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The Effect of Pre-Sowing Seed Treatments on Germination of Snake Bean (*Swartzia madagascariensis)*, a Reported Medicinal Plant

E. Amri

Department of Science and Laboratory Technology,
Dar es Salaam Institute of Technology, P.O. Box: 2958, Dar es Salaam, Tanzania

Abstract: This study was an effort to evaluate easy, appropriate and most effective techniques to improve seed germination of *Swartzia madagascariensis*. The effect of mechanical scarification, hot water treatments (5, 10, 15 and 20 minutes), dry heat treatments at 60, 80 and 100°C (15, 30 and 60 minutes) and sulphuric acid treatments (5, 10, 15 30 and 60 minutes) were investigated under laboratory conditions. The effects of mechanical scarification, hot water treatments, dry heat treatments and sulphuric acid treatment were significant ($p < 0.001$). Germination percentage varied among treatments, seeds treated with hot water for 10 minutes had the highest seed germination 86%. Dry heat treatment at 80 for 30 minutes and sulphuric acid treatment for 10 minutes also enhanced germination to 70 and 69%, respectively. These results have significant implication on the best methods to be used in improving seed germination of this economically important plant.

Key words: *Swartzia madagascariensis* · Boiling water · Dry heat · Germination · Scarification · sulphuric acid

INTRODUCTION

Snake bean *(Swartzia madagascariensis)* is one of the most important leguminous trees with presence of phytochemical compounds used for medicinal and other purposes. Leaves are used to cure scabies and cutaneous infections and root bark is mostly preferred as cure for toothaches [1]. There has been also discoveries of antifungal drug from *S. madagascriensis* which is has proved to be the most effective for treating fungi infections and is found only in this species particularly in the tree root [2]. The plant also contains active compounds against larval mosquitoes and extracts from the flowers can be used as insecticides to decrease transmission of dengue [3]. Pharmacological investigations have been also reported on molluscicidal activity of the pods of *S. madagascriensis* [4]. Antimalarial activity as other medicinal potential from *S. madagascariensis* leaves has also been reported [5]. With such discoveries and other economic uses of *S. madagascariensis* there is an urgent need to optimize its growth and establishment for sustainable availability of harvestable products in the future.

Understanding of the seed germination of *S. madagascariensis* is crucial for its development and life cycle. In spite of its potential as a multipurpose tree species, little information is available on the influence of pre-sowing treatments on seed germination. The objective of this study was to improve this knowledge, by assessing the response of seed germination of this species to the effects of mechanical scarification, hot water treatments, dry heat treatments and sulphuric acid treatments. The economic importances of *S. madagascariensis* make it imperative for the need of such study in order to optimize its seed germination.

MATERIALS AND METHODS

Seed Collection and Experimental Details: Seeds of *Swartzia madagascariensis* used in this study were collected from the wild in several locations of Mkundi (latitude 06°40' S and longitude 037°39' E) where the matured fruits were taken from as many plants as possible in healthy looking individuals.

Seeds were subjected to mechanical scarification by scratching seed coat of *S. madagascariensis* with abrasive sand paper until the surface of the coat was

Corresponding Author: E. Amri, Department of Science and Laboratory Technology, Dar es Salaam Institute of Technology, P.O. Box: 2958, Dar es Salaam, Tanzania

partially eliminated. Hot water treatments were done by immersion of seeds in hot water (100°C) for 5, 10, 15 and 20 minutes. For dry heat treatments, seeds were placed aluminum dish and exposed in preheated ovens at temperatures of 60, 80, 100°C and duration 15, 30 and 60 minutes for each temperature. Sulphuric acid treatments were done by soaking seeds in a concentrated sulphuric acid (98% purity) for 5, 10, 15, 30 and 60 minutes. Seeds were placed in separate beakers containing sulphuric acid and stirred at intervals to get a uniform effect. At the end of the treatments seeds were rinsed with distilled water for 5 minutes before being sown.

In each treatment 4 replicates of 25 seeds were used (one hundred seeds for each treatment). Untreated seeds were used as control in each experiment. Treated and untreated seeds were sown in 10.0 cm sterile Petri dishes containing cotton which was kept moist with distilled water. Seeds were inspected every day and were considered germinated if the radicle was about 2 mm long and cotyledons had emerged from the seed coat indicating the seedling was likely to become successfully established.

Data Analysis: Data analysis was done using GenStat Discovery Edition 3 Release 7.22 DE computer software package. Before analysis, the percentage data in germination were arcsine transformed to meet the normality assumption for the analysis of variance. Data of each experiment were analyzed separately. Analysis of variance (ANOVA) procedures were used to test for significant effect of treatments, followed by Duncan's Multiple Range Test (DMRT) for comparisons of means of different treatments.

RESULTS AND DISCUSSION

Germination of *S. madagascariensis* was significantly improved by through use of mechanical scarification, some treatment levels for hot water treatments, dry heat treatments and sulphuric acid treatments compared with the control.

Mechanical Scarification: The effects of mechanical scarification using abrasive paper and hot water treatments on seed germination were significant ($p < 0.001$). The seeds responded significantly ($p < 0.05$) to mechanical scarification reaching 45% germination within 7 days after sowing compared with the control 22% (Fig. 1). The results from mechanical scarification are in agreement with Teketay [6] who reported that germination was improved for leguminous seeds through mechanical scarification. Most of leguminous species have the characteristic feature of seed coat impermeability as a mechanism which delays germination until conditions are suitable for establishment [7].

In nature there are many mechanisms which are able to crack the tegmentary barrier, or the seed coat, in legumes. These can be abrasion, soil acids, bacteria and other soil micro organism action and the chemical scarification suffered throughout herbivore digestive system as well as temperature oscillation of the alternating dry and wet periods [8, 9]. Chewing ingestion and ruminating pod of legumes by animals may provide mechanical scarification of the seeds which is similar to treatment in the laboratory for breaking dormancy [10].

Hot Water Treatments: The effect of hot water treatments was significant ($p < 0.001$) on seed germination of *S. madagascaiensis.* Germination was increased as exposure time to hot water increased up to 10 minutes, where the percentage was significantly highest at 86% and slightly but insignificantly decreased to 79% for seeds treated for 15 minutes (Fig. 1). Hot water treatment for 20 minutes had significantly decreased seed germination.

The variable germinative behaviours with the different boiling times showed by the seeds of *Swartzia madagascariensis* means that seeds had unequal dormancy. Such unequal dormancy for seeds of the same species in legumes has been reported by Virginia [11] who indicates that the lens (strophiole) forms a region of structural weakness differing from seed to seed. This structure can be disrupted either naturally or by several specific treatments thus rendering the seeds permeable to water. The water then moves phenolic compounds which are soluble in water from embryo to aleurone layer of the endosperm [12]. The beneficial effect of hot water treatment on seed germination is common among legumes has traditionally been considered to be an effective agent for reducing seed impermeability [13]. Sudden dip of dry seeds in boiling water may lead to the rapture of the coat wall allowing water to permeate the seed tissues causing physiological changes and subsequent germination of the embryo [14]. Good response of seeds to boiling water treatments is an advantage since the method is relatively simple, convenient and cheap and requires little skill. The method can be practically applied for small scale tree plantations and for large scale seedling production in nurseries for conservation or distribution.

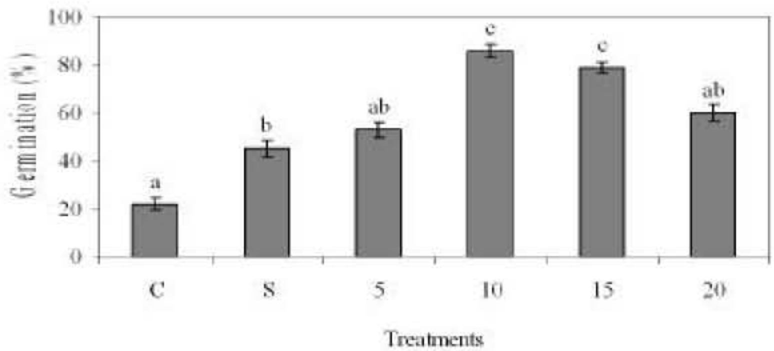

Fig.1: The effects of mechanical scarification and hot water treatments on germination of *S. madagascariensis*. C = control, S = sand paper scarification (mechanical scarification) and 5, 10, 15 and 20 are time in minutes of hot water treatments. Bar graph with the same letter indicate no significant difference at $p<0.05$ (DMRT)

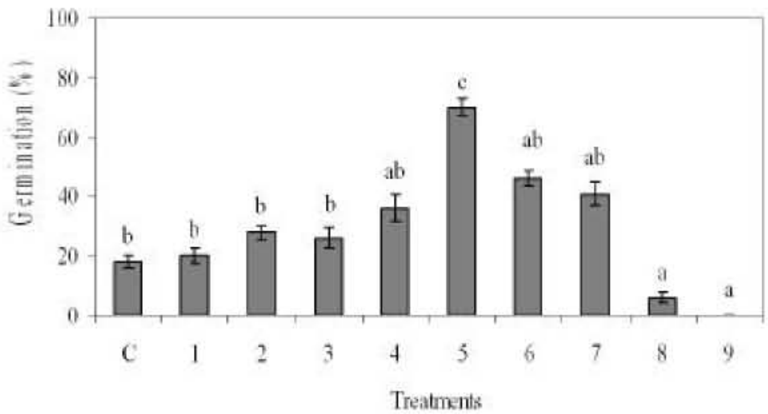

Fig. 2: The effect of dry heat scarification treatments on the germination of *S. Madagascariensis*.
C = control .

1 = 15 minutes at 60°C	2 = 30 minutes at 60°C	3= 60 minutes at 60°C
4 = 15 minutes at 80°C	5 = 30 minutes at 80°C	6 = 60 minutes at 80°C
7 =15 minutes at 100°C	8 = 30 minutes at 100dC	9 = 60 minutes at 100°C

Bar graph with the same letter indicate no significant difference at $p<0.05$ (DMRT)

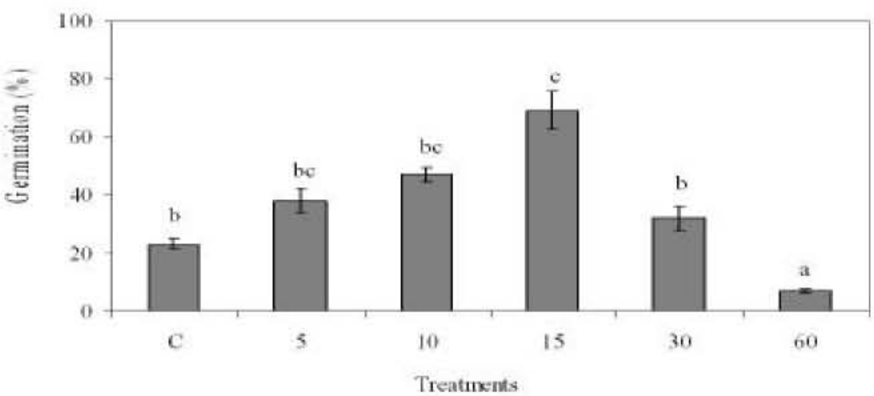

Fig. 3: The effect of Sulphuric acid treatments on germination of *S. madagascariensis*. C = control and 5, 10, 15 and 20 are time in minutes of sulphuric acid treatments. Bar graph with the same letter indicate no significant difference at $p<0.05$ (DMRT)

Dry Heat Treatments: The effect of dry heat treatments was significant ($p < 0.001$) on the germination of *S. madagascariensis,* seeds. Dry heat scarification treatment at 80°C for 30 minutes had significantly ($p > 0.05$) highest germination up to 70% (Fig. 2). Dry heat treatments for at 80°C for 15 and 60 minutes as well as 100°C for 15 minutes were not significant different from each other but had high germination compared with the control and other dry heat treatments (Fig. 2). There was no significant difference between treatments at 60°C for 15, 30 and 60 minutes and the control. Exposure of seeds to 100°C for 30 and 60 minutes resulted in poor germination and was lower than the control which could be attributed to a detrimental effect on the seeds due to long duration exposure to high temperature heat (Fig. 2).

The response to dry heat treatments as revealed for seeds of *S. madagascariensis* is the survival strategy of differentiation in heat requirements for germination. During wildfire the heat conditions in the soil are not uniform in space and time because of the uneven distribution of litter and standing biomass, Therefore when fire takes place there are a relatively high number of hard coat seeds released from physical dormancy, irrespective of the intensity and the duration of the fire because of their response to heat [15]. Apart from dry heat in the soil as a result of wildfire, there might also be moist heat which is available from thermal degradation and combustion of woody fuels which increase germination more effectively than dry heat in several species of legumes. The range of temperatures in the soil allows the seed of each legume, whose germination is promoted by thermal treatments, to find their specific heat requirements [16]. Some of the tested dry heat treatments were also effective in enhancing seed germination in *S. madagascariensis,* it has also revealed that at high temperatures or prolonged exposure has poor seed germination as it has been reported in other woody species [17- 19].

Sulphuric Acid Treatments: The effect of treatment with sulphuric acid was significant ($p < 0.001$) on seed germination of *S. madagascariensis*. The results of the effect of sulphuric acid treatments on seed germination is presented in Fig. 3. The significant ($p > 0.05$) highest germination was 69% for seeds treated for 15 minutes. Sulphuric acid treatments for 5 and 10 minutes had significant high germination compared to the control. Treatments for 30 minutes yielded low germination and prolonged treatment in acid for 60 minutes had a remarkable poor germination percentage compared to the control (Fig. 3).

Sulphuric acid scarification treatments in the laboratory reflect the ways seeds in nature overcome dormancy through softening of seed coat in the acidity of the soil [7] or pass of the seeds through the digestive tract of animals [20, 21]. Sulphuric acid is thought to disrupt the seed coat and expose the lumens of the macrosclereids cells, permitting imbibition of water which triggers germination [22]. The acid treatment has also been reported as an efficient method to increase, accelerate seed germination of species with hard impermeable seed coat [23]. However, time of exposure is critical and needs to be quantified for each species since seeds exposed for a long period seeds can be damaged easily [22]. This is in agreement with the current study where soaking in sulphuric acid for 30 gave low germination 32% and at 60 minutes it gave 7% germination. This fact was also confirmed by McDonald *et al.* [24] on *Prosopis africana and Tamarindus indica* where immersion of seed in sulphuric acid for more than 60 min increased the number of damaged seeds hence tremendously reducing germination percentage.

Dormancy in seeds is usually associated with the factors of the protective covering, the seeds coat or the enclosed embryo [22]. From the investigations carried out through mechanical scarification, hot water, dry heat and sulphuric acid treatments overall high germination was obtained for hot water treated seeds.

CONCLUSION

Conclusively, for all pre-sowing treatments evaluated, hot water treatment for 10 minutes is recommended as pre sowing seed treatments for *S. madagascaiensis*. The recommended method is cheaper and less hazardous pretreatment method to improve germination when compared with the use dry heat treatments or use of sulphuric acid which is expensive requires proper handling techniques which may not be known by some small scale farmers.

REFERENCES

1. Akerele, O., V. Heywood and H. Synge, 1991. Conservation of Medicinal Plants. Cambridge University Press, pp: 56-84.
2. Berger, K. and W. Schaffner, 1995. *In vitro* propagation of the leguminous tree *Swartzia madagascariensis*. Plant Cell Tiss. Org. Cutt., 40: 289-291.

3. Lwambo, N.J. and H.G. Moyo, 1991. The molluscicidal activity of seed pods of *Swartzia madagascariensis* on Marisacornuarietis. East Afr. Med. J., 68(10): 827-830.
4. Hostettmann, K. and J.L. Wolfender, 1997. The search for biologically active secondary metabolites. Pestic. Sci., 51: 471-482.
5. Ouattara, Y., S. Sanon, Y. Traoré, V. Mahiou, N. Azas and L. Sawadogo, 2006. Antimalarial activity of *Swartzia madagascariensis* desv. (leguminosae), *combretum glutinosum* guill. & perr. (combretaceae) and *tinospora bakis* miers. (menispermaceae), burkina faso medicinal plants. Afr. J. Trad. CAM, 3(1): 75-81.
6. Teketay, D., 1998. Germination of *Acacia origena, A. pilispina* and *Pterolobium stellatum* in response to different pre-sowing seed treatments, temperature and light. J. Arid Environ., 38: 551-560.
7. Tybirk, K., L.H. Schmidt and T. Hauser, 1994. Notes on soil seed banks of African acacia. Afr. J. Ecol., 32: 327-330.
8. Olesen, M.J. and A. Valido, 2003. Lizards as pollinators and seed dispersers: An island phenomenon. Trends Ecol. Evolut., 18: 177-181.
9. Schauer, C.S., D.W. Bohnert, M.F. Carpinelli and S.J. Falck, 2004. Nutritional calendar and germination responses to ruminai incubation of forage kochia. Rangelands, 26: 8-11.
10. Baskin, J.M. and C.C. Baskin, 2004. A classification system for seed dormancy. Seed Sci. Res., 14: 1-16.
11. Virginia, C., C. Julia and V. Carlos, 1996. Seed germination of woody legumes from deciduous tropical forest of southern Mexico. For. Ecol. Maneg. 82: 171-184.
12. Deghan, B., J.G. Norcini, S.M. Kabat and H.E. Pérez, 2003. Effect of Seed Scarification and Gibberellic Acid Treatment on Seedling Emergence of Sky-Blue Lupine (*Lupinus diffusus)***.** J. Environ. Hortic., 21(2): 64-67.
13. Muhammad, S. and N.A. Amusa, 2003. The effects of sulphuric acid and hot water treatments on seed germination of tamarind (*Tamarindus indica* L.). Afr. J. Biotechnol., 2: 267-279.
14. Emongor, V.E., T. Mathowa and S. Kabelo, 2004. The effect of hot water, sulphuric acid, nitric acid, gibberellic acid and ethaphon on the germination of *Corchorus tridens* J. Agron., 3: 196-200.
15. Briggs, C.L. and E.C. Morris, 2008. Seed-coat dormancy in *Grevillea linearifolia*: Little change in permeability to an apoplastic tracer after treatment with smoke and heat. Ann. Bot., 101: 623-632.
16. Jose, M.H., F. Pablo and J.M. Juan, 1998. Influence of heat on seed germination of seven Mediterranean Leguminosae species. Plant Ecol., 136: 95-103.
17. Qaderi, M.M. and P.B. Cavers, 2003. Effects of dry heat on the germinability and viability of scotch thistle (*Onopordum acanthium*) cypselas: Interpopulation and interposition variation. Can. J. Bot., 81: 684-697.
18. Travlos, I.S. and A.J. Karamanos, 2007. Influence of Heat on Seed Germination and Seedling Emergence of Chaste Tree (*Vitex agnus castus* L.) J. Agron., 6(1): 25-28.
19. Tilki, F., 2008. Seed germination of *C. creticus* L. & *C. laurifolius* L. as influenced by dry-heat, soaking in distilled water and gibberellic acid in J. Environ. Biol., 29(2): 193-5.
20. Godinez-Alvarez, H. and A. Valiente-Banuet, 2000. Fruit-Feeding Behavior of the Bals *Leptonycteris curasoae* and *Choeronycteris mexicana* in flight cage experiments: Consequences for dispersal of columnar cactus seeds. Biotropica, 32: 552-556.
21. Righini, N., J.C. Serio-Silva, V. Rico-Gray and R. Martínez-Mota, 2004. Effect of different primate species on germination of *Fiats (Urostigma)* seeds. Zoo. Biol., 23: 273-278.
22. Schmidt, L., 2000. Dormancy and pretreatment. Guide to handling of tropical and subtropical forest seeds. Danida Forest Centre, pp: 303.
23. McDonald, I. and O. Omoruyi, 2003. Effect of seed pre-treatment on germination of two surface types of *Dialium guianeense*. Seed Technol., 25: 41-44.
24. McDonald, I., A.C. Omonhinmin and I.A. Ogboghodo, 2002. Germination ecology of two species *Tamarindus indica* and *Prosopis africana*. Seed Technol., 24: 103-107.