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Kinetic study of wild medicinal plants in dependence of rate on the variations of seasons for the system

Abhineet Pandey, Priyanka Patel and Anjana Singh

Abstract
The kinetic study of three wild medicinal plants such as *Aloe vera* (Av), *Chlorophytum* (Chf) and *Asparagus racemosus* (Asp) have been carried out with Ag-Zn electrode pairs in three different seasons by measuring their bioelectrode potential. The freshly plucked injured plant's leaves of Av, Chf and Asp were dipped in 1.00 x 10^{-3} (mol dm^{-3}) solution of primary salts *viz*. NaCl and KCl for 30 minutes and delivery of potential was recorded with Ag-Zn electrode pair in different seasons. Overall assessing the data obtained for different seasons, for the Av, Chf and Asp the first-order kinetics was obeyed when study is carried out upto 54 hours and later on beyond this long span of time rate declines towards zero-order showing complicated kinetics.

Keywords: Kinetic study, *Aloe vera, Chlorophytum, Asparagus racemosus*

Introduction
Long before Wilhelmy carried out his work, even as early as the 18th century, some measurements had been made of rates of chemical reactions. For example, in 1777 C.F. Wenzel [1] described some measurements of thee rate of solution of metals in acids but gave no details, merely saying that the rate increased with increasing concentration of acid. In 1818 the French chemist Louis Jacques Thenard [2] (1777-1857) studied the rate of decomposition of hydrogen peroxide, a substance he had discovered.

Another collaboration between a chemist and a mathematician, carried out at shout the same time and quite independently, was much more successful as far as the field of kinetics is concerned. In the years 1865 to 1867 Augustus George Vernon Harcourt (1834-1919) carried out very detailed experimental investigations on the reactions between hydrogen peroxide and hydrogen iodide and between potassium permanganate and oxalic acid, paying particular attention to the influence of the reactant concentrations on the rate. His results were analyzed mathematically, in terms of the integrated forms of differential equations, by William Esson (1839-1916), whose procedures were very similar to those that are used today [3, 5]. Equations were obtained for the amount of product formed as a function of time, for 'first-order' reactions, in which the rate is proportional to the concentration of a single reacting substance, and for 'second-order' reactions, in which the rate is proportional to the product of two concentrations. Esson also developed a treatment for consecutive first-order reactions, in which the product of one reaction undergoes a subsequent reaction. Harcourt and Esson [3] paid no attention to the then very popular but nebulous topic of 'chemical affinity' and were not concerned with equilibrium states, this was probably fortunate, since at the time these questions tended to confuse the kinetic problem. Singh *et al.* (2007) [6] have reported electrochemically the extraction and exploration of biomass energy from the plant leaves of different biosystem namely, *Calotropis procera* (abbr. as Cp-1), *Kalenchoe glandulose* (abbr. as Kg-2), *Basella rubra* (abbr. as Br-3) and *Crinum latifolium* (abbr. as Cl-4) and also studied the kinetic study of the above mentioned system with electrode pairs C-Zn, Cu-Zn and Ag-Zn etc. Saket *et al.* (2012) [7] reported the electrochemical kinetic rate of some medicinal plants viz. *Coleus amboinicus* (Ca-1) and typical kinetic reading for the effect of winter season on *Coleus amboinicus* (Ca-2) of different varieties with Ag-Zn, C-Zn and Cu-Zn electrode pairs in three different seasons. The plot of graphs for system between log a/(a-x) vs. time were drawn for first-order, the nature of reaction was oscillatory and complicated. India is a paradise for medicinal plants [8-9]. There exists a list of large number of plants which have been used by Ayurved and Unani practitioners as medicines. The plant wealth of the country has been playing a vital role in providing materials useful for the human body.

Material and Methods

The study of electrical and electrochemical kinetic properties in system is due to the presence of ions. The wild medicinal plants seems most suitable organ which posses a lucrative quantity of ions and give large uniform surface area of system [10-11].

Thus, for the present investigation, the author has selected leaves of three wild medicinal plants viz. *Aloe vera* abbreviated as Av, *Chlorophytum* as Chf and *Asparagus racemosus* as Asp respectively.

In bio-system the variation of rate of reaction due to change in ionic concentration is known as 'salt effect'. The salt effect is of two types – primary and secondary salt effect. The added neutral salt alters the activities of the reactions, the effective concentration of a reactant ion or polar molecule, the effect is known as primary salt effect. When the effective concentration of a reactant ion coming from a weak electrolyte is decreased by the reduced ionization of the electrolyte due to the added salt, the effect is known as secondary salt effect. The primary salt effects (NaCl, KCl) have been studied, with the help of Bronsted[12], Bjerrum[13] equation

$$\log k_r = \log k_0 + 1.018\, Z_A.Z_B \sqrt{(\mu)} \ldots\ldots\ldots \quad (1)$$

Where,

K_r = rate constant of a given ionic strength.

K_0 = constant at zero ionic strength that is when no salt has been added.

Z_A and Z_B are the charges on the reacting species.

Results and Discussion

The experiments were performed for the plants (Av, Chf and Asp) in different seasons at their respective temperature by the addition of neutral salts viz. NaCl and KCl the summarized data of reaction rate are recorded in tables 1 and 2 respectively.

Table 1: Dependence of rate on [NaCl]

[NaCl] : 1.00 x 10^{-3} (mol dm^{-3})
Electrode pair : Ag-Zn
Temp.°K : 308(S), 298(R), 290(W)

S. No.	System	Summer	Rainy	Winter
		$K_1 10^6 s^{-1}$		
1.	Av	6.55	6.45	6.23
2.	Chf	6.33	6.19	6.07
3.	Asp	5.86	5.58	5.41

Table 2: Dependance of rate on [KCl]

[KCl] : 1.00 x 10^{-3} (mol dm^{-3})
Electrode pair : Ag-Zn
Temp.°K : 308(S), 298(R), 290(W)

S. No.	System	Summer	Rainy	Winter
		$K_1 10^6 s^{-1}$		
1.	Av	6.58	6.50	6.29
2.	Chf	6.38	6.23	6.10
3.	Asp	5.90	5.61	5.46

The freshly plucked injured plant's leaves of Av, Chf and Asp were dipped in 1.00 x 10^{-3} (mol dm^{-3}) solution of primary salts viz. NaCl and KCl for 30 minutes and delivery of potential was recorded with Ag-Zn electrode pair in different seasons. It was found that due to the effect of monovalent (Na^+, K^+) cations and monovalent (Cl^-) anions, which enter cells more readily than divalent or trivalent ions consequently more potential was exhibited, hence enhance the rate.

The experiment was performed for the plants in different seasons at different temperatures.

Table 3: The summarized data of rate constants are presented.

Electrode pair : Ag-Zn
Temp. °K : 308(S), 298(R), 290(W)

S. No.	System	Summer	Rainy	Winter
		$K_1 10^6 s^{-1}$		
1.	Av	6.37	6.16	5.87
2.	Chf	6.08	6.83	5.62
3.	Asp	5.56	5.36	5.20

The examination of data as recorded in table 3 clearly indicates that rate is maximum in summer rather than in rainy and winter seasons. It follows first-order kinetics to some extent up to 50 hours and declines towards zero-order, when study is carried out onwards showing omplex kinetic due to occurrence of oscillatory reactions in the system.

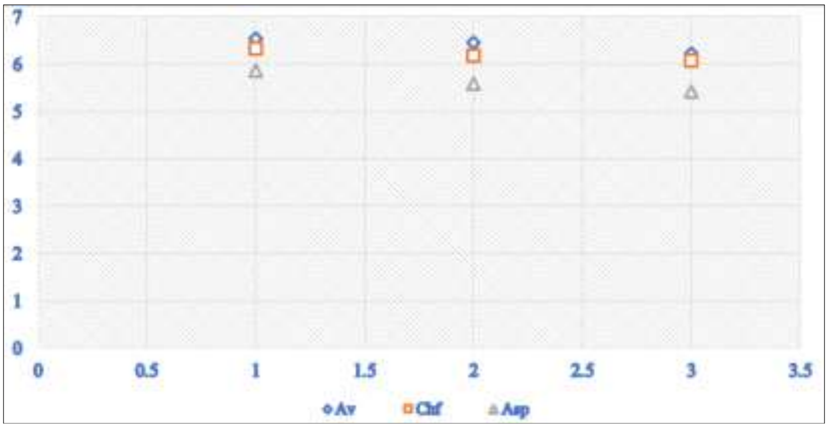

Fig 1: Dependence of rate on [NaCl]

Fig 2: Dependence of rate on [KCl]

Fig 3: The graphically analysis data of rate constants are presented.

The added neutral primary salts viz. [NaCl] and [KCl] to Av, Chf and Asp plants in three seasons with Ag-Zn electrode pair, accelerated the reaction velocity. The reason behind this increase is that, the monovalent (Na+, K+) cations and mono valent (Cl-) anions, enter cells more readily in comparison to divalent or trivalent ions consequently more rate was exhibited (Table: 1 and 2). The absorption and movement of ions of salts by the system, provide an additional ionic contribution in charge transfer reaction which causes increase in rate.

Overall assessing the data obtained for different seasons, for the Av, Chf and Asp the first-order kinetics was obeyed when study is carried out upto 54 hours (Table 3) and later on beyond this long span of time rate declines towards zero-order showing complicated kinetics. It is presumed that occurrence of oscillatory reaction involved in the system. The similar views have also been reported by earlier workers when studied this type of bio-system kinetically [14-16].

Conclusion

The oxidation process entirely depends upon the detachment of electrons from the tissues present in electrolyte of wild medicinal plants. The study of the primary salt effects show that the initial rate increases with potential values. There is increase in the life of BEP and the total columbic charge also increases in the same proportion.

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