Physical, Chemical and Mechanical Priming Techniques in Breaking Seed Dormancy of *Adenanthera pavonina Linn.*

Namitha L. H.
Research Scholar
Department of Botany, University of Kerala, Thiruvananthapuram, Kerala- 695581

Abstract: *Adenanthera pavonina* is native to Southeast Asia, India, Sri Lanka, Australia, and is grown widely as an ornamental tree. The seeds possess many traditional medicinal properties and is edible when cooked. The seeds of this tree are orthodox and possess physical dormancy due to the hard seed coat. Mechanical removal of seed coat was found to be the most effective in minimising the days taken for germination from 22 days to 3 days. Comparable results could be obtained by treating with 50% HNO_3 and H_2SO_4, where germination occurred within 7 and 6 days respectively. Though mechanical scarification is the best technique for breaking dormancy, it is labour intensive and time consuming. Therefore usage of 50% concentrated respective acids is advisable.

***Index terms: Adenanthera pavonina*, seed, dormancy, scarification**

I. INTRODUCTION

The seeds of most plants germinate when they are provided with favourable environmental conditions. However, there are viable seeds which do not germinate even after getting all the favourable environmental conditions. Germination of such seeds may be delayed for days, weeks, months or even years. The seeds of such plants are said to be in a state of dormancy. Dormancy may thus be defined as the condition of seed when it fails to germinate even though environmental conditions, usually considered favourable for active growth, are present (Vegis, A, 1964). Germination of seeds may not always be prevented due to dormancy. Sometimes seeds may be quite capable of germination but they fail to germinate due to non-availability of sufficient moisture or temperature. Physiologists have used two terms to distinguish between these two different situations: quiescence and dormancy. Quiescence is thus, defined as the condition of a seed when it fails to germinate because the environmental conditions normally required for growth are not present (Groot, S.P.C 1992). Whereas, dormancy is the condition of a seed, when it fails to germinate even when normal environmental conditions for growth are available. The seed considered in the current study is that of *Adenanthera pavonina*, commonly known as the Coral wood tree, a rather underutilized tree in India. Being a very hardy, fast growing tree which requires relatively little maintenance, it is found in most tropical countries. The current work is to study the effect of physical, chemical and mechanical treatments in breaking seed dormancy in *Adenanthera pavonina*. Being a member of the family Leguminosae, it has the ability to fix nitrogen in its root and help rejuvenate soil. The raw seeds of this tree are toxic, but may be eaten when cooked (cite). In traditional medicine, a decoction of the young leaves and bark of *Adenanthera pavonina* is used to treat diarrhoea. The ground seeds are used to treat inflammation. Preliminary scientific studies appear to support these traditional uses. High doses of the seed extract have shown anti-inflammatory effect in studies in rats and mice (Bewley, J.D. *et al*, (2006); Dholvitayakhun A. *et al*, (2012). Seeds are used for making soap (Ajani, 2017), and a red dye can be obtained from the wood (Mujahid *et.al.*, 2016). The wood, which is extremely hard, is also used in boat-building, making furniture and for firewood. It is grown as a forage plant and also as an ornamental garden plant. The fast growing nature of this tree, with an attractive, spreading canopy makes it suitable as a shade tree in gardens, parks and avenues (Maiden, 1889).Throughout the recorded history of many Asian countries, the seeds of *A. pavonina* are believed to have been used as a unit of weight for making fine measurements. It was once used to measure gold, owing to the almost identical weight of the seeds (Corner, E.J.H, 1988). The commonly known causes for seed dormancy are; due to hard and impermeable seed coat, conditions of the embryo, light requirement, chilling requirement and dormancy due to germination inhibitors. On literature survey various studies conducted with respect to the effectiveness of different pre-treatment techniques by Nwoboshi (1982), Onyekwelu and Akindele (2002) on many tree species could be observed. A single pre-treatment method effective for seeds of all tree species is not available, since the relative dormancy rate and the cause of delayed germination varies from one species to another. (Oboho, E.G *et al*, 2012)

II. MATERIALS AND METHOD

The treatments employed in breaking seed dormancy can be divided into physical, chemical and mechanical. Physical treatment involves the different treatments with water. Acid treatment, alkali treatment, and vinegar treatment are different methods of chemical treatments. Mechanical treatment involves the removal of seed coat before and after soaking in water.

2.1 Materials required

i) Viable seeds [Collected from Nalanchira, Parassala, and Kattakada areas of Thiruvanathapuram district in Kerala, grown in separate batches]

ii) Sterile substratum - soil and cotton

iii) Water (Distilled and tap water]

iv) Forceps and needle

(v) Conical flask and measuring cylinder

(vi) Chemicals (10%, 25%, 50% and 100% of nitric acid, sulphuric acid, and hydrochloric acid respectively; 50%, and 100% vinegar)

(vii) Plastic and glass cups

(viii) Markers, paper, label strip and data chart

2.2. Procedure:

Viable seeds of *Adenanthera pavonina*, collected from the three different locations are planted separately after doing the different pre-treatments. Prior to treating the seed with different chemicals, a few seeds are planted as control. The control took 22 days, to a maximum of 28 days for germination.

2.2.1 Physical Treatment

In this treatment, the seeds are exposed to water at different conditions, temperatures and time span. As the first method, the seeds are pre-soaked for 24 and 48 hours. After soaking, the seeds are planted. Cold water treatment was done by placing the seeds in cold storage at -18ºC (in freezer) and also in refrigerator (-4ºC) without freezing, for 12 and 24 hours and thereafter the seeds were planted. Then there is the hot water treatment, for 10 minutes before planting. The planted seeds are watered two times a day, constantly monitored and the date of germination is recorded.

2.2.2. Mechanical Treatment

Mechanical treatment can be adopted by the mechanical removal of seed coat before or after soaking in water for few hours. In this method, *Adenanthera pavonina* seeds are soaked in water for 12 hours. Using forceps and needles, seed coat is removed carefully and planted. During the mechanical removal of seed coat, care should be taken to prevent any injury to the embryo. The same technique is repeated without pre-soaking as well.

2.2.3. Chemical Treatment

Different concentration of acid solutions such as 100%, 50%, 25%, 10% of concentrated nitric acid, hydrochloric acid and sulphuric acid are made. *Adenanthera pavonina* seeds are soaked in it for an hour. The seed coat gets ruptured after half an hour. Followed by treatment set with 0.5 % urea is made, and *Adenanthera pavonina* seeds are immersed in it for 12 hours and 24 hours. Finally different concentrations of vinegar solution was used. Vinegar which is 4-18% acetic acid is a weak acid. For this experiment, we take 50% and 100% concentrations. In this solution *Adenanthera pavonina* seeds are soaked for 12 hours and 24 hours respectively, and then is planted. In all these cases, they were taken out, washed and planted carefully and watered twice daily.

RESULTS AND DISCUSSION

The outcome of the experiment is tabulated in Table 1. The results are also represented in Figure 1 bar graph, in the order of the most days taken for germination to the treatment with the least number of days taken for germination.

Table 1. Various priming treatments and number days taken for germination

Type of Treatment	Treatment	Planted on	Germinated on	Total no: of days
Control	Control	15/01/2014	5/02/2014	22
Water Treatment	Presoaking in water for 24 hours	20/01/2014	04/02/2014	16
	Pre-soaking in water for 48 hrs	20/01/2014	30/01/2014	11
	Boiling water treatment	22/01/2014	11/02/2014	21
Vernalization	-18º C 12 hours	22/01/2014	03/02/2014	13
	-18º C 24 hours	22/01/2014	04/01/2014	14
	4º C 12 hours	22/01/2014	02/02/2014	12
	4º C 24 hours	22/01/2014	03/02/2014	13
Acid scarification	100% HNO_3	24/01/2014	-	-

	50% HNO_3	24/01/2014	30/01/2014	7
	25 %HNO_3	24/01/2014	02/02/2014	10
	10% HNO_3	24/01/2014	05/02/2014	13
	100% HCl	24/01/2014	-	-
	50% HCl	24/01/2014	01/02/2014	9
	25% HCl	24/01/2014	03/02/2014	11
	10% HCl	24/01/2014	09/02/2014	17
	100%H_2SO_4	24/01/2014	-	-
	50%H_2SO_4	24/01/2014	29/01/2014	6
	25%H_2SO_4	24/01/2014	01/02/2014	9
	10%H_2SO_4	24/01/2014	03/02/2014	11
Alkali and weak acid scarification	Urea soaking for 12 hrs	24/01/2014	04/02/2014	12
	Urea soaking for 24 hrs	24/01/2014	03/02/2014	11
	50% Vinegar 12 hrs	22/01/2014	03/02/2014	13
	50% Vinegar 24 hrs	22/01/2014	01/02/2014	11
	100% Vinegar 12 hrs	22/01/2014	07/02/2014	17
	100% Vinegar 24 hrs	22/01/2014	09/12/2014	19
Mechanical scarification	12 hrs soaking + seed coat removal	22/01/2014	24/01/2014	3
	Seed coat removal, without soaking	22/01/2014	28/01/2014	7

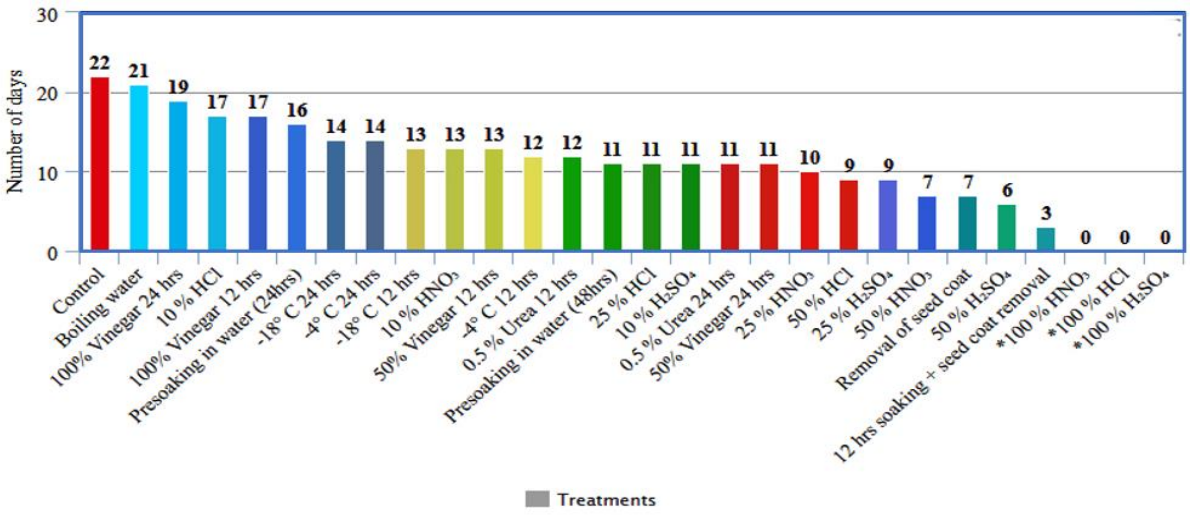

Figure 1. Bar graph showing the type of priming treatment given against the number of days taken for germination (*In 100%concentration germination rate was 0%)

Figure 2. *A. pavonina* seeds soaked in water

Figure 3. *A. pavonina* seeds, after -having undergone various treatments

Figure 4. Germinated *A. pavonina* seeds treated with H_2SO_4

Figure 5. Germinated seeds of *A. pavonina* , which were treated with HCl and H_2SO_4

The main objective of the present work was to determine the most effective method for breaking dormancy in *Adenanthera pavonina* seeds. For this, several treatments were conducted such as water treatment, acid treatment, alkali treatment (urea), vinegar treatment and mechanical scarification.

The water treatment included cold storage, hot water treatment and soaking the seed for 24 and 48 hours in water. Seeds soaked for 48 hours germinated first. It required 11 days for germination. So, it is confirmed that, it is the simplest method for breaking dormancy in seeds. Hot water treatment was found to be the least effective for germination. It took 21 days, which is nearly equal to the normal dormancy period of 22 days. Contrary to this, hot water treatments conducted to break seed dormancy in *Dialuim guineense* seeds (also from a plant of the Leguminosae family) was found to be very effective (Oboho, E. G. *et al*, 2012).

Nitric acid, hydrochloric acid and sulphuric acid are the acids used for strong acid treatment. Varying concentrations (100%, 50%, 25% and 10%) of acid solutions are prepared and the seeds are soaked in the respective acid solutions for an hour and is planted. Seeds soaked in 100% concentration of all three acids was found not to have germinated. The ones soaked in 50% H_2SO_4 germinated first, by taking a minimum of 6 days. Similar results were obtained by doing 50% H_2SO_4 treatment for 1 hour on Tamarind seeds. Increase in the sulphuric acid concentration, water temperature and soaking period were seen to have enhanced seed germination (Muhammad *et al*,2003). Treatment with 50% HNO_3 took 7 days for germination, and then the ones treated with 50% HCl took 9 days. From this study, it can be concluded that, among acids, sulphuric acid is the most potent breaking dormancy in seeds followed by nitric acid and hydrochloric acid respectively. And also it is found that lower concentrations of these acids did not favour germination to a great extent. These results of acid treatments were contrary to the seed dormancy studies on Sorghum, where treatment with acid was not found to be an effective method. (Shanmugavalli, M. *et al* 2007)

The seeds soaked in 100% vinegar solution for 12 hours required 17 days for germination and 24 hours required 19 days for germination. But the seeds soaked in 50% vinegar solution for 12 hours required 13 days for germination and 24 hours required 11 days for germination. It can be concluded that vinegar treatment is not that efficient in breaking seed dormancy in *Adenanthera povonina*.

Though vinegar treatment is not found to be effective in the case of *A. pavonina* seeds, its result was found positive in plants like lettuce and chrysanthemum [Mu, J. *et al*, 2003]. It could be due to the hard coat of the seeds in our study, that vinegar was not a good treatment choice.

In urea treatment, seeds were soaked in 0.5 % urea for 12 and 24 hours. Seeds soaked for 24 hours germinated earlier than that treated for 12 hours. But this treatment is not useful for breaking dormancy. Since the difference in days of germination is very small and the minimum time required was found to be 11 days. So it is not that efficient in breaking dormancy in our candidate tree seeds.

The last and most suitable method for breaking dormancy in *A. pavonina* seeds was found to be the mechanical scarification method. Here, the seed coat was removed after soaking in water. It required 3 days for germination. If seed coat was removed before planting, without soaking, it required 7 days for germination. Therefore seed coat removal after soaking is found to be the most suitable method for breaking seed dormancy on *Adenanthera pavovnina* seeds.

CONCLUSION

In conclusion, the present study revealed that, treatments such as physical, chemical and mechanical treatment has an enhanced effect on breaking dormancy in *Adenanthera pavonina* seeds. Certain concentrations of HNO_3, HCl and H_2SO_4 are found to be very efficient for this purpose. 50% solution of nitric acid, hydrochloric acid and sulphuric acid are effective for breaking dormancy. Seeds treated with 50% sulphuric acid took the least number of days for germination, among the three. It took a minimum of 6 days for germination. But the most suitable method for breaking dormancy is the removal of seed coat after soaking in water for 12 hours. In which the seeds germinated on the 3rd day.

Of the various water treatments, the seeds soaked in water for 48 hours germinated first. It required 11 days for germination. In vinegar treatment, seeds soaked in 50% vinegar solution for 24 hours germinated first. It required 11 days for germination. In urea treatment, seeds soaked in 0.5 % of urea for 24 hours germinated first. It also required 11 days for germination.

By this study it is observed that, mechanical removal of seed coat is the most favorable method for breaking dormancy of *Adenanthera pavonina*. Since mechanical scarification is time consuming and labor intensive, usage of 50% sulphuric acid treatment is suggested as the most efficient way for beaking seed dormancy in the seeds of *A. pavonina*. This study also reveals that, seed dormancy in

Adenanthera pavonina seed is probably due to its very hard seed coat. Therefore, it can be assumed that the thick seed coat is preventing water from entering into the embryo.

REFERENCE

1. Ajani, O. O. (2017). Proximate composition, structural characterization and phytochemical screening of the seed oil of Adenanthera pavonina Linn. Rasayan Journal of Chemistry, 10(3), 807-814.
2. Bewley, J. D., Black, M., & Halmer, P. (Eds.). (2006). The encyclopedia of seeds: science, technology and uses. Cabi.
3. Corner, E.J.H. (1988). Wayside Trees of Malaya, Volume 1. Malaysian Nature Society.
4. Dholvitayakhun, A., Cushnie, T. T., & Trachoo, N. (2012). Antibacterial activity of three medicinal Thai plants against Campylobacter jejuni and other foodborne pathogens. *Natural product research*, *26*(4), 356-363.
5. Groot, S.P.C. and C.M. Karssen. Dormancy and germination of abscisic acid-deficient tomato seeds. Plant Physiology 99: 952-958, (1992).
6. Maiden, J. H. (1889). *The useful native plants of Australia:(including Tasmania)*. Turner and Henderson.
7. Mu, J., Uehara, T., & Furuno, T. (2003). Effect of bamboo vinegar on regulation of germination and radicle growth of seed plants. *Journal of Wood Science*, *49*(3), 262-270.
8. Mujahid, M. D., Ansari, V. A., Sirbaiya, A. K., Kumar, R., & Usmani, A. (2016). An insight of pharmacognostic and phytopharmacology study of Adenanthera pavonina. Journal of Chemical and Pharmaceutical Research, 8(2), 586-596.
9. Nwoboshi, L. C. (1982). Tropical silviculture: principles and techniques.
10. Oboho, E. G., & Ogana, F. N. (2012). Effects of varying hot water temperatures on the germination and early growth of Dialuim guineense (Willd) seeds. *Annals of Biological Research*, *3*(3), 1247-1254.
11. Onyekwelu, J. C., & Akindele, S. O. (2002). Effect of pretreatments on the germination of the seed of Chrysophyllum abidum. Appl. Trop Agric, 7, 23-28.
12. Shanmugavalli, M., Renganayaki, P. R., & Menaka, C. (2007). Seed dormancy and germination improvement treatments in fodder sorghum.
13. Vegis, A. (1964). Dormancy in higher plants. Annual Review of Plant Physiology 15: pp.185-224.