# Dielectric Parameters of Herbal Medicines

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**ABSTRACT:** The medicinal plants and herbal products, products of metals, salts gems and poisons are used for therapeutic purposes. The study of dielectric properties of biological materials is of great assistance in exploring the molecular structure and dynamics of condensed matter. Spectroscopy in reflection mode has been used as a technique. A nonlinear least squares fit method have been used to obtain dielectric parameters viz., static dielectric constant (ε0 ) and dielectric relaxation time (τ) at temperatures 100C, 200C, 300C and 400C of Herbal Medicines (Punarnavasava – Spreading hogweed). Hogweed – Heracleum plant, heracleum is a genus of species of biennial and perennial herbs in the carrot family Apiaceae.

**KEYWORDS:** Herbal wines, Asava, Ethanol, Spectroscopy, Fourier transformation, Dielectric constant, Relaxation time.



## I. INTRODUCTION

The cell of living plants consists of chemical compounds like carbohydrates, proteins, fats etc. Human utilizes these compounds as food matter. There are other compounds like alkaloids, tannins glycosides etc. and these compounds exert physiological effects and used as therapeutic agents. The medicinal plants and herbal products, products of metals, salts gems and poisons are used for therapeutic purposes. Ayurvedic compound formulation are divided into two groups: plant drugs ( Kasthausadhi ), metals and minerals ( Rasausadhi ). Ayurvedic medicines Asava and Arista are made by soaking the drugs either in powder or in decoction forms in a solution of sugar or jiggery, for a specified period of time. During the specified period it undergoes a process of fermentation and generates alcohol which facilitates the extraction of the active principles contained in the drugs. The alcohol also serves as a preservative. Asavas and Ariatas may use as herbal wines. The Sanskrit names of medicinal plants and metals have been used to indicate the standard names of Asava. For examples, the basic medicinal plants used in the production of Drakshasava is a Black raisin and Arvindasava is Lotus. The Sanskrit names of Black raisin (a sweet dried grape) is Draksha and Lotus is Arvind. Asava are prepared by Indian traditional methods and identified by their common names. This 'Asava' can be easily absorbed by the body, is curative and lasts long. The solute-solvent biological molecular interactions between Herbal medicines, Punarnavasava and associative solvent Ethanol are presented in the paper.

## II. EXPERIMENTAL

Spectroscopy in reflection mode has been used as a technique. A fast rising step pulse of 25 ps is incident on the mixture kept in the cell. The mixtures were prepared at different volume percentage of Punarnavasava in Ethanol in steps of 10 vol. % within a ± 0.01 % error limit. The reflected pulse from the cell is sampled with incident pulse in sampling oscilloscope. The reflected pulse from sample contains the information regarding dielectric behaviour of biological materials. The reflected pulse without sample $R_1(t)$ and with sample $R_x(t)$ were digitized in 1024 points and stored on disc.

## III. DATA ANALYSIS

The time dependent data were processed to obtain complex reflection coefficient spectra $\rho^*(\omega)$ using Fourier transformation (Samulon[1]; Shannon[2]) as

$$\rho^*(\omega) = \frac{c\, p(\omega)}{j\omega d\, q(\omega)}$$

Where $p(\omega)$ and $q(\omega)$ are Fourier transforms of $(R_1(t)-R_x(t))$ and $(R_1(t)+R_x(t))$, respectively, c is the velocity of light, $\omega$ is the angular frequency, and d is the effective pin length.

The complex permittivity spectra $\varepsilon^*(\omega)$ were obtained from reflection coefficient spectra $\rho^*(\omega)$ by using the bilinear calibration method (Cole[3,4] et al.). The experimental values of $\varepsilon^*(\omega)$ are fitted with the Debye equation (Cole and Cole[3]; Davidson and Cole[5] ;Havriliak and Negami[6])

$$\varepsilon^*(\omega) = \varepsilon_\infty + \frac{\varepsilon_0 - \varepsilon_\infty}{(1 + j\omega\tau)}$$

with $\varepsilon_0$, $\varepsilon_\infty$ and $\tau$ as fitting parameters. A nonlinear least- squares fit method (Bevington[7]) was used to determine the values of dielectric parameters. The values of static dielectric constant ($\varepsilon_0$) and dielectric relaxation time ($\tau$) are listed in table I

## Bruggeman factor

The plot of experimental values together with ideal and theoretical values of Bruggeman factor ($f_B$) at 20°C, as a function of volume fraction of Punarnavasava in mixture, is shown in figure I and II. The values of Bruggeman factor ($f_B$) of Punarnavasava-Ethanol system for 11 different concentrations at four temperatures are listed in table II. The experimental values of ($f_B$) for Punarnavasava-ethanol mixture are fitted to modified Bruggeman mixture formula. The values of "a" for Punarnavasava-ethanol mixture are 0.484, 0.499, 0.420 and 0.457 at 10°C, 20°C, 30°C and 40°C respectively. The values of "a" indicates raise in effective volume of solvent. Furthermore values of "a" changes with increase in temperature, which shows temperature dependent nature of molecular interactions.

Table1: Temperature dependent dielectric parameters for Punarnavasava-Ethanol mixture

| Vol fra | 10°C | | 20°C | | 30°C | | 40°C | |
|---|---|---|---|---|---|---|---|---|
| | $\varepsilon_0$ | $\tau$ ps | $\varepsilon_0$ | $\tau$ ps | $\varepsilon_0$ | $\tau$ ps | $\varepsilon_0$ | $\tau$ ps |
| 0.0 | 26.8 | 167.0 | 25.9 | 150.7 | 25.2 | 128.0 | 24.5 | 111.2 |
| 0.1 | 33.5 | 133.5 | 33.4 | 111.7 | 30.1 | 95.5 | 29.7 | 90.8 |
| 0.2 | 39.6 | 112.1 | 35.7 | 93.9 | 34.9 | 81.0 | 34.3 | 76.3 |
| 0.3 | 42.5 | 92.6 | 41.2 | 81.4 | 40.1 | 67.0 | 38.8 | 66.3 |
| 0.4 | 48.2 | 81.8 | 47.8 | 69.1 | 45.3 | 59.8 | 43.8 | 59.2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0.5 | 52.2 | 73.6 | 53.4 | 60.5 | 50.4 | 55.3 | 48.6 | 54.9 |
| 0.6 | 60.5 | 66.6 | 58.9 | 53.7 | 57.4 | 45.2 | 54.2 | 44.4 |
| 0.7 | 66.1 | 61.7 | 63.6 | 48.3 | 61.0 | 39.0 | 59.0 | 38.6 |
| 0.8 | 70.6 | 49.1 | 67.7 | 40.8 | 65.1 | 37.4 | 63.1 | 36.2 |
| 0.9 | 73.7 | 43.5 | 71.7 | 33.8 | 68.3 | 33.3 | 67.0 | 32.8 |
| 1.0 | 76.9 | 34.7 | 74.7 | 30.4 | 69.8 | 28.5 | 68.1 | 27.2 |

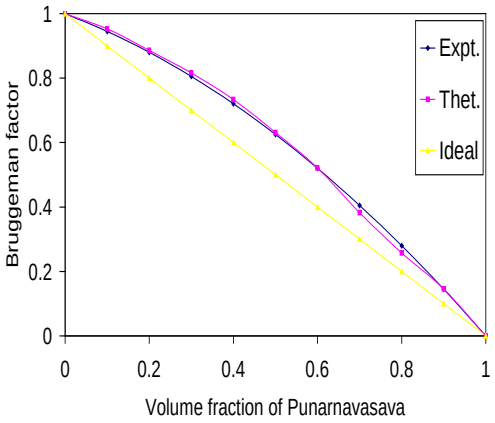


**Fig. I:** Variation of Bruggeman factor with volume fraction of Punarnavasav in Ethanol at $20^0$C.

Table2: Ideal, experimental & theoretical values of Bruggeman factor ($f_B$) for Punarnavasava-Ethanol mixture.

| vol fra Pun | Ideal | $10^0$C a=0.527 | | $20^0$C a=0.554 | | $30^0$C a= 0.629 | | $40^0$C a=0.703 | |
|---|---|---|---|---|---|---|---|---|---|
| | | exp | the | exp | the | exp | the | exp | the |
| 0.0 | 1.0 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 0.1 | 0.9 | 0.94 | 0.96 | 0.94 | 0.98 | 0.93 | 0.94 | 0.93 | 0.91 |
| 0.2 | 0.8 | 0.87 | 0.90 | 0.87 | 0.89 | 0.86 | 0.86 | 0.85 | 0.84 |
| 0.3 | 0.7 | 0.79 | 0.81 | 0.79 | 0.79 | 0.78 | 0.79 | 0.76 | 0.79 |
| 0.4 | 0.6 | 0.73 | 0.70 | 0.71 | 0.71 | 0.69 | 0.71 | 0.67 | 0.69 |
| 0.5 | 0.5 | 0.61 | 0.61 | 0.61 | 0.62 | 0.59 | 0.59 | 0.57 | 0.58 |
| 0.6 | 0.4 | 0.50 | 0.48 | 0.51 | 0.50 | 0.49 | 0.47 | 0.47 | 0.45 |
| 0.7 | 0.3 | 0.39 | 0.38 | 0.39 | 0.37 | 0.38 | 0.37 | 0.36 | 0.35 |
| 0.8 | 0.2 | 0.27 | 0.24 | 0.20 | 0.25 | 0.26 | 0.25 | 0.25 | 0.24 |
| 0.9 | 0.1 | 0.14 | 0.12 | 0.14 | 0.13 | 0.13 | 0.13 | 0.13 | 0.11 |
| 1.0 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

The thermodynamic parameters molar enthalpy of activation ΔH and the molar entropy of activation ΔS were obtained using equation

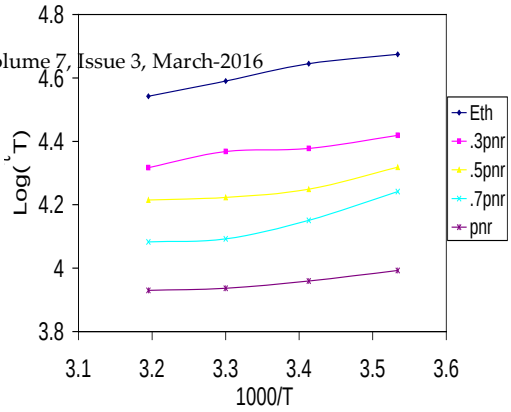


**Fig.II :** Arrhenius plot of Punarnavasava-Ethanol mixture

$$\tau = \frac{h}{KT}\exp\left[(\Delta H - T\Delta S)/RT\right]$$

and are listed in table III.

Table 3: Activation enthalpy and entropy of Punarnavasava-Ethanol mixture for various concentrations.

| Vol. fra.of Punarna. | ΔH KJ/mole | ΔS $J/^0$Kmole |
|---|---|---|
| 0.0 | 7.6740 | -0.0303 |
| 0.1 | 7.183 | -0.0298 |
| 0.2 | 7.162 | -0.0285 |
| 0.3 | 6.398 | -0.0296 |
| 0.4 | 5.805 | -0.0306 |
| 0.5 | 4.740 | -0.0333 |
| 0.6 | 7.830 | -0.0216 |
| 0.7 | 9.535 | -0.0149 |
| 0.8 | 4.981 | -0.0292 |
| 0.9 | 3.949 | -0.0316 |
| 1.0 | 3.444 | -0.0319 |

## IV. RESULT AND CONCLUSION

When a molecular system is placed in an electric field, there is always the tendency for the electrically charged species to move along the appropriate direction, causing the atom to develop an induced dipole moment. The amount of polarization depends on factors such as size of molecule,

effective dipole moment, and temperature. Relaxation time of biological material can be related to the size of molecule, mobility of molecules in liquid, molecular volume, viscosity and temperature. Decrease in relaxation time can be correlated to decrease in size of molecule as well as to increase in mobility of molecules in liquid. Relaxation time decreases with increasing volume of Punarnavasava in solution. The smaller structures may be formed due to breaking of long chain multimeric structures in ethanol.

The value of activation enthalpy gives an idea about nature of compactness in molecules of liquid. The variation in $\Delta H$ with change in solute concentration provides us information about relative change in amount of hydrogen bonding in mixture. The enthalpy decreases with increase in volume fraction of Punarnavasava in mixture, which shows decrease in amount of hydrogen bonding between molecules of liquid.

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