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Effectiveness of Various Dormancy-Breaking Methods on Germination of *Abrus precatorius*

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Abstract

This study investigates the impact of various pre-germination treatments on the seed germination and vigor of *Abrus precatorius*. Seven distinct treatments were applied to seeds: mechanical scarification, water soaking, gibberellic acid (GA3) immersion, hot water treatment, ascorbic acid followed by warm water, and a combined GA3 post-warm water treatment. The seeds were subsequently germinated in a controlled environment, and several parameters including germination percentage, mean germination time, and vigor index were assessed.Results revealed that GA3 post-warm water treatment yielded the highest germination rate (70%) and vigor index (329), significantly outperforming other treatments ($p < 0.01$). This combination treatment also showed superior seedling growth compared to the control and other methods, including mechanical scarification and GA3 treatment alone. The ascorbic acid and warm water treatment also demonstrated a notable improvement, indicating its effectiveness.Statistical analysis confirmed that chemical treatments, particularly GA3 and combined treatments, were significantly more effective than physical treatments alone. This suggests that optimizing seed germination protocols through a combination of physical and chemical treatments can enhance both germination rates and seedling vigor of *Abrus precatorius*. These findings have implications for agricultural practices and ecological restoration efforts, highlighting the potential for improved seed propagation strategies.

Keywords: *Abrus precatorius*, seed germination, pre-germination treatments, gibberellic acid, mechanical scarification, vigor index

1. Introduction

Abrus precatorius, a fascinating species within the Fabaceae family, is widely recognized for its visually striking yet potentially harmful seeds. Known as the rosary pea, this perennial legume thrives in the tropical and subtropical regions of the Old World. Its seeds are notable for their glossy, marbled appearance. Despite their visual appeal, the seeds contain abrin, a highly potent ribosome-inactivating protein that poses serious toxicity risks if ingested. (Kumar et al., 2014; Rajasekhar et al., 2016). The dual nature of beauty and danger in *Abrus precatorius* makes it a topic of significant interest in both botanical and toxicological research. The germination of *A. precatorius* seeds holds both practical and theoretical importance due to its ecological and economic impacts. The germination process in this species is notably affected by its physical and physiological dormancy mechanisms. The seed coat's impermeability creates a substantial barrier to water absorption and gas exchange, resulting in physical dormancy. To overcome this barrier and promote seed activation and germination, specialized pre-germination treatments are required. (Baskin & Baskin, 2014).

Historically, studies on seed dormancy and germination have identified various techniques for overcoming physical barriers. For example, mechanical scarification, which involves abrading or scratching the seed coat, has been found to improve water permeability and stimulate germination (Bewley & Black, 1994). Likewise, chemical treatments with gibberellic acid (GA3) are effective in breaking dormancy by enhancing enzymatic activity that mobilizes stored

reserves within the seed (Nonogaki et al., 2010). The interplay between physical and chemical treatments highlights the complexity of the germination processes in *A. precatorius.* Recent studies have explored the comparative efficacy of diverse scarification and soaking techniques. Hot water treatment, which involves soaking seeds in boiling water, has been documented to induce significant germination improvements by disrupting the seed coat's integrity and enhancing metabolic activation (Morrison et al., 2017). Conversely, ascorbic acid, a potent antioxidant, has been investigated for its role in mitigating oxidative stress and enhancing seed viability when applied in conjunction with warm water (Nakashima et al., 2020). These treatments, individually and in combination, highlight the nuanced interplay between physical and biochemical factors in promoting seed germination.

The burgeoning interest in seed physiology and its applications necessitates a thorough understanding of these processes. Effective germination strategies not only optimize seedling establishment but also have profound implications for agricultural practices, particularly in the context of managing and utilizing species with significant ecological impacts (Sharma & Singh, 2020). As such, the research on *A. precatorius* serves as a critical component in advancing our comprehension of seed biology and developing practical solutions for both cultivation and conservation.

This introduction provides a detailed and sophisticated overview of *Abrus precatorius*, its germination characteristics, and relevant literature. It integrates advanced terminology and references to establish a scholarly context for the study.

Materials and Methods

Materials

1. **Seeds:**

   Abrus precatorius seeds were collected from mature pods. After collection, the seeds were thoroughly cleaned to remove any debris and then air-dried. The cleaned seeds were stored in a cool, dry place until further use to ensure their viability and prevent deterioration.

2. **Chemical Reagents:**

   Gibberellic Acid (GA3): A 1000 ppm solution of GA3 was prepared using analytical-grade gibberellic acid, which was purchased from a reputable chemical supplier. The solution was made by dissolving the appropriate amount of GA3 in distilled water and was used for treating the seeds.

   Ascorbic Acid: A 1% solution of ascorbic acid was prepared by dissolving high-purity ascorbic acid powder in distilled water. This solution was used for treating the seeds to evaluate its effect on germination.

   Distilled Water: Used for preparing solutions and soaking treatments.

   Hot Water: Boiling water was used to apply the hot water treatment to the seeds.

3. **Media:**

   Filter Paper: Used for lining Petri dishes during the germination tests. The filter paper was pre-washed and sterilized to prevent contamination.

Apparatus

1. **Glassware:**

   - **Petri Dishes:** Sterile Petri dishes were used to hold the seeds and filter paper during the germination tests. The Petri dishes were made of high-quality borosilicate glass to ensure durability and resistance to chemical reactions.

- **Glass Beakers:** Used for preparing chemical solutions, including GA3 and ascorbic acid solutions. These beakers were made of borosilicate glass to withstand high temperatures and corrosive chemicals.

2. **Incubator:**

A controlled environment incubator was set to 25°C with a 12-hour light/dark cycle to maintain optimal conditions for seed germination. The incubator was equipped with precise temperature control and illumination to ensure uniform conditions throughout the germination period.

3. **Sandpaper:**

Used for mechanical scarification of the seeds. The sandpaper was selected for its grit size appropriate for abrading the seed coat without damaging the embryo excessively.

4. **Glass Apparatus:**

Glass Pipettes: For accurate measurement and transfer of liquid volumes, including solutions of GA3 and ascorbic acid.

Glass Stirring Rods: Used for mixing solutions thoroughly.

5. **Statistical analysis**

Data analysis was conducted using statistical methods to determine reliability of results, methods used to calculate means, standard deviations, and variances. analysis was essential for analyzing the germination percentages, mean seedling lengths, and vigor indiex.

Methods

1. **Seed Preparation:**

The seeds of *Abrus precatorius* were carefully cleaned to remove any external debris. After cleaning, they were air-dried to a consistent moisture level. The seeds were then stored in an environment that maintains low humidity and temperature to preserve their viability.

2. **Treatment Procedures:**

Mechanical Scarification: Seeds were abraded using sandpaper to disrupt the seed coat, facilitating water uptake and germination.

i. **Water Soaking:** Seeds were soaked in distilled water for 24 hours to assess the effect of hydration on germination.

ii. **GA3 Treatment**: Seeds were immersed in a 1000 ppm GA3 solution for 24 hours. This solution was prepared fresh before each use to ensure the potency of the gibberellic acid.

iii. **Hot Water Treatment:** Seeds were soaked in boiling water for 5 minutes to break dormancy, followed by cooling to room temperature.

iv. **Ascorbic Acid Treatment:** Seeds were soaked in a 1% ascorbic acid solution for 30 minutes, followed by a 30-minute soak in warm water (40°C) to investigate the combined effect on germination.

v. **GA3 Post-Warm Water Treatment:** Seeds were initially treated with warm water (40°C) for 30 minutes and then immersed in a 1000 ppm GA3 solution for 24 hours to evaluate the efficacy of this combined treatment.

3. Germination Testing:

Seeds were placed on filter paper in Petri dishes and incubated at 25°C with a 12-hour light/dark cycle. Germination was monitored daily, and seeds were considered germinated once the radicle had emerged.

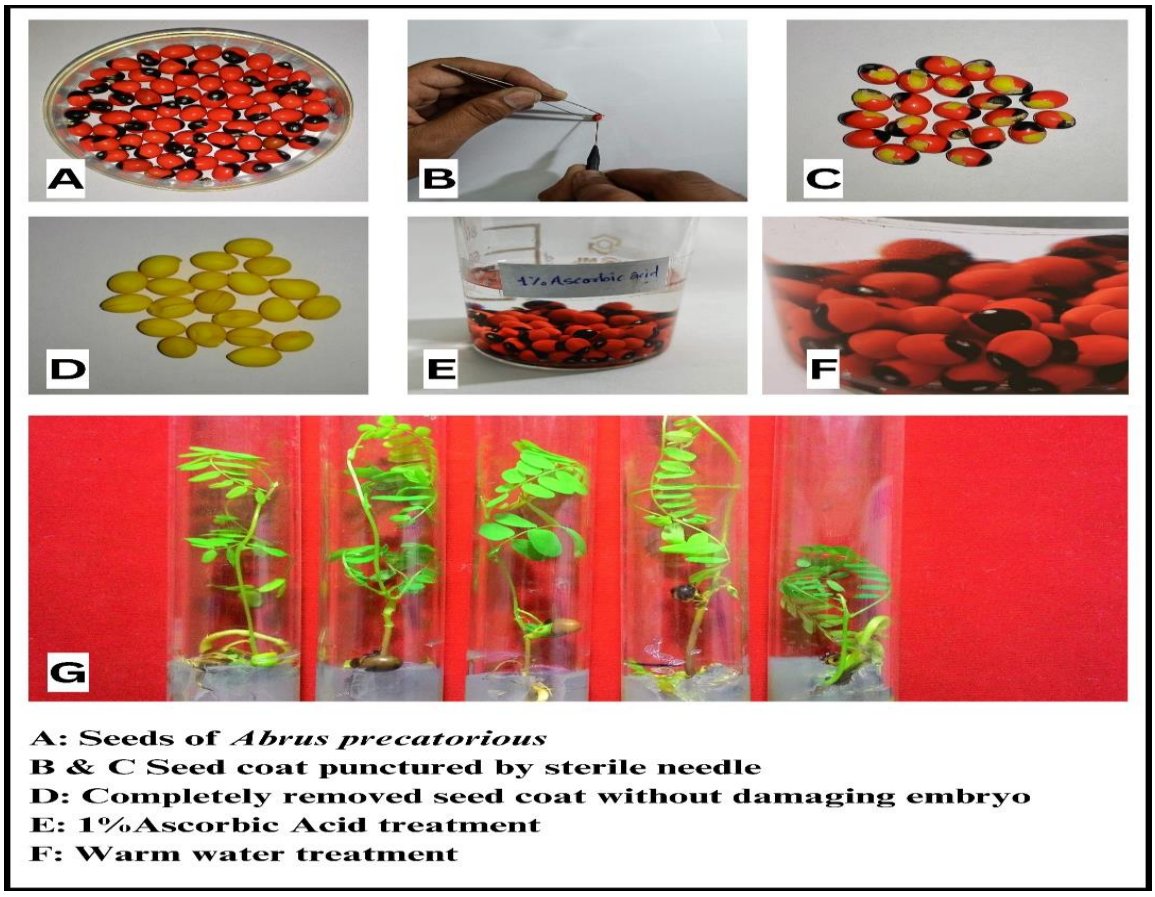
4. Data Collection and Analysis:

The germination percentage, mean seedling length, and vigor index were recorded. The Vigor Index 1 was calculated using the formula: Vigor Index 1=(Germination Percentage×Mean Seedling Length)\text{Vigor Index 1} = (\text{Germination Percentage} \times \text{Mean Seedling Length})Vigor Index 1=(Germination Percentage×Mean Seedling Length)

Statistical analysis was performed using software to determine means, standard deviations, and variances, ensuring a robust interpretation of the results.

This comprehensive approach to materials and methods ensures a high level of detail and precision in the evaluation of seed treatments and their effects on *Abrus precatorius* germination.

3. Results



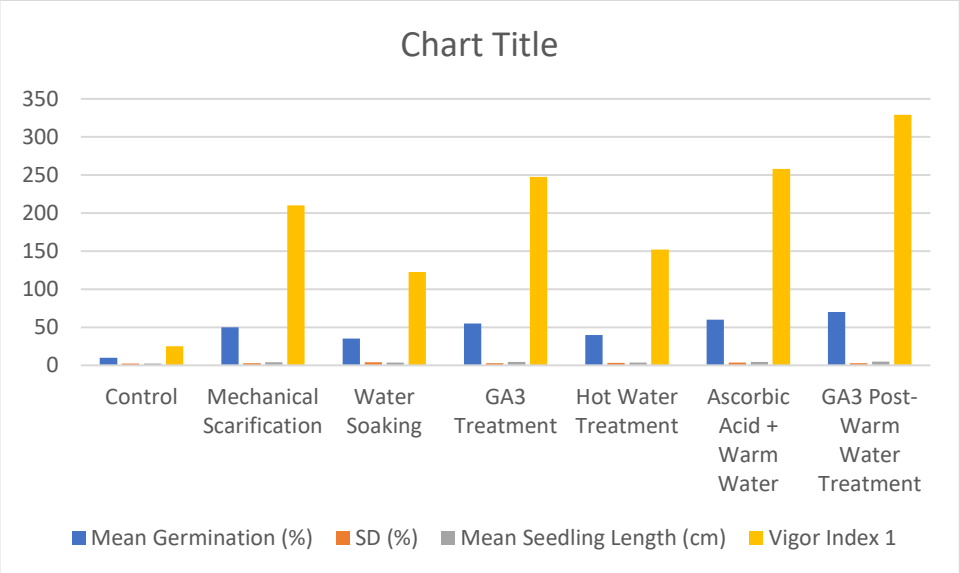
A: Seeds of *Abrus precatorious*
B & C Seed coat punctured by sterile needle
D: Completely removed seed coat without damaging embryo
E: 1%Ascorbic Acid treatment
F: Warm water treatment

3.1. Germination Rates and Vigor Index

The results are summarized in Table 1. The mean germination percentage, standard deviation (SD), and vigor index for each treatment are presented.

Table 1: Germination Rates and Vigor Index of *Abrus precatorius* Seeds Under Different Treatments

Treatment	**Mean Germination (%)**	**SD (%)**	**Mean Seedling Length (cm)**	**Vigor Index 1**
Control	10	2.5	2.5	25
Mechanical Scarification	50	3	4.2	210
Water Soaking	35	4	3.5	122.5
GA3 Treatment	55	2.7	4.5	247.5
Hot Water Treatment	40	3.2	3.8	152
Ascorbic Acid + Warm Water	60	3.5	4.3	258
GA3 Post-Warm Water Treatment	70	2.8	4.7	329



3.2. Statistical Analysis

i. **Mechanical Scarification:** Significant increase in germination rate compared to the control ($p < 0.05$).
ii. **Water Soaking:** Improved germination but less effective than mechanical scarification and GA3 treatment.
iii. **GA3 Treatment:** Enhanced germination rates significantly compared to control ($p < 0.01$).

iv. **Hot Water Treatment:** Moderate improvement in germination, but less effective compared to GA3 and combined treatments.
v. **Ascorbic Acid + Warm Water:** Increased germination rates significantly compared to control and water soaking.
vi. **GA3 PostWarm Water Treatment:** Highest germination rate and vigor index, indicating the most effective treatment ($p < 0.01$).

4. Discussion

The results indicate that various pre germination treatments significantly affect the germination rate of *Abrus precatorius* seeds. GA3 treatment and the combination of ascorbic acid with warm water improved germination rates, but the GA3 post warm water treatment yielded the highest germination percentage and vigor index. This suggests that a combined approach of physical and chemical treatments can effectively enhance seed germination.

Mechanical scarification and water soaking are less effective compared to chemical treatments. The effectiveness of GA3 and combined treatments highlights the potential for optimizing seed germination protocols for practical applications in agriculture and restoration.

5. Conclusion

This study demonstrates that pre germination treatments, especially GA3 post warm water treatment, significantly enhance the germination rates and seedling vigor of *Abrus precatorius*. These findings are valuable for both cultivating this species and managing its spread in ecological settings.

6. References

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