

Biopriming Effects of *Carica papaya* (PAWPAW) Plant Extract on Germination Rate and Growth Parameters of *Phoenix dactylifera* (Date Palm) Seedling

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Abstract

Phoenix dactylifera is a crop that is primarily cultivated in the arid and semi-arid regions of the Middle East, North Africa and parts of West Africa where it serves as a staple during religious festivities and a source income. However, Seed dormancy and weak seedling vigor limit the successful cultivation of *Phoenix dactylifera*. This study investigated the biopriming effects of *Carica papaya* aqueous extracts derived from ripe/unripe seeds, fruits, and leaves on seed germination and seedling growth of *Phoenix dactylifera*. Seeds were primed for varying durations of 0, 20, 40 60 and 80 minutes, and growth parameters such as root length, root weight, shoot length, shoot weight, germination rate and vigour index were assessed. Leaf extract showed the most significant improvement, with the highest vigor index (6646.5) and germination rate (88.9%), especially at 60 minutes. These eco-friendly treatments outperformed controls, demonstrating their effectiveness in breaking dormancy and enhancing early growth.

Keywords: *Phoenix dactylifera*, biopriming, seed germination, plant growth promotion and *Carica papaya* extract.

Introduction

The date palm (*Phoenix dactylifera*) is a vital crop grown in arid and semi-arid regions of the Middle East, North Africa and parts of West Africa including Northern Nigeria. It is valued for its nutritional, economic, and cultural importance (ALOTAIBI et al., 2023). In Nigeria, especially in the northern regions, the fruit—locally known as 'Dabino' in Hausa Language holds deep cultural and religious significance, particularly during Ramadan (HABILA et al., 2016). It also contributes significantly to livelihoods, providing

food, income, and employment across North Africa and the Middle East (HANIEH et al., 2020).

However, propagating date palms from seeds is challenged by seed dormancy, which delays germination and hinders large-scale cultivation (MUHAMMAD et al., 2017). While dormancy protects seeds under unfavorable conditions, it poses challenges in modern agriculture that demands uniform germination (PAUSAS and LAMONT, 2022). Traditional dormancy-breaking methods such as scarification or chemical

treatment are often costly or environmentally harmful (LAMONT and PAUSAS, 2023).

Biopriming is a technique that involves the hydration of seeds with biological agents such as plant extracts or beneficial microbes, to initiate early metabolic activities and improve seedling performance (CHANDEL et al., 2024). *Carica papaya*, rich in bioactive compounds like enzymes, antioxidants, and phytohormones, shows promise in this role (KANWAL et al., 2015). Given the importance of promoting sustainable agricultural practices, this study aims to explore the potential of *Carica papaya* extract in biopriming date palm seeds. The research will evaluate the effects of these agents on breaking seed dormancy, and enhancing key growth parameters.

The Justification lies in the challenges in seed propagation of date palms such as low seed germination rates and poor early seedling development, largely due to seed dormancy and sub-optimal growth conditions, have hindered its widespread cultivation and productivity. Addressing these challenges is crucial for improving the cultivation of date palm in Nigeria (PAUSAS and LAMONT, 2022). In Nigeria, the cultivation of date palm has the potential to contribute substantially to food security, poverty alleviation, and sustainable agriculture.

Materials and Methods

Study Area

The study was conducted in Nigerian Defence Academy, Afaka, Igabi Local Government Area of Kaduna State, Northwest region of Nigeria. The plants used for this study were grown in the Biological Garden of Biological Science Department and laboratory experiment was conducted in Biotechnology Laboratory at the Nigerian Defence Academy, Kaduna State located at 10.61235°N latitude and 7.37305°E

Experimental Design

The experiment used a completely randomized design with three replicates per treatment at 0, 20, 40, 60, and 80 minutes. Treatments included water and aqueous extracts from *Carica papaya* leaves, ripe fruits, unripe fruits, ripe seeds, and unripe seeds. Non-treated seeds served as the control.

Sample Collection and Preparation

Date Palm Seeds

Date palm fruits were sourced from Kawo market, Kaduna North Local Government Area of Kaduna State, and seeds were extracted manually using a nut cracker for experimentation.

Soil Used for Planting

Sandy loam soil used for planting was sourced from the Biological Garden at the Nigerian Defence Academy.

Collection of *Carica papaya* Plant Parts

Carica papaya leaves, seeds, and fruits were collected from Mando area, in Igabi Local Government Area of Kaduna state. They were washed, shade-dried, ground using an electric blender, and stored in jars at room temperature for further experimental use.

Carica papaya Plant Extracts Preparation

Aqueous extracts of *Carica papaya* parts were prepared by soaking 10g of powdered leaves, fruits, and seeds separately in 90ml sterile water overnight, then filtering the mixture through Whatman's filter paper for use in seed priming (KANWAL et al., 2015).

Date Palm Seed Priming

252 date palm seeds were surface sterilized using 1.5% Sodium Hypochlorite (NaOCl) for five minutes, rinsed with sterile water and air-dried. The seeds were variously treated with the extract of seeds, leaves and fruit of *C. papaya*.

Plant Growth Experiment

The plant growth experiment was conducted from May to August. Primed and non-primed date palm seeds were sown in polythene bags filled with soil. Three seeds were sown in each polythene and were watered daily. The control had non-treated seeds.

Growth Parameters

After a period of 90 days the plants were uprooted to observe growth parameters. The root and shoot length were measured in cm using a tape rule while an electronic balance was used to measure the root and shoot weight.

Germination Rate and Vigour Index

The number of germinated seeds were recorded weekly. The germination rate was computed as the ratio of germinated seeds to the total number of seeds planted (OKUNLOLA et al., 2011).

$$\text{Germination Rate (\%)} = \frac{\text{Number of germinated seed at time } t \times 100}{\text{Total number of seeds}}$$

replicated data to determine significant differences (IBM Corps., 2022).

The vigor index of date palm seedlings was calculated on the basis of root and shoot length as follows:

Vigor index of seedlings = (Root length + Shoot length) cm x Germination (%).

Statistical Analysis

Statistical analysis was performed using IBM SPSS statistic version 29. One-way analysis of variance (ANOVA) was performed on the

Results

Effect of duration of priming with Carica papaya aqueous extract on Shoot length and Shoot Weight of Phoenix dactylifera

At the 60-minute duration, the shoot lengths were maximized for most treatments. Both ripe fruit extract and ripe seed extract produced the longest shoots (37.0 ± 2.65 cm and 37.0 ± 6.25 cm, respectively), closely followed by unripe fruit extract (36.0 ± 2.65 cm) and unripe seed extract (34.0 ± 7.55 cm). (Table 1)

Table 1: Effect of duration of priming with *Carica papaya* aqueous extract on shoot length of *Phoenix dactylifera*.

Treatment duration (minutes)	Shoot Length (cm)	Water	Ripe Fruit Extract	Unripe Fruit Extract	Ripe Seed Extract	Unripe Seed Extract	Leaf Extract
20	8.0 ± 2.65^b		18.6 ± 3.33^b	27.0 ± 4.58^a	25.5 ± 3.28^a	24.0 ± 2.00^a	22.0 ± 2.65^a
40	13.0 ± 2.65^a		26.0 ± 4.36^b	32.0 ± 6.08^a	30.0 ± 6.56^a	30.7 ± 5.54^a	24.0 ± 6.56^a
60	14.5 ± 2.29^a		37.0 ± 2.65^a	36.0 ± 2.65^a	37.0 ± 6.25^a	34.0 ± 7.55^a	26.5 ± 4.40^a
80	17.0 ± 3.61^a		26.0 ± 4.36^b	6.1 ± 3.55^a	21.0 ± 2.65^b	32.0 ± 3.00^a	20.0 ± 5.57^a

Values are means of 3 replications $\pm$ standard deviation.

Mean values within each column that differ significantly ($p < 0.05$) were assigned different letters as superscript.

The results in Table 2 summarize the effects of varying bioprimer durations with *Carica papaya* aqueous extracts on the shoot weight of date palm (*Phoenix dactylifera*) seedlings. Leaf extract

exhibited the highest shoot weight at 60 minutes (1.44 ± 0.446 g) while the least was unripe fruit extract at 20 minutes (0.39 ± 0.129 g).

Table 2: Effect of duration of bioprimering with *Carica papaya* aqueous extract on shoot weight of *Phoenix dactylifera*.

Treatment duration (minutes)	Shoot Weight(g)	Water	Ripe Fruit Extract	Unripe Fruit Extract	Ripe Seed Extract	Unripe Seed Extract	Leaf Extract
20	0.74 ± 0.130^a		1.36 ± 0.324^a	0.39 ± 0.129^b	0.70 ± 0.096^a	1.28 ± 0.285^a	0.99 ± 0.070^a
40	0.97 ± 0.440^a		1.42 ± 0.098^a	1.29 ± 0.266^a	1.52 ± 0.312^a	1.14 ± 0.295^a	1.06 ± 0.303^a
60	0.65 ± 0.070^a		1.42 ± 0.577^a	0.42 ± 0.098^b	0.92 ± 0.366^a	0.94 ± 0.439^a	1.44 ± 0.446^a
80	0.92 ± 0.338^a		0.76 ± 0.424^a	0.64 ± 0.191^b	1.41 ± 0.501^a	1.41 ± 0.339^a	1.10 ± 0.168^a

Values are means of 3 replications $\pm$ standard deviation.

Mean values within each column that differ significantly ($p < 0.05$) were assigned different letters as superscript.

Effect of duration of priming with *Carica papaya* aqueous extract on Root length and Root weight of *Phoenix dactylifera*

Duration of bioprimering of *Phoenix dactylifera* with water, and ripe fruit extract did not have a significant effect on root length of plant.

However, ripe fruit extract, unripe fruit extract, unripe seed extract and leaf extract improved root length in a duration-dependent manner (Table 3).

Table 3: Effect of duration of bioprimering with *Carica papaya* aqueous extract on root length of *Phoenix dactylifera*.

Treatment duration (minutes)	Water	Root Length (cm)					
		Ripe Extract	Fruit Extract	Unripe Extract	Fruit Extract	Ripe Seed Extract	Unripe Seed Extract
20	20.0 $\pm$ 2.65 ^a	26.5 $\pm$ 3.12 ^a	24.0 $\pm$ 2.00 ^a	28.0 $\pm$ 3.61 ^a	19.0 $\pm$ 2.00 ^c	21.0 $\pm$ 2.65 ^c	
40	18.0 $\pm$ 3.00 ^a	25.3 $\pm$ 8.08 ^a	22.0 $\pm$ 2.65 ^a	35.0 $\pm$ 2.65 ^a	26.0 $\pm$ 2.00 ^b	34.0 $\pm$ 3.00 ^b	
60	21.0 $\pm$ 2.65 ^a	38.0 $\pm$ 5.29 ^a	32.0 $\pm$ 6.56 ^a	33.0 $\pm$ 3.61 ^a	36.3 $\pm$ 2.52 ^a	49.5 $\pm$ 1.32 ^a	
80	23.0 $\pm$ 3.61 ^a	34.0 $\pm$ 3.61 ^a	20.8 $\pm$ 3.55 ^b	20.5 $\pm$ 3.28 ^b	23.0 $\pm$ 2.00 ^b	23.0 $\pm$ 3.00 ^c	

Values are means of 3 replications $\pm$ standard deviation.

Mean values within each column, that differ significantly ($p < 0.05$) were assigned different letters as superscript.

Duration of bioprimering with *Carica papaya* aqueous extract did not have a significant effect on the root weight of *Phoenix dactylifera* (Table 4).

Table 4: Effect of duration of bioprimering with *Carica papaya* aqueous extract on root weight of *Phoenix dactylifera*.

Treatment duration (minutes)	Water	Root Weight(g)					
		Ripe Extract	Fruit Extract	Unripe Extract	Fruit Extract	Ripe Seed Extract	Unripe Seed Extract
20	0.13 $\pm$.026 ^a	1.24 $\pm$ 0.363 ^a	1.10 $\pm$ 0.390 ^a	1.48 $\pm$ 0.200 ^a	1.74 $\pm$ 0.229 ^a	1.65 $\pm$ 0.185 ^a	
40	0.32 $\pm$ 0.15 ^a	1.32 $\pm$ 0.182 ^a	1.34 $\pm$ 0.332 ^a	1.62 $\pm$ 0.410 ^a	1.82 $\pm$ 0.325 ^a	1.53 $\pm$ 0.180 ^a	
60	0.35 $\pm$ 0.14 ^a	1.36 $\pm$ 0.236 ^a	1.32 $\pm$ 0.244 ^a	1.96 $\pm$ 0.123 ^a	1.94 $\pm$ 0.233 ^a	1.67 $\pm$ 0.046 ^a	
80	0.72 $\pm$ 0.44 ^a	1.41 $\pm$ 0.236 ^a	1.21 $\pm$ 0.203 ^a	1.65 $\pm$ 0.175 ^a	1.86 $\pm$ 0.125 ^a	1.74 $\pm$ 0.182 ^a	

Values are means of 3 replications $\pm$ standard deviation.

Mean values within each column that differ significantly ($p < 0.05$) were assigned different letters as superscript.

Effect of duration of biopriming with Carica papaya aqueous extract on GerminationRate and Vigour Index of Phoenix dactylifera.

Duration of biopriming with Carica papaya aqueous extract on growth rate of Phoenix dactylifera did not significantly increase growth

rate of the plant (Table 5). Treatment using ripe seed, unripe seed and leaf extract had the highest germination rate at 60 minutes.

Table 5: Effect of duration of biopriming with *Carica papaya* aqueous extract on germination rate (%) of *Phoenix dactylifera*.

Treatment duration (minutes)	Germination rate (%)					
	Water	Ripe Fruit Extract	Unripe Fruit Extract	Ripe Seed Extract	Unripe Seed Extract	Leaf Extract
20	44.4 $\pm$ 19.24 ^a	55.6 $\pm$ 38.49 ^a	55.6 $\pm$ 38.49 ^a	44.4 $\pm$ 19.24 ^a	44.4 $\pm$ 19.24 ^a	33.3 $\pm$ 0.00 ^a
40	55.6 $\pm$ 19.24 ^a	66.7 $\pm$ 33.34 ^a	66.7 $\pm$ 33.34 ^a	55.6 $\pm$ 38.49 ^a	77.8 $\pm$ 19.25 ^a	44.4 $\pm$ 19.24 ^a
60	66.7 $\pm$ 0.00 ^a	77.8 $\pm$ 19.23 ^a	77.8 $\pm$ 19.25 ^a	88.9 $\pm$ 19.25 ^a	88.9 $\pm$ 19.25 ^a	88.9 $\pm$ 19.25 ^a
80	55.6 $\pm$ 38.49 ^a	66.7 $\pm$ 33.34 ^a	66.7 $\pm$ 33.34 ^a	77.8 $\pm$ 38.49 ^a	88.9 $\pm$ 19.25 ^a	66.7 $\pm$ 33.33 ^a

Values are means of 3 replications $\pm$ standard deviation.

Mean values within each column, that differ significantly ($p < 0.05$) were assigned different letters as superscript

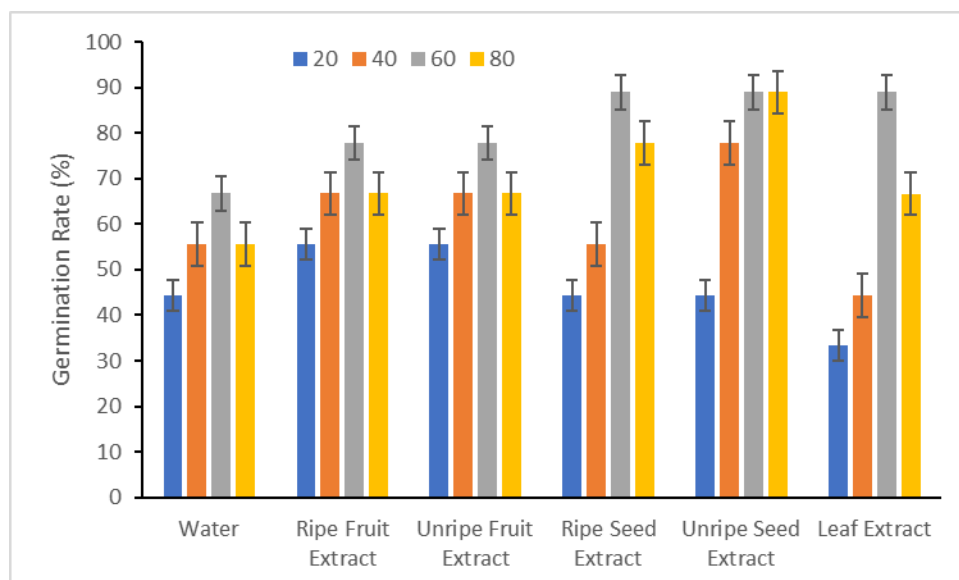


Fig 1: Effect of Bioprimering Duration with *Carica papaya* Extracts on Germination Rate (%) of Date palm seeds

Duration of bioprimering with unripe fruit extract and ripe seed extract of *Carica papaya* aqueous did not significantly increased vigour index of *Phoenix dactylifera*. However, ripe fruit extract, and unripe seed extract significantly increased vigour index (Table 6).

Table 6: Effect of duration of bioprimering with *Carica papaya* aqueous extract on vigour index of *Phoenix dactylifera*.

Treatment duration (minutes)	Vigour Index					
	Water	Ripe Fruit Extract	Unripe Fruit Extract	Ripe Seed Extract	Unripe Seed Extract	Leaf Extract
20	1677.7 ± 300.57 ^a	1504.3 ± 153.94 ^b	2699.9 ± 1564.64 ^a	2416.4 ± 1198.14 ^a	1911.4 ± 827.08 ^b	1433.1 ± 88.23 ^a
40	1822.1 ± 737.38 ^a	2288.7 ± 1095.50 ^b	3499.8 ± 1467.83 ^a	3766.5 ± 2540.69 ^a	3895.6 ± 2278.99 ^a	1754.1 ± 700.62 ^a
60	2417.2 ± 221.62 ^a	5644.1 ± 1881.55 ^a	5221.9 ± 910.27 ^a	6177.6 ± 1313.58 ^a	6199.8 ± 854.65 ^a	6646.5 ± 1001.83 ^a
80	2066.6 ± 1074.53 ^a	2644.2 ± 1063.08 ^a	3211.0 ± 1821.05 ^a	3283.3 ± 1722.23 ^a	4888.8 ± 1063.40 ^a	2933.8 ± 1619.72 ^a

Values are means of 3 replications ± standard deviation.

Mean values within each column that differ significantly ($p < 0.05$) were assigned different letters as superscript.

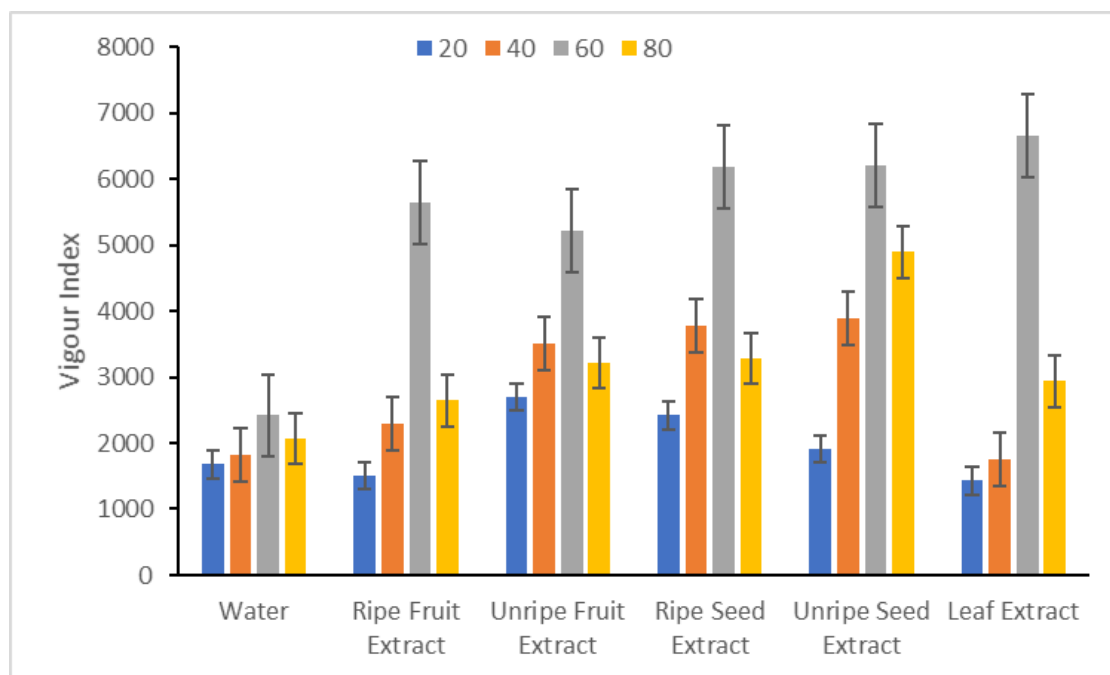


Fig 2: Effect of Bioprimering Duration with *Carica papaya* Extracts on Germination Vigour Index of Date palm seeds

Discussion

This study revealed that bioprimering date palm seeds with *Carica papaya* extracts significantly enhanced shoot and root development when compared to both the control and water-treated seeds. Among the treatments, unripe and ripe seed extracts yielded the greatest shoot weights (1.19 g and 1.14 g) and shoot lengths (30.18 cm and 28.38 cm), which were far superior to the control group (0.29 g and 4.00 cm). Leaf extract also showed strong performance, with shoot weight of 1.15 g and length of 23.12 cm. Additionally, unripe seed extract produced the highest root weight (1.84 g), while the leaf extract promoted the longest root length (31.88 cm).

These improvements are likely due to bioactive compounds present in *C. papaya*, such as phytohormones (gibberellins, auxins, cytokinins), antioxidants, and secondary metabolites, which support cellular processes and stress tolerance (YADAV and MATHUR, 2024). Seeds treated with leaf extract also recorded the highest vigor index (6646.5) and growth rate (88.9%), far exceeding the control and water-treated groups. The effectiveness of the extracts was most pronounced at a priming duration of 60 minutes,

beyond which results declined, possibly due to hormonal imbalance (MONALISA et al., 2017). These findings suggest that strategic bioprimering with *C. papaya* could greatly enhance seedling establishment.

The presence of natural bioactive compounds in *C. papaya* may have further promoted germination and early seedling growth, consistent with findings by FAROOQ et al. (2007) and KAUR et al. (2005). Similar observations were made by NAWAZ et al. (2013), who demonstrated that seed priming improves germination and vigor under normal conditions.

Conclusion

This study showed that bioprimering with *Carica papaya* extracts, especially leaf extract, significantly enhanced germination, seedling vigor, and growth in date palms. Optimal results occurred at 60 minutes, highlighting the effectiveness of timing and bioactive compounds in promoting early plant development and breaking seed dormancy naturally in date palms.

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