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The morphological structures and anatomical compositions of jackfruit (*Artocarpus heterophyllus* Lam) and African breadfruit (*Treculia africana* Decne).

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ABSTRACT

The morphological structures and anatomical compositions of jackfruit (*Artocarpus heterophyllus* Lam) and African breadfruit (*Treculia africana* Decne) was analyzed. The test samples, (the seeds, leaves, stem and root of *Treculia africana* and *Artocarpus heterophyllus*) were obtained from Umuoji, in Idemmili North Local Government Area of Anambra State, Nigeria. Samples of leaves, matured and immatured stems and roots of *Artocarpus heterophyllus* and *Treculia africana* were preserved as well as softened for easy sectioning in Formalin acetic alcohol (FAA). The solution contained 90 ml of 70% ethanol, 5 ml of glacial acetic acid and 5 ml of formaldehyde. Morphological studies of the features of *Artocarpus heterophyllus* and *Treculia africana* showed a close resemblance of the leaves,twig and fruits, while difference was seen more on the seedof the two plants. The result showed that *Artocarpus heterophyllus* gave a higher centimeter of twig (33.15±0.01), petiole length (1.40±0.02), seed length (3.77±0.01) and seed width (2.33±0.01) while *Treculia africana* gave higher centimeter of leaf blade length (18.20±0.01), leaf blade width (7.76±0.02) and number of lateral vein (21.50±0.01). Aside for the leaf blade width, petiole length, and seed width, there was significant difference in otherquantitative morphological parameter (twig length, leaf blade length, number of lateral vein and seed length) assayed ($P<0.05$). In conclusion, this study revealed that the different morphological, anatomical of A. heterophyllus and T. africana. The results showed that some of the constituents varies in the plant parts (root, stem, seed and leaf) and among species.

Keywords; Morphological structures, anatomical compositions, jackfruit (*Artocarpus heterophyllus* Lam) and African breadfruit (*Treculia africana* Decne).

INTRODUCTION

The global challenges of increase in human population, food scarcity, and rural poverty have led to increase in the demand on plant products and threatening of some valuable plant species such as African breadfruit (*T. africana* Decne) [1,2,3,4]. African breadfruitis of the family Moraceae and the most viable alternative to it may be plant of the same family. There are researches being carried out on how to mitigate the rate at which plants are going into extinction [5,6,7,8]. Part of the efforts are directed towards identification of possible alternatives to these endangered plant species while other works are planned to modify the growth and/or development pattern of the plants why retaining the fruit quality (quality of edible parts) [9,10]. *T. africana* is a tropical plant of desired economic value but which is rapidlydisappearing. Morphologically Jackfruit artocarpus species seem to be the closest alternative to the well known African breadfruit [11,12,13]. Within the genus is jackfruit (*A. heterophyllus*) which is one of the outstanding species. The fruit resembles that of African breadfruit [14,15,16]. It is therefore possible that this species may be the best alternative to African breadfruit. Jackfruit (*Artocarpus heterophyllus* Lam) is one of the most significant dicotyledonous trees in tropical homegardens and perhaps the most widespread and useful tree in the genus *Artocarpus* [17,18,19]. The generic name comes from the Greek words ‘artos’ (bread) and ‘karpos’ (fruit); the fruits are eaten and are commonly called ‘African breadfruit’ or ‘Bread of the Tropics’. The specific name, ‘heterophyllus’, in Latin means, with leaves of different sizes and shapes and the word ‘heteros’ in Greek corresponds to the word ‘different’. The word ‘jackfruit’ comes from Portuguese jaca, which in turn, is derived from the term ‘chakka’ in Malayalam language. The ancient Indian

Language Sanskrit refers this fruit as Atibruhatphala [20] and it is known in south east of Nigeria among the igbos as *ukwa bekee/ukwa oyibo* (white-man bread fruit) [21]. Jackfruit is both the name of the fruit and of the tree it grows on [22]. It is a perennial fruit tree crop, growing vigorously on both the branches and trunks of trees that can reach up to 8-25 meters in height and 2 meters in girth [23]. Fully- riped Jackfruit will fall from the tree, so it is often harvested early to avoid having the large fruits fall on top of anyone [24]. These attribute are close to the features of *Treculia*. The aroma of a mature Jackfruit has been described as off-putting, similar to overripe fruit. Younger ripe fruit has a sweeter aroma. Jackfruit has a sweet taste and a flavor that is likened to bananas, pineapple and even bubblegum. As the fruit matures, the bulbs become a darker orange-yellow and the taste gets sweeter [25]. The succulent, aromatic, and flavorful fruit is eaten fresh or preserved in myriad ways. The nutritious seeds are boiled or roasted and eaten like chestnuts, added to flour for baking, or cooked in dishes [26]. It is also known for its remarkable, durable timber, which ages to an orange or redbrown color. The leaves and fruit waste provide valuable fodder for cattle, pigs, and goats. Many parts of the plant including the bark, roots, leaves, and fruit are attributed with medicinal properties. Wood chips yield a dye used to give the famous orangered color to the robes of Buddish priest [27]. The tree can provide many environmental services. In homegardens, the dense jackfruit canopy can provide a visual screen and is very ornamental. The fruit is known as the 'poor man's fruit' in eastern and southern parts of India because it is a major part of their diet as a vegetable and nutritious dish during the season [28].

Aim of the Study

The aim of this research was to acertain the morphological structures, anatomical compositions of jackfruit (*Artocarpus heterophyllus* Lam) and African breadfruit (*Treculia africana* Decne)

MATERIALS AND METHODS

Source of Materials

The test samples, (the seeds, leaves, stem and root of *Treculia africana* and *Artocarpus heterophyllus*) (Plates 1-12) were obtained from Umuoji, in Idemmili North Local Government Area of Anambra State, Nigeria. Chemicals and facilities used in the practical were obtained from the Yitzhak Rabin Laboratory Biotechnology Research Centre, Nnamdi Azikiwe University, Awka and Plant Science and Biotechnology Laboratory, University of Nigeria Nsukka, Nigeria.

Identification of Materials

All plant materials used in this study were identified by Prof. C.U. Okeke,- a professor of Taxonomy in Botany Department, Nnamdi Azikiwe University, Awka.

Preparation of Samples for Anatomical Studies

Samples of leaves, matured and immatured stems and roots of *Artocarpus heterophyllus* and *Treculia africana* were preserved as well as softened for easy sectioning in Formalin acetic alcohol (FAA). The solution contained 90 ml of 70% ethanol, 5 ml of glacial acetic acid and 5 ml of formaldehyde.

Macromorphological Study

The qualitative parameters of the vegetative parts such as the habits, leaf architecture (leaf apex, leaf shape, arrangements, margin, attachment, base and tip, and venation patterns) were assessed. Quantitative parameters such as leaf size, petiole length and number of lateral veins were determined using thread and meter rule.

Micromorphological Study of the Foliar Epidermis (Epidermal and Stomatal Studies)

Impression techniques of [8] were used in the preparation on fresh leaves of *A. heterophyllus* and *T. africana*. Leaves were plucked out of freshly collected twigs, the abaxial and adaxial surfaces of the leaves at middle positions, and midrib were coated with a clear translucent nail vanish and allowed to

dry. A second and then a third coating was made allowing 10 - 15 minutes' intervals. After this the leaves were passed through air current (under a fan) to dry for 1-2 hours. Epidermal peel was stripped with a pair of fine forceps and the strip placed on a clean slide, stained with safranin solution and covered with a cover slip. Mounted strips were viewed under an Olympic light microscope (CHBS Olympus type) at differentmagnifications. The following parameters were observed and assessed:

1. Epidermal cells: the type and number of epidermal cells were counted and recorded.
2. Stomata type: the stomata complex types were observed and recorded following the terminologies of [8].
3. Stomata size (length and width): the stomata length and width were measured using motic microscope software a total of 5 fields of views for each sample.
4. Stomata density: the stomata density was determined as the number of stomata per square millimeter.
5. Stomata index: the stomata index was determined as follows:

$$SI = \frac{S}{S + E} \times 100$$

Where: S = Number of stomata in a field of view

E = Number of epidermal cells in the same field of view

All parameters were observed on both the abaxial and adaxial surfaces of the leaves [8].

Preparation of Permanent Sections

The method of [8] was used for anatomical studies. The leaves, stem, and root of some samples were fixed with 10% formal saline. Thereafter, the specimens were washed with distilled water for 3 times. The washed specimens were dehydrated by putting them in 30%, 50%,70%, 90% and 100% ethanol each for two hours. The dehydrates samples were cleared by transferring them to 25%, 50%, and 75% alcohol-chloroform mixtures for two hours in each, and thereafter to pure chloroform to which wax flakes had been added. The vials containing the samples were placed on a hot plate of 30^0C and more waxes were added at intervals for 48hours. Vial caps were removed and vial transferred to the oven at 60^0C and more waxes were added for four hours. The samples were transferred into a metal mould. Each material in a mould was oriented using mounted needles flamed frequently on a spirit lamp. Once a skin of wax had formed on the surface of the mould, it was submerged carefully in cold water. The resulting blocks were trimmed and sectioned on a microtome. The thin sections were mounted on clean slides already smeared with a thin film of Haupt's glue. The slides were passed over hot plate. The specimens were dewaxed and rehydrated by passing the slides through xylene, absolute alcohol, 90%, 70%, 50% and 30% alcohol and in each case allowed to stand for 5 minutes. The sections were stained with 1% alcian for 5 minutes, washed in two changes of distilled water and counter stained with 1% safranin for 5 minutes. Dehydration to critical point and clearing in xylene followed the reverse order of dewaxing and rehydration, the slides were mounted in 2 drops of Canada balsam covered with appropriate cover slip, and baked in an oven for 3 minutes. The slides were studied and photographs taken with a Japaneese made Olympics photo-microscope fitted with a digital camera at the Department of Vertinary Medicine, University of Nigeria Nsukka

Measurements Made from the Slides Bold of the Permanent Sections

The arrangement and distribution of cells in the slide were noted in the three planes of sections. Some quantitative measurement was made with the aid of an eye piece micrometer fitted to the eye piece tube of the light Olympus microscope. The following measurements of the wood element from permanent slides were made:

1. The number of vessels per field of view (vessel density) and their mean taken.
2. Vessel diameters (VD), vessel lumen diameter (VLD) and vessel

cell wall thickness (VCWT) were measured for the stem and root of the two plants (*A. heterophyllus* and *T. africana*) at ×100 magnification. Five measurements were made and their mean taken.

3. The recommended terminology and procedures by the IAWA Committee were followed in the description and determination of quantitative values.

The following measurement of the stomata from permanent slides were made:

1. Length and width of the various stomata found in the leaf epidermal

Wood Maceration

Wood maceration was carried out according to [11]. Chips of wood measuring 2cm thick were placed separately in long test-tubes which were labeled prior to the experiment with the names of the wood sample. Two grams of 5% potassium chlorate ($KClO_3$) crystals were added to each of the test tube. 10ml of conc. Nitric acid (HNO_3) were carefully added to each of the test tubes. The set up was allowed to react in a fume cupboard until the lignin and middle lamella of the chips dissolved. The presence of lignin was shown by the reddish-brown colour of the test tubes. At the end of the maceration, the tubes were allowed to cool. Each of the tube was filled with water and shaken to wash the fibres and then allowed to stand for about 24 hours. At the end of this period, there were sediments of fibres. Water was decanted and the concentrated sediments were put into two labeled injection bottles for each plant. In each of the injection bottles, one to two drops of 1% Safranine was added to stain the fibres. One to two drops of phenol were also added to prevent the fibres from decaying. Air trapped was removed by the addition of one to two drops of glycerine. A microscope fitted with a calibrated eyepiece micrometer at X100 and 400 magnificaations was used to measure fibre length (FLD), Lumen Diameter (FLD) and fibre cell wall thickness (FCWT). The derived values were calculated from the measured dimensions. The relevant formulae that were used for the determination of the parameters followed that of [16] as follows:

Runkel ratio 2C/l

Coefficient of Suppleness l/D

Slenderness ratio L/D

Where L=fibre length, C= fibre cell wall thickness, D= fibre diameter and l= fibre lumen diameter. Conversion factors for fibre length at X100 magnification and fibre cell wall thickness, fibre diameter and fibre lumen diameter at x 400 magnification were determined using eye-piece and stage micrometer under an Olympus microscope.

Statistical Analysis

Data collected was analysed using Analysis of Variance (ANOVA) and test of significance were processed using Duncan's Multiple Range Test and Student's 't' test at 5% level of probability

RESULTS

Morphological Studies of *Artocarpus heterophilus* and *Treculia africana*

Qualitative Morphological Studies of *Artocarpus heterophilus* and *Treculia africana*

Morphological studies of the features of *Artocarpus heterophyllus* and *Treculia africana* showed a close resemblance of the leaves,twig and fruits, while difference was seen more on the seedof the two plants. The detailed qualitative morphological expressions are stated in Table 1.

Table 1: Comparison of the Qualitative Morphological Parameters of *Artocarpus heterophyllus* and *Treculia africana*

Features	*Artocarpus heterophyllus*	*Treculia africana*
Habit	Perennial evergreen tree	Perennial evergreen tree
Leaves	Simple with undivided blade, Alternate and spirally arranged, with one leaf attached at each point and with erect branching pattern (Plate 1 and 3) (Page 57), dark green and shiny in adaxial side but light green in abaxial side. Petiolated, leaf apex acute to short-acuminate, leaf base Cuneate to rounded, leaf shape Elliptic, entire margins with pinnately netted vein (Plate 5and 7) (Page 58),	Simple leaves, alternatively arranged with one leaf attached at each point and Petiolated (Plate 2 and 4) (Page 57), leaf apex acuminate, leaf base Rounded to cuneate leaf shape Lamina (narrowly) obovate to elliptic (to narrow elliptic), entire margins, andvein pinnate(Plate 6 and 8) (Page 58),
Fruit	Oval in shape, big, greenish yellow in colour, hard and spined (Plate 9) (Page 59),	Ovoidin shape, big, greenish yellow in colour, hard and spongy in texture (Plate 10) (Page 59),
Seed	Bean-shaped achenes coated with a firm yellowish arid (seed coat) (Plate 11) (Page 60),	Whitish, roughly oval and spherical (Plate 12) (Page 60),
Stem (bark)	Greyish-brown and smooth. When injured releases a milky juice. Lateral branching pattern.	Dark grey and smooth. When cut, the thick bark produces white latex
Root	Tap root system	Tap root system

Plate 1: *Artocarpus heterophyllus* twig with adaxial leaves

Plate 2: *Treculia africana* twig with adaxial leaves

Plate 3: *Artocarpus heterophyllus* twig with abaxial leaves

Plate 4: *Treculia africana* twig with abaxial leaves

Plate 5: Abaxial leaf surface of *Artocarpus heterophyllus*

Plate 6: Abaxial leaf surface of *Treculia africana*

Plate 7: Adaxial leaf surface of *Artocarpus heterophyllus*

Plate 8: Adaxial leaf surface of *Treculia africana*

Plate 9: *Artocarpus heterophyllus* fruit

Plate 10: *Treculia africana* fruit

Plate 11:*Artocarpus heterophyllus* seeds

Plate 12:*Treculia africana* seeds

Quantitative Morphological Parameters of *Artocarpus heterophyllus* and *Treculia africana*

The morphological assessment of *Artocarpus heterophyllus* and *Treculia africana* is shown in Table 2,which showed that *Artocarpus heterophyllus* gave a higher centimeter of twig (33.15±0.01), petiole length (1.40±0.02), seed length (3.77±0.01) and seed width (2.33±0.01) while *Treculia africana* gave higher centimeter of leaf blade length (18.20±0.01), leaf blade width (7.76±0.02) and number of lateral vein (21.50±0.01). Aside for the leaf blade width, petiole length, and seed width, there was significant difference in otherquantitative morphological parameter (twig length, leaf blade length, number of lateral vein and seed length) assayed (P<0.05).

Table 2: Quantitative Morphological Parameters of *Artocarpus heterophyllus* and *Treculia africana*

Parameter	*Artocarpus heterophyllus*	*Treculia africana*	P-value
Twig Length (cm)	33.15±0.01	21.00±0.01	0.00
Leaf Blade Length (cm)	12.58±0.01	18.20±0.01	0.00
Leaf Blade Width (cm)	7.60±0.01	7.76±0.02	0.73
Petiole Length (cm)	1.40±0.02	0.50±0.01	0.80
No. of Lateral vein	17.00±0.01	21.50±0.01	0.00
Seed Length (cm)	3.77±0.01	0.70±0.01	0.00
Seed Width (cm)	2.33±0.01	0.23±0.02	0.80

Anatomical Studies of the Parts of *Artocarpus heterophilus* and *Treculia africana*

Comparison of Wood Fibre Parameters of *Artocarpus heterophilus* and *Treculia africana*

Comparison of the wood fibre parameter of the two plant species is shown in Table 3. The Table 3 revealed that *T. africana*gave higher value of wood fibre length (983.53±137.90 µm), fibre diameter (23.71±3.95 µm), fibre lumen diameter (16.61±3.22 µm), and coefficient of flexibility (0.70±0.02) while*A. heterophyllus* gave higher value of fibre cell wall thickness (3.5554±0.47), runkel ratio (0.62±0.03) and slenderness (49.84±0.04). There was significant difference only in the coefficient of flexibility in the wood fibre of the two plants (P<0.05).

Table 3: Comparison of Wood Fibre Parameters of *A. heterophyllus* and *T. africana*

Fibre Parameters	*A. heterophyllus*	*T. africana*	P- value
Fibre Length (µm)	926.30±100.22	983.53±137.90	0.43
Fibre Diameter (µm)	18.59±4.81	23.71±3.95	0.48
Fibre Lumen Diameter(µm)	11.59±4.43	16.61±3.22	0.37
Fibre Cell wall Thickness (µm)	3.5554±0.47	3.49±0.72	0.52
Coefficient of Flexibility	0.62±0.02	0.700±0.02	0.00
Runkel Ratio	0.62±0.03	0.41±0.04	0.16
Slenderness	49.84±0.04	41.48±0.03	0.16

Micrographs of Wood Fibre of *Artocarpus heterophyllus* and *Treculia africana*

The micrographs of wood fibre of *Artocarpus heterophyllus* and *Treculia africana* are shown in Plates 13 and 14. The Plates showed both plants to have long fibre length.

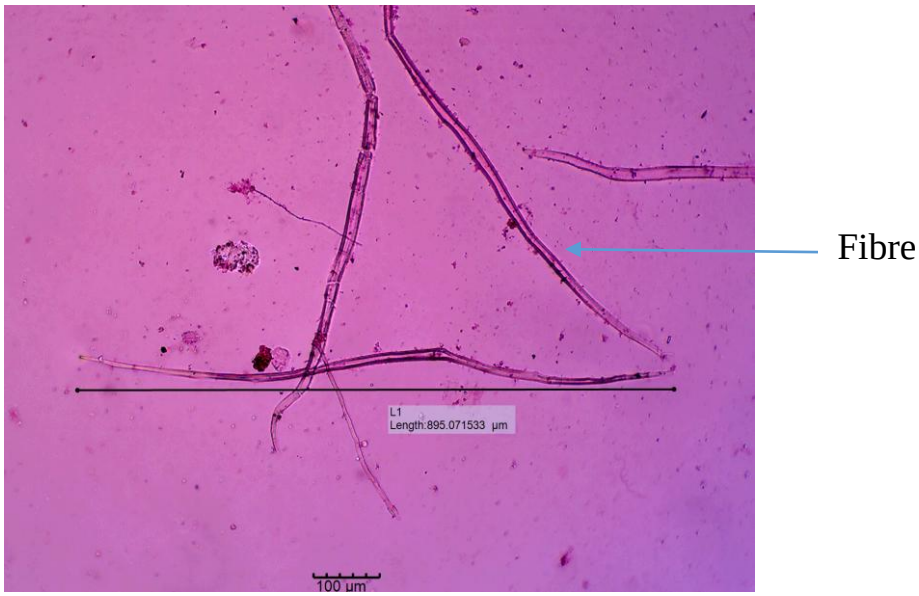

Plate 13 : *Artocarpus heterophyllus* Fibre ×100

Plate 14 : *Treculia africana* Fibre ×100

Comparison of Root Vessel Parameters of *Artocarpus heterophilus* and *Treculia africana*

Comparison of the root vessel parameters of the two Plant Species is shown in Table 4. The table 4 revealed that *A. heterophyllus*gave higher value of both root vessel diameter (198.11±36.84µm), root vessel lumen diameter (193.62±0.02µm) and vessel celwall thickness (4.49±0.01). Except in number of vessel. There was significant difference only in the vessel diameter of the root of the two plants. (P>0.05).

Comparison of Stem Vessel Parameters of *Artocarpus heterophilus* and *Treculia africana*

Comparison of the stem vessel parameters of the two Plant Species is shown in Table 5. The Table 5 revealed that *T. africana*gave higher values in all the stem parameters assayed. There was significant difference in the Vessel diameter and vessel cell wall thickness of the stem of both plants($p<0.05$).

Table 4: Comparison of Root Vessel Parameters of *A. heterophyllus* and *T. africana*

Plant Species	*A. heteropyllus*	*T. africana*	P- value
No. of Vessel	5.00±0.03	7.00±0.02	0.31
Vessel Diameter µm	198.11±36.84	149.90±10.00	0.01
Vessel Lumen Diameter µm	193.62±0.02	146.7±0.02	3.21
Vessel Cell Wall Thickness µm	4.49±0.01	3.20±0.14	12.63

Table 5: Comparison of Stem Vessel Parameters of *A. heterophyllus* and *T. africana*

Plant Species	*A. heterophyllus*	*T. africana*	P- value
No. of Vessel	9.00±0.05	10.00±0.06	12.99
Vessel Diameter µm	89.10±2.57	114.84±4.23	0.01
Vessel Lumen Diameter µm	86.33±0.02	109.9±0.02	3.21
Vessel Cell Wall Thickness	2.77±0.01	4.94±0.01	0.00

Comparison of Leaf Epidermal and Stomata Anatomical Parameters of *Artocarpus heterophilus* and *Treculia africana*

Quantitative Comparative Assessment of Leaf Epidermal and Stomata Parameters of *Artocarpus heterophilus* and *Treculia africana*

The comparison of leaf epidermal and stomata parameters of the two plant species is shown in Table 6. The Table 6 revealed that except for stomata index, *A. heterophyllus*gave higher values of the epidermal and stomata parameters assayed. There was no significant difference in the leaf epidermal and stomata parameters of the two plants (P>0.05).

Morpho-anatomy of the Surface View of Leaf Epidermis of *Artocarpus heterophyllus* and *Treculia africana*

The comparison of the surface view of leaf epidermis of the two plants is shown in Table 7. The Table 7 revealed that both plants have anomocytic type of stomata which were moderately distributed and absent of trichomes. The difference is seen in the shape of their epidermal cells by *Artocarpus heterophyllus* having irregularly shaped cell walls with chain-like orientation while *Treculia africana* has irregularly shaped with undulating walls.

Table 6: Comparison of Leaf Epidermal and Stomata Parameters of *A. heterophyllus* and *T. africana*

Stomata parameters	*A. heteropyllus*	*T. africana*	P- value
No. of Epidermal Cells	43.00±0.01	35.00±0.02	0.08
Stomata Density	7.00±0.02	6.00±0.05	1.24
Aperture length	20.42±0.01	16.00±0.05	2.56
Aperture width	2.24±0.01	2.03±0.02	0.80
Stomata Length	28.59±3.15	19.30±1.04	0.26
Stomata Width	23.00±1.27	10.84±0.94	0.57
Stomata Index	20.83±0.04	27.27±0.02	0.80

Table 7: Comparative Morpho- anatomy of the Surface View of Leaf Epidermis of *Artocarpus heterophyllus* and *Treculia africana*

Feature	*Artocarpus heterophyllus*	*Treculia africana*
Stomata distribution	Moderately distributed	Moderately distributed
Stomata type	Anomocytic (Ranunculaceous)	Anomocytic (Ranunculaceous)
Trichomes	Absent	Absent
Shape of epidermal Cells	Irregularly shaped cell walls and chain-like in orientation	Irregularly shaped with undulating walls

DISCUSSION

Morphological studies of the features of *A. heterophyllus* and *T. africana* (Table 1) showed a close resemblance in their habit, fruit and leaves. This morphological closeness may suggest that the plants belong to the same group of angiosperm, this is in line with the findings of [5], which states that morphological, anatomical and pollen characters are applied in solving controversial taxonomical and phylogenetical problems. Interestingly the two plants belong to the same family Moraceae. The anatomical analysis of wood fibres parameters of the two plants, showed *A. heterphyllus* to be of high fibre length (926.30±100.22 µm) as that of *T. africana* (983.53±137.90 µm) (Table 3) and thus can be of importance in pulp and paper production. The characteristic of fibre, such as fibre length and width, are important parameters in estimating the qualities of pulp [14,16] and the strength property of paper depends on the characteristics of its fiber. Fiber length is the most important physical property for pulping as it generally influences the strength of the pulp and the paper made from it [9,17]. The high fibre length of *A. heterophyllus* and *T. africana*, if used in paper making can produce papers with high tearing resistance for it was noted in the findings of [11] that the greater the fiber length, the higher the tearing resistance of paper. However, longer fibers tend to give a more open and less uniform sheet structure. The average fiber cell walls thickness of *A. hetero*phyllus and *T. africana* (3.5554±0.47µm and 3.49±0.72µm respectively) (Table 3) observed in this study, were lower than the 3.83 µm and

4.02 µm values of [13] on the cell wall thickness of *G. arborea*; an important species used in pulp production but fall within 1.94 to 4.99µm for different Ficus species [8]. Thus both plants will give better printing surface because wood with thick cell walls tends to produce paper with a poor printing surface and poor burst strength. Thick-walled cells do not bend easily and do not collapse upon pulping, which inhibits chemical bonding [8]. According to [7], a decline in wood density reduces pulp yield. Paper manufactured with thick fibre would be bulky with lower tensile and burst [7]. This study also showed that *A. heterophyllus* could be a good alternative material for pulp production in the scarcity of *T. africana* by having runkel ratio of 0.62±0.03 to that of 0.41±0.04 (Table 3). According to [17], for any wood species to be of good quality for pulp and paper production, its Runkel ratio must not be more than 1. Runkel ratio is also a measure of stuitability of fibre for pulp production. High Runkel ratio fibres form bulkier paper of lower bonded areas in comparison with lower Runkerl ratio fibre [16], its fibres are more flexible and collapse easily. *A. heterophyllus* and *T. africana* with 0.62±0.02 and 0.700±0.02 observed coefficient of flexibility value, tend to being also good source of pulp for paper production. Flexibility coefficient is one of the important derived indices to determine strength properties of paper and is governed by lumen diameter and fibre diameter. According to [8], the coefficient value for hardwood is 0.75 and hardwood fibre with flexibility coefficient more than 0.75 are considered as highly elastic [14], thus *A. heterophyllus* and *T. africana* with the above coefficient of flexibility value are slightly up to the recommended value. Furthermore, the slenderness ratio value of both plant as seen in table 16 were higher than the value (33) reported by [11] to be good for pulp and paper production and thus will produce long, thin high tearing resistance papers. The presence of wide size range vessels in the root and stem of *A. heterophyllus* and *T. africana* showed both plants to have better conducting efficiency, this is in line with the findings of [8] that angiosperm with bigger vessels is better for conducting efficiency while smaller vessels provides resistance against hydraulic [12]. The tangential and radial sections of both plants revealed the presence of fibres which can be source of support to the plant for [9], stated in his work that xylem fibre are source of mechanical support to plant. The parenchyma cells present in both plant shows that both plants have good storage, defense and biomechanical properties and this agrees with the report of [5] on woody plant parenchyma functions ranging from transport and storage to defense and biomechanics.

CONCLUSION

This study has revealed the different morphological, anatomical of A. heterophyllus and T. africana. The results showed that some of the constituents varies in the plant parts (root, stem, seed and leaf) and among species.

REFERENCES

1. Abdul, M. and Martin, K.A. (2015). Poor Man's Fruits: Now a Miracle Food. *Food Chemisty, 5(4):* 123-134.
2. Abdulrhaman, A.A. and Oladele, F.A. (2005). Stomata, Trichomes and Epidermal Cells as Diagnostic Features in Six Species of Genus Ocimum. L. (Lamiaceae). *Nigeria Journal of Botany, 18*: 214-223
3. Acedo, J. (1992). Jackfruit Biology, Production, and Use. *Philippine Research*. Monograph Number 1. Forestry/ Fuelwood Research and Development Project, Arlington Virginia. 210Pp.
4. Aderibigbo, A. O., Adeyemi, I. O. and Agboola O. I. (2010). Central Nervous System Depressant Properties of *Treculia africana* Decne. *Journal Ethonbotanical, 14*:108-2010.
5. Agbogidi, O.M. and Onomeregbor, V.A. (2008). Morphological Changes in the Seedlings of *Treculia africana* Grown in Crude Oil Impacted Soils. In: Climate Change and

Sustainable Renewable Natural Resources Management (Ed.) Popoola L. *Proceeding of 32nd Annual Conference of the Forestry Association of Nigeria, held in Umuahia, Abia-State, Nigeria. 20th -24th Oct; 2008*. Pp. 170-182.

6. Agu, H., Ayo, J.A., Paul A.M. and Folorunsho, F. (2007). Quality Characteristics of Biscuits Made from Wheat and African breadfruit (*Treculia africana*). *Nigeria. Food Journal, 25(2):* 19 – 27.
7. Ajayi, I.A. (2008). Comparative Study of the Chemical Composition and Mineral Element Content of Artocarpus heterophyllus and Treculia africana seeds and Seed Oils. *Bioresource Technology: 99(11)* 5125-9
8. Ajayi, I.B. and Adewale, R.A. (2013). Amino Acid Composition and Short-term Toxicological Evaluation of *Artocarpus heterophyllus* Seed Cake in Rat Diet. *NY Sci. J, 6(7):* 91-96.
9. Ajiwe, V.E., Okeke, C.A. and Agbo, H.U. (1995). Extraction and Utilization of African breadfruit Seed Oil (*Treculia africana*). *Bioresource Technology, 53*: 183-184.
10. Akhil, H., Revikumar, K. G. and Divya, D. (2014). Artocarpus: A Review of Its Phytochemistry and Pharmacology. *Journal of Pharmaceutical Search, 9(1)*:7.
11. Akinmutimi, A.H. (2006). Nutritive Value of Raw and Processed Jackfruit Seeds: Chemical Analysis. *Agricultural Journal. 1(4*): 266-271. DOI: http://dx.doi.org/10.1016/j.aaspro.2016.02.148
12. Ali, N.C., Agbo, A.E., Attah, C.P. Ekwueme, J.I. and Ugwoke, F.N. (2003). *A Note on African breadfruit*(*Treculia africana* Decne). (Unpublished) Report Submitted in Partial Fulfillment of CSC 341, Dept. of Crop Science, University of Nigeria, Nsukka. 11Pp
13. Allen, V. B. and Pilbeam, D.J. (2007). Handbook of Plant Nutrition CRC Press. ISBN 978-0-8247-5904-9. Retrieved 28 March 2019.
14. Al- Mayah, A.A and Hammadi, K.J. (1998). Vegetative Anatomy of Polygonum (Polygonaceae), *Basrah Journal of Science*, *16*: 55-62.
15. Al- Rubaie, I.M. (2002). Comparative Anatomical Study of Some Species of Malvaceae in Iraq. *Journal of Basrah Researches*, *28*: 90-109.
16. Balasbramanian, A., Thresiammar, A.J. and Saravanan, S. (1993). Petiolar Anatomy as an Aid to the Identification of Cinnmomum Species (Lauraceae). *Indian Forester, 199*: 583-586.
17. Bate- Smith and Swain (1962). Flavonoid Compounds.In: *Comparative Biochemistry.* Flokin, M. Mason, Academic Press, New York. P:75- 80.
18. Hakin, E.H., Juliawaty, L.D, Syah, Y.M. and Achmad, S.A. (2005). Molecular Diversity of *Artocarpus champeden* (Moraceae): A Species Endemic to Indonesia. *Journal of Molecular Divers. 9*: 149-158.
19. Haq, N. (2006). Jackfruit (*Artocarpus heterophyllus*). In: Tropical Fruit Trees, edited by Williams, J.T., Smith, R.W. and Dunsiger, Z., Southampton, U.K: Southampton Centre for Underutilized Crops, University of Southampton.76Pp.
20. Malan, F. (1991). Variation, association and Inheritance of Juvenile Wood Properties of Eucalyptus grandis Hill ex Maiden with Special Reference to the Effect of Rate of Growth. *South African Forestry Journal*. *157*:16-23.
21. Manjeshwar, S.B., Arnadi, R. S., Raghavendra, H., Jerome, D. and Bhat, P.H. (2011). Phytochemistry, Nutritional and Pharmacolgical Properties of *Artocarpus Heterophyllus* Lam (Jackfruit): *A Review of Food Research International. 44(7):*1800-1811.
22. Marques, G., Rencoret, J., Gutierrez, A. and Del-Rio, J.C. (2010). Evaluation of the Chemical Composition of

Different Non- Woody Plants Fibres Used for Pulp and Paper Manufacturing. *The Open Agriculture Journal*, *4*: 93-101.

23. Maton, A.J., Hopkins, C.W., Mc Laughlin, S., Johnson, M.G., Warner, D., Lahart, J.D.W. (1993). *Human Biology and Health.* Engle wood, New Jersey, USA. 809Pp.
24. Mbuya, L.P. (1994). *Useful Trees and Shrubs of Tanzania*: Identification, Propagation and Management for Agricultural and Pastoral Communities. Regional Soil Conservation Unit (RSCU), Swedish International Development Authority (SIDA) 440Pp
25. Mondal1, C., Remme1, R. N. Mamun, A.A. Sultana, S. Ali, M. H. Mannan, M.A. (2013). Product Development from Jackfruit (*Artocarpus heterophyllus*) and Analysis of Nutritional Quality of the Processed Products. *IOSR Journal of Agriculture and Veterinary Science, 4(1)*:76-84.
26. Morton, J. (1987). *Artocarpus heterophyllus*. Fruits of Warm Climates. Julia F. Morton, Miami, Florida. Pp. 58-64. In: Ocloo1, F.C.K., Bansa, D. Boatin, R., Adom, T. and Agbemavor, W.S. (2010). Physico-Chemical, Functional and Pasting Characteristics of Flour Produced from Jackfruits (*Artocarpus heterophyllus*) Seeds. *Agriculture and Biology Journal of North America*, 2151-7525.
27. Morton, J. (1987). *Artocarpus heterophyllus*. Fruits of Warm Climates. Julia F. Morton, Miami, Florida. Pp. 58-64. In: Bolanle – Ojo, O.T., Afolabi, J.O., Ogunsiji, A.O., Ogunade, J.O. and Morankinyo, D.A. (2017). Effects of Graded Levels of Organic and Inorganic Fertilizers as an Amendment to Potted Seedlings of *Artocarpus heterophyllus* Lam. *Journal of Forestry Research and Management, 14* (*2*):64-74.
28. Oladele, F.A., (1991). *Essentials and Applications of Wood Anatomy*. J. Olu Olatiregun (Nig.) Company, Ilorin. 410Pp.