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Germination and Early Growth Response of *Annona muricata* (Soursop) Seeds to Organic Growth Hormones in Port Harcourt, Rivers State, Nigeria

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ABSTRACT: The objective of this study was to assess the germination and growth response of *Annona muricata* (soursop) seeds to organic growth hormones such as Aloe vera gel, Coconut water, Lime juice, and Control in a nursery in Port Harcourt, Rivers State, Nigeria using appropriate standard methods. Results obtained show that the average number of days which seeds of *A. muricata* took to emerge after sowing varied between 9.33±1.33 days in lemon water and 21.67±0.33 days in control. Shortest average duration was observed in seeds treated with lemon water (27±0.58 days) and longest in control seeds (35±0.58 days). Seeds treated with aloe vera had highest germination percentage (GP) (97.78±2.22%) while control had lowest GP (71.11±2.22%). Seedlings of *A. muricata* showed no variation ($p > 0.05$) in height at week 8 but displayed a significant variation ($p \leq 0.05$) from weeks 10 to 20 with aloe vera gel treated seedlings having highest height at all stages of growth (15.59, 19.46, 23.35, 34.97 and 38.68 cm), significant variations ($p \leq 0.05$) in collar diameter at weeks 8 and 20 and a non-significant variation ($p > 0.05$) at weeks 10, 12 and 14 and significant variations ($p \leq 0.05$) in number of leaves at all stages of growth. The results demonstrated that Aloe vera significantly enhanced seed germination and growth, outperforming other organic hormones. Coconut water can also be used to enhance the germination and subsequent growth of the studied species. Therefore, aloe vera gel and coconut water are recommended as sustainable sources of plant growth promoting hormones for raising *Annona muricata* seeds.

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Annona muricata, an evergreen shrub is a fruit-bearing plant belonging to the family Annonaceae family and the genus *Annona* (Pinto *et al.*, 2005; Gavamukulya *et al.*, 2017). It is a native of Central America but it is also found in Southeast Asia, South America, and the African rainforests and often referred to as guanabana, soursop, graviola, or Brazilian pawpaw (Wélé *et al.*, 2004). Due to the fruit's sweet and sour flavour, *Annona muricata* is

frequently referred to as soursop. Sop-sop or shawasop are the names used in Nigeria (Wélé *et al.*, 2004). According to Joseph-Adekunle (2014), *Annona muricata* is a versatile plant with several uses, it can be used to produce food products with acceptable nutritional value, as well as goods for industry and medicine. It also helps small and medium-scale farmers supplement their income and directly contribute to food security. The species is a

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year-round bloomer and fruit producer (Pinto *et al.*, 2005). The upper surface of the obovate, oblate, and acuminate leaves is thick, glossy, and dark green. According to Nugraha *et al.* (2019), the herb of *Annona muricata* is frequently used to treat a variety of illnesses, including parasite infections, inflammation, diabetes, and cancer. Individuals who stay in tropical areas employ *Annona muricata* in all forms of conventional medication; the leaves, stem bark, roots, and seeds are the mostly for use as lively elements (Badrie and Schauss, 2010). All parts of the plant are used to cure diabetes, cancer, parasite infections, stomachaches, and malaria in a number of tropical sub-Saharan nations, including Uganda (Gavamukulya *et al.*, 2017, Ssenyange *et al.*, 2015; Pieme *et al.*, 2014).). To treat internal and external parasites, Malaysian natives used the leaves of *Annona muricata* (Badrie and Schauss, 2010). The use of leaves to treat malaria is very important in tropical countries as Cameroon, Togo, and Vietnam (Boyom *et al.*, 2011). In Ghana, some other plants are decocted with *Annona muricata* into a mixture and used in bath where females sit in (Asase *et al.*, 2012). The fruit is not only appreciated as food, but the juice is used as galactagogue to treat diarrhea, heart and liver diseases (Hajdu and Hohmann, 2012), and against intestinal parasites in South America (Badrie and Schauss, 2010). Additionally, the seeds are used as anthelmintic and antiparasitic treatments, and the leaves, bark, and roots of *Annona muricata* have been used for their anti-inflammatory, antihypertensive, sedative, antidiabetic, smooth muscle relaxant, and antispasmodic effects (Adewole and Ojewole 2009, Mishra *et al.*, 2013). As it has anthelmintic, antihypertensive, anti-inflammatory, and anticancer properties, *Annona muricata* is used to deal with bacterial and fungal infections. The propagation of plants by seeds is easy, fast and most preferred method of plant conservation because it preserves genetic variations. However, seeds of many plant species specifically trees exhibit dormancy and fail to germinate even in favourable conditions. Depending on the plant species and type of dormancy, various methods of pre-treatment including seed pretreatment with growth regulators have been used to break dormancy in some plants. The growth regulators from both organic and inorganic sources have been used to increase the germination and vigour of different seeds (Pulok *et al.*, 2015). Growth hormones have been found to affect different aspects of plant growth and development (Davies, 1996). Plant growth regulators are known to control plant's physiological and biochemical processes (Mukhtar, 2008). These growth regulators may be of natural origin (organic) or synthetic (inorganic) (Pulok *et al.*, 2015). Conventional hormone treatments may have

adverse effects on the environment and human health. (de Aquino *et al.*, 2021). Therefore, there is a critical need to explore alternative methods, such as organic hormones, to enhance soursop seed germination and growth. Despite extensive research on plant growth regulators and stress responses in various crops, limited studies have focused on the application of organic hormones in soursop cultivation. (Da Silva, *et al.*, 2019). This research is significant as it will contribute to the development of sustainable cultivation practices for soursop, reducing reliance on synthetic chemicals and promoting environmental sustainability.

Also, deforestation and encroachment into the natural ecosystem of the species have resulted in disappearance of most tree species including *Annona muricata*. It is inevitable that the cultivation of *Annona muricata* is typically operated under lack of knowledge on the effects of treatments for its growth and development thereby leading to low productivity or small-scale production. There is also paucity of information on the propagation of this species which creates the need for germination and seedling growth studies on the species to provide essential information on the silviculture of the species.

Also, it is an important species for soil preservation in water catchment areas. It becomes very important to examine how best to raise healthy seedlings for field establishment. The knowledge that will be gained from this study would increase the domestication (artificial regeneration) of *Annona muricata*. The objective of the study was to assess the germination and growth response of *Annona muricata* seeds, to organic growth hormones in the nursery Port Harcourt, Rivers State, Nigeria.

MATERIALS AND METHODS

Study Area: The study was carried out at the Research and Experimental Nursery of the Department of Forestry and Wildlife Management, Faculty of Agriculture, University of Port Harcourt Rivers State, Nigeria. The University is geographically located along latitudes 04°52'30"N to 04°55'0"N and longitudes 6°54'0"E to 6°55'30"E with an estimated annual rainfall of 2400 mm within the region (Fredrick *et al.*, 2024).

Seed Collection and Processing: The fruits of *Annona muricata* were bought from the market within the study area. The fruits were processed manually. The floatation method to test for seed viability was employed to detect the viable seeds. Seeds that floated after putting them in a container filled with water were regarded as non-viable and

discarded while the seeds that do not float was regarded as viable and used for the experiment.

Experimental Design: The experiment was set up in a completely randomized design. Seeds were pretreated with organic hormones (Coconut water, Lemon juice, Aloe vera gel extract and Control). Four hundred (400) randomly selected seeds were directly sown in a germination tray measuring filled with sharp sand. (25 seeds * 4 replicates * 4 hormones = 400 experimental units). Seeds were sown in germination trays measuring 17cmx13cmx35cm and filled with sterilized sharp sand. No fertilizers or bacterial and/or mycorrhizal inoculation will be used. Watering will be done daily while weeding was carried out regularly and when required throughout the period of the experiment. Before the transplanting operation, the polypots which were filled with topsoil were fully watered to maintain the moisture content of the soil. At the two-leaf stage, young seedlings of equal height were transplanted into a polypot measuring 15*15*20 when flat. A completely randomized design was used. A total number of 80 seedlings equally divided among four different organic growth hormones was used to determine the most appropriate growth hormone required by *Annona muricata* for germination and early growth. Watering and weeding were carried out regularly and when required throughout the period of the experiment. Each poly pot was taken as a replicate of its own. At the end of the experiment, 5 seedlings per treatment were carefully removed from the pots and the root system exposed by carefully washing off excess growth media from the roots, absorbent paper was used for blotting excess moisture from the plants. Seedlings were then be separated into shoot and root components; separation will beat the soil line. The length of the shoot and root were measured, and the shoots (including the leaves) and root were placed in a paper bag for drying. The samples were oven-dried at 70°C for three days (72 hrs) and weighed to determine the total dry weight of the shoot and root. Shoot and root parameter measurements were done at the end of the experiment.

Data Collection: Observation on germination were made and recorded daily; this was terminated after forty-nine days. Germination percentage (GP), germination emergence (GE) and germination duration (GD) were determined using the equations below;

$$G = \frac{\text{Total germinated seeds}}{\text{Total seeds sown}} * \frac{100}{1} \quad (1)$$

GP = Germination percentage
Germination Time (GE) = Seed germination time after sowing

Germination Duration (GD) = First day germination occurs to last day of germination after sowing

Initial shoot parameters measurement was done on all seedlings immediately after transplanting and bi-weekly thereafter until the end of the experiment. The seedling height was measured from the substrate level to the tip of the youngest leaf using a meter rule; stem collar diameter was measured at the root collar using a vernier caliper; while leaf production was determined by directly counting the number of leaves. The length of the shoot and root was determined using a meter rule. Shoot fresh and dry weight and root fresh and dry weight were used to determine; total fresh and dry weight, shoot and root moisture content and fresh and dry root to shoot (RSR) ratio using the following equation.

Total Fresh/Dry Weight (TF/DW) = Shoot fresh/dry weight + root fresh/dry weight (2)

Moisture Content (MC) = Fresh weight – Dry weight (3)

$$\text{Root to shoot ratio (RSR)} = \frac{\text{Total root dry weight}}{\text{Total shoot dry weight}} \quad (4)$$

Data Analysis: Data collected were analyzed using SPSS statistical software (SPSS version 18, SPSS Inc.). One-way analysis of variance was used to determine variation and F value was significant at $p < 0.05$. Duncan multiple range test (DMRT) was employed to determine the variation in means. All graphs were plotted using Microsoft excel 2010.

RESULTS AND DISCUSSION

Effect of organic growth hormones on the germination emergence of *Annona muricata*: The germination emergence of seeds sown at different soil salinity levels and organic growth hormone treatments is presented in Figure 1. Organic growth hormones significantly ($p \leq 0.05$) affected germination emergence of *Annona muricata* seeds. Salt treatments inhibited the germination of *A. muricata* seeds at 15 and 20g.

The average number of days which seeds of *A. muricata* took to emerge after sowing varied between 9.33 days in lemon juice and 21.67 days in control. Pretreatment of *Annona muricata* seeds with organic plant growth hormones significantly influenced germination of the species. Earliest germination emergence and duration observed in lemon juice treated seeds is an indication that it can be used to enhance germination of *Annona muricata* seeds. Lemon juice is an alternative to commercial industrial growth regulators Ali and Idris, (2014).

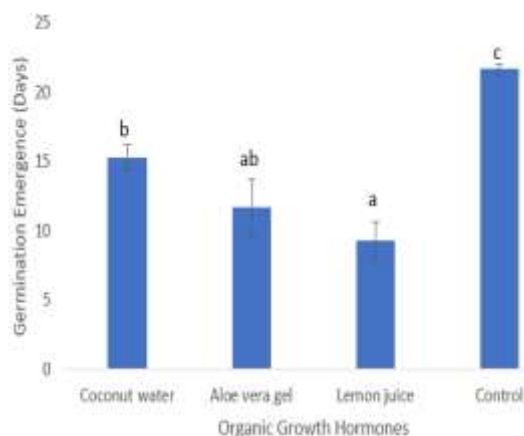


Fig. 1: Effect of organic growth hormones on the germination emergence of *Annona muricata*. Bars with the same letter (s) do not vary significantly ($p > 0.05$).

Effect of organic growth hormones on the germination duration of Annona muricata: The result of germination duration of seeds of *Annona muricata* treated with organic hormone is presented in Fig. 2. Organic growth hormones significantly ($p \leq 0.05$) affected germination duration of *Annona muricata* seeds.

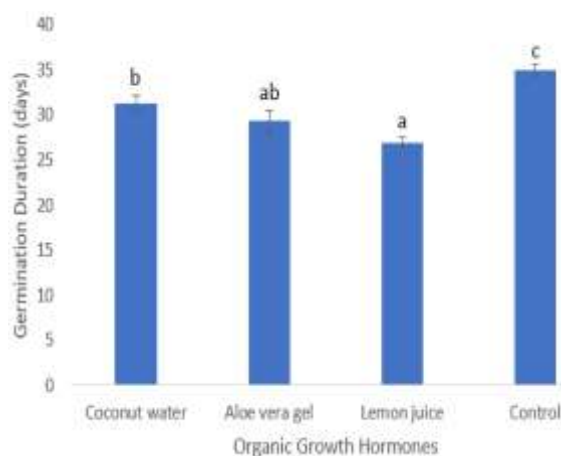


Fig. 2: Effect of organic growth hormones on the germination duration of *Annona muricata*. Bars with the same letter (s) do not vary significantly ($p > 0.05$).

Earliest duration was observed in seeds treated with lemon juice (27 days), followed by seeds treated with aloe vera gel (29.33 days) while longest duration was observed in control seeds (35 days). Highest germination percentage observed in *Annona muricata* seeds treated with aloe vera gel makes it suitable for enhancing germination of the species. Aloe vera gel is rich in plant hormones such as auxins and gibberellins (Surjushe *et al.*, 2008).

Effect of organic growth hormones on the germination percentage of Annona muricata: The

germination percentage (GP) of seeds pre-treated with organic growth hormone treatments is presented in Fig. 3. Average GP varied from 71.11 to 97.78%. Seeds treated with aloe vera gel had highest GP (97.78%) followed by coconut water treatment (91.11%) while control had lowest GP (71.11%). A higher germination percentage found in coconut treated seed indicates its suitability for raising this species. Coconut is reported to have a high diversity of biologically active components as plant growth hormones including auxins, gibberellins, cytokinins, ethylene and abscisic acid (Yong *et al.*, 2009). Control treatment showed the least performance, highlighting the importance of pre-treatment of the seeds of *A. muricata* with organic hormones in the germination of the species.

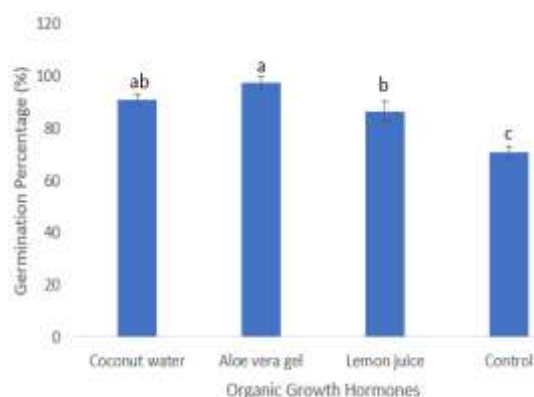


Fig. 3: Effect of organic growth hormones on the germination percentage of *Annona muricata*. Bars with the same letter (s) do not vary significantly ($p > 0.05$).

Height performance of Annona muricata seedling under different organic growth treatments: Seedlings of *A. muricata* showed no variation ($p > 0.05$) in height at week 8 and significant variations ($p \leq 0.05$) from weeks 10 to 20. Highest height was observed on aloe vera gel treated seedlings at all stages of growth (15.59, 19.46, 23.35, 34.97 and 38.68 cm respectively) while lowest height was observed in control at weeks 8 and 10 (14.43 and 17.06cm) and lemon juice at weeks 12, 14 and 20 (20.04, 22.50 and 26.78 cm) (Table 1).

Collar diameter of Annona muricata seedling under different organic growth treatments: Seedlings of *A. muricata* pretreated with different growth hormone displayed significant variations ($p \leq 0.05$) in collar diameter at weeks 8 and 20 and a non-significant variation ($p > 0.05$) at weeks 10, 12 and 14. Average collar diameter of seedling at 8 – 20 weeks varied from 0.407 mm in week 8 to 2.193 mm in week 20. Highest mean seedling collar diameter at all stages of growth was observed in aloe vera gel treated seedlings (0.807, 0.860, 0.943, 0.983 and 2.193 mm

respectively) and lowest in control treatments (0.407, 0.753, 0.767, 0.783 and 1.820 mm respectively). This is shown in Table 2.

Leaf production of *Annona muricata* seedling under different organic growth treatments: Seedlings of *A. muricata* pretreated with different growth hormone displayed significant variations ($p \leq 0.05$) in number of leaves at all stages of growth. Average seedling leaf number after 8 - 20 weeks varied from 3.93 in week 8 – 13.93 in week 20. Mean seedling leaf number was highest in aloe vera treated seedling (4.87, 6.43, 9.57, 12.37 and 13.93 respectively) at all

stages of growth and lowest in control at weeks 8 – 12 (3.93, 4.90 and 7.33 respectively) and in lime at weeks 14 and 20 (9.93 and 11.57 respectively) (Table 3).

Highest growth parameters including seedling height, collar diameter, leaf production, shoot fresh and dry weight, total plant fresh and dry weight were observed in seedlings treated with aloe vera gel. Aloe vera gel has been reported to poses plant growth promoting substance with huge potential to increase growth (Dominic *et al.*, 2023).

Table 1: Height performance of *Annona muricata* seedling at different seedling height ($\mu \pm SE$)

Organic Growth Hormones	Seedling Height (cm)				
	Week 8	Week 10	Week 12	Week 14	Week 20
Coconut water	15.52 $\pm$ 0.47a	17.89 $\pm$ 0.56b	21.10 $\pm$ 0.58b	28.60 $\pm$ 0.85b	31.23 $\pm$ 0.95b
Aloe vera gel	15.59 $\pm$ 0.46a	19.46 $\pm$ 0.52a	23.35 $\pm$ 0.61a	34.97 $\pm$ 0.97a	38.68 $\pm$ 1.00a
Lemon juice	14.62 $\pm$ 0.44a	17.49 $\pm$ 0.66b	20.04 $\pm$ 0.61b	22.50 $\pm$ 0.68c	26.78 $\pm$ 0.70c
Control	14.43 $\pm$ 0.62a	17.06 $\pm$ 0.48b	20.48 $\pm$ 0.72b	23.96 $\pm$ 0.86c	29.00 $\pm$ 0.93bc
Mean	15.04 $\pm$ 0.25	17.98 $\pm$ 0.29	20.84 $\pm$ 0.34	28.17 $\pm$ 0.64	30.76 $\pm$ 0.61
P	0.235	0.018	0.002	<0.001	<0.001

Means with the same alphabet on the same column do not differ significantly ($p > 0.05$).

Table 2: Effects of organic growth hormones on collar diameter of *Annona muricata* ($\mu \pm SE$)

Organic Growth Hormones	Collar Diameter (mm)				
	Week 8	Week 10	Week 12	Week 14	Week 20
Coconut water	0.697 $\pm$.0908a	0.763 $\pm$.0953a	0.860 $\pm$.0967a	0.893 $\pm$.0977a	1.893 $\pm$.0952c
Aloe vera gel	0.807 $\pm$.0876a	0.860 $\pm$.0829a	0.943 $\pm$.0962a	0.983 $\pm$.0859a	2.193 $\pm$.0776a
Lemon juice	0.713 $\pm$.0863a	0.820 $\pm$.0906a	0.840 $\pm$.0970a	0.897 $\pm$.1021a	2.037 $\pm$.0704ab
Control	0.407 $\pm$.0656b	0.753 $\pm$.0885a	0.767 $\pm$.0865a	0.783 $\pm$.0982a	1.820 $\pm$.1268c
Mean	0.656 $\pm$.0433	0.799 $\pm$.0443	0.852 $\pm$.0469	0.889 $\pm$.0479	1.986 $\pm$.0487
P	0.006	0.816	0.620	0.538	0.033

Values in the same column with the same subscript letter do not vary significantly ($p > 0.05$).

Table 3: Effects organic growth hormones on leaf number of *Annona muricata* ($\mu \pm SE$)

Organic Growth Hormones	Leaf production				
	Week 8	Week 10	Week 12	Week 14	Week 20
Coconut water	4.70 $\pm$.193	5.70 $\pm$.187	8.50 $\pm$.239	10.87 $\pm$.224	13.70 $\pm$.280
Aloe vera gel	4.87 $\pm$.164	6.43 $\pm$.190	9.57 $\pm$.213	12.37 $\pm$.222	13.93 $\pm$.279
Lemon juice	4.43 $\pm$.149	5.90 $\pm$.154	7.93 $\pm$.279	9.93 $\pm$.279	11.57 $\pm$.358
Control	3.93 $\pm$.258	4.90 $\pm$.255	7.33 $\pm$.333	10.40 $\pm$.394	12.43 $\pm$.394
Mean	4.48 $\pm$.102	5.73 $\pm$.111	8.33 $\pm$.153	10.89 $\pm$.165	12.91 $\pm$.186
P	0.006	<0.001	<0.001	<0.001	<0.001

Values in the same column with the same subscript letter do not vary significantly ($p > 0.05$).

Biomass accumulation of *Annona muricata* seedling under different organic growth treatments: Seedlings of *A. muricata* pre-treated with different growth hormone showed significant variations ($p \leq 0.05$) in shoot fresh and dry weight and a non-significant variation ($p > 0.05$) in shoot moisture content. Highest fresh and dry weight of shoot was observed in aloe vera treatments (1.738 and 1.290 g resp.) and lowest in coconut (1.184 and 0.606 g resp.). Shoot moisture content was highest control (0.578 g) and lowest in aloe vera (0.448) (Table 4.). Seedlings of *A. muricata* pre-treated with different growth hormone showed significant variations ($p \leq 0.05$) in root fresh weight, dry weight and moisture content. Highest and lowest root fresh weights were observed in coconut

and control treatments (0.858 and 0.656 g resp.) root dry weights in lime and coconut treatment (0.408 and 0.204g) and moisture content in coconut and control (0.654 and 0.316 g resp.) (Table 4). Total fresh and dry weight of *A. muricata* seedlings pre-treated with organic growth hormones displayed significant variations ($p \leq 0.05$). Highest total fresh (2.506 g) and dry (0.810) weights were observed in Aloe vera and coconut treatments respectively while lowest total fresh (2.014 g) and dry (0.468) weights were observed in control and lemon juice treatments respectively (Table 4). Hormone treatments displayed significant variation ($p \leq 0.05$) in fresh root to shoot ratio of *A. muricata* seedlings and a non-significant variation ($p > 0.05$) in dry root to shoot ratio of *A.*

muricata seedlings. Highest root to shoot ratio for both fresh (0.742 g) and dry (0.617 g) weights were observed in coconut and control treatments respectively while lowest root to shoot ratio for both fresh (0.446 g) and dry (0.263 g) weights were observed in aloe vera (Table 4). Highest root fresh weight, root moisture content and fresh root to shoot ratio and better seedling height, leaf production, shoot moisture content and dry root to shoot ratio observed in coconut treated seedlings makes it a suitable treatment for raising *A. muricata* seedlings.

Coconut water was found to be effective when compared to synthetic hormone (IBA) as it has been reported to contain factors promoting growth of young embryo in plants (Jatto *et al.*, 2012). This finding is in line with that of Asma and Kashif (2008) and Ibironke (2016) who reported that coconut water enhanced the shoot length of species studied. This result further highlights the potentials of aloe vera gel and coconut water as sustainable alternative sources of plant growth promoting substances (Ibironke, 2016; Mirinhgalla and Fernando. 2020).

Table 4: Effects of organic growth hormones on biomass accumulation of *A. muricata* seedlings ($\mu\pm$ SE)

Biomass Parameters	Treatments				P value
	Coconut water	Aloe vera gel	Lemon juice	Control	
Shoot Fresh Weight (g)	1.184 $\pm$ 0.09b	1.738 $\pm$ 0.08a	1.620 $\pm$ 0.15a	1.358 $\pm$ 0.14ab	0.021
Shoot Dry weight(g)	0.606 $\pm$ 0.12c	1.290 $\pm$ 0.08a	1.060 $\pm$ 0.16ab	0.744 $\pm$ 0.19bc	0.015
Shoot Moisture Content (g)	0.578 $\pm$ 0.14a	0.448 $\pm$ 0.09a	0.560 $\pm$ 0.13a	0.614 $\pm$ 0.14a	0.801
Root Fresh Weight(g)	0.858 $\pm$ 0.01a	0.768 $\pm$ 0.04ab	0.840 $\pm$ 0.01a	0.656 $\pm$ 0.08b	0.025
Root Dry weight(g)	0.204 $\pm$ 0.04b	0.338 $\pm$ 0.02ab	0.408 $\pm$ 0.08a	0.340 $\pm$ 0.05ab	0.054
Root Moisture Content (g)	0.654 $\pm$ 0.05a	0.430 $\pm$ 0.03ab	0.432 $\pm$ 0.07ab	0.316 $\pm$ 0.12b	0.035
Total Fresh Weight (g)	2.042 $\pm$ 0.09ab	2.506 $\pm$ 0.10a	2.460 $\pm$ 0.16ab	2.014 $\pm$ 0.21b	0.053
Total Dry Weight (g)	0.810 $\pm$ 0.14c	1.628 $\pm$ 0.09a	1.468 $\pm$ 0.20ab	1.084 $\pm$ 0.16bc	0.007
Fresh Root to Shoot Ratio(g)	0.742 $\pm$ 0.06a	0.446 $\pm$ 0.03b	0.538 $\pm$ 0.05b	0.482 $\pm$ 0.02b	0.001
Dry Root to Shoot Ratio(g)	0.462 $\pm$ 0.16a	0.263 $\pm$ 0.01a	0.396 $\pm$ 0.08a	0.617 $\pm$ 0.32a	0.344

Values in the same row with the same subscript letter do not vary significantly ($p > 0.05$).

Conclusion: This study investigated the effects of organic hormones (Aloe vera, Coconut, Lime and control) on the germination and growth of *Annona muricata* seeds. The results demonstrated that aloe vera significantly enhanced seed germination and growth, outperforming other organic hormones. These findings suggest that aloe vera gel has potential as a natural growth promoter for *Annona muricata* cultivation. Coconut water can also be used to enhance the germination and subsequent growth of the studied species.

DECLARATIONS

Ethical Approval: This study did not involve human participants or animal experimentation and therefore did not require formal ethical approval. All procedures involving data handling and analysis were conducted responsibly and in accordance with standard academic and institutional guidelines.

Disclaimer (Artificial Intelligence): Author(s) hereby declare that no generative Artificial Intelligence (AI) technologies such as Large Language Models (ChatGPT, COPILOT, XLNet, Ernie 3.0 Titan etc) and text-to-image generators have been used during writing or editing of this manuscript.

Declaration of Conflict of Interest: The authors declare that no known conflict of interest or personal relationships that have influence the work reported in this paper

Declaration of Data Availability: Data are available upon request from the Corresponding Author.

REFERENCES

- Adewole, SO; Ojewole, JAO (2009). Protective Effects of *Annona muricata* Linn. (Annonaceae) Leaf Aqueous Extract on Serum Lipid Profiles and Oxidative Stress in Hepatocytes of Streptozotocin Treated Diabetic Rats. *Afr. J. Trad. Compl. Alt. Med.* 6 (1): 30 - 41. DOI: <https://doi.org/10.4314/ajtcam.v6i1.57071>
- Ali, SAM; Idris, AY (2014). Germination and seedling growth of pearl millet (*Pennisetum glaucum* L.) cultivars under salinity conditions. *Int. J. Plant Res.* 1 (1): 1 - 5. <http://www.aiscience.org/journal/ijpse>
- Asase, A; Hesse, DN; Simmonds, MSJ (2012). Uses of multiple plants prescriptions for treatment of malaria by some communities in southern Ghana. *J. Ethnopharmacol.* 144 (2): 448 - 452. DOI: <https://doi.org/10.1016/j.jep.2012.09.028>
- Asma, NA; Kashif, SK (2008). In-vitro propagation of croton (*Codiaeum variegatum*). *Pak. J. Bot.* 40: 99 - 104. [https://www.pakbs.org/pjbot/PDFs/39\(4\)/PJB39\(4\)1257.pdf](https://www.pakbs.org/pjbot/PDFs/39(4)/PJB39(4)1257.pdf)

- Badrie, N; Schauss, AG (2010). Soursop (*Annona muricata* L.): Composition, nutritional value, medicinal uses, and toxicology. *Bioact. Foods Promot. Health.* 39: 621 - 643. <https://doi.org/10.1016/B978-0-12-374628-3.00039-6>
- Boyom, FF; Fokou, PV; Yamthe, LR; Mfopa, AN; Kemgne, EM; Mbacham, WF; Tsamo, E; Zollo, PH; Gut, J Rosenthal, PJ (2011). Potent antiplasmodial extract from Cameroonian Annonaceae. *J. Ethnopharmacol.* 134 (3): 717 - 724. <https://doi.org/10.1016/j.jep.2011.01.020>
- Da Silva, AAR; De Lima, GS; de Azevedo, CAV; Veloso, LLDSA; Capitulino, JD; Gheyi, HR (2019). Induction of tolerance to salt stress in soursop seedlings using hydrogen peroxide. *Comunicata Scientiae.* 10 (4): 484 - 490. <https://doi.org/10.14295/cs.v10i4.3036>
- Davies, PJ (1987). Plant Hormones and their Role in Plant Growth and Development. *Springer Netherlands*, 531 - 546. DOI: <https://doi.org/10.1007/978-94-009-3585-3>
- de Aquino, SF; Brandt, EMF; Bottrel, SEC; Gomes, FBR; Silva, SDQ (2021). Occurrence of pharmaceuticals and endocrine disrupting compounds in Brazilian water and the risks they may represent to human health. *Int. J. Environ. Res. Public. Health.* 18 (22) 11765. DOI: <https://doi.org/10.3390/ijerph182211765>
- Dominic, K. (2023). Effect of Some Plant Growth Hormones on the Performance of *Artemisia vulgaris* L. Cuttings. *Int. J. Plant Res.* 1 (1): 1 - 5. DOI: <https://doi.org/10.30954/0974-1712.01.2023.6>
- Fredrick, C; Ofodile, EAU; Basiru, AO Omokhua, GE (2024). Influence of Temperature on Early Growth of *Pterocarpus santalinoides* L'Hérit. ex DC. *Renew.* 4 (1): 26 - 32. <https://journals.ui.edu.ng/index.php/ren/article/view/1172>
- Gavamukulya, Y; Wamunyokoli, F; El-Shemy, HA. (2017). *Annona muricata*: Is the Natural Therapy to Most Disease Conditions Including Cancer Growing in Our Backyard? A Systematic Review of Its Research History and Future Prospects. *Asian Pac. J. Trop. Med.* 10 (9): 835 - 848. DOI: <https://doi.org/10.1016/j.apjtm.2017.08.009>
- Hajdu, Z; Hohmann, J (2012). An ethnopharmacological survey of the traditional medicine utilized in the community of Porvenir, Bajo Paraguay Indian Reservation, Bolivia. *J. Ethnopharmacol.* 139 (3): 838 - 857. DOI: <https://doi.org/10.1016/j.jep.2011.12.029>
- Ibironke, OA (2016.) Effect of growth promoting substances on selected three ornamental plants. *Adv. Crop Sci. Technol.* 4(3): 1-4. DOI: <https://doi.org/10.4172/2329-8863.1000222>
- Jatto, MI; Bello, LL; Jakusko, BB (2012). Effect of growth hormones on the germination of shea-nut (*Vitellaria paradoxa* CF Geartn) after pre-treatment. *Glob. J. Agric. Sci.* 11 (2): 99-103. DOI: <https://doi.org/10.4314/gjass.v11i2.5>
- Joseph-Adekunle TT (2014) Influence of seed treatments on germination and seedling growth of Soursop - *Annona muricata*. *J. Biol. Agric. Healthcare.* 4(21), 30-35. <https://api.semanticscholar.org/CorpusID:82738979>
- Mirihagalla, MKPN; Fernando, KMC (2020). Effect of Aloe vera gel for inducing rooting of stem cuttings and air layering of plants. *J. Dry Zone Agric.* 6 (1): 13 - 26. <http://repo.lib.jfn.ac.lk/ujrr/handle/123456789/3081>
- Mishra, S; Ahmad, S; Kumar, N; Sharma, BK (2013). *Annona muricata* (the Cancer Killer): A Review. *Glob. J. Pharm. Res.* 2 (1): 1613 - 1618. <https://www.yumpu.com/en/document/read/14436104/annona-muricata-the-cancer-killer-a-reread/1>
- Mukhtar, FB (2008). Effect of some plant growth regulators on the growth and nutritional value of *Hibiscus sabdariffa* L. (Red sorrel). *Int. J Pure Appl. Sc.* 2 (3): 70 - 75. https://funaab.edu.ng/wp-content/uploads/2010/11/1538_2985-10556-1-PB.pdf
- Nugraha, AS; Damayanti, YD; Wangchuk, P; Keller, PA (2019). Anti-Infective and Anti- Cancer Properties of the *Annona* Species: Their Ethno-medicinal Uses, Alkaloid Diversity, and Pharmacological Activities. *Molecul.* 24 (23): 4419. DOI: <https://doi.org/10.3390/molecules24234419>
- Pieme, AA; Kumar, GG; Dongmo, SS; Moukette, MM; Boyoum, FF; Ngogang, YY; Saxena, KK (2014). Anti-proliferative Activity and Induction

- of Apoptosis by *Annona muricata*, (Annonaceae) Extract on Human Cancer Cells. *BMC Compl. Altern. Med.* 14 (1): 516. DOI: <https://doi.org/10.1186/1472-6882-14-516>
- Pinto, AC de Q; Cordeiro, MCR; Andrade, SRM; Ferreira, FR; Filgueiras, HAC; Alves, RE; Kinpara, DI (2005). *Annona* Species. In: Williams, J.T., et al., Eds., International Centre for Underutilised Crops, University of Southampton, Southampton, UK, 268 p. https://www.researchgate.net/publication/235256377_Annona_Species
- Pulok, MAI; Rahman, MM; Haque, MN; Chakraborty, R; Ali, MS (2015). Effect of growth regulators on germination and vigor of lentil seeds. *J. biosci. agric. res.* 3 (1): 8 - 14. https://www.researchgate.net/publication/271842529_Effect_of_Growth_Regulators_on_Germination_and_Vigor_of_Lentil_Seeds
- Shenyang, CW; Namulindwa, A; Oyik, B; Ssebuliba, J (2015). Plants Used to Manage Type II Diabetes Mellitus in Selected Districts of Central Uganda. *Afr. Health Sci.* 15 (2): 496 - 502. DOI: <https://doi.org/10.4314/ahs.v15i2.24>.
- Surjushe, A; Vasani, R; Saple, DG (2008). Aloe vera: A short review. *Ind. J. Dermatol*, 53 (4): 163 - 166. DOI: <https://doi.org/10.4103/0019-5154.44785>
- Wélé, A; Zhang, Y; Caux, C; Brouard, JP; Pousset, JL; Bodo, B (2004). Annomuricin C, a novel cyclohexapeptide from the seeds of *Annona muricata*. *C. R. Chim.* 7 (10-11): 981 - 988. DOI: <https://doi.org/10.1016/j.crci.2003.12.022>
- Yong, JWH; Ge, L; Ng, YF; Tan, SN (2009). The chemical composition and biological properties of coconut (*Cocos nucifera* L.) water. *Molecul.* 14 (12): 5144-5164. DOI: <https://doi.org/10.3390/molecules14125144>