The Study of Electrical Conductance Spectroscopy of The Inner membrane of Salak

Wenny Maulina[1]
[1]Biophysics Division: Physics Department, Faculty of Mathematics and Natural Sciences, Jember University, Jember, Indonesia,
e-mail: wenny@unej.ac.id

Abstract— Main objective of the present work was to investigate mechanism transport of the inner membrane of salak (*Salacca edulis*) using electrical conductance measurements. The inner thin membrane obtain after removing the outer cover of salak has been found to record electrical conductance when it separates two different concentration of electrolyte solution; NaCl, $MgCl_2$ and $CaCO_3$. Conductance values were measured for each concentration at different temperature. The temperature range studied is between 303 K and 333 K at 5 K intervals. The normal behaviour of these conductance shows that the values increase smoothly with increase in concentration. The magnitude follow the order Mg^{2+} > Na^{+} > Ca^{2+}. The increase of temperature makes mobilisation of the ions was rapidly during the measurement of conductance.

Keywords— inner thin membrane, salak, conductance.

INTRODUCTION

The membrane is essentially a barrier, which separates two phases and restricts transport of various chemicals in a selective manner. A membrane can be homogeneous or heterogeneous, symmetric or asymmetric, solid or liquid; it can carry positive or negative charges or can be neutral. Transport through a membrane can be affected by convection or by diffusion of individual molecules, and induced by the chemical gradient or electrical gradient. A Membrane should have some basic requirements, such as high flux of the product; good mechanical strength for supporting the physical structure; and good selectivity for the desired substances. Membranes can be either dense or porous. There are various types of membrane processes: a) Microfiltration (pore sizes ranging from 0,1 to 10,0 µm); b) Ultrafiltration (0,001-0,1 µm); c) Reverse Osmosis (0,0001-0,001 µm); and d) Conventional Filtration (10-100 µm). Membranes consist of two types: biological membrane and synthetic membrane [1-2]. Focus on this study is biological membrane i.e. the inner membrane of Salak.

Salak (Salacca edulis) also known as snake fruit belongs to Arecaceae family. This palm is native in Indonesia and Malaysia. Nevertheless, cultivation of salak palm can also be found in Thailand and Philippines recently. Salak fruit is a good source for dietary fibres and carbohydrate. It also contains valuable bioactive antioxidants such as Vitamin A, Vitamin C and Phenolic compound. However, salak has a short shelf life of less than a week. Salak that stored in the room temperature could not be consumed after the day of 14 after harvesting. It is because rapid ripening and degradation of the bioactive ingredients. Numerous studies have been conducted to analysis thermo-physical properties and transport properties of fruit, such as garlic, pumpkin, grapes, apple and orange skin. Several mathematical models have been proposed for the evaluation of transport behaviour by either applying theoretical (Fick's law), semi-theoretical and empirical modelling [3]. Meanwhile, the theoretical models may not able to explain the exact mechanism of transport but it often gives good estimation by incorporating some values into the model parameters. Electrical measurements provide the opportunity to address this case.

Generally, electrical properties of the fruit were studied in order to develop a rapid and non-destructive assessment method or to characterize its ripening. Electrical properties are important in the cognitive aspect, especially to find out responses of the fruit to electric fields of variable frequency. Behaviors of the electrical properties are related to the nature of the material (composition, structure), conditions of the material (temperature, frequency), and the age or maturity stage of the material. Utilization of electrical measurements because simple, low cost, and quick assessment of product quality [4].

Transport processes through biological membranes, as well as in many synthetic membranes, are important because of their potential use in different separation processes. Studies on the conductance of electrolyte solution through such polymeric networks are related to the ions transport through the pores. Extensive research work related to the conductance and diffusion of electrolyte solution through ion-exchange or porous membrane has been reported by different workers. Studies of the biological membrane are necessary to interpretation the mechanism of transport occurring in the biological system [5]. The purpose of the present paper is to report the conductance studies of the inner thin layer membrane of Salak with different electrolyte concentration and various temperatures. The observing of mechanism transport through this membrane has been calculated by using conductance spectroscopy.

METHODS

The inner thin layer membrane was separated manually from the outer of Salak. The membrane was throughly washed with deionised water to remove any adsorbed. It was always kept in the wet condition to avoid any disturbance arise due to the entrapped air within the pores and also to prevent the crack in dry condition. The membranes were cut into rectangular small piece and attached at a chamber. A chamber was filled with a different concentration solution. Solutions of different concentrations were prepared with analytical grade NaCl, MgCl2 and CaCO3 by using distilled water. Platinum electrode used to the electrical connections to the spectroscopy. Conductance measurements were carried out with an LCRmeter Hitester 5322-50. Conductance values were measured for each concentration at different temperature. The variation of concentration electrolyte solution were 0,1 mM, 1 mM, 10 mM, and 100 mM, respectively. The temperature range studied is between 303 K and 333 K at 5 K intervals.

RESULTS AND DISCUSSION

Based on the result of conductance spectroscopic measurements indicated that the inner membrane of salak as a semipermeable membrane. It is evidence by some specific ions could selective transport through the membrane. The nature of variations of conductance with concentrations for different electrolytes at room temperature, are shown in Fig 1. The common trend found for all the electrolytes is that the membrane conductance increases almost linearly with increase in concentration. The magnitude follow the order Mg^{2+} > Na^{+} > Ca^{2+}. After certain concentrations, these two different concentrations may have a tendency to balance each other.

The increase in conductance of $CaCO_3$ is not too significant. Because of ion Ca^{2+} has been prevented from passing through the membrane. At this time, membrane shrinkage occurs due to the exclusion of water within the pores, showing steady conductance values. The linear correlation indicates that the inner membrane of Salak is able to respond various changes in increasing concentrations toward values of conductance that through the membrane.

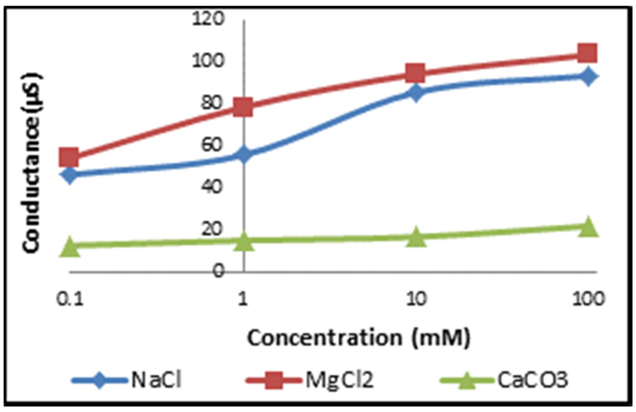

Fig 1. Plot of conductance of different electrolytes through the inner membrane of Salak at room temperature

The effect of temperature on the membrane conductance is shown in Fig 2 represents the specific conductance values for $MgCl_2$ solutions of different concentrations in the temperature range 303-333 K at 5K intervals. The linear regression with a negative slope shows a correlation between Conductance and Temperature. The increase of temperature makes mobilisation of the ions was rapidly during the measurement of conductance.

By applying the Arrhenius equation in its basic form, where is:

$$G = G_0 exp(-dU/kT) \quad (1)$$

ln G values of an various electrolyte are plotted against 1/T. Fig 3 shows the plots of the different electrolytes at the concentration of 100 mM. The smooth linear plots suggest that there may be no abrupt irreversible change in the membrane structure within the concentration and temperature range studied [5].

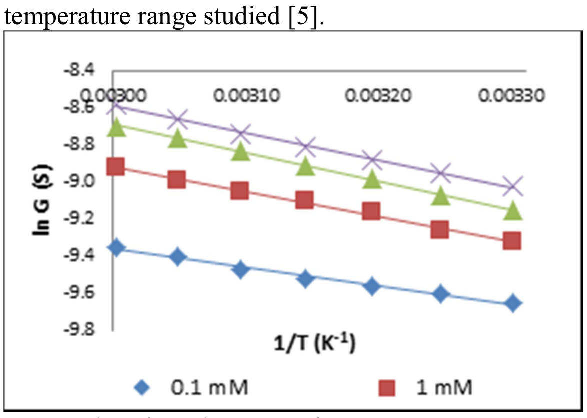

Fig 2. Plot of conductance of various concentration $MgCl_2$ through the inner membrane of Salak at different temperatures (303-333 K)

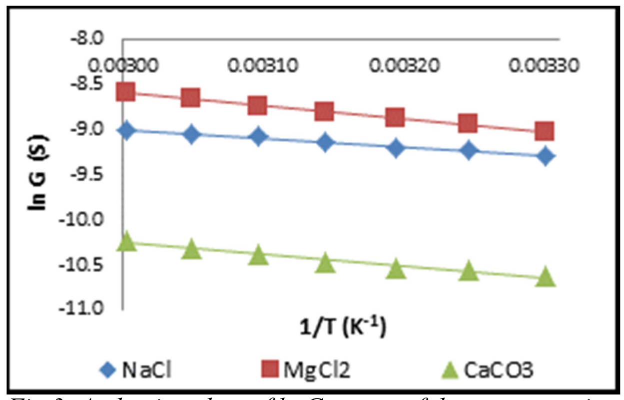

Fig 3. Arrhenius plots of ln G at one of the concentrations (100 mM) against 1/T at different electrolytes through the inner membrane of Salak

CONCLUSION

The inner membrane of Salak indicated as a semipermeable membrane. The normal behaviour of conductance shows that the values increase smoothly with increase in concentration. The slope shows correlation between changes of temperature with a conductance as a mechanism transport ion through the inner membrane.

REFERENCES

[1] J.P. Chen, H. Mou, L.K. Wang, T. Matsuura, and Y. Wei, “Membrane Separation : Basics and Applications,” in Handbook of Environmental Engineering, Volume 13: Membrane and Desalination Technologies. Springer Science, Business Media, LLC, 2011, pp. 271-332.

[2] R.W. Baker, Membrane Technology and Applications, 2nd ed, England: John Wiley & Sons Ltd, 2004.

[3] S.P. Ong and C.L. Law, “Mathematical Modelling of Thin Layer Drying of Salak”, Journal of Applied Sciences., vol. 9, no. 17, 2009, pp. 3048-3054

[4] J. Juansah, I.W. Budiastra, K. Dahlan, and K.B. Seminaar, “Electrical Behavior of Garut Citrus Fruits During Ripening Changes in Resistance and Capacitance Models of Internal Fruits”, International Journal of Engineering & Technology IJET-IJENS, vol. 12, no. 04, 2012, pp. 1-8

[5] T. Samanta, “Physico-chemical Aspects of Some Biological Membranes. II Studies on The Conductances of The Inner Membrane of Chicken Egg in Presence of Alkali Chlorides and The Application of Absolute Reaction Rate Theory”, Colloids and Surfaces B: Biointerfaces, vol 27, 2002, pp. 95-101.