



# Ethnobotanical study of sweet orange (*Citrus sinensis*) and mango (*Mangifera indica* L.) varieties in Nigeria

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## Research

### Abstract

**Background:** This study was carried out to explore the indigenous traditional knowledge about the two horticultural species and their uses in seven major sweet orange and mango-producing states in Benue, Kaduna, Bauchi, Plateau, Cross River, Osun, and Oyo states.

**Methods:** The ethnobotanical data were collected using questionnaires and extensive conversation with 493 respondents grouped into 23 ethnic groups. A descriptive statistical method was used in the analysis of the collected data.

**Results:** Thirty-four mango varieties and one orange variety were identified in the local communities surveyed through a multi-stage sampling procedure, indicating a genetic diversity of mango varieties. The results also showed that among the farmers, 68% were men and 30% were women. Forty-eight percent of respondents had more years of experience in fruit farming. Among the farmers, 37% had 6 to 10 acres of mango crop and sweet orange varieties. Mango and sweet orange were primarily cultivated in mixed cropping and monoculture farming systems. Some farmers produced sweet orange varieties and mango varieties in cultural associations. The harvested mango and sweet orange fruits, leaves, and barks were mainly used for commercial, healing, and occult consumption. Informants recognized that the mango fruit, leaves and barks have been effective in treating blood pressure, diabetes I and II, malignant hypertension, malaria, typhoid, increased immune system, preventing blindness, and ringworms.

**Conclusion:** We documented farmers' indigenous traditional knowledge on the utilization of the two horticultural species, the methods of processing, administration, and ailments treated, and recorded the different mango species produced in Nigeria.

**Keywords:** Biodiversity, curing, ethnobotany, fruit tree parts, herbal medicine

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## Background

Fruit production is an important horticultural sector in the economy of the country because of the income it generates and the employment it provides. It is also amongst the most important export sectors. The two horticultural species are economically important fruit trees and widely consumed fruits in Nigeria. They very are rich in vitamin C, potassium,  $\alpha$ -carotene, calcium, carbohydrates, fibre, minerals, carotenoids, and phenolic compounds (Gómez *et al.* 2017; Liu *et al.* 2014). The antioxidants of these fruits are known to decrease the risk of cardiac disease, cancer, and viral activities (Jash and Brahmachari, 2015). The essential micronutrients and many bioactive compounds have beneficial effects on the health of consumers. They play important roles in the current context of climate change by providing shelter and habitats for animals and humans, reducing heat during dry seasons, sequestering carbon dioxide to reduce the amount of CO<sub>2</sub> in the atmosphere, and preventing erosion. They are also sources of incomes for farmers, which play substantial role in the worldwide economy as it is cultivated in many countries of the globe. The peels of Mango and orange are used to produce biofuels as alternatives to fossil fuels (Vinotha *et al.* 2023)

Ethnobotanical study allows us to better comprehend the plant genetic resources and ecosystem services, which constitute raw materials in agroecosystems. Many of these plant genetic resources have been domesticated and cultivated for the benefit of people, and distinctly characterize genetic reservoirs adapted to each local environmental condition (Gaoue *et al.* 2017; Prance, 2007; Pie *et al.* 2020).

Ross (2011) noted that ancient people of Mesoamerican Maya planted what they refer to as “forest gardens” many centuries ago; they tended to these gardens and they played crucial roles in satisfying their daily household needs, including nutrition and health. This pattern is still observed today in many cultures wherein ethnobotanical knowledge is essential for their survival. As Zarger (2002) notes, many members of such communities have some information - handed down over many generations by word of mouth - about the ambient wild, cultivated, and semi-cultivated flora in their environment. Ethnobotany has many applications in several fields of present universal concern such as biodiversity preservation and conservation, changes in climate, food and nutrition security, and human health (Pie *et al.* 2020).

According to WHO, about 80% of the world’s population - especially in rural areas - depend on herbal medicine for their healthcare needs. Unfortunately, several reasons, including globalization, aging of experienced folks/unwillingness to transmit the information, and lack of interest of younger generations, among other things means that some of this knowledge may be lost, and so ethnobotanical studies are a useful way to preserve this knowledge. This knowledge is especially important in these communities considering they are typically without access to modern healthcare because of limited access to biomedical health systems and indigency. These communities also share deep cultural ties with these plants, and so, the cultural preservation of this knowledge is essential. Finally, as Harshberger (1896) and Voeks (2017) suggested, some of this knowledge should be relevant for contemporary societies, and so these plants are increasingly adopted in the design of modern medicine, for example, the anti-malarial drug, artemisinin (Tu, 2016).

While 80% of the world’s arable land is cultivated with ten annual cereals, grains, pulses, and oil crops (Sthapit *et al.* 2012), fruit trees remain an important biological resource in the Nigerian ecosystem. Nigeria is home to a diverse array of food crops that are critical to the survival of its over 200 million inhabitants. Among these food crops in cultivation, orange (*Citrus sinensis*) and mango (*Mangifera indica*) are among some of the most economically important crops in the country. Nigeria is one of the top 10 producers of mango fruits in the world. Although the utility of the mango fruit as a food item is more prevalent, different parts of the mango tree have been used for medical purposes in the treatment of various diseases and conditions since ancient times, including the bark, leaves, roots, fruits, and flowers. Many studies have touted the benefits of these plant parts in anticancer, anti-inflammatory, antioxidant, antidiabetic, antifungal, gastroprotective, etc. properties (Ediriweera *et al.* 2017). Like the mango tree, Citrus fruits like oranges, lime, lemon, grapefruits, tangerines, etc., have been shown to have beneficial effects on human food and nutrition. Sweet oranges, one of the most important Citrus fruits, are important for both fresh markets and processing industries. In addition to their role in food and nutrition, some authors have also alluded to their health benefits, including antioxidant, antidiabetic, antibacterial, antiosteoporosis, and anti-obesity properties (Dongre *et al.* 2023) stemming from the use of different parts including the peels, young and mature fruits, flowers, and other tissue of the plant. A critical understanding of the local medicinal application of these fruits can bring more illumination to their age-old traditional usage, as well as the applicability of this knowledge in contemporary medicine. Future generations of these communities (and others) will also benefit from the preservation of this knowledge. The two horticultural important species have many benefits for human beings based on their diverse virtues. This study is carried out to ascertain the contributions of mango and sweet orange to cure diseases and their many other advantages and document

the existing varieties in the country. This information will be useful to people in treating their ailments and help breeders to embark on breeding program knowing that there is variability among these important horticultural crops in Nigeria.

The objectives of this research were therefore to explore and record the indigenous traditional knowledge about sweet orange and mango, their uses, and diversity in Nigeria.

## **Materials and Methods**

### **Nigerian climatic conditions for mango and sweet orange production**

The Nigerian environmental conditions are conducive for the production of Mango and sweet orange, which necessitates both rainfall from June to October for adequate growth and rainless conditions during the dry season from November to April, an important period for flowering and fruiting. It is reported that mango and sweet orange seedlings and trees thrive under a rainfall of 890-1,015 mm annually; and temperatures ranging from 24-37°C (Sherman and Beckman, 2003). The soil conditions and atmospheric conditions of Nigeria are very suitable for horticultural tree production including mango and sweet orange.

### **Description of the study areas**

The investigation was carried out in seven main production states in the country which produce mango and sweet orange. They include Benue, Kaduna, Bauchi, Plateau, Cross River, Osun, and Oyo states producing mango and sweet orange in the country (Figure 1). The surveyed states showed that Benue, Kaduna, Plateau, and Bauchi are within the ecological zones of the Guinea Savanna zone in the North Central part of the country while Cross River, Osun, and Oyo states are in the tropical ecological zone in the Southern part of the country.

Oyo, Osun, Ondo, Edo, and Cross River States (Figure 1) are the major mango-producing States in the Southern Rainforest region of Nigeria. Mango and sweet orange productions are supported by conducive climatic conditions and well-drained soils characterizing the tropical ecological zone. The rainforest belt experiences high temperatures with little seasonal variation. The average annual temperature varies between 25°C and 30°C, and the average annual rainfall ranges from 1,500 mm to 3,000 mm.

The Guinea Savanna zone is a transitional region between the dry Sahel zone and the more southern humid rainforest, one of the major ecological zones in Nigeria. Grass vegetation and a mixture of climatic conditions characterize the Guinea Savanna zone. Apart from these three states in the study areas, other states in the northern part of the country within the belt are Kebbi, Sokoto, Zamfara, Katsina, Kano, Jigawa, Bauchi, Gombe, Yobe, Borno, Taraba, Adamawa, and parts of Niger States. The zone is characterized by a semi-arid climate with a dry season (from October to May) and a wet season (from May to October) every year. The average annual rainfall varies between 800 mm and 1,200 mm, permitting the germination and development of grasses, shrubs, and dispersed trees. The vegetation in these areas includes the presence of acacias, big grasses, baobab trees, and shea trees. Apart from this vegetation, farmers intensively grow the following crops maize, groundnut, cowpea, millet, cotton, sorghum, and rice and sweet orange, mango, guava, avocado, and banana, among many others.

The major languages speak in the study areas are Yoruba in Osun and Oyo; Efik, Bekwarra, and Ejagham in Cross river; Tiv, Idoma, and Igede in Benue state; Amo, Angas, Aten, Bada, Berom, and Boghom in Plateau state, Hausa, Gbagyi, Adara, Ham, Atyap, Bajjuu and Agworok in Kaduna, Chadic, Jimbu, Kariya, Mburku, Diri, Pa'a, , Siri, Tsagu, and Warji in Bauchi. Christian, Islam and tradition beliefs are the main religions in the country. We are endowed with natural resources, agriculture and business but some people are living in wealth and prosperity, while others are in abject poverty and inequality.

### **Sampling techniques and data collected**

Multi-stage sampling technique was used to select respondents for this study. The first stage of the multi-stage sampling technique involved the purposive selection of seven main mango and sweet orange-producing states including two states in South West, four states in the North, and one state in the South-south of Nigeria. The second stage involves the purposive selection of the 28 major sweet orange and mango-producing Local Government Areas (LGA) in the selected States. The third sampling stage was the use of a simple random sampling technique to select 4 villages from each of the LGAs, to give a total of 28 villages. In the fourth stage, the snowball sampling technique was used to select 80 mango and sweet orange farmers from each of the selected villages. Twenty farmers were randomly selected from each of the four rural communities (Table 1). The surveyed farmers were both men and women and their ages ranged from 18 years to above 65 years. Indigenes very fluent in each dialect were used to collect data. These mango and sweet orange samples were marked with their local names

and English names from the place of collection. The English names of these species were confirmed with the help of 5 literate people in the areas of collection, the local elders, and the horticulturists.

Some of the data collected include the following; What are the local names? What are the uses or traditional uses (food, animal forage, condiments, beverage, construction, medicine) of these important tree plants? Which diseases or ailments do you treat with these plants? Which parts (leaves, roots, barks, flowers, fruits, seeds, stems, exudate) of the tree plant species are used for medicinal purposes? Are the parts used to cure the diseases? Is mango or orange the subject of symbolic beliefs? Are there any myths about it? What is the way or mode of preparation? How do you administer it to the sick?

The collected varieties were given accession numbers and deposited at the Crop Production unit, Bowen University, Iwo, Nigeria.

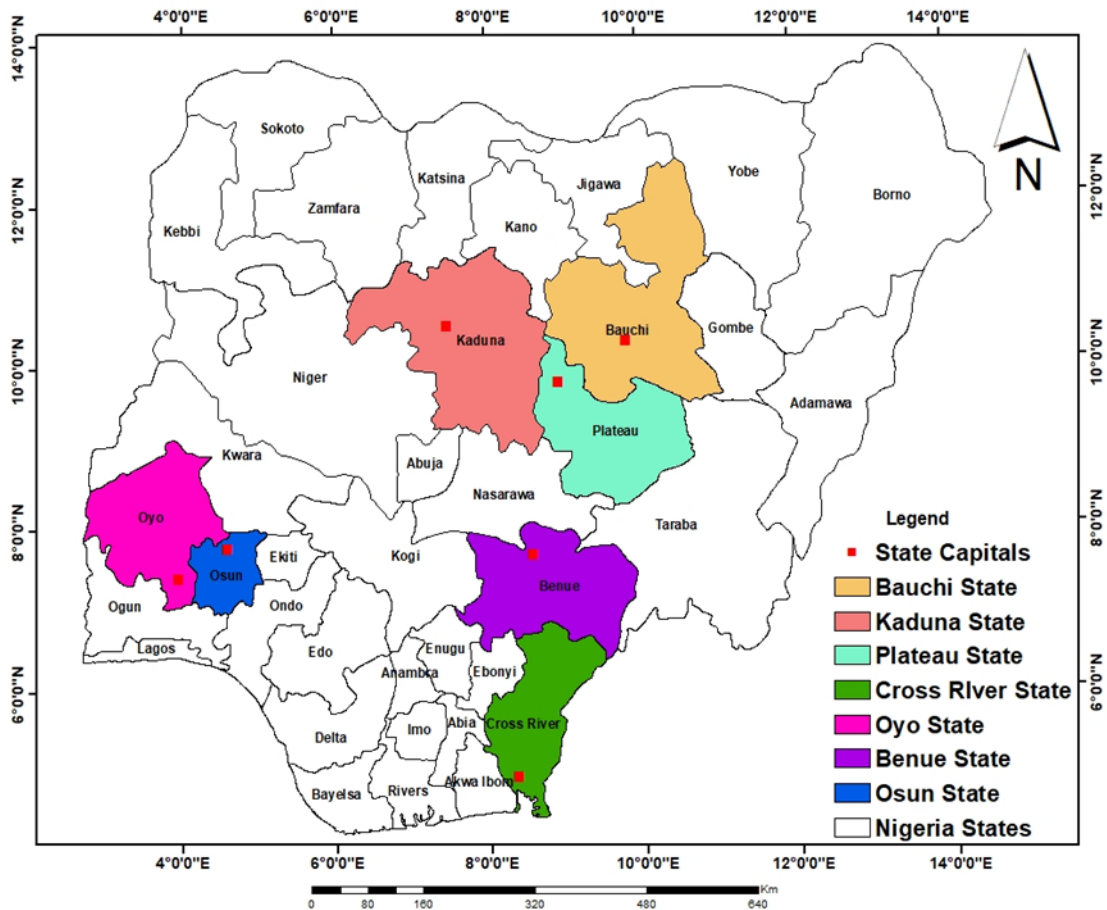


Figure 1. Map of Nigeria indicating the study areas

Table 1. Distribution of the questionnaire across the study areas

Ecological Zone	Name of State	LGA	Names of villages	Number of respondents	Number Retrieved	Cumulative Total Retrieved
Guinea Savanna Ecological zone	Benue	Gboko	Luga	80	72 (90.0%)	72
		Ukum	Kyado			
		Kon shisha	Gungu			
		Ukum	Ukukal			
	Plateau	Jos North	Kuru	80	68 (85.0%)	140
		Bassa	Jingre			
		Ryom	Tahoss			
		Bassa	Ruguba			
	Kaduna	Rigacikun	Kawo	80	69 (86.25%)	209
		Gaza	Dumbi			

	Bauchi	Giwa	Zaria	80	75 (93.75%)	284
		Zango	Chikun			
		Akaleri	Futuk			
		Bogoro	Lusa			
		Dambam	Zaura			
		Ningi	Balma			
Rainforest Ecological zone	Cross River	Boki	Bukalum	80	61 (76.25%)	345
		Biase	Iko Esa			
		Yakuur	Agoi Mbami			
	Oyo	Surulere	Oko	80	75 (93.75%)	420
		Ogbomoso North	Pakiotan			
		Ogo-Oluwa	Pontela			
		Afijio	Fiditi			
	Osun	Ayedire	Olupona	80	73 (91.25%)	493
		Iwo	Toto			
		Egbedore	Iwoye			
		Ejigbo	Ifeodan			
					560	493(88.03)

#### Profile of respondents

In the current study, a total of 493 respondents, including 341 men, and 152 women, and 12 did not disclose were interviewed using 560 questionnaires, face-to-face interviews, and one group discussion per village (Table 2). The farmers were of different educational backgrounds and various age groups. The age of the informants ranged from 18 years to above 65 years and the distribution across the various age groups appears evenly distributed; thirty-four informants were 18 years old; 259 respondents were between 19 and 45 years old, and 112 informants were above 65 years old. The older people gave useful and important information about the medicinal uses of mango and sweet orange species. About half of the respondents were reported to have been involved in the cultivation of these crops for more than 15 years, indicating their reliance on the crops. The fruits mango and orange species reported are used for consumption or commercial purposes, suggesting that the respondents relied on these plants for food security directly and indirectly.

Eighteen percent of informants had less than 1 acre of farm size for mango and orange production; 15% had 2-5 acres; 37% had 6 to 10 acres of land for the two horticultural species, and 29% of respondents produced mango and sweet orange on land areas greater than 10 acres. Mixed cropping remains the main cropping system used in all the states under investigation: 69% of informants adopted the mixed cropping system while 25% of respondents used a mono-cropping system (Table 2).

Table 2. Respondents detail

Variables	Categories	Number of Informants	Percentage
Gender ratio	Men	341	69
	Women	152	31
Age	18	34	7
	19-45	259	52
	46-65	88	18
	>65	112	23
Educational Background	No formal education	92	17
	Basic education	50	10
	Secondary education	105	21
	Tertiary education	246	50
Years of fruit farming	>5 years	104	21
	6 to 10 years	46	9
	11 to 15 years	109	22
	> 15 years	234	48

Size of farm	< 1acre	89	18
	2-5acres	72	15
	6 to 10 acres	180	37
	> 10 acres	142	29
Reasons for fruit farming	Consumption	115	23
	Commercial purpose	378	77
Cultural practices	Monocropping	123	25
	Mixed	339	69
	No Data	21	4

### Data Analysis

The data were analyzed using descriptive statistics, relative frequency citation, and preference ranking. Ethnobotanical data were organized using Microsoft Excel spreadsheets.

The ethnomedicinal data was assessed using a relative frequency citation (RFC) index (Vitalini *et al.*, 2013):

$$RFC = FC/N \quad (0 < RFC < 1)$$

Where, FC is the frequency of citation; N is the total number of respondents participating in the study, without considering use categories into account.

## Results

The investigation collected an amount of significant data on the informants' socio-demographic characteristics, botanical aspects, and medicinal uses of the mango and sweet orange.

### Diversity of mango and citrus species, their usage, and ethnic groups associated

The ethnic groups were recorded, the number of varieties of sweet orange species identified and their local names are presented in Table (3). We recorded only one variety of sweet orange across the seven different states sampled. However, the different ethnic groups had different local names given for the sweet orange plant as shown in Table (3).

We also inquired about the different mango varieties cultivated across the different ethnic groups in the mango-growing states in the country. The ethnic groups, varieties of mango, and their local names are presented in Table 4. Several mango varieties were recorded during the investigation suggesting a high diversity of mango in Nigeria. For instance, in Benue State, at least 12 different mango varieties were cultivated across the sampled ethnic groups in the state. Although there were intersections in the cultivated mangoes, the different ethnic groups appeared to have preferences for certain varieties. Farm fruit juice and yogurt were produced from a blend of mango, sweet orange, and guava only grown locally in Kaduna. This pinpoints the strong relationship between ethnic groups and the horticultural species. In some cultures, it is forbidden to pluck mango and orange from the trees especially when dedicated to a god. People do abide by the interdiction for fear of attracting curses and spells to themselves. Mango trees are parts of forest vegetation where the gods of the areas are worshipped. The results also showed that people don't get hungry during mango fruit production, indicating that it serves as food. Mango fruits are used to settle differences among people in rural areas.

Table 3. Ethnic groups surveyed, number of varieties of sweet orange identified, and local names

State	Ethnic group	Local names of orange varieties /Voucher No
Benue	Tiv	Alum/BU-001
	Idoma	Alemu/BU-002
	Igbede	Ugboji/BU-003
Cross River	Ugep	Usokolo wo-gai-yi/BU-004
	Efik	Inine Sokoro/ BU-005
	Bekwara	Ulom/ BU-006
	Bette	Urom/BU-007
	Becheve	Egbenga/BU-008
	Yala	Oromu/BU-009

	Utanga	Ogbenge/BU-010
Kaduna	Gwari, Atyap, Kamantan, Ham, Adara, Gbagyi, Berom, Bajju and Kogoro	Lemu/BU-011, lamu/BU-012, alemu BU-013, malemo/BU-014
Osun	Yoruba	Osan/BU-015
Oyo	Yoruba	Osan/BU-016
Plateau	Kuru	Lemu/BU-017
	Tahoss	Lemu/BU-018
	Jengre	Alemmo/BU-019
	Ruguba	Lomu/BU-020
Bauchi	Bolewa	Lemu dadi/BU-021
	Butawa	
	Warji	
	Kanuri	
	Zaar	

Table 4: Ethnic groups surveyed, number of varieties of mango identified, and local names

State	Ethnic group	Varieties identified/Voucher name	Local names
Benue	Tiv	Chugbev/BU-022, Peter/BU-023, Hindy/BU-024, Johnbul/BU-025, and Jully/BU-26	Mango
	Idoma	Chugbev/BU-022, Opioro/BU-027, Peter/BU-023, Hindy/BU-024, Ofu mango/BU-028, Johnbul/BU-025, Utochi/BU-029, kpapieka/BU-030, Kerosene/BU-031, Aba mango/BU-032 and Jully/BU-26	Aja
	Igbede	Chugbev/BU-022, Peter/BU-023, Hindy/BU-024, Johnbul/BU-025, and Jully/BU-26	Omangoro ima, omangoro ori, omangoro agrik
Cross River	Ugep	Kerosene/BU-031, touch/BU-033, plug/BU-034, Akpur/BU-035, Opiolo/BU-036 and opioru/BU-037	Isokoro mango
	Efik		Isokoro mango
	Yala		Oromu mango
	Bette		Urom mango
	Becheve		Oranchi mango
	Bekwara		Uliom mango
Kaduna	Gwari, Atyap, Kamantan, Ham, Adara, Gbagyi, Berom, Bajju and Kogoro	Kaduna-Abash/BU-038, Tommy Atkins/BU-039, Cherry/BU-040, Kesar/BU-041, Sindhri (honey mango)/BU-042, Durshea/BU-043, Peter/BU-023, Jully/BU-26	Jan Baki, Binta suga, Mai waringawasa, Bakin aku, Dan aure, Paparanda, Mangoro maijijiya, Gwaiwan rago, and Dan kwallo
Osun	Yoruba	Kerosene/BU-031, Olokun/BU-044, Ojo Purple/BU-045, Ogbomosho mango/BU-046, and Ojo Pink/BU-047	Mango
Oyo	Yoruba	Ogbomosho mango/BU-046, and Seminary Ogbomosho big mango/BU-048, Kerosene/BU-031, Olokun/BU-044, Agege Kent/BU-049, Alfonso/BU-050, Edward/BU-051, Harden/BU-052, Johnbul/BU-025, Julie/BU-053, Lipen/BU-054, Madoe/BU-055, Palmer/BU-056, Peach/BU-057, Saigon/BU-058, Tommy Atkins/BU-039 and Uno/BU-059	Mango
Plateau	Boki	Julie/BU-053, Paul/BU-060, Peter/BU-023, Cherry/BU-040	Buzeb okagara
	Obudu	Julie/BU-053, Paul/BU-060, Peter/BU-023, Cherry/BU-040	Umugul
Bauchi	Bolewa		Mangwaro

	Butawa	Kitchen butterfly/BU-061, Julie/BU-053, Paul/BU-060, Peter/BU-023, Cherry/BU-040,	
	Warji		
	Kanuri		
	Zaar		

#### Methods of processing, administration, and ailments treated

Multi-herbal preparation methods used for mango and sweet orange to cure diseases are presented in Table 5. 342 respondents used parts of mango and sweet orange to treat diseases, the frequency of citation and relative frequency of citation are given in Table 5. The results showed that the respondents had a wide range of uses for the mango and sweet oranges. The respondents reported frequently relying on these crops to cure many diseases including malaria (32% in Oyo state), typhoid (27% in Kaduna state), ringworm (27% in Kaduna state), blood pressure (30% in Osun state), and diarrhea (25% in Bauchi state and 23% in Plateau state). They reported typically using leaves and barks of the trees in the preparation of herbal concoctions that were consumed orally. Some used orange peels as pesticides against pests around the houses. Some respondents revealed the mode of preparation of mango leaves and bark to treat and cure blood pressure, malignant blood pressure, diabetes I, and diabetes II. The most commonly used method of preparation was boiling (32% in Oyo state). The most communal method of administration of concoctions or herbal recipes was drinking (32% in Oyo state). The mode of preparation and administration of mango concoction is as follows: collection of 6 to 12 of dried mango leaves under mango trees, washed thoroughly, and then placed in a pot with water. It should be boiled for 20 minutes. A cup of warm liquid from the pot taken in the morning and in the evening relieves systemic arterial pressure blood pressure or hypertension. But in the case of malignant hypertension, mango leaves and mango are mixed in a pot with water after which it is boiled. A cup in the morning and evening drastically reduces malignant blood pressure, with many respondents convinced of its effectiveness in preventing a reoccurrence. In the same vein, Figure 2 shows some of the uses of mango and sweet orange. While the crop is predominantly used as food, many of the respondents still reported relying on them for medicine as well in the absence of immediate access to medical facilities. 80% of respondents used mango and orange as foods, while 20% used them as medicine and a few (10%) used them for other purposes including animal feeds and beverages. Responses showed that mango and sweet orange fruits were used in the households during festive periods, wedding ceremonies, graduations, anniversaries, royal palace ceremonies, and other events to entertain the guests.

Some respondents in the areas of study recognized that mango leaves have been effective in treating blood pressure, diabetes I and II, malignant hypertension, malaria, typhoid, increased immune system, and prevent blindness and ringworms. In the case of malignant hypertension treatment, mango leaves and mango are mixed in a pot with water after which it is boiled. A cup in the morning and evening drastically reduces the malignant blood pressure, blood disorders, and it will never rise again. The same preparation can also be used to cure both diabetes I and diabetes II, and there is total regeneration of the pancreas. Sore throats are treated by drinking water from boiled mango bark as reported by the informants.

The symbolic and mythical aspects of mango and sweet orange trees are presented in Figures 3 and 4. The symbolic aspects of mango and sweet orange reside in the fruitfulness, prosperity, love, appetite, and solid relationships of people, while the mythical aspect of mango and sweet orange incarnates the presence of a god and the return of ancestors to their homes, deliverance of a possessed person by an evil spirit. Eighty percent (80%) of respondents in Benue strongly believe in the symbolic and mythical aspects of mango and sweet orange, while only a few respondents in the other states had such belief. Some informants used the trees to symbolize members of the community who were deceased. The trees were also used to symbolize significant events. This served as a strong reminder of the person or the events in the family or community. This practice was mostly peculiar to Benue State and was not commonly reported in the other sampled states.

Table 5. Multi-herbal preparation methods used for mango and sweet orange to cure diseases

State	Botanical name	Plant parts used	Ailments treated	Preparation	Administration	FC	RFC
						342	100
Benue	<i>Citrus sinensis</i>	Leaves	Malaria	Boiling	Drinking	20	5.85
	<i>Mangifera Indica</i>	Leaves and bark	Malaria	Boiling	Drinking	20	5.85
Cross River	<i>Citrus sinensis</i>	Leaves	Malaria	Boiling	Drinking	25	7.31
	<i>Mangifera Indica</i>	Leaves and bark	Malaria	Boiling	Drinking	25	7.31



Kaduna	<i>Citrus sinensis</i>	Leaves	Malaria	Boiling	Drinking	25	7.31
	<i>Mangifera Indica</i>	Leaves, bark	Typhoid, Ring worm	Boiling	Drinking	27	7.90
Osun	<i>Citrus sinensis</i>	Leaves, Orange peel	Malaria, Pesticide	Boiling, spread around the house	Drinking, spreading	20	5.85
	<i>Mangifera Indica</i>	Leaves and bark	Malaria, blood pressure, tumors	Boiling, concoction	Drinking	30	8.77
Oyo	<i>Citrus sinensis</i>	Leaves	Malaria Anaemia	Boiling	Drinking	18	5.26
	<i>Mangifera Indica</i>	Leaves	Malaria	Boiling	Drinking	32	9.36
Plateau	<i>Citrus sinensis</i>	Leaves	Malaria, sore throats	Boiling	Drinking	27	7.90
	<i>Mangifera Indica</i>	Leaves and bark	Diarrhea Malaria	Boiling	Drinking	23	6.73
Bauchi	<i>Citrus sinensis</i>	Leaves	Malaria	Boiling	Drinking	25	7.31
	<i>Mangifera Indica</i>	Leaves and bark	Diarrhea Malaria	Boiling	Drinking	25	7.31

RFC=relative frequency citation FC= frequency citation

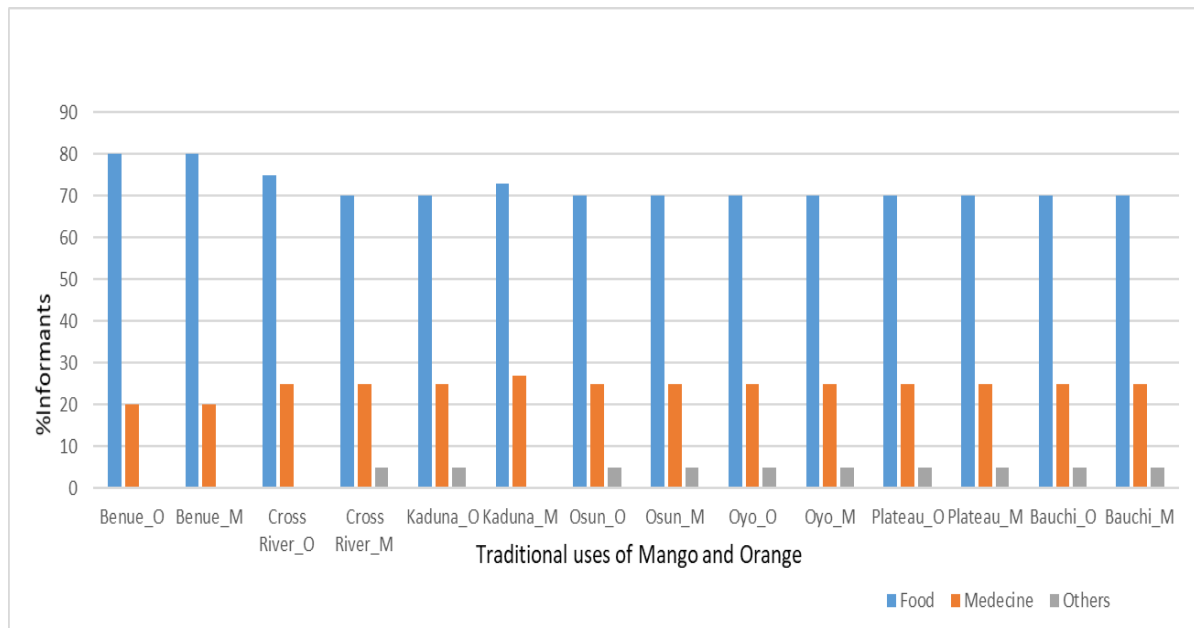


Figure 2. Different usages of mango and sweet orange; O=orange, M= mango

## Discussion

Horticultural crops are medicinally, nutritionally, and economically important fruit trees in the world. They serve members of the communities where these crops are cultivated as the members rely on them for food, medicine, and sustenance through commercial activities. These age-old crops have continued to sustain the human and animal populations that have relied on them through the ages. As with many other crops, there is a high diversity in the types cultivated including traditional cultivars, improved cultivars, crop wild relatives, and other wild plant species (Rymbai et al. 2014; Ezin et al. 2021; Salgotra and Chauhan, 2023). Their conservation in situ and ex-situ and sustainable use are key to ascertaining their production and meeting people's needs, and the challenges of environmental conditions and climate change (FAO, 2009).

Our analysis also revealed a diversity in the different varieties of mango cultivated in the mango-producing states. Some of the varieties recorded include Ogbomosho mango, Seminary Ogbomosho, big mango, Kerosene, Olokun, Agege Kent, Alfonso, Edward, Harden, John Bull, Julie, Lipen, Madoe, Palmer, Peach, Saigon, Tommy Atkin, Uno, Kaduna-Abash, Tommy Atkins, Cherry, Kesar, Sindhri (honey mango), Durshea, Peter, July, Kerosene, touch, plug, Akpur, Opiolo and opioru, Chugbev, Opioro, Peter, Hindy, Ofu mango, Johnbul, Utochi, kpapierka, Kero mango, Aba mango, etc., Several species of mango and sweet orange mango have been domesticated and adapted in the tropics and subtropics. One explanation is that these are a landrace and/or bud-sport of the landrace that have been passed down through generations. Ascertaining the origin and genetic diversity of these cultivated varieties will require genetic analyses, but the sampled communities were convinced about the importance of preserving the landraces they cultivated knowing that they had been passed down through many generations (Malik et al. 2012; Ravishankar et al. 2000; Rey et al. 2006).

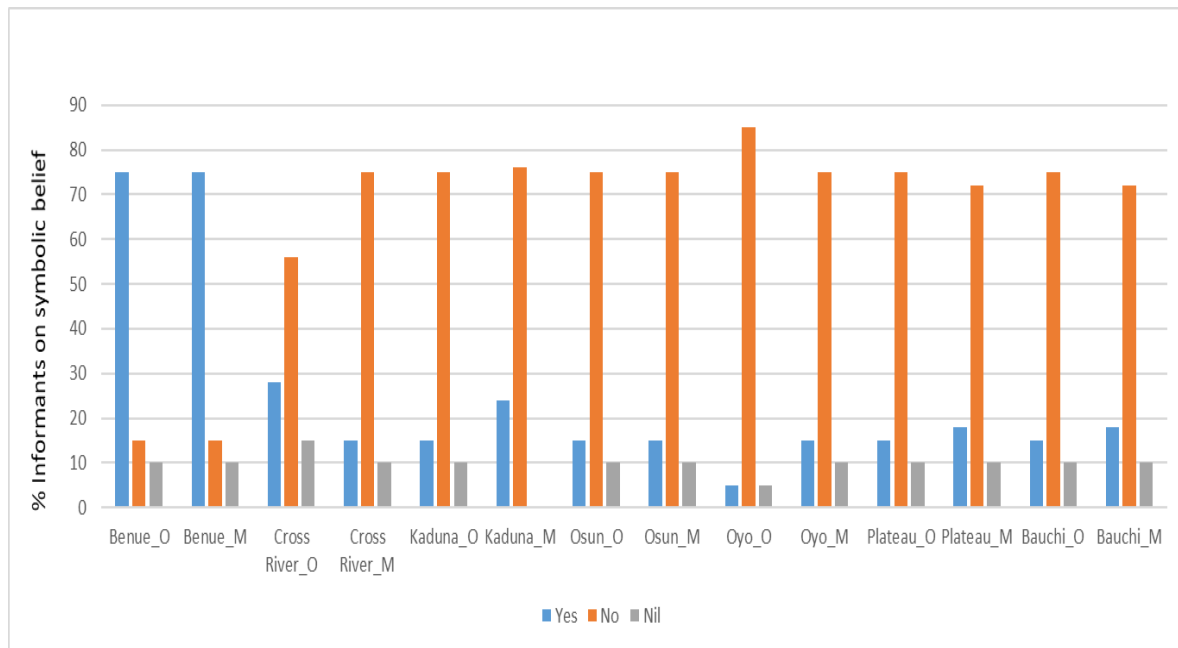


Figure 3. Symbolic belief on mango and sweet orange species; O=orange, M= mango

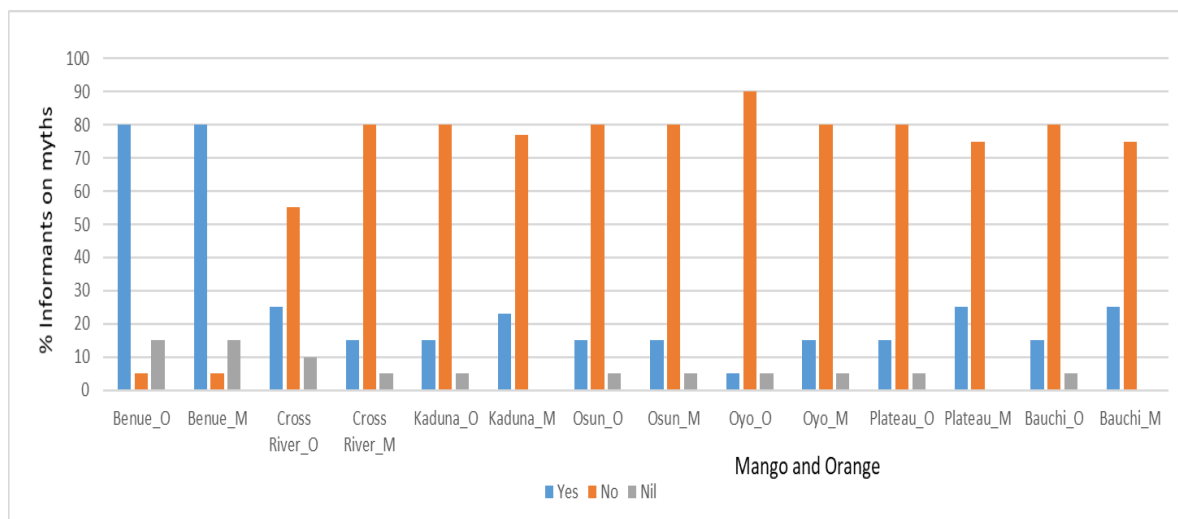


Figure 4. Mythic belief about mango and sweet orange species; O=orange, M= mango

The ethnobotanical surveys allow us to understand the relationship between human beings and plant species (Fatur 2019; Petran et al. 2020; Liu et al. 2021; Mulyanto et al. 2023). We can infer indigenous knowledge of mango and sweet orange species based on their current utilization and benefits to people who cultivate and use them (Iwu 2002). Patra et al. (2018) reported that the earliest ethnobotanical investigations were basically on how other ethnic groups used the plant species but did not take into consideration their own. It focused on the surveys of traditional and medicinal uses of species by

indigenous beliefs and principles. Holistically, ethnobotanical studies involve the recording of different species and the rapport between plant and ethnic groups and the benefits associated. Regrettably, there is some useful information that are getting lost due to many reasons such as the aging of experienced people, worldwide integration, refusal to transfer important secrets, and lack of interest of younger generations, and thus ethnobotanical investigations are the best way for knowledge conservation and sustainability.

There was a high diversity in the number of mango and sweet orange trees of different cultivated in the producing states included in this survey. This indicates the importance of species in the lives of the people. This agrees with the work of Metusala et al. (2020) who reported the presence of mango trees all over Indian places such as village settlements, wild forests, royal gardens, farms, reliefs of Borobudur Temple, etc. Similar results were obtained by Mulyanto et al. (2023) who recorded 63 names of mango species in Indonesia.

Mango and sweet orange are used as food, medicine, beverage, animal feed in Nigeria (Ogunbode et al. 2024). The different purposes of mango and orange used are capital importance as contributors to food and nutrition security and health care of the people in the areas of study and the entire communities of Nigeria. It is extensively used as raw materials in the food industry for mango and orange juices. It helps to digest, sort out heart and eye issues, and to maintain fine hairs and skin. They are produced for fresh fruits, dried fruits, juices and for many other products. Mature fruits are used to refresh the body, soul and spirit. According to Shah et al. (2010) mango fruits is regarded as revitalizing and freshening horticultural fruit crop. Mulyanto et al. (2023) have reported that *Artocarpus heterophyllus*, *Citrus* sp., *Salacca zalacca*, and *Musa* sp are used as dessert during celebratory atmosphere in the royal palaces of Indonesia. Many ailments have been treated using mango leaves and orange parts as recorded in the areas of studies. The decomposition of the dead leaves of these horticultural species aids in the fertilities of soils.

It is also observed that different ethnic groups appeared to have preferences for certain varieties of mango. The farmers explained this through certain characteristics of mango loved by the communities, which include size, color, taste and what their fathers passed down to them. They further explained that they have been eating them from their childhood and have become part of them. These preferences could also be due to the adaptability and stability of those varieties to their environmental conditions. World Bank (2005) reported that farmers mostly rely on their traditional varieties because of socio-economic and natural factors. In the same vein, Asrat et al. (2010) and Acheampong et al. (2018) showed that farmers will not like high yielding varieties except they see some important characteristics of their choice in them.

Traditional medicine or indigenous medicine has been useful for human beings to keep the body in good health, to prevent, detect, and cure physical and emotional sickness inversely from modern medicine (WHO, 2012). Responses from the respondents in this survey buttresses this viewpoint considering that up to 20% of the respondents relied on the crop for medicine and in curing a range of ailments. While the preparation appeared simple (mostly boiling), the respondents reported that the resulting concoction was effective in curing and or managing a range of common ailments in these communities. Shah et al. (2010) reported that mango species possess anthelmintic, anti-diarrheal, anti-parasitic, anti-allergic, anti-tumor, antipyretic, anti-HIV, antispasmodic properties.

Paul and Cox (1995) reported that orange leaves are prepared with the corosol leaves, and *Annona muricata* leaves to reduce the temperature of a fever from a cold. The patients use the water from the boiled leaves to bathe. The patients also use the boiled leaves to massage their bodies and are asked to sleep straight away after the treatment.

The informants revealed that there are symbolic beliefs and myths with the use of the different parts of mango trees. Some informants used the trees as a symbol for a dead person or events to always remind themselves of the person or events and to tell future generations about it. Mulyanto et al. (2023) reported that mango trees are associated with religious importance and connotations in Indian religion. Mango tree is masquerade as Prajapati God in Hinduism religion, meaning the creator of the universe, its leaves are used to embellish and beautify the rooms during the wedding whereas its woods are used for burial ceremonies (Rana et al. 2016). Goddess Lakshmi is represented in a pot mixed with water coconut and mango leaves (Chauhan and Chauhan 2019). In the same vein, it has been reported that Javanese plants are also used in symbolic belief and mango trees as parables in Indonesia.

## Conclusion

The ethnobotanical study of seven states' mango and sweet orange shows these states to be very rich in cultivated variety and, recipes of mango and sweet orange-based remedies. People use traditional plants to maintain their health. Informants used the trees as a symbol for a dead person or events to always remind themselves of the person or events and to tell future generations about it. Mango leaves and barks have been used to successfully treat malaria, blood pressure, diabetes I and II, malignant hypertension, malaria, and typhoid, increase the immune system, and prevent blindness and ringworms. Through this study we documented farmers' knowledge of the various utilization, and production of sweet orange and mango, and categorized the varietal diversity of mangoes in Nigeria. These results could serve as benchmark data to study further the genetic diversity and the conservation of mango and sweet orange varieties to avoid genetic erosion. People can make use of the availability of these horticultural species in Bowen University and those who were not aware of the medicinal benefits of mango and sweet orange could start using them to cure diseases from the time of the publication of this piece of work. There is a diversity of these important horticultural species in Nigeria.

## Declarations

**List of abbreviations:** SC - Santa Catarina State; MT - Mato Grosso State

**Ethics approval and consent to participate:** Each participant was informed of the conditions for participating and validated a consent form. The research was carried out in conformity with the Declaration of Belmont Report (1979) Ethical Principles and Guidelines for the Protection of Human Subjects of Research. <https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/read-the-belmont-report/index.html>. The research was approved by Bowen University Ethics committee with Ethical Approval Number (EAN) BUI/COAES/AGR/0002.

**Consent for publication:** People who participated in this study gave their prior informed consent for the publication of the article.

**Availability of data and materials:** All the supporting data available in the article

**Competing interests:** The authors declare that there are no conflicts of interest in this article.

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**Author contributions:** Vincent Ishola Esan: conceived the idea, designed experiments, collected data, data analysis, and wrote the manuscript. Timothy Oyebamiji Ogunbode, Oladotun Matthew Ogunlaran, Modupe Helen Ayegboyin, and O. O. Omilani: Performed experiment, data collection, and reviewed the manuscript. Titilayo E. Sangoyomi, and John A. Akande reviewed and edited the manuscript.

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