

Electrochemical Kinetic Study of *Zatropa Curcas* Medicinal Plants

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ABSTRACT

The kinetic study of three varieties of *Zatropa Curcas* medicinal plants have been carried out with electrode pair Ag-Zn in three different seasons by measuring their bio-electrode potential through redox process. The reaction velocity follow first-order kinetics but at higher span of time, becomes asymptotic to x-axis, showing zero-order of reaction. The complicated mechanism was observed due to the occurrence of oscillatory reactions in the system. The charge transfer enhance the activity of the system. Various thermodynamic properties were evaluated to explain the proposed mechanism in consistent with the derived rate law.

Keywords: velocity, Span, prevail, probe, polyphormic, excitation.

1. INTRODUCTION

India is a heaven for medicinal plants [1-4]. There exists a large number of plants which have been used by Ayurved and Unani practitioners as medicines. The plant kingdom of the country has been playing a vital role in providing materials useful for human body and animal kingdom. The plants are consumed as our man's food and are used as medicines in curing several diseases. Indian documents, the Vedas emphasize the planting of trees for mythological and socio economic purposes. The plant cell is highly sophisticated bio-chemical laboratory, where hundred of chemical reactions are occurring simultaneously, accompanied by absorption or release of heat to the environment. The xerophytic herbal plants are good source of ionic potential. Bose J.C. [5] the first Indian bio-physicsts has already been established the fact that the movements of ions in plants associated with electromagnetic waves. The bio-electrode potential originates from various sources of ions and may form assembly of bimolecular substrate. The plant leaves contain a large number of bio-chemicals like amino acids with building block from which the proteins are made etc. are capable of forming charge complexes between electrodes that enhance activity [6]. Using electrochemical concept, few researchers- Sarabhai et al. [7] The kinetics of plant leaves of *Opuntia coccinellifera* and *Euphorbia neriifolia* and Agrawal et al. [8] studied, *Calotropis procera* Saket et al. [9] *Coleus amboinicus* and Swami et al. [10] determined rate of *Calotropis gigantea* medicinal plants in three different seasons employing C-Zn, Cu-Zn and Ag-Zn pairs of electrodes. However, literature survey shows that there seems to be no work of kinetic investigation done in context of *zatropa curcas*. Hence inspired by this the authors intended to probe the problem by selecting three kinds of above mentioned plants abbreviated as zc_1 zc_2 and zc_3 respectively.

2. EXPERIMENTAL- measurement of bio-electrode potential activity in medicinal plants

The electrical activity in living cells on the other hand takes place through the movement of ions, which are charged atoms or groups of atoms such as Na^+ , K^+ and Cl^- etc. The charge on the ion, whether positive or negative may vary depending on its atom or molecule. These ions are essential in regulating several vital physiological processes of plants. These metal ion maintain the photo electron transport activity in plants. The presence of ions in the system apparently makes them physically electrolytic system. The system are capable of developing electrical potential of their own whenever necessary.

Leaf BED (Bio-emf-device) performance during morning, noon, evening, and mid night in vitro during summer, rainy and winter season.

The temperature recorded during observation are as under :

TABLE 1

S. No.	Season	Morning 06:00AM	Noon 12:00AM	Evening 06:00PM	Night 12:00PM
1.	Summer	$36 \pm 3^{\circ}\text{C}$	$38 \pm 3^{\circ}\text{C}$	$37 \pm 3^{\circ}\text{C}$	$37 \pm 3^{\circ}\text{C}$
2.	Rainy	$29 \pm 3^{\circ}\text{C}$	$29 \pm 3^{\circ}\text{C}$	$29 \pm 3^{\circ}\text{C}$	$29 \pm 3^{\circ}\text{C}$
3.	Winter	$15 \pm 4^{\circ}\text{C}$	$21 \pm 4^{\circ}\text{C}$	$16 \pm 4^{\circ}\text{C}$	$16 \pm 3^{\circ}\text{C}$

The study is divided into two parts viz.

Potential development on uninjured leaf as electrolyte surface during morning, noon, evening and midnight in three season summer, rainy and winter of three medicinal plants [zatropha curcas] i.e. (zc -1), (zc-2) and (zc-3) with electrode pairs Ag-Zn has been recorded in Table 1. zatropha curcas plant belongs to Acopynae family found everywhere. It is polymorphic, polyannual and is a coloyal herbal plant. It is widely used in a treatment of cardiac, urological, nephrological, dropsy, respiratory, leprosy insanity, ophthalmological, urological and nephrological diseases. The medicinal plant's leaf seems most suitable organ which possesses a lucrative quantity of ions and give uniform surface area of system [11]. The leaves are cut to the size of bioelectrodes. The epidermis on both the sides is scrapped to get the smooth contact with Ag-Zn. The injured leaf of the system is sandwiched between electrode pair Ag-Zn of size 2×2 cm dimension pressed by non-conducting clips. (Fig.1) International Journal of Chemical Studies Fig 1: Circuit diagram of Bio-cell, E1 and E2 are electrodes, R, (Resistance), K (Key), A (Ammeter), V (Voltmeter) and L (Leaf) The Bio-electrode potential (BEP) was measured through digital panelmeter having resolution of 1 mV with an accuracy of + 0.1% D.C. in three different seasons.

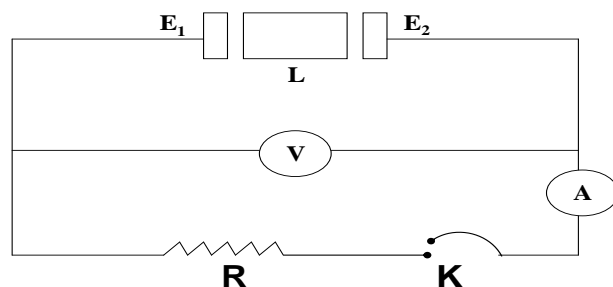


Fig.1 Circuit diagram

(E₁ and E₂ = electrodes, Ag, Zn), R = Resistance,

A = Ammeter, V = Voltmeter, L = Electrolyte (sap)

The velocity rate constant was evaluated by using integration method ($k = 2.303/t \log a/a-x$) at different intervals of time. The amino acids and chlorophylls were identified chromatographically by measuring their R_f values. The physical parameters such as pH, conductivity, density, surface tension etc. were determined from the bio-mass by modern existing techniques. The various thermodynamic parameters were evaluated from the electrochemical kinetic data obtained.

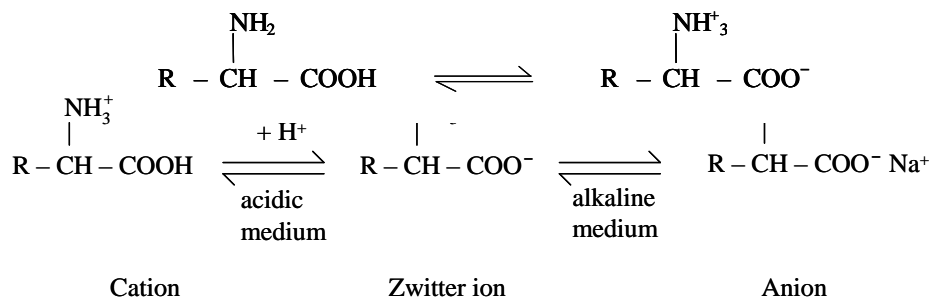
3. RESULTS AND DISCUSSION

The electrochemical kinetic study of chemical constituents of zatropha curcas Rauwolfia serpentina with Ag-Zn electrode pair have been carried out in three different seasons. Summer (308 K), winter (290 K) and Rainy (298 K) by considering their peak values of BEP measured. The kinetic rate of each plant follows firstorder but at higher span of time beyond 140 hours shows zero-order. The graph drawn between $\log a/(a-x)$ vs. time of zc as a typical kinetic study for winter (W) season

at 290 K has been shown. The other plot made for dependence of rate on system with variations in three different seasons. The study indicated oscillatory reactions occur which make the kinetics very complicated. The addition of Cu⁺⁺ ions to the system, led to the retardation of rate in all the seasons. This shows deactivating effect on the physiological activities of tissues, whereas added respiratory substrate carbohydrate does not alter the rate. The absorption of primary salts (NaCl and KCl) by the system, provide an additional ionic contribution towards charge transfer reaction which causes slightly increase in rate. It has been observed that multi-layers of waxy materials deposited around the injured portion of the system, reflecting incident solar radiation which causes less dehydration. The surface of the leaf becomes less shiny being photosensitive giving higher potential at the injured site. The study shows that rate of healing is equal to rate of injury at equilibrium i.e. the number of tissues present in sap varies to the potential that follow redox process. The factor humidity, pH, conductivity, ionic transport plays important role in kinetic investigation. The rate is highest in the morning as mesophyll cell of leaf gets activated due to start of photosynthesis, pushing electron to higher energy state by photic excitation, vis-a-vis swelling and shrinking of chloroplast has been observed across the membrane. During redox process the dipolar Zwitter ions decompose into cations and anions. The chlorophylls exist in cell, as a building blocks of protein. The amino acid molecules comprise both acidic and basic groups in the ionic form.

MECHANISM AND RATE LAW

The rate of reaction increases during photic excitation by chlorophyll due to absorption of photons of light as per Quantum theory consequently flow of electrons occur and forms an electrochemical double layer by the synthesis of ATP.



During redox process, the amino acids present in the medicinal plants form dipolar

Zwitter ions equally splitted into cation and anions.



The rate equation was derived as

$$\text{Rate} = K [\text{Amino acid}] (k_1 + k_2)$$

The derived law is in good agreement with the experimental findings, explain all the facts of the kinetic investigations. The energy of activation (E_a) is measure of activity/ reactivity of any system. The active system is expected to have lower E_a and vice versa.

The observed activity found in light of E_a value in the following order:

$$Zc-1 > zc-2 > zc-3$$

The proton migrate from the carboxyl to amino group, thus producing carboxylate (COO^-) and ammonium (NH_3^+) ion,

Rate Law The rate law was derived as:

Rate = k_1 [Amino acid] ($k_1 + k_2$) The Zwitter ions is responsible for flow of current because it possesses additional charge. Similar mechanism that prevail in bio-system, have already been reported by a couple of workers [7-10] The younger cells increase the rate of permeability of ions whereas the older cell hinder the physiological process reducing conductance and ionic potential.

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