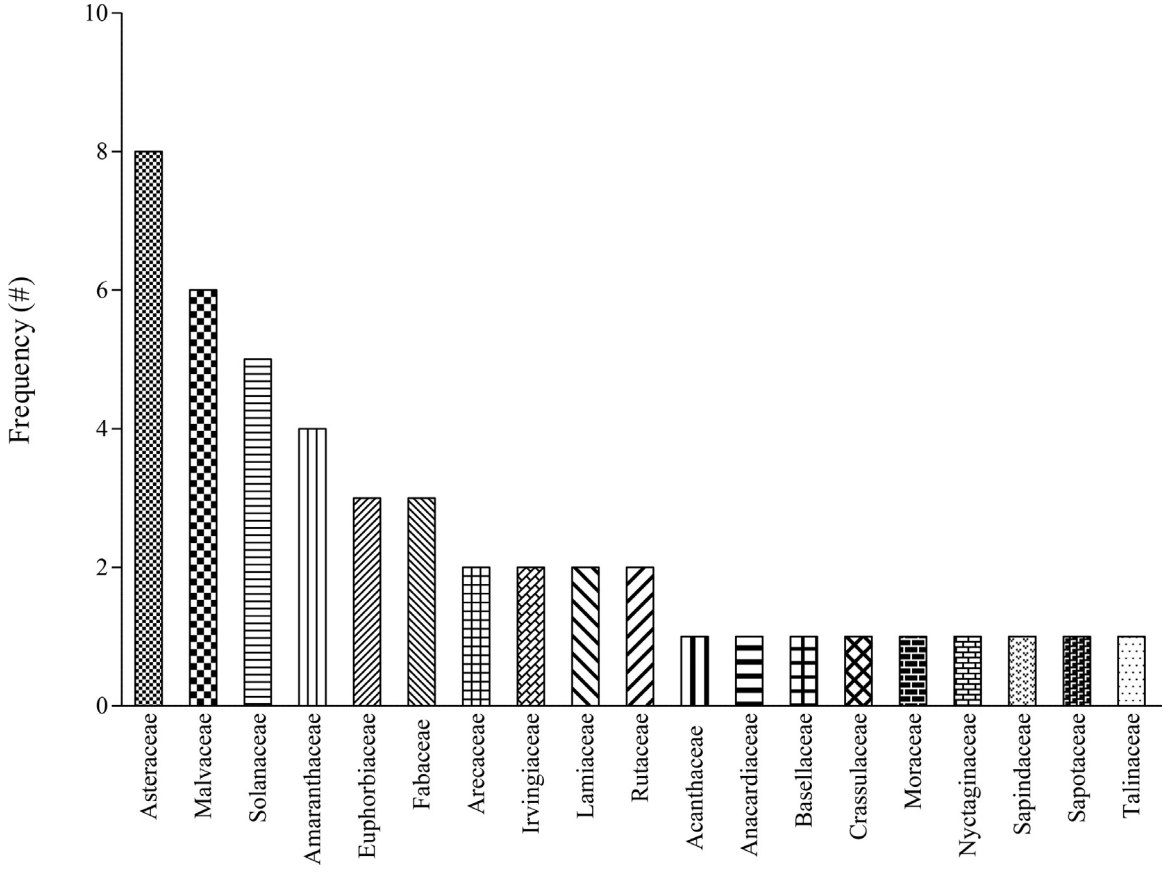

Figure 2. Plant families of indigenous fruits and vegetables documented among participants in 40 selected communities in Akure South local government area, Ondo State, Nigeria.

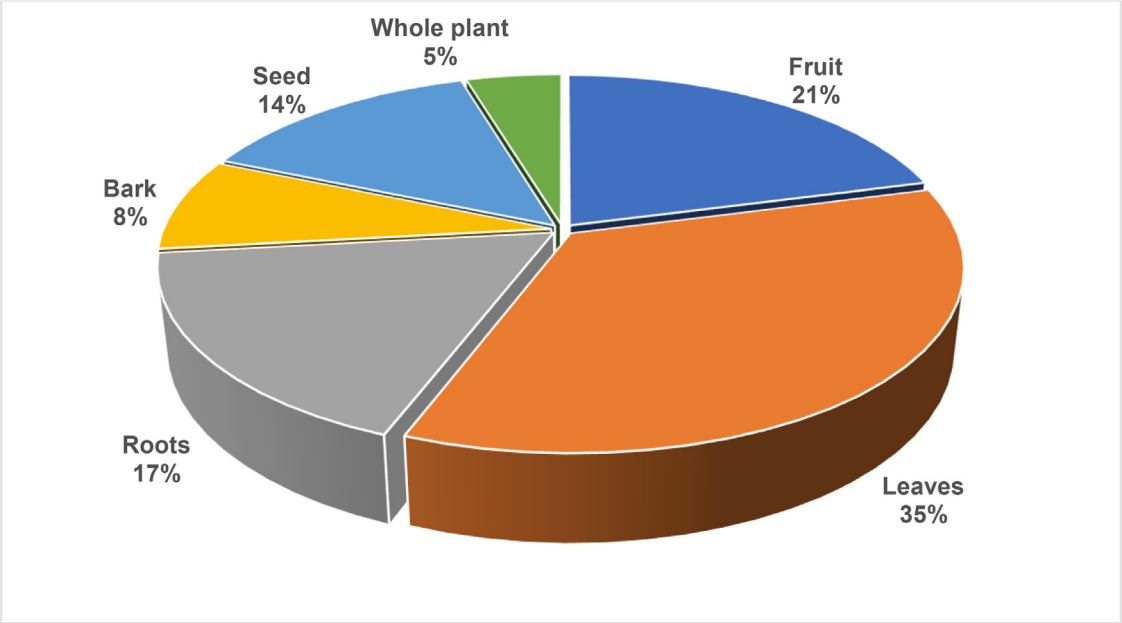

Figure 3. Plant parts of the indigenous fruits and vegetables used among participants in 40 selected communities in Akure South local government area, Ondo State, Nigeria (n=86).

3.2. Use pattern for plant parts of indigenous fruits and vegetables (IFVs)

Based on the plant parts used and the method of consumption of the IFVs identified in the study, 56% of the participants utilise the leaves and fruits, whereas 44% of the participants indicated the use of other plant parts as food, medicinal/health benefits and fuel/energy source (Figure 3). These findings are similar to previous studies that indicated that leaves and fruits are the dominant plant part used as food (Mayes et al. 2012; Adebooye et al. 2014; Oseni and Olawoye 2015; Magwede et al. 2019; Manlosa et al. 2019; Welcome and Van Wyk 2019). Furthermore, these results identified the existence of closely-related cultural practices and knowledge regarding plant parts used and in the consumption pattern of IFVs among different local communities in Sub-Saharan countries (Mashile et al. 2019; Dejene et al. 2020). Particularly, indigenous/naturalised fruits have continuously played a crucial but largely neglected role in household food security (Omotayo and Aremu 2020; Jideani et al. 2021).

3.3. Use-categories for indigenous fruits and vegetables (IFVs)

As indicated by Shai et al. (2020), indigenous plants especially fruits are often abundant in rural areas, readily available and cheap which may explain why many community members rely solely on them for diverse uses especially nutritional and medicinal needs. Indigenous fruits and vegetables form an important part of the human diet and livelihoods, with a significant number of plant species known for their untapped potential (Ekesa et al. 2009; Aworh 2015). According to Omotayo et al. (2020), many underutilised indigenous plants have high nutritional value and could improve the nutritional status of many impoverished individuals. Research has shown that the consumption of IFVs offers a sustainable way of mitigating micronutrient deficiencies in resource poor communities (Moyo et al. 2018; Mabhaudhi et al. 2019; Akinola et al. 2020). In this study, the documented IFVs were mainly used as food (53%), medicinal/health benefits (46%) and fuel/energy source (1%) (Figure 4). Particularly, *Elaeis guineensis* Jacq. was recorded as a highly diverse IFV with applications in the three aforementioned use-categories. It was the only plant identified as being useful for fuel (energy source) among the participants. On the other hand, the majority of the IFVs had dual applications (e.g. *Ageratum conyzoides, Basella alba* L., *Corchorus olitorius* L., *Parkia biglobosa* (Jacq.) G.Don and *Vernonia amygdalina*) or single use especially as food (e.g. *Amaranthus hybridus, Citrus aurantiifolia, Solanum aethiopicum* L., *Manihot esculenta* Crantz, *Solanum aethiopicum* L. and *Theobroma cacao* L.). Indigenous fruit and vegetables form a significant part of the traditional diets of agricultural communities (Oseni and Olawoye 2015). From some previous studies (Shackleton et al. 2000; Abdoulaye et al. 2014; Mashile et al. 2019), plants such as *Citrus aurantiifolia* and *Corchorus olitorius* were readily available in the communities and are being cultivated at homesteads.

3.4. Occurrence status for the indigenous fruits and vegetables (IFVs)

In various communities, the cultivation of indigenous vegetables are often essential to meet the needs of the households in terms of food and income sustenance (Phillip et al. 2009; Alagba et al. 2015; Aworh 2015; Omotayo et al. 2020; Olowo et al. 2022). This study revealed that 65% of the IFVs were domesticated while 35% grow in the wild (Figure 5). Similar results were observed in a previous study in Nigeria (Akinnifesi et al. 2007), whereby domesticated plant species were more dominant when compared to the plants collected from the wild. Jansen van Rensburg et al. (2007) and Maroyi (2017) established that people have often depended on domesticated and wild plants for food. This dependence continues today and has remained relatively unchanged especially for inhabitants of rural areas (Ajesh et al. 2012).

3.6. Relationship of the findings in the study area with previous studies

In relation to earlier ethnobotanical studies conducted in Ondo State and other parts of Nigeria, the present study revealed some trends with respect to the uses of the documented plants (Table 2). In the present study, *Elaeis guineensis* was mentioned as being used for fuel purposes. However, the findings of Erinoso et al. (2020), reported that the plant was used for making brooms, palm oil, palm wine, and for hunting purposes. Plants such as *Amaranthus hybridus, Ocimum grattissimum, Ageratum conyzoides, Artocarpus altilis* (synonym: *A. communis*), *Corchorus olitorius, Talinum fruticosum* (synonym: *Talinum triangulare*), *Vernonia adoensis* and *Vernonia amygdalina* had

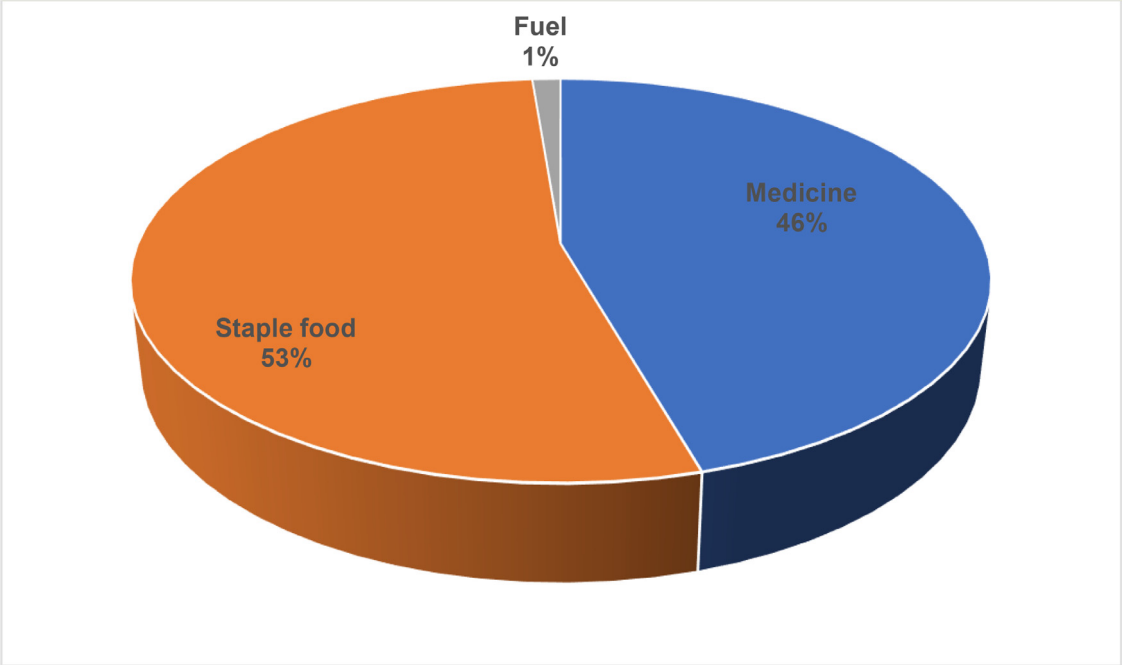

Figure 4. Use-categories for indigenous fruits and vegetables among the participants in 40 selected communities of Akure South local government area, Ondo State, Nigeria (n = 79).

similar uses in previous studies (Omara-Achong et al. 2012; Shomkegh et al. 2013). In rural areas, some of these IFVs are essential to reduce malnutrition as they are a valuable source of minerals, proteins and fats/oils (Stadlmayr et al. 2013; Moyo et al. 2018). The current uses for these aforementioned plants demonstrate the importance of collecting new ethnobotanical information, even on well-known plant species (Mashile et al. 2019). In a previous study (Lawal et al. 2020), *Citrus aurantiifolia* and *Ageratum conyzoides* were among the most common indigenous plants used in the treatment of cough associated with respiratory conditions among local communities in Osun State, Nigeria.

3.7. Common practices and knowledge associated with the documented indigenous fruits and vegetables (IFVs)

Indigenous agricultural practices used by locals rely heavily on traditional knowledge, which is prevalent in agricultural systems to conserve ecosystems and biodiversity, as well as to ensure

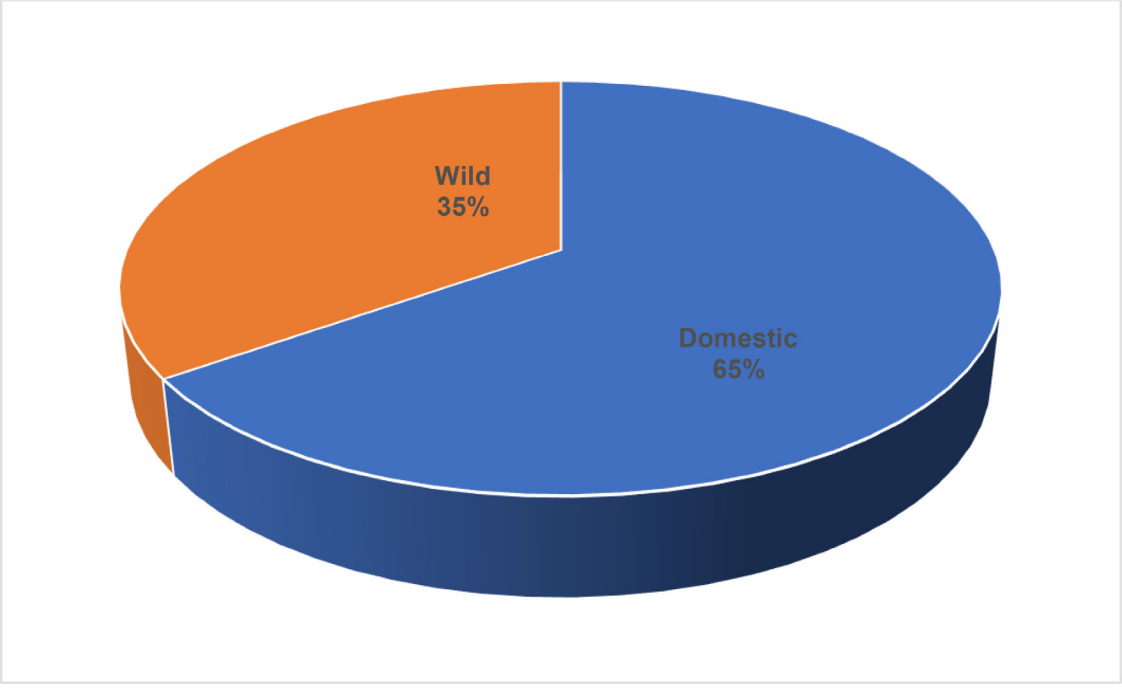

Figure 5. Occurrence of indigenous fruits and vegetables documented in 40 selected communities of Akure South local government area, Ondo State, Nigeria (n=46).

sustainable food and human health (Sharma et al. 2020). Participants use a variety of indigenous agricultural practices based on years of experience, informal education, and extensive knowledge and interaction with their environments (Šūmane et al. 2018). According to Okoye and Oni (2017), indigenous preservations are a less expensive, economically practical, and sustainable way to ensure the integrity of micronutrients in plants. The application of indigenous practices amongst the participants encompasses a wide range of factors, including soil fertility management, weeding, pest control, seed storage, soil preparation, harvesting, and storage (Ndwandwe 2013). Furthermore, there have been several developments among indigenous people concerning their practices and technology for storing, processing, and preservation of their food and associated nutrients (Okoye and Oni 2017).

One of the participants indicated that the cultivation of *Cocos nucifera* requires some indigenous measures that need to be taken before planting can occur. For example, *Cocos nucifera* (10 to 20) must be kept outside under a tree, inside a sack, to receive rain and dew for a long period of time, and it must not be touched or shaken, or else it is no longer good for planting. The participants indicated in Yoruba dialect: "*Eewo ni lati fowo kan tabi kan jiwo leti*," meaning "it is a taboo for it to be touched, held, or shaken". It will grow on its own without any interference. With respect to its harvesting, it has to drop the fruit by itself before it can be picked because of its height, so the elderly ones will say during harvesting in Yoruba dialect, "*A wo moju lawo ausa*," meaning "if it does not drop, it cannot be picked." In terms of storage, some of the participants believed that the best way to preserve IFVs is to sun-dry or shade to dry, placed inside a calabash (*Akeregbe*) with a cover and left on roof-top of their huts.

Furthermore, some interesting sayings associated with some of the IFVs were recorded. For instance, a participant described *Crassocephalum rubens* as follow: *'A o ti se ebolo ti ko ni rungbe'* which means there is no way you will cook coriander without bringing out its smell. Some people detest it because of its smell. The consumption of *Corchorus olitorius* is associated with the saying: '*Ki omode ati agba ilu ko ma yonu si mi*' which means anytime you eat jute leaves, you will be in favour with both children and adults in society. This may also be attributed to the slippery nature of *Corchorus olitorius* when cooked. Some of the participants described *Citrus aurantiifolia* as *"Koko moni osan"* due to its diverse applications in the treatment of several ailments and it is often regarded as an indispensable orange among households.

According to 65% of participants, ensuring the soils maintained their fertility is essential way to support the growth and productivity of IFVs. Some of the participants described this process as soil conservation which entails the soil is enriched with essential nutrients required for the growth and survival of IFVs. According to Garutsa and Nekhwevha (2016), soil conservation refers to ways of preserving soils to attain their optimum fertility. In the study area, participants use organics, mulching, and contouring if the slopes are steep. In addition, the use of sandbags is introduced to avoid soil erosion during flooding. The importance of these methods and strategies are consistent with the view described by Giller et al. (2009). Proper land preparation through appropriate soil conservation and enhancement practices ensures high crop productivity. In recent years, indigenous soil conservation methods have diminished due to the use of fertilizers, pesticides, and incompatible technologies, which are largely responsible for soil degradation (Garutsa and Nekhwevha 2016).

5. Conclusion

Relative to the inventory of 46 IFVs (from 19 families), *Ageratum conyzoides, Citrus aurantiifolia, Talinum fruticosum, Amaranthus hybridus, Vernonia adoensis* var. *adoensis* and *Vernonia amygdalina* were regarded as the most popular among the participants in the study area. In addition, *Elaeis guineensis* had the most diverse uses with applications as food, medicine and fuel (energy-source). Currently, many people still rely on these aforementioned plants for their sustainable livelihoods and survival. Asteraceae and Malvaceae were the dominant families while the leaves and fruit were the most utilised plant parts. This study revealed the patterns of consumption of IFVs among the population especially for food sustenance and health benefits. Thus, promoting these indigenous/naturalised plant species is a viable means of exploring the rich biodiversity which indirectly has the potential to expand the existing food pool. This will contribute to food sufficiency among local communities. However, the nutritional and phytochemical content of these identified IFVs needs to be explored as essential evidence to enhance their acceptability. It is also important to assess the storage aspect of the IFVs given their short shelf-life, especially during the peak harvest period.

Author Contributions

Conceptualisation A.O.O. and A.O.A; Methodology S.F.O., A.O.O.; Resources, A.O.O., I.O.L. and A.O.A.; Writing – Original Draft Preparation, S.F.O., A.O.O.; P.T.N.; Writing – Review & Editing, A.O.O., I.O.L. and A.O.A; Supervision, A.O.O., I.O.L. and A.O.A.; Project Administration, A.O.O., I.O.L. and A.O.A; Funding Acquisition, I.O.L. and A.O.A. The final version of the manuscript has been read and approved by all authors.

Declaration of Competing Interest

The authors declare that there is no conflict of interest. The opinions, conclusions/recommendations herein this study are based on the findings of the authors, therefore, the funders (NRF and NWU) accept no liability whatsoever in this regard.

Acknowledgments

We sincerely appreciated the postgraduate bursary awarded to SFO by the North-West University. AOA received research funds from the National Research Foundation (NRF, Pretoria, South Africa) in the form of the African Interaction fund (NRF Grant UID: 138253). Institutional support was provided by the Faculty of Natural and Agricultural Sciences, North-West University, South Africa. We thank the Staff of the Forestry Research Institute of Nigeria (FRIN), Ibadan, Oyo state, Nigeria for assisting with the identification and preparation of the voucher specimens for the selected indigenous fruits and vegetables.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.sajb.2022.03.040.

References

Abdoulaye, T., Abass, A., Maziya-Dixon, B., Tarawali, G., Okechukwu, R., Rusike, J., Alene, A., Manyong, V.M., Ayedun, B., 2014. Awareness and adoption of improved cassava varieties and processing technologies in Nigeria. Journal of Development and Agricultural Economics 6, 67–75.

Adebooye, O.C., Olanike, F.D., Adeolu, B.A., Oyedele, D.J., Oluwagbenga, A.T., 2014. Nigerian women reap benefits from indigenous vegetables. Canada, WRENmedia.

Ajao, A.A., Mukaila, Y.O., Sabiu, S., 2022. Wandering through southwestern Nigeria: An inventory of Yoruba useful angiosperm plants. Heliyon 8, e08668. https://doi.org/10.1016/j.heliyon.2021.e08668.

Ajesh, T., Naseef, S.A., Kumuthakalavalli, R., 2012. Ethnobotanical documentation of wild edible fruits used by Muthuvan tribes of Idukki, Kerala-India. International Journal of Pharma and Bio-Sciences 3, 479–487.

Akinnifesi, F., Ajayi, O.O., Sileshi, G., Kadzere, I., Akinnifesi, A.I., Akinnifesi, F.K., Ajayi, O.C, Sileshi, G., Kadzere, I., Akinnifesi, A.I, 2007. Domesticating and Commercializing Indigenous Fruit and Nut Tree Crops for Food Security and Income Generation in Sub-Saharan Africa. Haq, N. (Ed.), Proceedings 5th International

Symposium on New Crops and Uses: their role in a rapidly changing world. Centre for Underutilized Crops, University of Southampton, p. 32.
Akinola, R., Pereira, L.M., Mabhaudhi, T., de Bruin, F.-M., Rusch, L., 2020. A review of indigenous food crops in Africa and the implications for more sustainable and healthy food systems. Sustainability 12, 3493. https://doi.org/10.3390/su12083493.
Alagba, R., Ofor, M., Okoli, N., Ibeawuchi, I.I., Obiefuna, J.C, 2015. Fruit and vegetable crop production in Nigeria: The gains, challenges and the way forward. Journal of Biology, Agriculture and Healthcare 5, 194–208.
Anderson, W., Taylor, C., McDermid, S., Ilboudo-Nébié, E., Seager, R., Schlenker, W., Cottier, F., de Sherbinin, A., Mendeloff, D., Markey, K., 2021. Violent conflict exacerbated drought-related food insecurity between 2009 and 2019 in sub-Saharan Africa. Nature Food 2, 603–615.
Aworh, O.C., 2015. Promoting food security and enhancing Nigeria's small farmers' income through value-added processing of lesser-known and under-utilized indigenous fruits and vegetables. Food Research International 76, 986–991.
Ayanlade, A., Radeny, M., 2020. COVID-19 and food security in Sub-Saharan Africa: implications of lockdown during agricultural planting seasons. npj Science of Food 4, 13. https://doi.org/10.1038/s41538-020-00073-0.
Bless, C., Higson-Smith, C., Kagee, A., 2006. Fundamentals of social research methods: An African perspective. Juta and Company Ltd.
Bohm, B.A., Stuessy, T.F, 2001. Flavonoids of the sunflower family (Asteraceae). Springer Science & Business Media, Berlin/Heidelberg, Germany.
Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qualitative Research in Psychology 3, 77–101.
Buettner, T., 2015. Urban estimates and projections at the United Nations: The strengths, weaknesses, and underpinnings of the world urbanization prospects. Spatial Demography 3, 91–108.
Bvenura, C., Sivakumar, D., 2017. The role of wild fruits and vegetables in delivering a balanced and healthy diet. Food Research International 99, 15–30.
Chivenge, P., Mabhaudhi, T., Modi, A.T., Mafongoya, P., 2015. The potential role of neglected and underutilised crop species as future crops under water scarce conditions in Sub-Saharan Africa. International Journal of Environmental Research and Public Health 12, 5685–5711.
Conway, G.R., Barbier, E.B, 2013. After the green revolution: sustainable agriculture for development. Routledge, United Kingdom.
Crane, P.R., Ge, S., Hong, D.-Y., Huang, H.-W., Jiao, G.-L., Knapp, S., Kress, W.J., Mooney, H., Raven, P.H., Wen, J., Wu, W.-H., Yang, H.-M., Zhu, W.-H., Zhu, Y.-X., Committee, S.D.D, 2019. The Shenzhen declaration on plant sciences—Uniting plant sciences and society to build a green, sustainable Earth. Plants. People, Planet 1, 59–61.
Crush, J., Frayne, B., 2010. The invisible crisis: Urban food security. Southern Africa.
De Vynck, J.C., Van Wyk, B.E., Cowling, R.M, 2016. Indigenous edible plant use by contemporary Khoe-San descendants of South Africa's Cape South Coast. South African Journal of Botany 102, 60–69.
Dejene, T., Agamy, M., Agúndez, D., Martín-Pinto, P., 2020. Ethnobotanical survey of wild edible fruit tree species in Lowland areas of Ethiopia. Forests 11, 177. https://doi.org/10.3390/f11020177.
Ekesa, B., Walingo, M.K., Onyango, M., 2009. Accesibility to and consumption of indigenous vegetables and fruits by rural households in Matungu division, western Kenya. African Journal of Food, Agriculture, Nutrition and Development 9, 1725–1738. https://doi.org/10.4314/ajfand.v9i8.48410.
Erinoso, S., Aworinde, D., 2018. Current outlook and future promise of ethnobotany in Nigeria: A review and personal observation. African Journal of Plant Science 12, 73–80.
Erinoso, S.M., Aworinde, D.O., Teniola, O.A., Ojo, S.O, 2020. Ethnobotany of *Elaeis guineensis* Jacq. and its importance in the household economy of the Ikale and Ilaje of Ondo State, Nigeria. Ethnobotany Research and Applications 20, 1–16.
FAO/WFP, 2014. The State of Food Insecurity in the World 2014. Food and Agriculture Organization of the United Nations, Rome.
Garutsa, T.C., Nekhwevha, F.H, 2016. Labour-burdened women utilising their marginalised indigenous knowledge in food production processes: The case of Khambashe rural households, Eastern Cape, South Africa. South African Review of Sociology 47, 106–120.
Giller, K.E., Witter, E., Corbeels, M., Tittonell, P., 2009. Conservation agriculture and smallholder farming in Africa: the heretics' view. Field Crops Research 114, 23–34.
Huang, C.-W., McDonald, R.I., Seto, K.C, 2018. The importance of land governance for biodiversity conservation in an era of global urban expansion. Landscape and Urban Planning 173, 44–50.
Jansen van Rensburg, W.S., van Averbeke, W., Slabbert, R., Faber, M., van Jaarsveld, P., van Heerden, I., Wenhold, F., Oelofse, A., 2007. African leafy vegetables in South Africa. Water SA 33, 317–326. https://doi.org/10.4314/wsa.v33i3.49110.
Jideani, A.I., Silungwe, H., Takalani, T., Omolola, A.O., Udeh, H.O., Anyasi, T.A, 2021. Antioxidant-rich natural fruit and vegetable products and human health. International Journal of Food Properties 24, 41–67.
Jones, R.A., 2020. Disease pandemics and major epidemics arising from new encounters between indigenous viruses and introduced crops. Viruses 12, 1388. https://doi.org/10.3390/v12121388.
Lawal, I.O., Olufade, I.I., Rafiu, B.O., Aremu, A.O, 2020. Ethnobotanical survey of plants used for treating cough associated with respiratory conditions in Ede South local government area of Osun State, Nigeria. Plants 9, 647. https://doi.org/10.3390/plants9050647.
Mabhaudhi, T., Chibarabada, T.P., Chimonyo, V.G.P., Murugani, V.G., Pereira, L.M., Sobratee, N., Govender, L., Slotow, R., Modi, A.T., 2019. Mainstreaming underutilized indigenous and traditional crops into food systems: a South African perspective. Sustainability 11, 172. https://doi.org/10.3390/su11010172.
Magwede, K., Van Wyk, B.E., Van Wyk, A.E, 2019. An inventory of Vhavenḓa useful plants. South African Journal of Botany 122, 57–89.
Manlosa, A.O., Hanspach, J., Schultner, J., Dorresteijn, I., Fischer, J., 2019. Livelihood strategies, capital assets, and food security in rural Southwest Ethiopia. Food Security 11, 167–181.
Maroyi, A., 2017. Diversity of use and local knowledge of wild and cultivated plants in the Eastern Cape province, South Africa. Journal of Ethnobiology and Ethnomedicine 13, 43. https://doi.org/10.1186/s13002-017-0173-8.
Mashile, S.P., Tshisikhawe, M.P., Masevhe, N.A, 2019. Indigenous fruit plants species of the Mapulana of Ehlanzeni district in Mpumalanga Province, South Africa. South African Journal of Botany 122, 180–183.
Matos, R.A., Adams, M., Sabaté, J., 2021. The consumption of ultra-processed foods and non-communicable diseases in Latin America. Frontiers in Nutrition 8, 622714. https://doi.org/10.3389/fnut.2021.622714.
Mayes, S., Massawe, F., Alderson, P., Roberts, J., Azam-Ali, S., Hermann, M., 2012. The potential for underutilized crops to improve security of food production. Journal of Experimental Botany 63, 1075–1079.
Mbavai, J., 2013. An assessment of the effectiveness of the Sudan Savanna Taskforce project in adoption and diffusion of improved cowpea varieties in selected communities in Musawa Local Government Area of Katsina State. Thesis submitted to the Department of Adult Education and Community Services, Faculty of Education. Bayero U. Bayero University Kano, Kano, Nigeria.
Mishra, R., Tripathi, A.D., Singh, R.B., Tomar, R.S., Wilson, D.W., Smail, M.M, 2022. Estimates of functional food and nutraceutical availability in the world, with reference to food peroxidation and food safety. In Singh, R.B., Watanabe, S., Isaza, A.A. (eds). Functional Foods and Nutraceuticals in Metabolic and Non-Communicable Diseases. Academic Press, Oxford, United Kingdom, pp. 23–42.
Moyo, M., Amoo, S.O., Aremu, A.O., Gruz, J., Šubrtová, M., Jarošová, M., Tarkowski, P., Doležal, K., 2018. Determination of mineral constituents, phytochemicals and antioxidant qualities of *Cleome gynandra*, compared to *Brassica oleracea* and *Beta vulgaris*. Frontiers in Chemistry 5, 128. https://doi.org/10.3389/fchem.2017.00128.
Ndwandwe, S., 2013. The contribution of indigenous knowledge practices to household food production and food security: A case of Okhahlamba local municipality. University of Kwa-Zulu Natal, Pietermaritzburg, South Africa.
Nkambule, S.J., Moodley, I., Kuupiel, D., Mashamba-Thompson, T.P., 2021. Association between food insecurity and key metabolic risk factors for diet-sensitive non-communicable diseases in sub-Saharan Africa: a systematic review and meta-analysis. Scientific Reports 11, 5178.
Ogbu, J.U., Umeokechukwu, C.E, 2014. Aspects of fruit biology of three wild edible monkey kola species fruits (*Cola spp*: Malvaceae). Annual Research and Review in Biology 4, 2007–2014. https://doi.org/10.9734/ARRB/2014/8066.
Ogle, B.M., Grivetti, L.E, 1985. Legacy of the chameleon: Edible wild plants in the kingdom of Swaziland, Southern Africa. A cultural, ecological, nutritional study. Part I - Introduction, objectives, methods, Swazi culture, landscape and diet. Ecology of Food and Nutrition 16, 193–208.
Ogunrayi, O.A., Akinseye, F.M., Goldberg, V., Bernhofer, C., 2016. Descriptive analysis of rainfall and temperature trends over Akure, Nigeria. Journal of Geography and Regional Planning 9, 195–202.
Okonji, C., Awolu, O., 2021. Factors influencing adoption of improved technology among maize farmers in Ekiti State, Nigeria. Agrosearch 20, 102–112.
Okoye, J., Oni, K., 2017. Promotion of indigenous food preservation and processing knowledge and the challenge of food security in Africa. Journal of Food Security 5, 75–87.
Olowo, S.F., Omotayo, A.O., Lawal, I.O., Aremu, A.O, 2022. Improving rural livelihood through the cultivation of indigenous fruits and vegetables: Evidence from Ondo State, Nigeria. Agriculture 12, 372. https://doi.org/10.3390/agriculture12030372.
Omara-Achong, T., Edwin-Wosu, N., Edu, E., Nkang, A., 2012. Survey of indigenous vegetables species in parts of Ogoja and Calabar, Cross River State, Nigeria. European Journal of Experimental Biology 2, 1289–1301.
Omotayo, A.O., Aremu, A.O., 2020. Underutilized African indigenous fruit trees and food–nutrition security: Opportunities, challenges, and prospects. Food and Energy Security 9, e220. https://doi.org/10.1002/fes3.220.
Omotayo, A.O., Ndhlovu, P.T., Tshwene, S.C., Aremu, A.O, 2020. Utilization pattern of indigenous and naturalized plants among some selected rural households of North West Province. South Africa. Plants 9, 953. https://doi.org/10.3390/plants9080953.
Oseni, K., Olawoye, B., 2015. Underutilized indigenous vegetable (UIV) in Nigeria: a rich source of nutrient and antioxidants-a review. Annals Food Science and Technology 16, 236–247.
Phillip, D., Nkonya, E., Pender, J., Oni, O.A, 2009. Constraints to increasing agricultural productivity in Nigeria: A review. International Food Policy Research Insititute, Abuja, Nigeria.
Rolnik, A., Olas, B., 2021. The plants of the Asteraceae family as agents in the protection of human health. International Journal of Molecular Sciences 22, 3009. https://doi.org/10.3390/ijms22063009.
Shackleton, C.M., Dzerefos, C.M., Shackleton, S.E., Mathabela, F.R, 2000. The use of and trade in indigenous edible fruits in the Bushbuckridge savanna region. South Africa. Ecology of Food and Nutrition. 39, 225–245.
Shai, K.N., Ncama, K., Ndhlovu, P.T., Struwig, M., Aremu, A.O, 2020. An exploratory study on the diverse uses and benefits of locally-sourced fruit species in three villages of Mpumalanga Province, South Africa. Foods 9, 1581. https://doi.org/10.3390/foods9111581.
Sharma, I.P., Kanta, C., Dwivedi, T., Rani, R., 2020. Indigenous agricultural practices: A supreme key to maintaining biodiversity. In: Goel R., Soni R., Suyal D. (eds).

Microbiological Advancements for Higher Altitude Agro-Ecosystems & Sustainability. Rhizosphere Biology. Springer, Singapore, pp. 91–112.
Shomkegh, S.A., Mbakwe, R., Dagba, B.I, 2013. Ethnobotanical survey of edible wild plants in Tiv communities of Benue State, Nigeria. Journal of Natural Science Research 3, 17–23.
Stadlmayr, B., Charrondière, U.R., Eisenwagen, S., Jamnadass, R., Kehlenbeck, K., 2013. Nutrient composition of selected indigenous fruits from sub-Saharan Africa. Journal of the Science of Food and Agriculture 93, 2627–2636.
Šūmane, S., Kunda, I., Knickel, K., Strauss, A., Tisenkopfs, T., des Ios Rios, I., Rivera, M., Chebach, T., Ashkenazy, A., 2018. Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture. Journal of Rural Studies 59, 232–241.
Tardío, J., Pardo-de-Santayana, M., 2008. Cultural Importance Indices: A comparative analysis based on the useful wild plants of Southern Cantabria (Northern Spain). Economic Botany 62, 24–39.
Thomas, E., Vandebroek, I., Sanca, S., Van Damme, P., 2009. Cultural significance of medicinal plant families and species among Quechua farmers in Apillapampa, Bolivia. Journal of Ethnopharmacology 122, 60–67.
Thomas, E., Vandebroek, I., Van Damme, P., 2007. What works in the field? A comparison of different interviewing methods in ethnobotany with special reference to the use of photographs. Economic Botany 61, 376–384.
Van der Hoeven, M., Osei, J., Greeff, M., Kruger, A., Faber, M., Smuts, C.M, 2013. Indigenous and traditional plants: South African parents' knowledge, perceptions and uses and their children's sensory acceptance. Journal of Ethnobiology and Ethnomedicine 9, 78. https://doi.org/10.1186/1746-4269-9-78.
Welcome, A.K., Van Wyk, B.-E, 2020. Spatial patterns, availability and cultural preferences for edible plants in southern Africa. Journal of Biogeography 47, 584–599.
Welcome, A.K., Van Wyk, B.E, 2019. An inventory and analysis of the food plants of southern Africa. South African Journal of Botany 122, 136–179.