The effect of giving electric field to the metabolism of andaliman (*Zanthoxylum acanthopodium* DC) seeds which contributes to accelerating germination

The effect of giving electric field to the metabolism of andaliman (*Zanthoxylum acanthopodium* DC) seeds which contributes to accelerating germination

S E Panggabean, W Kamson, A P Simanjuntak and N Rahmawati*

Faculty of Agriculture, Universitas Sumatera Utara, Medan, North Sumatera, Indonesia

E-mail: *nini@usu.ac.id

Abstract. Andaliman is a typical plant in Sumatera Utara that hasn't been widely cultivated because it's difficult to germinate. The aim of this research was to study the effect of giving an electric field to the metabolism of andaliman (*Zanthoxylum accanthopodium* DC) seeds which contributes to accelerating germination. Research conducted at the Laboratory of Plant Ecology, Tissue Culture Laboratory and Molecular and Genetic Laboratory of the Faculty of Agriculture, Universitas Sumatera Utara from June to July 2018 was arranged in a complete non-factorial randomized design repeated three times. Seeds are given by an electric field for 18 days with a voltage of 324 volts. The results of this research showed that the electric field treatment and differences in fruit colour not different significantly on seed metabolism in accelerating germination after do analysis of proteins, APX, SOD and electrical conductivity. Descriptively the highest average of APX was showed on without electric field: red colour seeds 2.39 µM/min/mg protein (P_1). The highest average of SOD was showed on with electric field: red colour seeds 485.27 unit/mg protein (P_4). The highest average of electrical conductivity was showed on without electric field: red colour seeds 6733.33 μS (P_1).

1. Introduction

Indonesia has undeveloped natural wealth, one of which is a typical plant that grows commonly in Sumatera Utara, namely andaliman (*Zanthoxylum acanthopodium* DC). Andaliman fruit which is cultivated as a spice in traditional Batak cuisine. Andaliman has other benefits such as medicinal ingredients, supplements, preservatives and also vegetable pesticides because of the content of terpenoids [1].

Although it has many benefits, andaliman is a plant that is difficult to cultivate because it is still limited in knowledge about this. In addition, this plant is also difficult to germinate [2]. Scientists claim that the volatiles in it can be an inhibitor of andaliman to germinate. In addition, hard seed shells and not all seeds have an embryo are difficult causes of germination [3,4]. However, the scarification method is difficult to do because the size of andaliman seeds is small with a diameter of 2-3 mm. While the scarification method was carried out by a former scientist and he stated that andaliman germinated in 40-90 days after immersion [5].

Therefore needed a method to accelerate andaliman seed germination, which is using an electric field. To survive, cells and living tissue need electricity because it shows various electrical properties. Based on the research that has been done, biological activity, roots, seeds, pollen and shoots of some plants

that electromagnetic waves can produce seed germination from some cultivated plants. The results of the research [6] show that health applications have a positive effect on cell metabolism. The application of a 7 volt electric field effectively improves the process of germination of alfalfa plants to see harvests. In addition, research conducted on garlic plants, the application of an electric field increases the price to 9kV/cm [7].

The seed germination process involves specific enzyme activities at the right time and regulates the activity of these enzymes. Imbibition is a sign of enzyme activity because the seeds quickly increase oxygen uptake and oxygen phosphorylation because the process requires high energy for the germination process [8].

The aim of this research was to study the effect of giving electric field to the metabolism of andaliman seeds which contributes to accelerating germination by using seeds derived from andaliman fruit in reddish green and red and given a voltage of 324 volts.

2. Materials and Methods

The research was conducted on June until July 2018 in Laboratory of plant ecology, Laboratory of Tissue Culture and Laboratory of molecular genetics, Faculty of Agriculture, Universitas Sumatera Utara. This research was arranged in a completely non-factorial randomized design with six replications. The treatment are P1 (no electric field: red seed), P2 (no electric field: reddish green seed), P3 (with electric field: red seed), P4 (with electric field: reddish green seed). The research start with the preparation of materials and equipment, then application of electric fields, protein analysis, ascorbate peroxidase enzyme (APX), superoxide dismutase (SOD) enzyme and electrical conductivity test.

Separated reddish andaliman fruit and red fruit, peeled peel to be considered as seeds. Then the seeds are placed in petri dish without cover. Petri dish containing seeds uses a form of construction from aluminium plates on the upper and lower sides of the construction. The aluminium plate is electrified with a voltage of 324 volts sourced from the battery. The electric field application is carried out 24 hours for 18 days. Then, seeds that have been given an electric field in physiological parameter analysis consisting of protein analysis, APX, SOD and conductivity tests. This research was completed on July 6th, 2018.

The data were analysed statistically using F-test and significant results were followed by Duncan's multiple distance test with 5% level.

3. Results and Discussions

Based on the table 1, it is known that the result of protein analysis is the standard to do SOD and APX analysis and not as an osmolite.

Table 1. Analysis of andaliman seed protein originating from different fruit colours to electricity and without electricity fields

Treatment	Protein
	...mg protein...
P_1 (without electrical field: red colour seeds)	0.10
P_2 (without electrical field: reddish-green colour seeds)	0.08
P_3 (with electrical field: red colour seeds)	0.25
P_4 (with electrical seeds: green colour seeds)	0.09

Table 2 shows that the red colour seeds of non-electric field (P_1) have the highest amount of ascorbate peroxidase that is 2.39 unit/mg protein. While the green seeds of electric field (P_4) has the high amount of ascorbate peroxidase that is 0.86 unit/mg protein.

Table 2. Analysis of ascorbate peroxidase enzymes (APX) of andaliman seeds derived from different fruit colours on the provision of an electric field and without an electric field

Treatment	Ascorbate Peroxidase
	..μM/min/mg protein..
P_1 (without electrical field: red colour seeds)	2.39
P_2 (without electrical field: reddish-green colour seeds)	0.69
P_3 (with electrical field: red colour seeds)	0.25
P_4 (with electrical seeds: green colour seeds)	0.86

The activity of APX depends on the amount of H_2O_2 accumulation as substrate enzyme APX. It will cause the plant to be able to increase the side effects which is cause by H_2O_2 [9]. The amount of APX will neither increase nor decrease along the activity of SOD. The increasing of APX that happens to P4 can be caused by the electric field itself. It was observed that the electric field can increase the enzyme activity depends on duration and the level of its voltage [10].

The average amount of analysing the APX enzyme of red colour of andaliman seeds shows that its activity has activated to solve Reactive Oxygen Species (ROS) [11]. It means that those seeds have been ready to germinate without giving the electric field [12]. It also happens to SOD which can eliminate ROS and make it neutral.

Table 3 shows that P_1 is higher than P_2, which is 478.18 units/mg of protein. While P_4 is also higher than P_3, which is 485.27 units / mg of protein.

Table 3. Analysis of superoxide dismutase enzyme (SOD) of andaliman seeds derived from different fruit colours to electricity and without electricity

Treatment	Superoxide Dismutase
	.. unit/mg protein..
P_1 (without electrical field: red colour seeds)	478.18
P_2 (without electrical field: reddish-green colour seeds)	473.86
P_3 (with electrical field: red colour seeds)	306.68
P_4 (with electrical seeds: green colour seeds)	485.27

Based on the results of the F-test, giving an electric field to andaliman seeds with fruit colour is not significant to the SOD enzyme process. Based on data known that SOD activity on P_4 was still higher than P_3. For andaliman seeds from red fruit do not need to be given an electric field because it can inhibit the process of seed germination. SOD activity used in the development of seed germination. This is consistent with the literature [13] which states that the activities and ROS levels in the plant life are included in the development of seed germination.

Table 4 shows that average of P_4 is lower than P3 which shows the strength of P_4 is better than P_3.

Table 4. Average of electrical conductivity test (EC) of andaliman seeds

Treatment	Electrical conductivity
	..... μS.....
P_1 (without electrical field: red colour seeds)	6733.33
P_2 (without electrical field: reddish-green colour seeds)	1080.00
P_3 (with electrical field: red colour seeds)	2812.00
P_4 (with electrical seeds: green colour seeds)	2464.00

The results of the F-test indicate that the electric field is not significantly different from the electrical conductivity parameters. Based on data from table 4, P_1 and P_2 are not given an electric field, while P3 and P_4 are given an electric field. Thus the P3 is higher than P_4 which means the power of P_4 seeds is

better than P_3. This happens when the cell membrane is not leaked. Seed electrolytes don't come out of the cell. This shows the strength of the seeds is still good. There are many factors that influence seed power, namely the number of seeds, aquabidest volume, temperature and period of imbibition and moisture in seeds [13]. This phenomenon was revealed by cell membrane leaks. Solute solution with electrolyte character carries an electrical load that can be detected by the meter. This statement is researched by [14] which states that institutions provide integrity. That is the change that allows, exchange energy and nutrition.

4. Conclusion

The results of this research showed that the electric field treatment and differences in fruit colour not different significantly on seed metabolism in accelerating germination after do analysis of proteins, APX, SOD and electrical conductivity. While the reddish-green seeds must be given the electric field because the activity of enzyme is increasing. By giving the electric field to reddish-green seeds, the seeds can germinate rapidly. According to the result of electrical conductivity test, sample P_4 has higher seed vigour than P_3.

References

[1] Siregar B L 2013 Perkecambahan dan pematahan dormansi benih andaliman (*Zanthoxylum acanthopodium* DC) [Germination and breakdown dormancy of andaliman seed (*Zanthoxylum acanthopodium* DC)] *J. Agronomi Indonesia* **41** pp 249– 54

[2] Sebayang L 2016 *Tanaman Andaliman (Zanthoxylum sp) dan Manfaatnya [Andaliman plant (Zanthoxylum sp) and its benefits]* (Medan: Balai Pengkajian Teknologi Pertanian Sumatera Utara)

[3] Asbur Y and Khairunnisyah 2018 Pemanfatan andaliman (*Zanthoxylum acanthopodium* DC) sebagai tanaman penghasil minyak atsiri (Utilization of andaliman (*Zanthoxylum acanthopodium* DC) as an essential oil producing plant) *J. Kultivasi* **17** pp 537-42

[4] Florez M, Carbonell M V and Martinez E 2009 Early sprouting and first stages of growth of rice seeds exposed to a magnetic field. *Electromagnetic Biology and Medicine* **23** pp 157-66

[5] Sedighi N T, Abedi M and Hosseini S E 2013 Effect of electric field intensity and exposing time on some physiological properties of maize seed European *J. Exp. Biol.* **3** pp 126-34

[6] Mohebbifar M R 2012 The effect of electric field on the germination and growth of *Medicago sativa* planet as a native Iranian alfalfa seed *Acta Agriculturae Serbica* **34** pp 105-15

[7] Molamofrad F, Lotfi M, Khazael J, Afshari R T and Akmal A A S 2013 The effect of electric field on seed germination and growth parameters of onion seeds (*Allium cepa*) *Advanced Crop Science* **3** pp 291–8

[8] Tommasi F, Paciolla C, Cocetta de Pinto M and De Gara L A 2001 Comparative study of glutathione and ascorbate metabolism during germination of Pinus pinea L seeds *J. Exp. Bot.* **52** pp 1647-54

[9] Manurung I R, Rosmayati and Rahmawati N 2018 Physiology response of fourth generation saline resistant soybean (*Glycine max* (L) Merrill) with application of several types of antioxydants *Earth Environ. Sci.* 122 012068

[10] Patwardhan M S and Gandhare W Z 2013 High voltage electric field effects on the germination rate of tomato seeds *Acta. Agro. Physica.* **20** pp 403-13

[11] Caverzan A, Passaia G, Rosa S B, Ribeiro C W, Lazzarotto F and Pinheiro M M 2012 Plant Responses Too Stresses: Role of ascorbate peroxidase in the antioxidant protection *Genetics and Molecular Biology* **35** pp 1011-9

[12] Pinheiro D T, Silva A L, Silva L J, Sekita M C and Dias D C F 2016 Germination and antioxidant action in melon seeds exposed to salt stress *Pesq. Agropec. Trop. Goiânia.* **46** pp 336-42

[13] Olivera P, Prodanović R, Bogdanović J, Mitrović A, Milosavić N and Radotić K 2007 Antioxidative enzymes during germination of two lines of serbian spruce [*Picea Omorika* (Panč.) Purkyně] *Biol. Sci*. Belgrade **59** pp 209-16

[14] Tabatabaei S A 2015 The changes of germination characteristics and enzyme activity of barley seeds under accelerated aging cercetări *Agronomice În Moldova*. **48** 162
[15] Stepan K 2016 Study of structural changes in the cells of the stimulated seed sprouts *Int*. *Agrophys*. **30** pp 545-50

Acknowledgments
This research was funded by Ministry of Technology Research and Higher Education Republic of Indonesia under the scheme of Program Kreativitas Mahasiswa (College Student Creativity Program) 2018.