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Chemical composition of indigenous wild herbs, spices, fruits, nuts and leafy vegetables used as food

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Abstract. Thirty wild fruits, nuts, herbs, spices and leafy vegetables were characterized and their chemical composition determined. Some of them were not only used for food, but for medicine in minor aliments by the natives. Results of the proximate analysis showed that on dry weight basis, the crude protein content ranged from 4.6 to 22.1 percent for spices and herbs, 3.2 to 43.1 percent for fruits and nuts, and 15.9 to 35.7 percent for leafy vegetables. The fat (ether extract) ranged from 7.5 to 36.0 percent for spices and herbs, 1.8 to 72.6 percent for fruits and nuts and 10.6 to 22.6 percent for leafy vegetables. Total carbohydrate content ranged from 34.6 to 71.9 percent for spices and herbs, 11.3 to 76.1 percent for fruits and nuts, and 24.6 to 51.4 percent for leafy vegetables. The wild fruits, nuts and leafy vegetables are high in ascorbic acid (Vitamin C.) Ascorbic acid content ranged from 18 mg/100 g dry sample to 113 mg/100 g sample for fruits and nuts, and 23 mg/100 g to 232 mg/100 g sample for leafy vegetables. The levels for peroxide value and free fatty acids (as percent oleic acid) of the spices are generally low indicating good storage stability of these plant materials. The flavour imparting essential oils (as percent oleoresin) content of the spices/herbs were fairly high and ranged from 0.1 to 5.2 percent.

Introduction

In Nigeria, many fruits, spices, herbs and leafy vegetables used as food are obtained from the wild where there may be as many as one thousand species. To date, little attempt has been made to domesticate and cultivate these species despite the fact that they constitute a large proportion of the daily diet of the rural dweller. The implication is that several of these species could become extinct due to deforestation menace and the reluctance of people to venture into the forest to harvest them. The net result is that some of these crops such as 'utazi' (*Gongronema ratifolia*) 'uziza' (*Piper guinenses*) 'ogorima' (*Macsobtyra baterri*) are difficult to find in urban markets.

Indigenous spices and herbs are used generally to prepare pepper soups which are hot and spicy especially during the cold season. In addition, they are

very important in the diets of post partum women during which time it is claimed that these spices and herbs aid the contraction of the uterus. Spices and herbs are generally known to possess antibacterial and antioxidant properties [5, 9]. It is likely that indigenous spices and herbs found in Nigeria may also possess these properties.

Leafy vegetables and fruits found in the wild also contribute immensely to the diet of Nigerians. Leafy vegetables contribute significant amounts of ascorbic acid, protein, minerals (particularly calcium) and carbohydrates to most diets [18]. Leafy vegetables obtained from the wild include 'oha' (*Pterocarpus soyauxii*) 'okazi' (*Gnetum ofericanum*) 'nturukpa' (*Pterocarpus santalinoides*) 'atama' (*Hernsia crinata*).

Fruits and nuts which are found in the wild include African walnut (*Tetracarpidium conoforum*) 'udara' (*Crysophyllum albidium*) 'achicha' (*Diospyros monobuttensis*) 'ube okpoko' (*Dacryodes edulis*). These fruits also provide nutrients especially ascorbic acid and minerals. Fruits in addition to being eaten raw can also be processed into fruit drinks and spreads such as jams.

Considering the importance of these wild fruits, vegetables, spices and herbs in the diet, it is therefore, necessary to investigate the nature and properties of these spices. The aim of this study was to investigate the chemical composition of some spices, herbs, leafy vegetables and fruits obtained from the wild, determine the essential oil content of spices and herbs and investigate the storability of processed spices by determining their peroxide value and free fatty acids.

Materials and methods

Test plant materials included 17 fruits and nuts, 7 spices and herbs and 6 leafy vegetables. They were harvested from various forests in Ikwerre Local Government Area of Rivers State, Nigeria.

The wild fruits, nuts, herbs, spices and leafy vegetables were washed and each sample divided into two sets. One set was shredded into small pieces and dried at 55 °C in a hot air oven for 72 h. After drying, the samples were ground in a mortar and stored in airtight glass jars in the refrigerator until they were required for analysis. The second set of samples were also shredded into small pieces and used for the determination of moisture, total carbohydrate and ash content. Samples used for ascorbic acid determination were harvested on the day of the analysis.

Moisture, crude fat (ether extract), crude protein, fibre and ash content were determined according to the AOAC [4] methods. Total carbohydrate was determined by the anthrone method [13]. Ascorbic acid determination was by the method [13] while mineral and peroxide value were determined by AOAC [4] methods. Essential oils were determined as percentage oleoresine [7].

Results and discussion

Table 1 shows the crude protein, fat and total carbohydrate contents of the test samples. The spices and herbs contained appreciable amounts of these basic nutrients. Some fruits and leafy vegetables are good sources of carbohydrate while there is relatively little protein or fat in most fresh fruits and leafy vegetables.

From the results shown (Table 1), the crude protein content of the leafy vegetables was high, with *Gongronema ratifolia* having the highest value of 35.7 percent as against those indicated by other workers [15] which showed that leafy vegetables are low in protein. Leafy vegetables with high crude protein content may be used as cheap sources of protein. Some of the wild fruits and nuts which include *Artocarpus altilis* have high protein content, similar to that reported [1] which gave the crude protein content of defatted *Artocarpus altilis* samples as 164.0 g/kg dry weight. He suggested that *Artocarpus altilis* could be a good source of protein due to its high content of essential amino acids.

The total carbohydrate content of the indigenous wild plants analysed are high with *Artocarpus altilis* having the highest value of 76.1 percent dry weight. This agrees with earlier research [8, 18]. The species and herbs are also rich in total carbohydrate as reported by others [11]. Carbohydrate (starches) have several applications. In most developing countries, starches from cereals, roots and tubers constitute major energy giving food. Some of these indigenous wild fruits, nuts and leafy vegetables can supplement the energy giving foods since they also may be good sources of carbohydrates.

The fat content of most of the indigenous wild food plants analysed are quite low, with the exception of a few which includes some herbs, and fruits. *Dacryodes edulis* which is a very oily pulpy fruit has the highest ether extract value of 76.6 percent dry weight. The fat contents of leafy vegetables agreed with the literature [14, 15]. The authors gave a range between 1.5 to 18.5 percent with waterleaf (*Talinum triangulare*) having the lowest fat content (1.5 percent) while Indian spinach (*Basella alba*) had the highest (18.5 percent). The ether extract content of spices and herbs is low except for *Xylopia aethiopicum* with 36.0 percent. This result is comparable to those reported in the literature [17] which had values ranging from 0.62 percent for onion powder to 45.2 percent for mace.

Table 2 shows the ascorbic acid content of the fruits, nuts and leafy vegetables. Fruits and leafy vegetables are particularly rich in ascorbic acid. The ascorbic acid content of these plant materials is of interest to the community where there is still shortage in vitamin consumption. Fruits, nuts and leafy vegetables also provide most of the indigestible dietary fibre in our food and assist the evacuation of waste from the colon thereby preventing constipation.

Other workers [16, 10] have comparable results from other Nigerian

Table 1. Proximate composition[a] of thirty indigenous wild spices, herbs fruits and leafy vegetables (% dry-weight basis) ± SD

S/NO	Sample (local or common name)	Moisture %	Ash %	Fat %	Protein %	Carbohydrate %	Fibre %
1.	*Allium vativum* (Garlic)	53.0±1.5	10.7±0.5	7.5±0.8	22.1±0.8	55.1±1.3	3.8±0.5
2.	*Brachystecia nigerica* (Achi)	13.9±0.3	4.3±0.9	16.3±1.2	4.6±0.8	71.1±2.3	3.5±0.5
3.	*Piper quineense* (Aziza seeds)	16.9±0.8	7.7±0.9	20.5±2.8	16.9±1.5	49.9±2.1	2.8±0.8
4.	*Tetrapleura tetraptera* (Achilicha)	30.3±1.2	2.2±0.5	13.6±1.5	8.1±1.3	68.1±3.2	6.6±0.8
5.	*Xylopia aethiopicum* (Okada)	21.1±1.4	7.9±0.7	36.0±2.8	14.9±1.2	34.6±2.2	6.5±0.8
6.	*Zingiber officinalis* (Ginger)	16.1±0.8	9.6±0.9	12.1±1.1	19.9±1.8	53.1±2.5	4.5±0.9
7.	*Monodora Miristica* (Ehuru)	20.9±0.3	8.0±0.7	25.7±1.8	14.9±1.1	44.4±2.3	5.4±0.8
8.	*Artocarpus altills* (African bread fruit)	4.8±0.1	1.9±0.2	1.8±0.3	18.7±1.3	76.1±3.5	1.1±0.3
9.	*Cola pachycupa* (Oyiya)	64.5±1.0	2.9±0.3	5.7±0.9	16.3±1.3	70.3±3.8	2.2±0.4
10.	*Cola milenii* (Wonirinyebo)	58.2±1.0	1.4±0.8	14.1±1.3	43.1±2.5	21.9±1.8	5.5±0.5
11.	*Tetracarpidium conoforum* (Okpa)	7.1±0.3	4.5±0.5	23.7±1.8	11.6±1.3	54.9±3.8	3.6±0.8
12.	*Crysophyllum albidum* (Oda)	48.2±1.1	6.6±0.8	19.6±1.3	23.4±2.1	42.5±3.2	6.3±0.5
13.	*Dacryodes edulls* (Ube Okpoko)	44.9±1.3	4.2±0.3	72.6±3.5	7.3±0.9	11.3±1.5	3.1±0.5
14.	*Diospyros monobuttensis* (Achicha)	48.3±1.0	6.4±0.8	12.5±11.9	9.4±1.2	64.5±3.5	4.5±0.4
15.	*Garcina cola* (Bitter cola)	38.3±1.5	2.5±0.6	9.7±1.1	9.1±0.8	73.0±3.6	4.1±0.8
16.	*Icucina trichantha* (Mbia)	65.5±2.1	6.1±0.6	13.2±1.8	20.4±1.5	49.9±2.8	5.9±0.3
17.	*Landolphia dulcis* (Ekete)	50.9±2.1	6.8±0.8	36.6±2.3	17.7±1.3	30.3±2.1	7.1±0.6
18.	*Maesobotyra barterii* (Ogorioma)	83.0±2.0	6.1±0.5	7.5±0.8	3.2±0.4	76.7±3.2	3.1±0.4
19.	*Myrianthus arboreus* (Ezizi)	58.3±2.0	5.2±0.6	8.4±0.8	12.6+1.5	62.9±3.1	9.6±0.8
20.	*Napoleona imperalis* (Osunkwu)	45.7±1.0	6.8±0.6	26.0±1.8	17.9±1.5	41.5±2.5	2.9±0.4
21.	*Salcia nitida* (Mbelekwulekwu)	47.1±1.1	6.4±0.8	41.2±2.3	21.4±1.6	22.7±1.3	2.6±0.3
22.	*Akator*	63.5±2.5	7.0±0.8	41.7±2.9	5.9±0.8	35.7±2.2	8.2±0.8
23.	*Spondias mombin* (Ogogo)	74.5±2.9	9.3±0.9	39.3±2.1	13.7±1.8	16.8±1.5	15.6±1.2
24.	*Denattia tripetola* (Opu)	62.5±2.0	9.3±0.7	38.5±1.9	5.8±0.8	37.5±2.7	6.8±0.5
25.	*Gnetum otericanum* (Okazi)	25.6±1.0	9.2±0.8	10.6±1.0	25.5±1.7	47.4±2.3	6.4±0.9
26.	*Gongronema ratifolia* (Utazi)	51.5±2.0	15.1±1.1	14.4±1.6	35.7±2.4	24.6±1.3	8.4±0.8
27.	*Hernsia crinata* (Atama)	25.4±1.0	8.9±0.8	19.1±1.2	15.9±1.8	50.1±3.2	5.4±0.4
28.	*Lascanthera africana* (Nkanka)	28.9±1.1	9.0±0.5	22.6±1.8	32.7±2.2	28.0±2.4	6.5±0.6
29.	*Piper quineense* (Aziza Leaves)	55.3±2.0	4.5±0.5	11.7±1.3	26.6±1.7	38.9±2.3	8.7±0.7
30.	*Pterocarpus soyauxii* (Oha)	30.8±2.0	10.9±1.2	22.1±2.1	19.2±1.6	51.4±3.3	2.1±0.3
	%CV	68.82	11.01	49.89	31.01	61.24	6.59

SD = Standard Deviation.
( ) = The names in brackets are their local (Ikwerre) or common names.
a = Mean of 6 determinations.
%CV = Coefficient of variation.

Table 2. Minerals (g/100 g) and vitamin C (ascorbic acid) contents of some indigenous wild fruits and leafy vegetables ± SD

S/No	Sample (local or common name)	Phosphorous	Iron	Magnesium	Calcium	Sodium	Potassium	Vitamin C (ascorbic acid) mg/100 g dry sample
		g/100 g dry matter						
1.	*Artocarpus altilis* (African bread fruit)	0.11	0.07	0.03	1.85	0.17	1.59	40.3 + 0.01
2.	*Cola pachycupa* (Oyiya)	0.03	0.08	0.16	1.03	0.16	0.70	20.3 + 0.00
3.	*Cola milenii* (Womirinyebo)	0.06	0.09	0.13	1.05	0.04	0.63	22.5 ± 0.00
4.	*Coula eduiis* (African walnut)	0.14	0.03	0.28	0.59	0.15	1.56	22.6 ± 0.18
5.	*Crysophyllum albiodum* (Oda)	0.02	0.07	0.17	1.89	0.05	1.38	22.5 ± 0.00
6.	*Dacryodes edulis* (Ube Okpoko)	0.03	0.08	0.19	0.69	0.06	2.00	19.5 ± 0.00
7.	*Diospyros monobuteensis* (Achicha)	0.03	0.08	0.04	0.91	0.18	0.94	44.7 ± 0.14
8.	*Garcina Cola* (Bitter Cola)	0.04	0.08	0.13	1.95	0.03	2.13	17.8 ± 0.36
9.	*Icunina trichantha* (Moia)	0.04	0.06	0.16	1.52	0.04	1.88	26.1 ± 0.00
10.	*Landolphia dulcis* (Ekete)	0.03	0.05	0.02	0.78	0.07	1.34	112.5 ± 0.000
11.	*Maesobotyra barterii* (Ogorioma)	0.05	0.07	0.19	1.11	0.06	1.40	45.4 ± 0.71
12.	*Myrianthus arboreus* (Ezizi)	0.03	0.05	0.10	0.95	0.04	0.63	18.1 ± 0.36
13.	*Napoleona imperalis* (Osunkwu)	0.06	0.06	0.11	0.96	0.07	1.00	20.1 ± 0.01
14.	*Salcia nitida* (Mbelekwulekwu)	0.02	0.02	0.33	0.82	0.23	0.56	22.5 ± 0.00
15.	*Akator*	0.03	0.04	0.28	0.77	0.20	0.05	24.5 ± 0.14
16.	*Spondias mombin* (Ogogo)	0.02	0.07	0.19	1.03	0.06	1.39	65.2 ± 0.00
17.	*Denattia tripetela* (Opu)	0.03	0.08	0.17	1.12	0.07	0.99	20.6 + 0.01
18.	*Gnetum of ercanum* (Okazi)	0.01	0.13	0.12	1.25	0.19	2.98	92.5 ± 0.36
19.	*Gongronema ratifolia* (Utazi)	0.05	0.09	0.30	1.16	0.08	1.73	232.0 ± 0.71
20.	*Hernsia crinata* (Atama)	0.05	0.07	0.04	1.25	0.05	1.38	22.5 ± 0.00
21.	*Lascanthera africana* (Nkanka)	0.05	0.08	0.22	0.92	0.15	1.76	44.7 ± 0.04
22.	*Piper quineense* (Aziza leaves)	0.03	0.07	0.35	1.15	0.06	1.08	22.8 ± 0.00
23.	*Pterocarpus soyauxii* (Aga)	0.06	0.55	0.12	0.47	0.06	1.23	67.3 ± 0.04
	%CV	0.13	0.45	0.41	1.69	0.27	2.73	208.03

cultivated plants as the ascorbic acid content of the indigenous wild fruits, nuts and leafy vegetables. It was reported [12] that the ascorbic acid content of the leafy vegetables commonly found in Nigeria ranged from 18.0 to 98.0 mg/100 g of the fresh materials and that the ascorbic acid content in fresh samples [10] was highest in *Hibiscus esculenta* (Okra) with 203 mg/100 g and lowest in *Vernonia amygdalina* (bitter leaf) with 31.0 mg/100 g. The ascorbic acid contents of some common local fruits and vegetables was determined and the contents of fruits ranged from 21.8 to 98.0 mg/100 g same while that of vegetables ranged from 21.3 to 98.8 mg/100 g sample [2].

The highest value of ascorbic acid of black currants among other commonly used fruits was 200 mg/100 g [16]. These results from literature agreed with those of the food plants which were analysed. *Congronema ratifolia* which is a leafy vegetable has the highest ascorbic acid content of 232.0 mg/100 g sample. From the result in Table 2, it appears that fruits and nuts have a lower ascorbic acid content than the leafy vegetables. Much of ascorbic acid content in leafy vegetables may be lost during processing especially cooking, unlike the fruits which are often eaten raw [10, 12]. Thus there seems to be little loss of ascorbic acid in fruits which may be through leaching in washing water.

These abundant wild local food plants have not been fully studied by researchers. The current investigation is aimed at exploring their nutritive qualities as sources of basic food nutrients. This will help to re-introduce their use as food supplements and encourage their cultivation in home gardens as these wild indigenous food plants are almost going extinct due to deforestation.

Table 2 shows the content of six minerals. The values of some of the minerals are low except for calcium and potassium in the fruits and vegetables. The results agreed with those from the literature [3, 8]. Despite the low level of other minerals, these wild plants may be good sources of calcium and potassium.

Table 3 shows the peroxide value and the free fatty acid content. The peroxide value was low with *Brachystegia nigerica* with the highest value of

Table 3. Free fatty acids (as % [dry matter] oleic acid) content and peroxide value of the wild spices ± SD (Storage stability tests)

S/No	Sample (local or common name)	Free fatty acid (% oleic)	Peroxide value (mg/100 g sample)
1.	*Allium sativum* (Garlic)	0.79±0.000	0.86+0.03
2.	*Brachystegia nigerica* (Ukpo)	0.48±0.04	3.90±0.14
3.	*Piper quineense* (Aziza seeds)	1.99±0.02	0.40±0.00
4.	*Tetrapleura tetraptera* (Achilicha)	0.78+0.02	0.40±0.00
5.	*Xylopia aethiopicum* (Okada)	0.78±0.00	3.20±0.00
6.	*Zingiber officinalis* (Ginger)	0.48±0.04	3.20±0.00
7.	*Monodora tenuafolia* (Ehuru)	2.00±0.04	2.72±0.00
	% CV	9.49	21.32

3.9 mg/100 g. Pearson [16] reported that fresh oils usually have a peroxide value below 10 meq/kg. A rancid taste becomes noticeable when the peroxide value is between 20 and 40 meq/kg. The free fatty acid content as per cent oleic acid is also low with *Xylopia aethiopicum* having the highest (3.1 percent). The free fatty acid as per cent oleic acid is used as a general indicator of the condition and edibility of oil samples because rancidity is usually accompanied by free fatty acid formation. The spices will have a long shelf life because of the low peroxide value and free fatty acid content. Table 4 shows the essential oil (as per cent oleoresin) content of the spices. The essential oils were low compared with the values of garlic, chillies and ginger [11]. *Xylopia aethiopicum* has the highest content (5.2 percent) of the essential oil. Manay [11] showed values ranging from 1.5 percent for tumeric to 26.1 percent for chilli seeds.

The essential oils contain all the aroma and flavour of the spices. The essential oils are in great demand in food and pharmaceuticals [11]. They are used for flavouring and as food condiment. They are also used in liquors, concentrates in non alcoholic drinks, and in perfumery. Some of them have therapeutic, antiseptic or bactericidal properties [6]. Research is in progress to explore the usefulness of the essential oils of these wild species.

Apart from their uses as food, some of the wild plants are used in various other ways. *Tetrapleura tetraptera* (achilicha) is used to prepare pepper soup for women immediately after delivery. It is believed that it strengthens and heals the walls of the womb. *Xylopia aethiopicum* (Okada) is used to treat the navel of a new born baby which not only heals it fast but prevents any form of infection. *Maesobotyra barterri* is used to make local wine, body cream and perfume. Others like *Gnetum ofericanum, Pterocarpus soyauxii* are used as mild laxatives and the twine of *Landolphia dulcis* is used to stake yam and make mats and baskets.

Table 4. Essential oil (as % oleoresin) content of the wild spices ± SD storage stability test

S/No	Sample (local or common name)	Essential oil (% oleoresin)
1.	*Allium sativum* (Garlic)	0.10±0.01
2.	*Brachystegia nigerica* (Ukpo)	2.80±0.00
3.	*Piper quineense* (Aziza seeds)	3.23±0.02
4.	*Tetrapleura tetraptera* (Achilicha)	0.11±0.00
5.	*Xylopia aethiopicum* (Okada)	5.22±0.01
6.	*Zingiber officinalis* (Ginger)	2.00±0.00
7.	*Monodora tenuafolia* (Ehuru)	4.35+0.19
	% CV	28.06

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