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Checklist, conservation status and health status assessment via total photosynthetic pigment contents of plants found at the Akwa Ibom State University Botanical Garden, Nigeria

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Key words: AKSU, Checklist, Chlorophyll, Conservation, IUCN, Photosynthesis

Abstract

This research aimed at providing a checklist of plants found at the Akwa Ibom State University (AKSU) Botanical Garden, their conservation status and physiological health status via total photosynthetic pigment (TPP) assessment. A total of about 98 plant species was recorded, family Euphorbiaceae recording the highest number of species (8), Fabaceae (7), Asteraceae (6), Rubiaceae and Malvaceae (5), 3 families recorded 4 species each, 2 families had 3 species each, 8 families recorded 2 species each, while 32 families recorded 1 species each. Herbs had the highest frequency with 35.71%, trees (29.59%), shrubs (21.43%) and climbers recorded the lowest (13.27%). Conservation status check revealed that 52.04% of the plants found in AKSU Botanical Garden are rated data deficient/unranked by the IUCN, while 42.86% are rated least concern/secure-low risk, 4.08% (near threatened) and 1.02% (vulnerable). Tree species recorded the highest total photosynthetic pigment contents mostly; as observed in *Dacryodes edulis* (76.93±1.13mg/g), *Ananas comosus* (74.33±0.47), *Pentaclethra macrophylla* (74.30±1.76), *Clorophytum comosum* (70.97±0.86), *Elaeis guineensis* (70.60±0.79), *Garcinia spicata* (70.43±1.65) and *Anthonatha macrophylla* (70.12±0.44). The lowest TPP contents was observed in mostly climbers and herbs as observed in *Euphorbia tirucalli* (2.43±0.92mg/g), *Pteridium aquilinum* (17.53±3.96), *Selaginella myosorus* (22.60±5.56), *Samanea saman* (23.23±2.40), *Ageratum houstonianum* (32.70±1.11), *Aspilia africana* (36.10±6.65), *Icacina trichantha* (36.30±4.25), *Sphagneticola trilobata* (37.13±2.63). Considering the wide economic usage and value of the plants found in the study area, it is imperative that proper measures be taken to protect vulnerable species or those at low risk which are fast decreasing or becoming threatened.

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Introduction

The usage and exploitation of plants by man is as old as man himself. Plants have been used by man for several purposes which includes; usage as food for man and animals, construction of shelter, treatment of various ailments, clothing as well as spiritual purposes and aesthetics. The documentation of the importance and economic usage of plants can be traced to about 1500 BC when the Egyptians first used the papyrus and that of 2000 BC by the Chinese emperor Sheng Nung when he first compiled the list of medicinal plants (Sofowora, 1982; 1984; Sommer and Ross, 2010). Yet, despite the extreme importance of plants in the preservation and sustenance of mankind, over exploitation, agricultural practices as well as structural development which gives room for deforestation and ecosystem destruction has and is still driving many plant species into extinction. Researchers such as AbdulRahaman *et al.* (2006) howled that some of the extinct plant species might have contained substances in them to prevent cancer or help to find a cure for deadly diseases such as AIDS (Acquired Immune Deficiency Syndrome). These losses are evidently affected by targeted species and mostly trees are preferred. Elsiddig (2003) as well as Alamu and Agbeja (2011) revealed that the dependence of people on trees and forests is unlimited; as almost 1.6 billion people in the world rely on forest resources for their livelihood and 1.2 billion people in developing countries use trees on farms to generate food and cash (Nodza *et al.,* 2013).

The Akwa Ibom State University Botanical Garden is found within the main campus of the University, which is located at Ikot Akpaden, Mkpat Enin Local Government Area of Akwa Ibom State, Nigeria. The Akwa Ibom State University Botanical Garden has a rich floral diversity which has been conserved overtime *in situ* as well as *ex situ*. The conservation of plants in Botanic gardens is as old as history itself (Sikolia and Omondi, 2017). Botanic Garden Conservation International (BGCI) defines a botanic garden is an institution that is open to the public, has a reasonable degree of permanence, and is undertaking scientific or technical research on plants in the collections, has adequate labelling of the plants and proper documentation of the collections, including wild origin. Botanic gardens have in the past, and continue today to play major roles and purposes in society and world cultures (Botanic Garden Conservation International (BGCI), 2015; Sikolia and Omondi, 2017). According to the International Agenda for Botanic Garden Conservation (BGCI, 2015), botanic gardens play important roles as the world's greatest resource for cultivation and conservation of individual plant species. However, these habitats are under threat from advancing civilization and other unsustainable human activities, the attitude of the populace towards conservation is relatively poor; thereby resulting to inevitable loss of genetic resources at all levels. Ideally, conservation of biodiversity is supposed to be an intrinsic responsibility for all mankind (IUCN, 2010), but this is far from the case, as the rate of destructive anthropogenic activities on the floras and biodiversity at large escalates daily with nearly 90% of forest in Nigeria cleared (Kabiru, 2008). In 2010 Nigeria had 9 million hectares of forest, 336,000 hectares of which were primary forest (FAO, 1994; Nodza *et al.*, 2014).

Plant pigments, such as Chlorophyll a and b, carotenoids, anthocyanins, and a range of accessory pigments, play a vital role in the earth's biosphere and in sustaining life on the planet, through the light-harvesting reactions of photosynthesis, stress avoidance, and defense (Croft and Chen, 2017). Chlorophyll molecules facilitate the conversion of absorbed solar radiation into stored chemical energy, through harvesting light energy, transferring excitation energy to reaction centers, and driving charge separation in the reaction centers (Chen, 2014; Croft and Chen, 2017). Changes in leaf pigment content have been shown to highlight areas of plant disturbance and stress, and as such act as a bioindicator of plant physiological condition (Sampson *et al.*, 2003; Croft *et al.*, 2014). According to several authors, the total carotenoid to chlorophyll ratio increases during vegetation stress or senescence, as the declines in chlorophyll content exceed any

corresponding declines in carotenoid content (Gitelson and Merzlyak, 1994; Penuelas and Filella, 1998). Esteban *et al.* (2015) conducted a thorough meta-analysis of changes in plant pigment ratios in response to a range of environmental stresses (LT, low temperature; HT, high temperature; D, drought; Sa, salinity; Ch, chilling; O_3, ozone; CO_2, carbon dioxide; S, seasons) (Esteban *et al.*, 2015).

In Nigeria, checklist of plants in the botanical garden has been done, however, in Akwa Ibom State, none has been documented in any of the numerous botanical gardens of higher institutions in the State. Therefore, this work is aimed at providing a checklist for some plants found at the Akwa Ibom State University Botanical Garden and to document the rate of depletion on the floras as well as their physiological health status.

Materials and methods

Study Area

The Akwa Ibom State University (AKSU) Botanical Garden is located at Ikot Akpaden, Mkpat Enin Local Government Area. The Akwa Ibom State University Botanical Garden was established in 2010 as a biodiversity centre for Akwa Ibom State University. The garden lies at a latitude of 4°37'21" and longitude of 7°46'0" at altitude of 22.7.

Fig. 1. Entrance of the Akwa Ibom State University (AKSU) Botanical Garden.

Plant Sampling and Data Collection

The identification of the plants in the garden was done through the use of taxonomic keys according to the standard methods outlined by (Dalziel, 1937; Hutchison and Dalziel, 1954) and by oral interviewing of University botanic garden staff, curator as well as a Taxonomist about their knowledge of plant names and usage. Field notes on the plants were taken and this included; plant habit, family, plant usage and the total photosynthetic pigments.

Assessment of the conservation status of the plant species encountered during this study was done following IUCN (2021), Nature Serve (2021). Total photosynthetic pigment contents were assessed using the handheld atLeaf portable chlorophyll meter.

Results and discussion

Results from this survey research revealed that percentage habits of plants found in the highlighted part of the AKSU botanical garden surveyed recorded herbs as highest with 35.71%, followed by trees (29.59%), shrubs (21.43) while climbers recorded the lowest value with 13.27% (Fig. 2).

A total number of about 98 plant species was recorded with the family Euphorbiaceae recording the highest number of species (8), followed by Fabaceae (7), Asteraceae (6), Rubiaceae and Malvaceae (5), 3 families recorded 4 species each, 2 families recorded 3 species each, 8 families recorded 2 species each, while 32 families recorded 1 species each (Table 1 and 2).

Results obtained here is similar to the work of Sikolia and Omomdi (2017) who reported the high abundance of the plant species from the families Euphorbiaceae and Fabaceae in the University Botanic Garden in Maseno (Nodza *et al.*, 2014) also reported high frequency of plants from the family Fabaceae growing on Akoka Campus of University of Lagos. The high abundance of species from the families observed in this study can be accredited to the extensive spread economic value and uses of the plants belonging to those families.

This information containing the total number of plants belonging to each family is presented in Table 5.

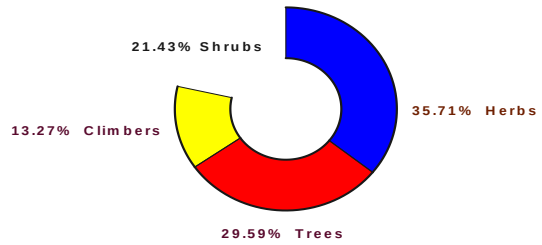

Fig. 2. Percentage distribution of plant habits in AKSU Botanical Garden, Nigeria.

The total numbers of plant species found in AKSU Botanical Garden presented in Table 1-4 were crosschecked on the International Union for Consrvation of Nature and Natural Resources/Nature Serve websites to assess their conservation status. Results of the conservation status analysis revealed that 52.04% of the plants found in AKSU Botanical Garden are rated as data deficient/unranked, while 42.86 are rated least concern/secure-low risk, 4.08% (near threatened) and 1.02% (vulnerable) (Fig. 3).

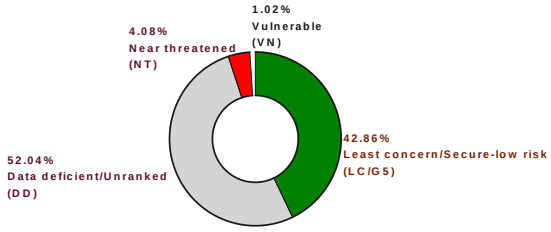

Fig. 3. Conservation status of plant species found in AKSU Botanical Garden, Nigeria.

Photosynthetic pigment assessment of the plant species found in AKSU Botanical Garden revealed that tree species recorded the highest total photosynthetic pigment contents mostly; as observed in *Dacryodes edulis* (76.93±1.13mg/g), *Ananas comosus* (74.33±0.47), *Pentaclethra macrophylla* (74.30±1.76), *Clorophytum comosum* (70.97±0.86), *Elaeis guineensis* (70.60±0.79), *Garcinia spicata* (70.43±1.65) and *Anthonatha macrophylla* (70.12±0.44).

The lowest total photosynthetic pigment contents was observed in mostly climbers and herbs as observed in *Euphorbia tirucalli* (2.43±0.92mg/g), *Pteridium aquilinum* (17.53±3.96), *Selaginella myosorus* (22.60±5.56), *Samanea saman* (23.23±2.40), *Ageratum houstonianum* (32.70±1.11), *Aspilia africana* (36.10±6.65), *Icacina trichantha* (36.30±4.25), *Sphagneticola trilobata* (37.13±2.63) (Table 1-4). The significant differences observed in the total photosynthetic pigment contents of the above listed plants can be as a result height differential and limited access to sunlight by the herbs and climbers.

The whole practice of monitoring plant health *in-situ* is based on the assessment of its chlorophyll and photosynthetic contents which also help determine the productivity of photosynthesis in such plants.

Table 1. Checklist of trees in AKSU botanical garden showing Botanical, common, family name, total photosynthetic pigment contents, conservation status and uses.

SN	Botanical names	Common name	Family	Total Photosynthetic Pigment (mg/g)	Conservation status (IUCN/Nature Serve)	Uses
1	*Persea Americana* Mill	Avocado	Lauraceae	55.97±2.11	LC	Food
2	*Anona muricata* L.	Sour sop	Anonaceae	52.37±3.59	LC	Food
3	*Rauwolfia vomitoria* A.	Devil's pepper	Apocynaceae	64.13±2.40	LC	Medicinal
4	*Anacardium occidentale* L.	Cashew	Anacardiaceae	55.73±1.03	LC	Food, Fodder
5	*Gmelina arborea* Roxb.	Beechwood	Lamiaceae	52.8±0.40	LC	Wood
6	*Baphia nitida* Lodd.	Camwood	Fabaceae	59.8±0.32	LC	Wood, Dye
7	*Tectona grandis* L.f.	Teak	Lamiaceae	44.03±1.47	DD	Wood, Food
8	*Syzygium owariensis* P. Beauv.	-	Myrtaceae	59.3±7.77	LC	Food, Dye
9	*Washingtonia filifera* H. Wendl.	California palm	Arecaceae	62.2±1.22	NT	Ornamental, food
10	*Newbouldia laevis* P. Beauv.	Boundary tree	Bignoniaceae	63.33±1.62	DD	Boundary marker, medicinal
11	*Barteria nigritiana* Hook. f.	-	Passifloraceae	43.33±1.73	LC	Medicinal
12	*Psidium guajava* L.	Guava	Myrtaceae	50.47±0.52	LC	Food, Wood, Medicinal
13	*Mangifera indica* L.	Mango	Anacardiaceae	56.93±1.05	DD	Food, Wood, Medicinal
14	*Alchornea laxiflora* Benth.	-	Euphobiaceae	68.13±0.96	LC	Medicinal, Religion
15	*Croton zambesicus* Mull. Arg.	Eto Obuma	Euphobiaceae	61.8±2.54	DD	Spices, wood, medicine
16	*Musanga cecropiodes* R.Br. & T.	Umbrella tree	Uticaceae	54.90±4.16	LC	Flotation devices, Medicine
17	*Cola nitida* S.&E.	Kola nut	Malvaceae	62.93±4.19	LC	Nut, Stimulant, Dye
18	*Garcinia kola* H.	Bitter kola	Clusiaceae	56.33±1.52	VN	Medicinal
19	*Anthocleista vogelii* Planch.	Cabbage Tree	Loganiaceae	54.57±2.32	LC	Medicinal
20	*Raphia hookeri* G.Mann & H.Wendl.	Raphia Palm	Arecaceae	64.77±0.03	LC	Wine, Liquor
21	*Elaeis guineensis* Jacq.	African Oil palm	Arecaceae	70.60±0.79	LC	Palm and kernel oil
22	*Nauclea diderrichii* (DeWild & T.D.) Merr.	Bilinga	Rubiaceae	64.00±2.85	NT	Wood

SN	Botanical names	Common name	Family	Total Photosynthetic Pigment (mg/g)	Conservation status (IUCN/Nature Serve)	Uses
23	*Garcinia spicata* Hook. f.	Garlic fruit	Clusiaceae	70.43±1.65	DD	Ornamental
24	*Pentaclethra macrophylla* Benth.	African oil bean	Leguminosae-Mimosoideae	74.30±1.76	LC	Food, medicinal, oil
25	*Albizia zygia* (DC.) JF Macbride	Okuro	Leguminosae-Mimosoideae	60.17±4.21	LC (Decreasing)	Food, medicinal, resin
26	*Dracaena arborea* (Wild.) Link	Slender dragon tree	Dracaenaceae	69.9±0.87	LC	Ornamental, air purification
27	*Harungana madagascariensis* Lam.	Dragon's blood tree	Hypericaceae	68.07±2.37	LC	Medicinal. gum, food
28	*Carica papaya* L.	Pawpaw	Caricaceae	61.77±0.83	DD (Decreasing)	Food, Medicinal
29	*Dacryodes edulis* H.J. Lam.	African pear	Burseraceae	76.93±1.13	DD	Food, Wood, Medicine

G5 (Secure-low risk), DD (Data deficient/Unranked), EN (Endangered), LC (Least concern), NT (Near threatened), VN (Vulnerable), CE (Critically endangered), EX (Extinct).

Table 2. Checklist of Shrubs in AKSU botanical garden showing Botanical, common, family name, total photosynthetic pigment contents, conservation status and uses.

SN	Botanical names	Common name	Family	Total Photosynthetic Pigment (mg/g)	Conservation status (IUCN/Nature Serve)	Uses
1	*Acalypha wilkesiana* Mull. Arg.	Copperleaf	Euphorbiaceae	51.23±0.93	DD	Medicinal
2	*Manihot esculenta* Crantz	Cassava	Euphorbiaceae	51.43±0.55	DD	Food, Liquor
3	*Hibiscus rosa-sinensis* L.	Chinese hibiscus	Malvaceae	57.80±046	DD	Medicinal, Cosmetics, Ornamental, food
4	*Ixora chinensis* Lam.	Chinese ixora	Rubiaceae	66.20±0.91	DD	Medicinal, Ornamental
5	*Samanea saman* (Jacq.) Merr.	Rain tree	Fabaceae	23.23±2.40	G5	Carbon sequestration, Medicinal
6	*Euphorbia tirucalli* L.	Pencil cactus	Euphorbiaceae	2.43±0.92	LC	Latex, Rubber
7	*Alchornea cordifolia* Mull. Arg.	Christmas bush	Euphorbiaceae	46.17±1.04	LC	Medicinal
8	*Lantana camara* L.	Lantana	Verbenaceae	48.2±1.15	G5	Medicinal, Ornamental
9	*Heinsia crinita* (Afzel.) G. Taylor	Bush apple	Rubiaceae	69.57±1.03	LC	Food, Medicinal
10	*Anthonatha macrophylla* P.Beauv.	African rosewood	Fabaceae	70.12±0.44	LC	Food, medicinal, Wood
11	*Gardenia jasminoides* J.Ellis	Gardenia	Rubiaceae	68.77±0.38	DD	Cosmetics, food, medicine
12	*Codiaeum variegatum* (L.) A. Juss.	Garden croton	Euphorbiaceae	59.87±3.01	LC	Ornamental
13	*Lasianthera Africana* P.Beauv.	Editan	Icacinaceae	52.53±1.79	LC	Food, Medicinal
14	*Dypsis lutescens* B.&J.	Areca palm	Arecaceae	60.87±3.18	NT	Ornamental, air purification
15	*Solanum torvum* Sw.	Devil's fig	Solanaceae	55.33±2.37	DD	Food
16	*Polyscias guilfoylei* (W.Bull) L.H.Bailey	Wild coffee	Araliaceae	50.03±1.34	DD	Ornamental, wind break
17	*Lonchocarpus griffonianus* (Baill.) Dunn.	-	Fabaceae	60.57±0.33	LC	-
18	*Cucurbita ficifolia* Bouche	Figleaf gourd	Cucurbitaceae	55.47±1.28	DD	Food, fodder
19	*Araliopsis soyauxii* Engl.	-	Rutaceae	67.70±1.46	DD	-
20	*Senna alata* (L.) Roxb.	Candle bush	Fabaceae	41.37±0.32	LC	Medicinal
21	*Manniophyton fulvum* Mull. Arg.	Manniophyton	Euphorbiaceae	62.97±0.50	DD	Medicinal, gum, resin

G5 (Secure-low risk), DD (Data deficient/Unranked), EN (Endangered), LC (Least concern), NT (Near threatened), VN (Vulnerable), CE (Critically endangered), EX (Extinct).

Table 3. Checklist of climbers in AKSU botanical garden showing Botanical, common, family name, total photosynthetic pigment contents, conservation status and uses.

SN	Botanical names	Common name	Family	Total Photosynthetic Pigment (mg/g)	Conservation status (IUCN/Nature Serve)	Uses
1	*Pueraria phaseoloides* (Roxb.) Benth.	Puero	Fabaceae	47.93±1.76	DD	Cover crop, medicinal
2	*Ipomea involucrata* P.Beauv.	Morning glory	Convolvulaceae	54.9±0.95	DD	Food, medicinal
3	*Clerodendrum thomsoniae* Balf.f	Bleeding heart vine	Lamiaceae	62.8±2.29	DD	Ornamental
4	*Smilax kraussiana* Meisn.	-	Smilacaceae	59.53±1.60	DD	Aphrodisiac
5	*Gnetum africanum* Welw.	African jointfir	Gnetaceae	66.22±1.31	NT (Decreasing)	Food
6	*Byrsocarpus coccineus* Schum. & Thonn.	Diola	Connaraceae	57.17±0.85	LC	Medicinal
7	*Selaginella myosorus*	-	Selaginellaceae	22.60±5.56	DD	Medicinal
8	*Icacina trichantha* Oliv.	-	Icacinaceae	36.30±4.25	DD	Food, Medicinal
9	*Abrus precatorius* L.	Rosary pea	Fabaceae	40.93±2.46	DD	Jewelry, poison
10	*Combretum platypetalum* Welw.	-	Combretaceae	68.30±1.77	LC	Medicinal, Religion
11	*Urena lobata* L.	Caeserweed	Malvaceae	55.5±0.51	LC	Food, medicinal, fibre
12	*Gongronema latifolium* Benth.	Utasi	Apocynaceae	42.50±2.45	DD	Food
13	*Adiantum capillus-veneris* L.	Venus hair fern	Pteridaceae	40.03±1.77	G5	Medicinal

G5 (Secure-low risk), DD (Data deficient/Unranked), EN (Endangered), LC (Least concern), NT (Near threatened), VN (Vulnerable), CE (Critically endangered), EX (Extinct).

Table 4. Checklist of herbs in AKSU botanical garden showing Botanical, common, family name, total photosynthetic pigment contents, conservation status and uses.

SN	Botanical names	Common name	Family	Total Photosynthetic Pigment (mg/g)	Conservation status (IUCN/Nature Serve)	Uses
1	*Emilia sonchifolia* (L.) DC. Ex Wight	Lilac tasselflower	Asteraceae	49.80±0.61	DD	Medicinal, food
2	*Ageratum conyzoides* L.	Goat weed	Asteraceae	37.07±5.62	G5	Medicinal, insecticide
3	*Ageratum houstonianum* Mill.	Bluemink	Asteraceae	32.70±1.11	DD	Medicinal, insecticide
4	*Aspilia Africana* (Pers.) C.D.Adams	Wild sunflower	Asteraceae	36.10±6.65	DD	Medicinal
5	*Schwenckia Americana* Linn.	-	Solanaceae	51.43±1.88	DD	Medicinal
6	*Scoparia dulcis* L.	Licorice weed	Plantaginaceae	44.30±1.84	DD	Medicinal
7	*Oldenlandia herbacea* (Linn.) Roxb.	-	Rubiaceae	3.40±0.06	DD	Medicinal, dye
8	*Stachytarpheta angustifolia* (Mill.) Vahl.	Devil's coach whip	Verbenaceae	56.60±2.71	DD	Medicinal
9	*Pteridium aquilinum* (L.) Kuhn	Eagle fern	Dennstaedtiaceae	17.53±3.96	LC	Food, medicinal
10	*Chromolaena odorata* (L.) R.M.King & H.Rob	Siam weed	Asteraceae	42.43±1.12	DD	Medicinal
11	*Pelargonium capitatum* (L.f.) L'Her	Rose geranium	Geraniaceae	58.47±2.38	LC	Ornamental
12	*Asystasia gangetica* (L.) T.Anderson	Chinese violet	Acanthaceae	56.90±10.01	LC	Food, Medicinal
13	*Sida acuta* Burm. f.	Wireweed	Malvaceae	50.53±2.68	G5	Fodder, Fibre, Medicinal
14	*Kalanchoe pinnata* (Lam.) Pers.	Miracle leaf	Crassulaceae	57.83±1.63	DD	Medicinal
15	*Dracaena goldieana* Bullen	Green zebra plant	Dracaenaceae	61.30±2.50	DD	Air purification
16	*Cordyline fruticosa* (L.) A.Chev.	Ti plant	Asparagaceae	69.7±0.84	DD	Ornamental
17	*Costus afer* Ker-Gawl	Ginger lily	Costaceae	67.93±0.14	DD	Medicinal
18	*Acanthus montanus* (Nees) T.Anderson	Mountain thistle	Acanthaceae	54.50±2.37	DD	-
19	*Sansevieria liberica* Ger.&Labr.	Mother in-law's tongue	Dracaenaceae	66.30±4.16	DD	Air purification
20	*Sphagneticola trilobata* (L.) Pruski	Trailing daisy	Asteraceae	37.13±2.63	LC	Ornamental, Medicinal
21	*Caladium bicolor* Vent.	Elephant ear	Araceae	31.73±4.13	DD	Ornamental
22	*Clorophytum comosum* (Thunb.) Jcq.	Spider plant	Asparagaceae	70.97±0.86	DD	Air purification
23	*Curcuma longa* L.	Tumeric	Zingiberaceae	38.10±0.85	DD	Spice, dye, medicinal
24	*Dissotis rotundifolia* (Sm.) Triana	Pinklady	Melastomataceae	41.80±2.29	DD	Spice
25	*Ananas comosus* (L.) Merr.	Pineapple	Bromeliaceae	74.33±0.47	DD	Food
26	*Commelina benghalensis* L.	Hairy Honohono	Commelinaceae	53.73±2.19	G5	Medicinal
27	*Hibiscus surattensis* Linn.	-	Malvaceae	44.63±2.38	DD	Medicinal, Food
28	*Xanthosoma sagittifolium* (L.) Schott	Yautia-Blanca	Araceae	48.60±1.01	DD	Food
29	*Justicia secunda* Vahl.	-	Acanthaceae	57.00±0.67	DD	Medicinal
30	*Eremomastax polysperma* (Benth.)	-	Acanthaceae	60.57±2.10	DD	Medicinal
31	*Cytosperma senegalense* Schott Engl.	Swamp arum	Araceae	61.17±2.59	DD	Food, medicinal
32	*Crinum jagus* Thomps.	Poison bulb	Amaryllidaceae	52.23±1.28	DD	Medicinal
33	*Nephrolepis biserrata* (Sw.) Schott	Giant swordfern	Nephrolepidaceae	46.10±0.44	G5	Medicinal
34	*Dicranopteris linearis* (Burm.f.) Underw.	Old world forked fern	Gleicheniaceae	38.00±4.56	G5	Medicinal
35	*Anchomanes difformis* (Bl.) Engl.	-	Araceae	40.97±1.27	DD	Medicinal, Food

G5 (Secure-low risk), DD (Data deficient/Unranked), EN (Endangered), LC (Least concern), NT (Near threatened), VN (Vulnerable), CE (Critically endangered), EX (Extinct).

Table 5. Frequency of plants per family found at AKSU Botanical garden.

SN	Families	Number of species encountered
1	Acanthaceae	4
2	Amaryllidaceae	1
3	Anacardiaceae	1
4	Anonaceae	1
5	Apocynaceae	2
6	Araceae	4
7	Araliaceae	1
8	Arecaceae	4
9	Asparagaceae	2
10	Asteraceae	6
11	Bignoniaceae	1
12	Bromeliaceae	1
13	Burseraceae	1
14	Caricaceae	1
15	Clusiaceae	2
16	Combretaceae	1
17	Commelinaaceae	1
18	Connaraceae	1
19	Convolvulaceae	1
20	Costaceae	1
21	Crassulaceae	1
22	Cucurbitaceae	1
23	Dennstaedtiaceae	1
24	Dracaenaceae	3
25	Euphorbiaceae	8
26	Fabaceae	7
27	Geraniaceae	1
28	Gleicheniaceae	1
29	Gnetaceae	1
30	Hypericaceae	1
31	Icacinaceae	2
32	Lamiaceae	3
33	Lauraceae	1
34	Leguminosae-Mimosoideae	2
35	Loganiaceae	1
36	Malvaceae	5
37	Melastomataceae	1
38	Myrtaceae	2
39	Nephrolepidaceae	1
40	Passifloraceae	1
41	Plantaginaceae	1
42	Pteridaceae	1
43	Rubiaceae	5
44	Rutaceae	1
45	Selaginellaceae	1
46	Smilacaceae	1
47	Solanaceae	2
48	Uticaceae	1
49	Verbenaceae	2
50	Zingiberaceae	1

A variation in the photosynthetic contents of a plant is the major sign of plant stress (Lichtenhaler and Babani, 2004; Pavlović, 2005). Several changes in intrinsic factors such as physiology (the synthesis and decomposition of chlorophyll coupled with its distribution in the leaf mesophyll), genetic, morphology (size, age and position of leaves) (Kastori, 1995; Nikolić, 1997) and several abiotic factors which include light quality, humidity, temperature, mineral nutrition, herbicides etc. (Milivojević and Nikolić, 1998) all affect the photosynthetic pigment contents in plant leaves. Analysis of percentage plant usage revealed that for tree species, 30.00% are exploited for medicinal purposes, food (20.00%), wood/timber (16.00%), ornamental and dye (6.00%), oil (4.00%), spice, resin, air purification, fodder, boundary, latex and liquor (2.00%) (Fig. 4).

For shrubs, major usage includes; medicinal (34.29%), food (22.86%), ornamental (17.14%) and fodder and latex (5.71%) (Fig. 5). For climbers, major usage includes; medicinal (42.11%), food (26.32%), fiber, stimulant, cosmetics, religious and poison (5.26%) (Fig. 6). For herbs; medicinal (52.08%), food (16.67%), ornamental (8.33%) and air purification (6.25%) (Fig. 7).

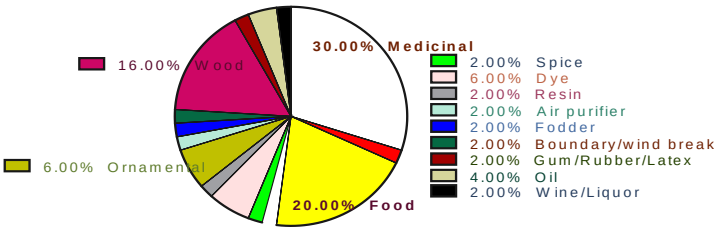

Fig. 4. Percentage usage of tree species in AKSU Botanical Garden of Nigeria.

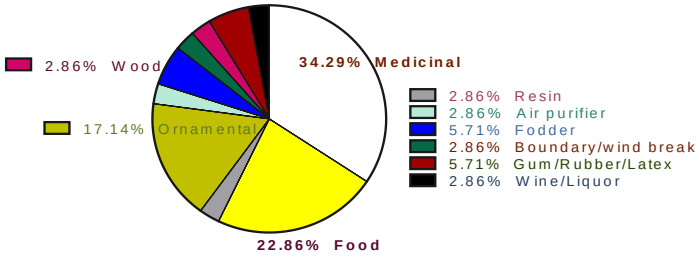

Fig. 5. Percentage usage of shrubs in AKSU Botanical Garden, Nigeria.

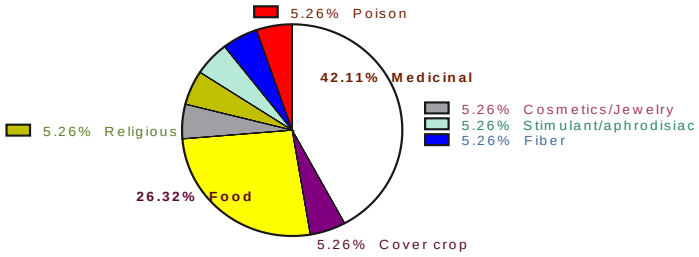

Fig. 6. Percentage usage of climbers in AKSU Botanical Garden, Nigeria.

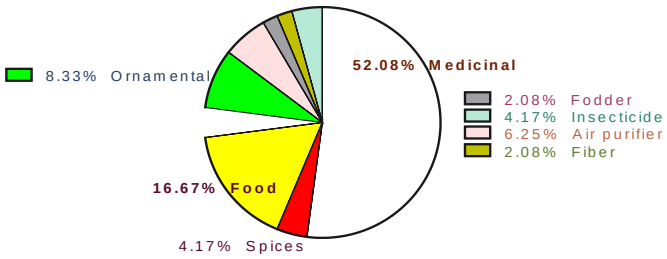

Fig. 7. Percentage usage of herbs in AKSU Botanical Garden, Nigeria.

This checklist has given critical insight into the existence, availability, health and conservation status as well as the rate at which the plant biodiversity in the Akwa Ibom State University (AKSU) Botanical Garden is being depleted. Over exploitation of the plants available in the garden is one of the major causes of the disappearance of plant species due to the different economic and medicinal values of the plants available in the garden. Other factors include construction, agriculture, littering etc. It is imperative that proper measures should be taken to curtail these encroachments into the garden to protect vulnerable species, extinct or those with low risk vulnerable which are fast decreasing or threatened.

Conclusion

This study has provided a checklist of plants found in the Akwa Ibom State University (AKSU) Botanical Garden as well as their conservation and health status. Percentage habits of plants found recorded herbs as highest with 35.71%, followed by trees (29.59%), shrubs (21.43) while climbers recorded the lowest value with 13.27%. A total number of about 98 plant species was recorded with the family Euphorbiaceae recording the highest number of species (8), followed by Fabaceae (7), Asteraceae (6), Rubiaceae and Malvaceae (5), 3 families recorded 4 species each, 2 families recorded 3 species each, 8 families recorded 2 species each, while 32 families recorded 1 species each. Considering the importance of plants to mankind and the numerous threats it faces either through overexploitation, construction, agriculture, environmental stresses, climate change etc. their conservation is extremely necessary in other to reduce the risk of biodiversity loss and hence there is need to come up with numerous conservation strategies which if implemented will save the threatened plants from extinction.

Author contributions

OO and JO (research design, data analysis, initial and final draft), SS, LU and FU (Field survey, plant identification and compilation of data). All authors read and approved the manuscript.

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