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Short Communication

LACK OF EFFECT OF PRETREATMENT ON THE VIABILITY OF MACADAMIA (*Macadamia integrifolia*) SEED

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ABSTRACT

One problem in developing macadamia in Indonesia is the limited availability of good quality seed. Viability of the seed is easily lost and erratic, and the seed has long dormancy periods. The objective of the study was to find a method for enhancing germination percentage of macadamia seed. The study evaluated different pretreatments of macadamia seeds before planting. The pretreatments were period of fermentation, i.e., 0, 1, 2, 3, 4, 5, 6, and 7 days; one day each soaking-drying-soaking; one day each drying-soaking-drying; and alternate drying-soaking until the seeds were cracked. The treatments were arranged in completely randomized design. Results showed that no treatment significantly affected percentage of seed germination, index of speed of germination, number of leaves, and dehydrogenase enzyme activity, but treatments significantly affected seedling height and electric conductivity of seed leakage solution. Seed germination percentage ranged from 66.67 to 86.67.

[*Keywords*: *Macadamia integrifolia*; seed; viability; seed treatment]

INTRODUCTION

Macadamia (*Macadamia integrifolia*) is an economical plant-producing nut of many countries. The main producing countries of macadamia are Australia and USA, whereas other minor producing countries are South Africa, Malawi, Zimbabwe, Kenya, Guatemala, Costa Rica, Brazil, and Israel (Nagao and Hirae, 1992; CSIRO, 2000). The nut is consumed roasted or in various forms, including as chocolate covered candies and as an ingredient of variety of cookies and ice cream (Nagao and Hirae, 1992). Macadamia tree may also be planted for erosion control, as shading plant, and as ornament (Armini and Wattimena, 1993).

In Indonesia, macadamia are not yet cultivated by farmers, although the tree can be found in saveral places such as at the Cibodas Botanical Garden (1000 m above sea level, asl), Experimental Gardens at Manoko, Lembang (1.100 m asl) and Tlekung, Malang (950 m asl), and conservation areas at Ijen Plateau (900 m asl) (Hasanah, 1994). According to Tirtoboma (1989), macadamia can be grown at various types of soils with air temperature around 18^{o}C and rainfall 1600-3000 mm year^{-1}. According to Djaenudin *et al.* (2001), there are huge potential areas in Indonesia that may be suitable for growing macadamia.

Grafting onto seedling of 10-12 month-old rootstock can propagate macadamia. The grafted seedling is transplanted into the orchard 8-12 months later. Cutting and air layering are commonly practiced in South Africa and Israel, but the trees are weakly rooted which makes them prone to be falling down in strong wind (Nagao and Hirae, 1992).

One problem in developing macadamia in Indonesia is the limited availability of good quality seed. Hasanah (1998) showed that viability of macadamia seed is easily loss in storage; such seed is called semirecalcitrant. Seed germination is very erratic and low, and also not simultaneous. From one lot of seeds, the first germination may appear within 3-4 weeks, and the last may not appear until 6 months (Storey and Kemper, 1960).

Hamilton (1957) reported that germination and storage life of macadamia seeds were affected by varieties and density. For example, Keauhou variety had 39% germination after 7-month storage at room temperature, but Kakea variety only germinated 16%. Hasanah (1994) showed that predrying treatment of the seed at 40^{o}C for 5 days increased germination up to 77.6%. Kosasih and Supriana (1986) working with *M. hildebrandi* Steen, reported that good germination (89.2%) was obtained from the seeds directly planted after harvest. Storage of the seed for 1 and 2 weeks significantly reduced germination to 67.6% and 55.6%, respectively.

Murniati (1995) showed that fermenting the seed in sterile quartz mixed with decomposing fungus such as *Trichoderma reesei* at concentration of 2.97x10^{6} spore ml^{-1} increased germination of candlenut seed, which has a harder coat than macadamia seed. Microscopic study indicated that the treated seeds noticeably changed in their color from brown to whitist with

vegetative growth of the fungus after 5 and 6-month incubation. It was suspected that the fungus, which produced cellulose enzyme, actively degraded the seed coat to soften and easily absorb water. Rusmin and Hasanah (1993) also showed that pretreatment of hard coat seeds such as *Caesalpinia sappans*, by alternate soaking-drying-soaking, improved seed germination percentage. It was speculated that physiological, chemical, and biological activities during fermentation increased water imbibitions and decomposition of seed coat, which speeds up seed germination.

This study aimed to evaluate the effect of pretreatments of macadamia seed on their viability and growth performance of the seedling.

MATERIALS AND METHODS

The experiment was conducted at the greenhouse and laboratory of the Indonesian Spices and Medicinal Crops Research Institute, Bogor. Macadamia seeds were obtained from the Manoko Experimental Garden (1100 m asl), Lembang, West Java. The seeds were harvested at the physiological maturity period according to Hasanah *et al*. (1994), i.e., at 164 days after flowering, indicated by green color of the fruits and dark brown color of the seed coat.

The experiment was arranged in a completely randomized design with 10 treatments and 3 replications. The treatments were periods of fermentation, i.e., 1 up to 7 days (7 treatments); one day each soaking-drying-soaking; one day each drying-soaking-drying; and alternate drying-soaking until the seeds were cracked. The seeds were fermented in a bamboo box filled with damp rice husk, and stored in room temperature for periods according to the treatments. The number of seeds used for each treatment was 150.

Parameters were observed according to AOSA (1988) such as germination percentage and index of speed of germination. Seed germination was tested by sowing 25 seeds taken from each replicate in plastic box (35 cm x 25 cm x 15 cm) filled with sand. Number of germinated seed was determined 4 weeks after planting for the first count and 8 weeks for the second count. Index of speed of germination (index of SG) was assessed according to the standard method (AOSA, 1988) with little modification as follows:

$$\text{Index of SG} = \frac{\text{number of normal seedlings}}{\text{days of first count}} + \ldots + \frac{\text{number of normal seedlings}}{\text{days of final count}}$$

Growth performance of the seedling was evaluated by selecting normal germinated seeds, which had been pretreated as described above. The normal seedlings, which have normal radicule, epicotyls, and plumule, were separated for evaluating. Parameters observed were seedling height and number of leaves of the seedlings assessed at 8 weeks after treatment.

Other important parameters of good quality of seed were electrical conductivity of seed leakage and activity of dehydrogenase enzyme. Electrical conductivity of the macadamia seed leakage was determined according to AOSA (1988) method. Five seeds (30 g) each replicate were soaked in 125-150 ml of distilled water for 24 hours at 25^{o}C. The seeds were removed and electric conductivity of the solution was measured with conductivity meter YSI model 35.

The activity of dehydrogenase enzyme was determined by tetrazolium method (Grabe, 1970). After removing seed coats, five seeds were conditioned overnight in moist rolled paper towel. Seeds were then soaked in 50 ml of 0.5% tetrazolium solution for 4 hours at 40^{o}C. The seeds were removed and the solution was measured by spectrophotometer at wavelength of 693 nm, to determine the activity of dehydrogenase enzyme.

RESULTS AND DISCUSSION

Results of the study indicated that no pretreatments of macadamia seeds significantly affected percentage of seed germination, index of speed of germination, number of leaves, and activity of dehydrogenase enzyme, but pretreatments significantly affected seedling height and electric conductivity of the seed leakage solution. Seed germination percentage ranged from 66.67 to 86.67 (Table 1).

Seed germination was evaluated up to 8 weeks allowing enough time for the seed to germinate. In fact not all the seeds germinated (13-33%), indicating that quality of the seeds varied.

Pretreatment of the seeds by alternate drying and soaking until seed coat was cracked did not affect germination percentage significantly, possibly due to larger amount of water absorbed through seed coat cracks. This condition may enhance imbibition and consequently increase enzyme activities. Rusmin and Hasanah (1993) indicated that alternate soaking-drying-soaking of *Caesalpinia sappans* seeds produced 32% seed germination, significantly higher than drying-soaking-drying (21.71%). However, it was not significantly different with control.

Table 1. Effect of fermenting, drying, and soaking of macadamia seed on the characteristics of the seed.

Treatments[1]	Percentage of seed germination	Index of speed of germination	Seedling height (cm)	Number of leaves	Seed leakage (µmos)	Dehydrogenase (ppm)
F for 1 d	66.67a	0.95a	10.92ab	4.87a	0.40a	0.34a
F for 2 d	80.00a	0.82a	10.31ab	6.04a	0.22ab	0.50a
F for 3 d	84.00a	0.82a	7.20b	4.67a	0.32ab	0.17a
F for 4 d	70.67a	0.73a	10.63ab	5.50a	0.23ab	0.14a
F for 5 d	71.67a	0.73a	8.83ab	4.57a	0.28ab	0.04a
F for 6 d	80.00a	0.81a	10.58ab	5.17a	0.23ab	0.13a
F for 7 d	78.33a	0.85a	12.05a	6.13a	0.21ab	0.04a
S - D - S	80.00a	0.85a	9.63ab	4.53a	0.19b	0.08a
D - S - D	73.33a	0.79a	11.13ab	5.57a	0.27ab	0.28a
Alternate D - S until seed coat cracked	86.67a	0.94a	10.65ab	5.73a	0.27ab	0.17a
CV (%)	18.08	19.42	14.69	17.06	25.43	6.02

[1]F = fermentation, D = drying, S = soaking

Means in each column followed by the same letter are not significantly different at 5% according to Duncan Multiple Range Test (DMRT).

Evaluation of the seed leakage as shown by the electric conductivity of the fermented seed solution indicated significant variation amongst treatments, but it did not correlate with other parameters, especially germination percentage and speed of germination. This result contradicted with previous study on cashew nut seed by Sukarman *et al.* (2002), which showed that the higher the germination percentage, the lower the electric conductivity. According to Sivasubramanian and Ramakrishnan *in* Powell (1986), sunflower seeds, which had low leakage conductivity, indicating good quality of the seeds, performed well in the field. Seed leakage is closely related to poor membrane structure and leaky cells. Therefore, higher seed leakage or greater electric conductivity value means that the seeds have deteriorated because of greater loss of electrolytes such as amino acids and organic acids, i.e., glucose, fructose, sucrose, raffinose, maltose, and xylose.

Bulan (1988) and Marjuni *et al.* (1995) showed that evaluation of dehydrogenase enzyme activity of mungbean (*Paseolus aureus* Roxb.) and white bean (*Phaseolus vulgaris* L.) seeds was important because it correlated with seed germination. In the present study, however, no significant differences were found in the enzyme activity of macadamia seed on seed germination. This needs to be further studied using better quality seed. It seems that physical properties of the seed must be considered, therefore, seeds should be uniform in size and selected exactly at the same physiological maturity.

CONCLUSION

Pretreatment of macadamia seed did not significantly affected germination of the seed.

REFERENCES

Armini, N.M. dan G.A. Wattimena. 1993. Meraih peluang meningkatkan pendapatan petani daerah pegunungan dengan menanam tanaman makadamia. Agroteknologi 1 (2): 57-60.

AOSA (Association of Official Seed Analysts). 1988. Seed Vigor Testing Handbook, AOSA Handbook on Seed Testing. Contribution No. 32. Ston Printing Company, Lansing, Michigan. 93 pp.

Bulan, P. 1988. Tetrazolium evaluation of mung bean (*Phaseolus aureus* Roxb.) and white bean (*Phaseolus vulgaris* L.) seeds. Thesis, Missisipi. State University, USA.

CSIRO. 2000. Macadamia. Farmer's Bookshelf. Information system of tropical crops in Hawaii. CSIRO, Canberra, Australia.

Djaenudin, D., Saefoel B., dan H. Suhardjo. 2001. Lahan yang berpotensi untuk pengembangan tanaman makadamia (*Macadamia integrifolia*) di Indonesia. Jurnal Penelitian dan Pengembangan Pertanian 20 (1): 32-37.

Grabe, D.F. (Ed.). 1970. Tetrazolium Testing Handbook for Agricultural Seeds. The Tetrazolium Testing Committee of the Association of Official Seed Analyst. 62 p. Contribution No. 29 to the Handbook of Seed Testing.

Hamilton, R.A. 1957. A study of germination and storage life of macadamia seed. Proc. Amer. Soc. Hort. Sci. V. 70: 209-211. University of Hawaii, Honolulu.

Hasanah, M. 1994. Perkembangan penelitian benih makadamia. Keluarga Benih (1): 48-56.

Hasanah, M. 1998. Peluang pengembangan makadamia di Indonesia. Jurnal Penelitian dan Pengembangan Pertanian XVIII (1): 32-38.

Kosasih, A.A. dan N. Supriana. 1986. Percobaan pendahuluan daya tumbuh benih *Macadamia hildebrandii* Stenn. Buletin Penelitian Kehutanan 2 (2): 9-14.

Marjuni, S., A. Qadir, dan T. Budiarti. 1995. Studi keabsahan uji tetrazolium sebagai tolok ukur viabilitas benih kedelai (*Glycine max* L. Merr) yang cepat dan akurat. Keluarga Benih 6 (1): 78-86.

Murniati, E. 1995. Studi beberapa faktor penyebab dormansi dan peranan mikroorganisme dalam mempengaruhi proses pematahan dormansi benih kemiri (*Aleurites mollucana* W). Disertasi Program Pascasarjana, Institut Pertanian Bogor.

Nagao, M.A. and H.H. Hirae. 1992. Cultivation and physiology. Critical Rev. in Plant Sci. 10 (5): 441-470.

Powell, A.A. 1986. Cell membranes and seed leachate conductivity in relation to the quality of seed for sowing. J. Seed Technol. 10 (2): 81-100.

Rusmin, D. dan M. Hasanah. 1993. Perlakuan fisik dan kimia untuk menghilangkan kekerasan benih secang. Buletin Penelitian Tanaman Rempah dan Obat VIII (2): 108-110.

Storey, W.B. and W.C. Kemper. 1960. A study of macadamia seed germination. http;//www. Cooper Snut house. Com/maclib/macadamia/seed germination. Html.

Sukarman, D. Rusmin, dan M. Hasanah. 2002. Pengaruh cara panen terhadap viabilitas benih jambu mente (*Anacardium occidentale* L.) selama penyimpanan. Makalah pada Seminar Nasional PERSADA IX, Bogor, 19 Maret 2002.

Tirtoboma. 1989. Makadamia (*Macadamia integrifolia*). Informasi umum untuk perkebunan di Indonesia. Pusat Penelitian Perkebunan Bogor. 13 hlm.

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