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CLIMATE CHANGE PARTNERSHIP ACTIONS FOR SUSTAINABLE FUTURE AND RESTORING LIFE ON EARTH

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PREFACE

There is a growing concern on the adverse impacts of climate on biodiversity. This phenomenon is greatly manifested in form of shifting weather patterns threatening global food security, health and species existence. Humanity is at the receiving end of the consequences of climate change hence there is a need to step up actions on all fronts- overtime, everywhere all at once.

This calls for collaboration, partnership and networking to strengthening synergy among relevant stakeholders in a bid to tackling climate change menace. This forms the basis for the theme of this year world Environmental conservation conference: **CLIMATE CHANGE PARTNERSHIP ACTIONS FOR SUSTAINABLE FUTURE AND RESTORING LIFE ON EARTH.** The theme is conceived with a view to create an interface for information sharing and offer opportunities for participants to refine their commitments and pledges in the quest to achieving Sustainability in the face of climate change.

This year World Environmental Conservation Conference is memorable in the sense that it received overwhelming funding from the host - West African Science Service on Climate Change and Adapted Land use). WASCAL is posed to provide information and knowledge at the local, national and regional level to cope with the adverse impacts of climate change. Thus, this conference will offer opportunities for participants to learn from good practices demonstrated and showcase by WASCAL during the course of the conference. It will also strengthen staff-student exchange and provide prospect for Doctorate Research Doctoral Research in West Africa Climate System Programme (DRP WACS) – WASCAL among others.

Special appreciation goes to the management of The Federal University of Technology, Akure the host institution, National Park Service and African Regional Center for Space Science and Technology Education-English (ARCSSTE-E) that co-host this conference. We equally acknowledge other private, individual and corporate organizations that have contributed towards the success recorded in this event.

All the submitted articles were subjected to strict double blind peer-review process by the reviewers that are experts in the area of the particular submitted manuscript. The accepted manuscripts are published in WECC 2023 proceedings and also available for download on the organization website (www.necorng.org).

The accepted manuscripts fall within the underlisted subthemes:

- Climate change adaptation strategies in Agriculture, Forestry and Other Land Use (AFOLU)
- Climate smart city and architectural landscape design
- Retrofitting and decarbonization in tourism and hospitality industry
- Indigenous knowledge and local innovation in climate change adaptation
- Climate risk management, health, safety and hygiene
- Carbon credit-offset marketing/circular economy
- ICT development in environmental conservation (image processing and acquisition, computer vision, graphics, speed, interface technology, HMD devices, GIS: Body Tracking, AI and IOT, VRT, IVE).

We commend our keynote speaker Prof. Douda Kone Director Capacity Building Department, WASCAL Headquarter, Ghana and other guest speakers Prof. Babatunde Rabiu, Director General, Chief Executive Office, African Regional Centre for Space Science and Technology Education-English (ARCSSTE-E) and Dr. Goni I. M., Conservator General National Park Service.

It is hoped that researchers, students and policy makers will find the papers in this book very useful. Even though all the papers were reviewed and edited, the content and option expressed remain essentially that of the authors and not necessarily that of Netlink Environmental Conservation Organization.

Dr. Oladeji S. O.

President Netlink Environmental Conservation Organization

Convener World Environmental Conservation Conference

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MORPHOLOGICAL VARIATIONS IN FRUITS AND SEEDS OF *Gambeyaalbida* (Don) IN SOUTHWESTERN, NIGERIA

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ABSTRACT

The demand for fruits tree have increased across Africa as well as Nigeria. The young and the old people do search for the location of any fruit tree especially Gambeya albida. The fruit can easily be consumed and enjoy by everyone without any side effects. Gambeya albida is a unique tree that grow in wild mostly, but have vitamins C for proper growth for children and body maintenance of the older ones. The research was carried out at within Southwestern, Nigeria with visitation to Osun, Oyo, Ekiti and Ondo States to collect the fruits in which seeds were extracted and watched and measurement was carried out on the fruit and seeds of G. albidum. The results from the analysis shows that Ekiti and Ondo States have highest average mean values in seed weight, diameter of fruit, fruit length while Oyo and Osun State with the least value across the parameters. The number of seeds in each fruits across the four selected States are 4 to 5 seeds. Base on this experiment, for any establishment of Gambeya albida plantation in Nigeria or introduction to other countries the best seeds recommended should be acquired from either Ekiti or Ondo State of Nigeria.

Keywords: *Gambeya albida, Parameters, Morphological and Genetic.*

INTRODUCTION

Due to population growth, unsustainable farming practices, a lack of viable employment options, intense human pressure on forests, and poverty, indigenous forest trees with specific nutritional and gastronomic values are currently being over-harvested in Nigeria (Anegbeh *et al.,* 2004). Fruit trees are rapidly going to extinction, which threatens not only the availability of food but also the ecology, health, and genetic preservation of species. According to Ehiagbonare *et al.,* (2008), the African star apple (*Gambeya albida*) is an edible fruit tree from the Sapotaceae family, which includes up to 700–800 species. The species, which is mostly a lowland rainforest tree, has been observed naturally in a number of biological zones (Bada, 1997). According to Olayode *et al.* (2018), the species was one of the top 14 tropical hardwood species that dominated the continent's international timber commerce between 1950 and 1975. *C. albidum*is one of the species of forest trees that provide Non Timber Forest Products (NTFPs) of substantial domestic value to rural and urban residents in West and Central Africa, with significant export potential (Nwoboshi, 2000). Due to greater understanding of the nutritional value, social, cultural, and therapeutic worth of *Gambeya albida*, its economic significance has grown recently (Onyekwelu and Stimm, 2014). Consequently, the fruit is crucial for ensuring the safety of household food.

According to Ruiz-Perez *et al.,* (2004) and Leakey *et al.,* (2005), wild harvesting of these fruits from woods and semi-domesticated trees growing on farms and homesteads can significantly increase rural income and job opportunities. Farmers have identified these regional species as trees for domestication through agroforestry as a result of their commercial relevance (Franzel *et al.,* 1996). The process of domesticating trees entails using genetic principles to raise the value of tree crops and the final product's economic returns. The process of market-driven domestication, inventory of the natural resource, and sustainable production of agroforestry products based on strategies that take into account the needs of farmers and their priorities for domestication are all contributing to an increase in the quality and productivity of agroforestry trees (Simons and Leakey 2004; Leakey *et al.,* 2005).However, due to intensive fruit extraction brought on by *Gambeya albida's* high economic value and the consequent scarcity and rapid decline in fruit availability, the species has been listed as endangered or threatened (FORMECU, 1999). *Gambeya albida* may be a victim of unsustainable exploitation, as evidenced by high rates of male to female sex ratio, high rates of fruit and seed consumption, and scant or no regeneration efforts. . In order to identify the best trees for domestication, this study intends to define the intraspecific variability among *Gambeya albida* trees in four selected States of southwestern Nigeria using fruit and seed attributes and to analyse correlations between these traits.

MATERIALS AND METHODS

The study was carried out within the Southwestern Nigerian, the following State; Ekiti, Ondo, Osun, and Oyo, State were selected and forty matured *Gambeya albida* trees were chosen at random with ten mother trees from each State. For the purpose of identifying variations in fruit and tree morphology, thirty fruits from each of the mother trees in the chosen States with a total of one thousand two hundred (1200) fruits were carefully chosen respectiely.

Fruit Measurement

The following dimensions of the fruit were measured such as; fruit length (mm), fruit diameter (mm), number of seeds per fruit, weight of seeds (g), and fruit weight (g) were measured. According to Gontcharova's (2009) recommendation the weight and size of the fruits were measured using digital top loading balances and vernier calipers respectively. The seeds of each fruit were meticulously taken out, washed in clean water, allowed to dry for 48 hours, and then weighed on an electronic scale. The diameter at breast height (1.3 meters above ground level), the crown diameter, and the overall height of each selected mother tree were measured using a Spiegel relascope, a diameter tape, and a metre rule, respectively.

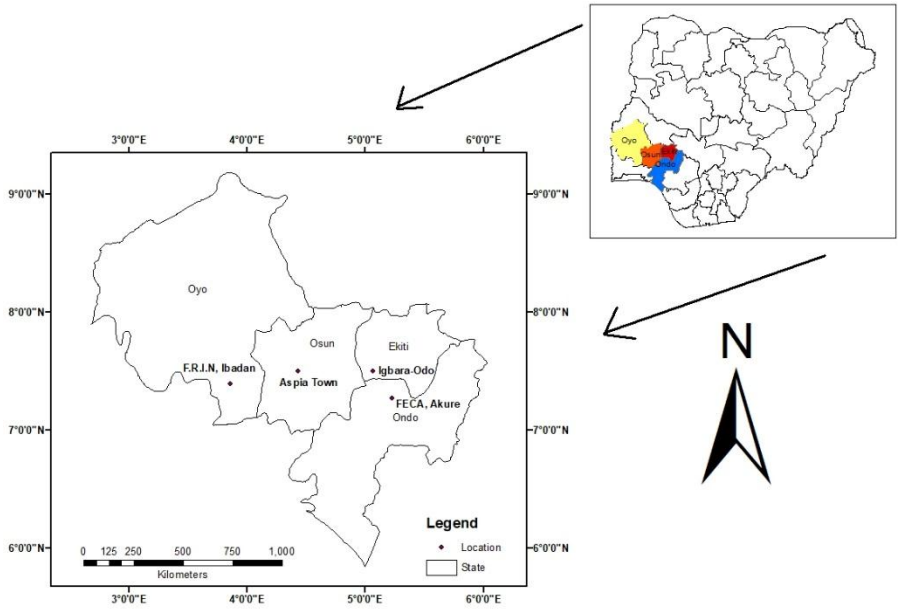

Figure 1: Selected locations for collection of *Gambeyaalbida* in Southwestern Nigeria

Plate 1: Fruit and Seeds of *Gambeya albida* in Southwestern Nigeria

RESULTS AND DISCUSSION

Morphology Characteristics of *Gambeya albida* fruits in in Selected States in Southwestern Nigeria

Oyo State

The results from the sampled trees of *G. albida* shows a significant difference in the fruit length of *Gambeya albida* in Oyo State as shown in table 1 below. Largest fruit length was obtained from *Gambeya albida* (Ga) 1 with value of (46.193^{a}) followed by Ga 6 with value of (45.780^{a}) while the least value were obtained from Ga 9 (37.393^{c}) and Ga 3 (31.108^{d}) respectively. There is significant difference in the diameter of fruit of *Gambeya albida*, with the largest fruit diameter was obtained from Ga 6 (40.632^{a}) followed by Ga 2 (40.479^{ab}) and Ga 10 (40.076^{ab}) while the least was obtained from Ga 8 (35.724^{c}) and Ga 3 (30.703^{d}) respectively. In addition,' there is significant difference in the fruit Weight of *Gambeya albida.* Highest fruit weight was obtained from Ga 6 (45.400^{a}) followed by Ga 2 (44.667^{a}) and Ga 1 (43.333^{a})

while the lowest was obtained from Ga 8 (29.833^{e}) and Ga 3 (18.867^{f}).Also there is a significant difference obtained in the number of seeds per fruit of *Gambeya albida.* The highest number of seeds per fruit were obtained from Ga 9 (5.233^{a}) followed by Ga 5 (5.167^{a}) while the least was obtained from Ga 8 (4.867^{b}).There is significant difference in the seed eight of *Gambeya albida*. Highest seed weight was obtained from Ga 6 (5.767^{a}) followed by Ga 10 (5.667^{ab}) while the least were obtained from Ga 3 (4.100^{c}) and Tree 4 (3.933^{c}) in the State respectively.

Osun State

There were significant differences in fruit length across the *Gambeya albida* trees in Osun State as shown in table below. Highest fruit length was recorded for Ga 6 with the value of 42.098^{a} followed by Ga 1 (41.976^{a}) while the shortest fruit length was recorded for Ga 8 (37.527^{ab}) and Tree 9 (36.507^{b}). Also, there is a significant differences observed in diameter of fruit across the *Gambeya albida* trees sampled. Highest fruit diameter was recorded in Ga 9 and Ga 6 with the same value (39.656^{a}) while the least fruit diameter was obtained from Ga 9 (34.355^{c}) and Ga3 (28.961^{d}).Moreover, there is no significant difference in fruit weight across the *Gambeya albida* trees also sampled. The highest fruit weight was obtained from Ga 6 (41.867^{a}) followed by Ga 8 (41.533^{a}) while the least was recorded for Ga 9 (37.333^{a}) and Ga 10 (36.367^{a}).There is no significant difference in the number of seed per fruit across the *Gambeya albida* trees. But the highest number of seed was obtained from Ga 1 and Ga 10 with equal value of 5.067^{a} while the least was recorded for Ga 3 (4.967^{a}).However, there were significant differences in the seed weight across the *Gambeya albida* trees. Highest seed weight was recorded for Ga 4 (4.300^{a}) followed by Ga 10 (4.233^{ab}) while the lowest was recorded for Ga 1 (3.367^{ab}) and Ga 2 (3.300^{b}).

Ondo State

There is significant difference in the fruit length of *Gambeya albida* (Ga) in Ondo States shown in table below. Highest fruit length was obtained from Ga 8 (52.251^{a}) followed by Ga 9 (52.167^{a}) while the least were obtained from Ga 10 (44.169^{cd}) and Ga 7 (42.075^{de}) respectively. There is significant difference in the diameter of fruit of *Gambeya albida* in Ondo State. Highest diameter of fruit was obtained from Ga 3 (45.143^{a}) followed by Ga 7 (44.628^{a}) while the least were obtained from Ga 9 (40.170^{ef}) and Ga 1 (39.645^{f}) respectively. In addition, significant difference was observed in the fruit weight of *Gambeya albida* in Ondo State. Highest fruit weight was obtained from Ga 3 (51.233^{a}) followed by Ga 7 (50.067^{ab}) while the lowest was obtained from Ga 9 (43.900^{c}) and Ga 1 (42.333^{c}) respectively.

Also, significant difference was discovered in the number of seed per fruit of *Gambeya albida* in Ondo State. Largest number of seed was obtained from Ga 4 (4.967^{a}) followed by Ga 3 (4.933^{ab}) while the least was obtained from Ga 5 (4.667^{an}), Ga 6 (4.667^{ab}) and Ga 1 (4.567^{b}) respectively. There was significant differences seed weight of *Gambeya albida* in Ondo State. Ga 3 had the highest seed weight with a value of 6.300^{a} followed by Ga 4 (6.000^{ab}) while the least was recorded for Ga 8, Tree 10 and Ga 9 with the value of 5.400^{bcd}, 5.400^{bcd} and 5.267 respectively.

Ekiti State

There were significant differences in the fruit length of *Gambeya albida* across the trees in Ekiti State shown in table below. Ga 8 has the highest fruit length followed by Ga 9 with a value of 52.251^{a} and 52.167^{a} respectively while the least were found with Ga 7 (42.075^{de}) and Ga 3 (39.876^{e}).However, there is no significant difference in the diameter of fruit across the *Gambeya albida* trees. The most robust fruit was obtained from Ga 10 (57.8383^{a}) followed by Ga 4 (45.380^{a}) while the less robust fruit was obtained from Ga 3 (39.159^{a}).There are significant differences in fruit weight across the *Gambeya albida* trees. Highest fruit weight was obtained from Ga 4 (65.667^{a}) followed by Ga 6 (65.167^{a}) while the lowest was found with Ga 1 (40.700^{d}) and Ga 2 (38.133^{e}).There is no significant difference in Number of Seed per fruit across the *Gambeya albida* trees. Highest number of seeds were obtained from Ga 6 (4.917^{a}) followed by Ga 7 (4.900^{a}) while the lowest were recorded for Ga 2 (4.733^{a}) and Ga 1 (4.700^{a}).There were significant differences in Seed weight across the *Gambeya albida* trees. Highest seeds weight was obtained from Ga 4 and Ga 6 with the same value (6.600^{a}) followed by Ga 3 (6.200^{ab}) while the lowest were found with Ga 1 (4.800^{d}) and Ga 2 (4.733^{d}) respectively.

RESULT SUMMARY

Generally, the genetic variation across the selected locations in Southwestern Nigeria shows that for fruit length selection in *Gambeya albida* the highest value were recorded from Ondo, Ekiti States respectively, follow by Oyo and Osun States, this correlated with Okwu *et al*. (2017). Highest value of diameter of fruit occurred in Ekiti, Ondo State while Oyo and Osun have the least values this correspond to selection of seeds from Ekiti State by (Olayode *et al.,* 2018) for research work. For fruit weight the highest value were observed in Ekiti, Ondo, Oyo and Osun respectively (Olayode *et al.,* 2018). There is no significant change in the number of seeds in each fruit across the four selected States in southwestern Nigeria (Okwu *et al*., 2017). However, there were significant changes in the seed weight across the four States. Ekiti State have the highest value in seed weight per fruit follow by Ondo, Oyo and Osun respectively.

Table 1: Morphology characteristics of *Gambeya albida* fruits in some selected states in Southwestern Nigeria.

PARAMETER	Selected tree 1	Selected tree 2	Selected tree 3	Selected tree 4	Selected tree 5	Selected tree 6	Selected tree 7	Selected tree 8	Selected tree 9	Selected tree 10
Oyo										
Fruit Length (mm)	46.193^{a}	43.825^{ab}	31.108^{d}	37.467^{c}	40.722^{bc}	45.780^{a}	39.201^{c}	38.047^{c}	37.393^{c}	40.717^{bc}
Diameter of fruit (mm)	39.590^{ab}	40.479^{ab}	30.703^{d}	37.778^{bc}	38.502^{abc}	40.634^{a}	39.609^{ab}	35.724^{c}	36.879^{bc}	40.076^{ab}
Fruit weight (g)	43.333^{abc}	44.667^{ab}	18.867^{f}	31.567^{de}	36.333^{cde}	45.400^{a}	39.200^{abcd}	29.833^{e}	32.767^{de}	36.967^{bcde}
No. of seed per fruit	5.067^{ab}	4.967^{ab}	4.933^{ab}	4.933^{ab}	5.100^{ab}	5.000^{ab}	5.167^{ab}	4.867^{b}	5.233^{a}	5.067^{ab}
Seed weight (g)	5.067^{abc}	5.533^{ab}	4.100^{c}	3.933^{c}	5.300^{abc}	5.767^{a}	5.167^{abc}	5.167^{abc}	4.300^{bc}	5.667^{ab}
Osun										
Fruit Length (mm)	41.976^{a}	38.098^{ab}	30.821^{c}	40.446^{ab}	40.434^{ab}	42.098^{a}	40.630^{ab}	37.527^{ab}	36.507^{b}	40.896
Diameter of fruit (mm)	39.656^{a}	34.859^{bc}	28.961^{d}	39.032^{ab}	38.628^{abc}	39.656^{a}	38.901^{ab}	34.950^{bc}	34.355^{c}	38.947^{ab}
Fruit weight (g)	39.933^{a}	41.333^{a}	40.233^{a}	38.800^{a}	38.633^{a}	41.867^{a}	39.567^{a}	41.533^{a}	37.333^{a}	36.367^{a}
No. of seed per fruit	5.067^{a}	5.000^{a}	4.967^{a}	5.000^{a}	5.000^{a}	5.000^{a}	5.033^{a}	5.033^{a}	5.000^{a}	5.067^{a}
Seed weight	3.367^{ab}	3.300^{b}	3.400^{ab}	4.300^{a}	3.767^{ab}	3.767^{ab}	3.700^{ab}	3.800^{ab}	3.500^{ab}	4.233^{ab}
Ondo										
Fruit Length (mm)	46.822^{abcd}	44.487^{cd}	45.896^{bcd}	44.171^{d}	49.068^{a}	47.140^{bc}	42.075^{de}	52.251^{a}	52.167^{a}	44.169^{cd}
Diameter of fruit (mm)	39.645^{f}	43.747^{ab}	45.143^{a}	43.417^{abcd}	42.496^{bcd}	40.697^{def}	44.628^{a}	41.388^{def}	40.170^{ef}	41.576^{cde}
Fruit weight (g)	42.333^{c}	47.467^{abc}	51.233^{a}	44.533^{abc}	47.733^{abc}	45.933^{abc}	50.067^{ab}	46.467^{abc}	43.900^{c}	46.700^{abc}
No. of seed per fruit	4.567^{b}	4.800^{ab}	4.933^{ab}	4.967^{a}	4.667^{ab}	4.667^{ab}	4.700^{ab}	4.600^{ab}	4.900^{ab}	4.767^{ab}
Seed weight	4.967^{d}	5.600^{bc}	6.300^{a}	6.000^{ab}	5.738^{abc}	5.667^{bc}	5.733^{abc}	5.400^{bcd}	5.267^{cd}	5.400^{bcd}
Ekiti										
Fruit Length (mm)	43.400^{d}	43.702^{d}	39.876^{e}	47.931^{b}	49.135^{ab}	47.140^{bc}	42.075^{de}	52.251^{a}	52.167^{a}	44.169^{cd}
Diameter of fruit (mm)	40.607^{a}	39.048^{a}	39.159^{a}	45.380^{a}	44.220^{a}	45.331^{a}	40.883^{a}	43.655^{a}	42.318^{a}	57.838^{a}
Fruit weight (g)	40.700^{d}	38.133^{e}	59.700^{ab}	65.667^{a}	60.033^{ab}	65.167^{a}	47.967^{bc}	53.767^{bc}	53.767^{bc}	52.633^{bc}
No. of seed per fruit	4.700^{a}	4.733^{a}	4.783^{a}	4.783^{a}	4.817^{a}	4.917^{a}	4.900^{a}	4.800^{a}	4.867^{a}	4.833^{a}
Seed weight	4.800^{d}	4.733^{d}	6.200^{ab}	6.600^{a}	5.900^{abc}	6.600^{a}	5.433^{bcd}	5.266^{cd}	5.533^{bcd}	5.500^{bcd}

Means that do not share the same letter are significantly different

CONCLUSION AND RECOMMENDATION

In conclusion, Ekiti State fruit genetic characteristics performed better in structure and phenotypic than Ondo State but the gap is not significant enough. But Oyo and Osun state phenotypic are smaller compare to the previous state. These made it necessary to recommend Ekiti State fruits of *Gambeya albida* for research work and for farmers and forest for establishment of their plantation for good yield that will attract consumers.

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