

Auto-catalytic Ion Efflux Constant of Seeds

MOHAMMAD ABDUL MUJEEB¹, S. VENKATESWARA RAO², M. K. M. ZAFAR³, ADEEL AHMAD⁴

¹Biophysics Research Laboratory, Nizam College (Autonomous), Osmania University, Hyderabad, TS, India.

²Dept of Physics, Jawaharlal Nehru Technological University, Hyderabad, TS, India.

³Moulana Azad National Urdu University, Hyderabad, TS, India, E-mail: abdulmujeeb18@yahoo.com.

Abstract: The paper reports autocatalytic ion efflux constant of seeds, namely *Hordeum Vulgare* (Barley), *Vignaradiata* (Mung beans) and *Sorghum vulgare* (Jawar). Auto Catalytic ion efflux constant of seed is calculated as a function of time, measuring electrical conductivity of imbibing medium. The method of ion efflux, involving the measurement of specific conductance of imbibition medium, as a function of time is more advantageous than the measurement of the water content of the seeds.

Keywords: Ion Efflux, Autocatalytic Ion Efflux Constant, Seeds, Electrical Conductivity.

I. INTRODUCTION

Studies on seed germination are usually confined to the changes in mass or volume of the seed as a function of time during the process of imbibition to evaluate the time of germination [1, 2]. Studies on the electrical properties of the imbibitions medium are scanty in literature. Pitman [3] reviewed the work on ion uptake and electrical properties of plant root; the interaction of water; and solute flows. Pandey [4] developed a useful, rapid simple inexpensive and highly predictive vigour test of French beans. Williams et al [5] studied the effect of weathering on Mung beans. Shanmuga Sundaram et al [6] reported that the ion efflux from whole seedling increases the specific conductance of the bathing medium. The increase in electrical conductivity in leachates of imbibing seeds is due to the increased leakage of these electrolytes [7]. Blacklow [8] attempted to devise a mathematical equation to predict germination in corn based on the rate of water uptake in relation to time.

II. MATERIAL AND METHODS

Three varieties of seeds were chosen for the present investigation. They are: *Hordeum Vulgare* (Barely), *Sorghum vulgare* (Jawar) and *Vignararidiata* (mung bean). Seeds were wiped with wet muslin cloth to remove extraneous matter. They were then dried to room temperature, and then used for experimentation. There are two methods for the study of germination of seeds. They are

- Imbibition method
- Ion Efflux method

In the present investigation ion efflux method is considered.

Imbibition Method: The absorption of water by hydrophilic collides is known as imbibition. In this method, change in water content in the seed with time interval is considered. **Ion Efflux Method:** The concept of ion efflux views the process of imbibition as essential a system surrounding interaction,

where the changes taking place in the system have been reflected on the surrounding medium. The increase in the specific conductance due to the efflux ion into the imbibitions medium is governed by an auto catalytic rate law. Thus the rate of ion efflux in to the imbibitions medium could be then described by the differential equation,

$$d\sigma/dt = k\sigma(\sigma_t - \sigma) \quad (1)$$

Where σ is the specific conductance at any time t , and σ_t is the specific conductance at infinite time.

III. EXPERIMENTAL

50gm of seeds (*Barely*, *Mung beans* and *Jawar*) were taken. They were cleaned with wet muslin cloth and dried at room temperature and were allowed to imbibe in 50 ml of distilled water the specific conductance of imbibition medium was determined with the help of electrical conductivity meter, at an interval of half an hour of imbibition. The increase in the specific conductance at every half an hour was determined as a percentage of the conductance of distilled water at time at $t = 0$. The seeds undergoing imbibition was assumed to a cell, and the physics of transport across the membrane made use to explain the seed behaviour during the imbibitions.

TABLE I: Auto Catalytic Ion Efflux Constant of Three Seeds

S.No.	Scientific Name	Common Name	Auto catalytic ion efflux constant (hour ⁻¹)
1.	<i>Vigna radiata</i>	Barely	8.50
2.	<i>Hordeum vulgare</i>	Mung	3.85
3.	<i>Sorghum vulgare</i>	Jawar Yellow	2.31

The rate of water uptake (dw/dt) was assumed to be controlled by osmosis and at the rate of ion efflux ($d\sigma/dt$) from the seed system to the imbibition medium could be a differential equation. A plot of $\log(\sigma/(\sigma_t - \sigma))$ against time t

should be a straight line from the slope of which the value of k , the autocatalytic ion efflux constant is calculated.

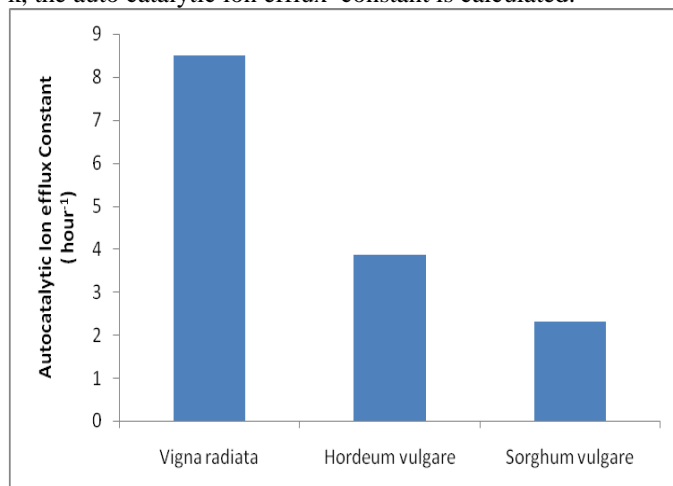


Fig. 1. A comparison on Autocatalytic Ion Efflux Constant of Seeds.

IV. RESULTS AND DISCUSSION

The Autocatalytic Ion Efflux Constant of the selected seeds, determined by ion efflux method, is considerably high in Vignaradiata, when compared to the other seeds Sorghum vulgare and Hodeum Vulgare as shown in Fig.1. In the present study a new and vital concept of System – Surrounding Interaction is introduced, which leads to a novel approach for the study of seed germination. The Ion Efflux Constant can be the measure of germination time and can help one to differentiate viable and dormant seeds. Biological systems are complex in nature. In order to understand a biological system the principle of physics and the techniques of the mathematics at different levels of complexity are usually applied to the study of roots. Similar studies on seeds are scanty in literature. The interaction of the seed with imbibition medium is essentially an interdisciplinary line of investigation involving physics, Botany, Chemistry. A biological approach of this type is bound to throw light on the chemical kinetics of the process operating during seed germination and is considered a useful biophysical phenomenon to understand the seed kinetics which may be assessed from knowledge of the electrical behaviour of the imbibitions medium.

V. REFERENCES

- [1] Dewez, J. 1964. Water uptake and heat evolution by germinating cotton seed. *Plant physiology*, 39: 240 - 4.
- [2] Kellar, W. and Bleak, A. T., 1970, Factors influencing water absorption by seeds of the Crusted wheat grass complex, *Crop science*, 10(422).
- [3] Pitman, M.G.1982. Transport across plant roots. *Quarterly Reviews of Biophysics*15 (3): 481-554.
- [4] Pandey, D.K, 1988. priming induced repair in French bean seeds *seed Sci. and Technol*,16: 527-532.
- [5] Williams, R. W. R. J. Lawn, B. C. Imrie and D. E. Byth, 1995. Studies on water damage in mung bean. II. Electrical conductivity of seed damage as an assay of level of damage. *Aust. J. Agric. Res.* 901-907.

- [6] Shanmuga Sundaram,E. R. B, Sivasithamparam,N, Janardana Rao, G. and Govindaraju, C. 1982. Effect of culture filtrates of *Aspergillus terric acid* on cell permeability of green gram (*Vigna radiata* (Linn) Wilczek) seedlings, *Current Science* 51:370-1.

- [7] Simon, E. W. 1984. Early events in germination. In Murray R (ed), *The living seed*, Academic Press, Australia. Vol.2. pp: 77-115.

- [8] Blacklow, W. M. 1972. Mathematical description of the influence of temperature and seed quality on imbibitions by seed of corn. *Crop Science*,12: 643-6.