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Kinetic study of potential development in injured plants *in vitro* conditions

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Abstract
The kinetic study of potential development in injured plants *in vitro* conditions. Potential is high in summer season as for Av (1802 mV) with Ag-Zn electrode pair in night whereas it is less as for Asp (1525 mV) in morning with C-Zn electrode pair. The examination of the results presented in tables 1 to 3 for the Av, CHF and Asp plants with Ag-Zn, Ag-Mg and C-Zn electrode pair in three seasons clearly reveal that: (I) Potential is high in summer season as for Av (1802 mV) with Ag-Zn electrode pair in night whereas it is less as for Asp (1525 mV) in morning with C-Zn electrode pair. (ii) It was observed in rainy season that potential is high for Av (1800 mV) in night when studied with Ag-Zn electrode pair, whereas it is less in Asp (1503 mV) in morning with C-Zn electrode pair. (iii) It was also found in winter season that potential is high for Av (1742 mV) in night with Ag-Zn electrode pair and is low in Asp (1500 mV) in morning when studied with C-Zn electrode pair.

Keywords: Kinetic study, potential development, *aloe vera, Chlorophytum, asparagus racemosus*

Introductions

Chemical reaction kinetics, also known as reaction kinetics, provide a quantitative measurement of rates of reactions. Reaction kinetic studies provide insight into the dependence of these rates on variables, such as concentration, temperature, pressure, the presence of catalysts, or the physical state of the reactants. Since chemical reactions are dependent on the concentration of the reactant molecules and the conditions in which enable their collision, understanding the effect of variables on these interactions is critical to controlling the reaction for a successful outcome. Information provided by reaction kinetics measurements can corroborate or contradict postulated reaction mechanisms, and support mathematical modeling of the reaction. Experimental measurement of the progress of a reaction as a function of time yields the reaction rates, and from this data, rate laws, rate constants, activation energies, and other kinetic parameters are derived.

The chemical kinetic remains one of the important tool even this day in finding out the underlying mechanism of the reaction. The elucidation of reaction mechanism is still one of the most fascinating problem in inorganic and organic chemistry. Kinetics has furnished a pool of precious wealth of information about the nature and course of a reaction (Bansal, 1978) [1]. Kinetic studies are of fundamental importance in any investigation of reaction mechanism. Kinetics may be approached either as a discipline in its own right or as a tool for the elucidation of reaction mechanism. Franclin (Pauling, 1962) [2] introduced the electron transfer reaction which has created a new era in the field of chemical kinetics. The oxidants based on redox reactions are of considerably academic interest and of technological importance. In 1969 A. Broido developed Thermo gravimetric (T.G.) techniques and employed to study the kinetics of chemical reaction based on the Arrhenius equation. Recently this valuable phenomenon of kinetics is fully utilized to carry out the reaction exhibiting radioactivity (Taube, 1959) [3] with half-lives less than a second. Yalman (1959) [4] applied electronegativity and well defined oxidation state to kinetics. In 1970, Goldstein (1970) [5] (U.S.A.) has utilized molecular orbital theory to provide a strong evidence of changes in order of electro negativities based on redox reacteions. Singh *et al.* (2007) [6] have reported electrochemically the extraction and exploration of biomass energy from the plant leaves of different bio system 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 Saket *et al.* (2012) [7] reported the electrochemical kinetic rate of some medicinal plants *viz*. etc.

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.

Gangwal *et al.* (1995 & 1998) [8-9] reported the similar results with Ayurvedic medicinal plants (Boswellia serrata, copercicon, esculentum).

Material and methods

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.

Electrodes are the main components of any electrochemical cell. The electrodes employed in this study are: Carbon (C), Silver (Ag), Zinc (Zn) and Magnesium (Mg). Cut into strips of 2 x 2 cm. When an electric current is passed through an electrode, electrochemical redox process (Hewitt, 1950; Caster, 1960; Srinivasan, 1985; Roberts, 1992 and Antroprov, 1977) [10-14] take place and the potential developed is a function of the quantity of electricity passed.

The metallic plates of Zinc (Zn), Silver (Ag), Magnesium (Mg), and Carbon (C) are procured and cut into strip of 2 x 2 cm dimension. Each electrode was connected by copper wire for circuit connections. The electrodes were cleaned, washed with distilled water and then washed with N/10 NaOH. They were again cleaned with distilled water and finally cleaned with acetone. The dried electrodes were then rubbed/polished with emery paper with successive increasing fineness.

Results and discussion

The maximum and minimum potential development for injured leaf during each season is also pointed out separately, which is tabulated below in tables 1-3 at their respective temperatures.

Table 1: Comparative account of potential of the injured system across Ag-Zn, Ag-Mg and C-Zn electrode pairs.

S. No.	System	Time	Ag-Zn		Ag-Mg		C-Zn	
			Min. (mV)	Max. (mV)	Min. (mV)	Max. (mV)	Min. (mV)	Max. (mV)
1.	Av	Morning	1753	-	1683	-	1613	-
		Night	-	1802	-	1739	-	1687
2.	CHF	Morning	1601		1607		1573	
		Night		1711		1691		1617
3.	Asp	Morning	1595		1537		1525	
		Night		1636		1631		1617

Temperature: 308±2°K; Season: Summer

Table 2: Comparative account of potential of the injured system across Ag-Zn, Ag-Mg and C-Zn electrode pairs.

S. No.	System	Time	Ag-Zn		Ag-Mg		C-Zn	
			Min. (mV)	Max. (mV)	Min. (mV)	Max. (mV)	Min. (mV)	Max. (mV)
1.	Av	Morning	1741	-	1710	-	1603	-
		Night	-	1800	-	1775	-	1669
2.	CHF	Morning	1623		1602		1555	
		Night		1701		1686		1608
3.	Asp	Morning	1578		1512		1503	
		Night		1617		1619		1600

Temperature: 302±2°K; Season: Rainy

Table 3: Comparative account of potential of the injured system across Ag-Zn, Ag-Mg and C-Zn electrode pairs.

S. No.	System	Time	Ag-Zn		Ag-Mg		C-Zn	
			Min. (mV)	Max. (mV)	Min. (mV)	Max. (mV)	Min. (mV)	Max. (mV)
1.	Av	Morning	1650	-	1620	-	1586	-
		Night	-	1742	-	1702	-	1650
2.	CHF	Morning	1605		1590		1585	
		Night		1696		1666		1657
3.	Asp	Morning	1576		1502		1500	
		Night		1607		1577		1568

Temperature: 288±2°K; Season: Winter

It is evident from the above tables that in summer season, the plants have maximum potential during night for AV, CHF and Asp when studied with Ag-Zn electrode pair whereas minimum in the morning for Av, CHF and Asp. The reason is that in morning when the sun rises the mesophyll cells of leaf get activated and photosynthesis starts at the time, then the movement of Na^{+} and K^{++} ions become feasible. The other reason is that the transpiration rate is slow at morning while in noon to night due to high transpiration rate, the water changes into water vapour, the leaf begins to dry easily and gradually potential (Sharma, 1998; Glasstone, 1968 and Silva-Diaz, *et al.* 1964) [15-17] becomes zero.

In rainy season, the maximum and minimum potential have been observed in night and morning which depends upon rainfall. In winter season, there is maximum potential (Suthanthiragan, 1986; Gangadharan, 1985 and Trivedi, 1988) [18-20] observed at evening and night and minimum at noon and morning. The reason being that due to low temperature in morning, the ions of leaf get inactivated.

The comparative account of potentials throughout the year in three seasons (S, R, and W) with three electrode pairs *viz.* ZG-Zn, Ag-Mg and C-Zn have also been given for perusal in Table III H-1 to III H-3.

The outer reasons are (i) when sun rises, the mesophyll cells of leaf get activated and photosynthesis starts at the time, where movement of Na^+ and K^+ ions become feasible, (ii) the transpiration rate becomes slow at morning while in noon to night due to high transpiration, the water changes into water vapour, the leaf begins to dry easily and gradually potential falls. In rainy season, potential depends upon rainfall. In winter season due to low temperature in morning, the ions of leaf get in activated.

The electro-chemical study shows that Ag-Zn pair give maximum potential than others. The reason being the Ag is larger in size than others. The outer electronic configuration of Ag is $4d^{10}5s'$. This shows that the outer electron of Ag is loosely attached so it can be detached easily similarly Zn has high ionization potential due to its complete d-sub-shell.

Table 4: The comparative properties for employed electrodes.

S. No.	Properties	Carbon	Mg	Zinc	Silver
1.	Atomic number	6	12	29	47
2.	Outer electronic co	$2s^2 2p^2$	$[Ne]^3s^2$	$3d^{10}4s^2$	$4d^{10}5S^1$
3.	Standard electrode potential	-	+2.37	-0.763	+0.799
4.	Oxidation state	+4 in unhybridized state	+1, +2	+2	+1, +2, +3
5.	Conductivity to heat & electricity	Good	Good	Good	Good
6.	Covalent radiradic A^0	0.77	1.36	1.25	1.34
7.	Ionisation potential eV per mol.	11.3	7.6	9.4	7.6

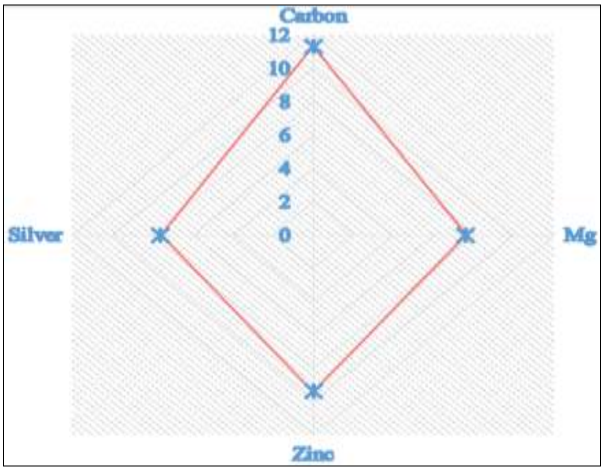

Fig 1: The graphically analysis ionization potential eV per mol.

The tendency of Ag to gain the electron from bio-sap is more pronounced that Zn and Mg. Summing up all the above properties it is clear that Ag-Zn pair gives highest potential.

Conclusion

It was concluded from the above findings that injured plants show high potential and average mid maximum value were found with Ag-Mg electrode pair for all the plants. The study indicates that for extracting high power and energy from the system, it is essential to scrap off the epidermis on both the sides of leaf/stem and also the injure the internal tissue by needle pricks in summer season if needle is used of the electrodes. The plants are good source of ionic potential. Bio-electrical potential is generated due to redox couple present in the plant as bio-fuel cells. The promising results of study opens a new dimension of alternative source of energy i.e. non-conventional form might give a help, hope to get energy in cheaper rates by knowing he secret of plants. Therefore, in order to know the secrets of plants the study will be fruitful in creating the new zeal among the people about the nature and to maintain environmental, ecological balance on earth planet. The applied aspects of this study would be very useful in preparations of bio-cell used in calculators, wristwatches, gadgets electronic devices, based on low voltage and also in operation of electronic telecommunications etc.

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