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Refractometric Study of Gibberellic acid in Binary Solution of Ethanol-Water at 303 K

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Abstract:
Refractive indices and densities of solutions of gibberellic acid over different concentration range from 0.05 M - 0.01 M in 50% - 35% ethanol-water at 303K have been determined. The data obtained is used to determine Specific Refraction, Molar Refraction and polarizability constant of solution. As the concentration increases the values of Refractive indices, Molar Refraction and Polarizability constant are decreases. The result has been interpreted in terms of interaction of gibberellic acid with ethanol and water binary solution.
Keywords: Gibberellic acid, Density, Refractive index, Molar Refraction, Polarizability Constant

INTRODUCTION

Gibberellic acid is a hormone found in plants and fungi having chemical formula $C_{19}H_{22}O_6$. Plants in their normal state produce large amounts of gibberellic acid. It is possible to produce the hormone industrially using microorganisms [1]. Gibberellic acid is a simple gibberellin, a pentacyclic diterpene acid accelerates growth and elongation of cells. It affects decomposition of plants and helps plants growth if applied in small amounts, but eventually plants develop tolerance to it. Gibberellic acid stimulates the cells of germinating seeds to produce mRNA molecules that code for hydrolytic enzymes. Gibberellic acid is a very potent hormone whose natural occurrence in plants controls their development. Gibberellic acid was first isolated in Japan, as a metabolic by-product of the plant Gibberellafujikuroi, which affect rice plants. Fujikuroi-infected plants developed bakanae, which causes them to rapidly elongate beyond their normal adult height. The plants subsequently lodge due to lack of support, and die [1]. Since gibberellic acid regulates growth, applications at lower concentrations can have a positive effect while too much will have the negative effect [2]. It is usually used in concentrations between 0.01 and 10 mg/L. Gibberellic acid can stimulate rapid root and stem growth, induces mitosis in the leaves of some plants and increases rate of seed germination [3]. The refractive index of the material is an important optical parameter of the materials. Thermodynamic and other important physical properties such as specific refractivity, molar refractivity and polarizability of solutions provide useful information regarding molecular structure of the components used in the solutions [6]. The molar refractivity shows arrangements of the electron shells of ions in molecule and yields information about the electronic polarization of ions. Molar refraction and polarizability constant of aqueous solutions of $KBrO_3$ has been evaluated in different concentration of ionic salts in aqueous solution [7-8]. Density, refractive index, molar refraction and polarizability constant of substituted 2-oxo2Hchromene-3-carbohydrazide derivatives in binary solution are done [9].Comparative evaluation of refractive index of aqueous solution of zinc and lead acetate at different concentration and temperature has been worked out successfully [10].

The present research paper deals with the evaluation of molar refraction and polarizability constant of gibberellic acid in binary solution of ethanol and water.

EXPERIMENTAL:

MATERIALS:

All chemicals used for study of analytical grades, gibberellic acid used for study are obtained from local market and purified by known method. Double distilled water was used for solution preparation. Solution of gibberellic acid in water are prepared by dissolving appropriate weight in binary solution of 50%, 45%, 40%, 35% ethanol-water in concentration range from 0.05M – 0.01M. Weighing were carried on electronic Contech plus balance having accuracy (0.0001gm). Refractive indices were measured by using Abbe's Refractometer, densities of solution were measured by using density bottle.

RESULT AND DISCUSSION

Specific Refraction, Molar refraction of solution and Polarizability constant (α) of gibberellic acid solutions were determined by using following formulae [9 -14].

The densities of solutions were determined from the relation as

$D = M/V$ ------ (1)

Where 'M' - Mass of solution in grams and '

V - Volume of solution filled in the density bottle.

$E = n^2$ ----(2)

$R_{E\text{-}W} = X_1R_1 + X_2R_2$ ----------(3)

Where R1 and R2 are molar refraction of ethanol and water respectively.

The molar refraction represents actual or true values of the substance molecules in one mole.

The molar refraction of solution of ligand in ethanol–water mixture is determined from,

$R_{mixture} = [(n_2-1)/(n_2+2)]\{[X_1M_1 + X_2M_2 + X_3M_3]/d\}$ --------(4)

Where n – Refractive index of solution

X_1 - Mole fraction of ethanol

X_2 - Mole fraction of water

X_3 - Mole fraction of solute

M_1 - Molecular weight of ethanol.

M_2 = Molecular weight of water.

M_3 = Molecular weight of solute (Gibberellic acid).

The molar refraction of ligand is calculated as

$R_{ligand} = R_{mixture} - R_{E\text{-}W}$ ----------(5)

Polarizability of a substance can be determined by measuring the refractive index of the gibberellic acid.

$R_{ligand} = (4/3)\pi N_o\alpha$ ----------(6)

Where α – Polarizability constant of gibberellic acid.

Table – 1. Molar Refraction and polarizability constant of Gibberellic acid in Ethanol -Water at 303K.

S.No.	Composition (Ethanol-Water)	Concentrations C(M)	Density of Solution ($gmcm^{-3}$)	Refractive Index	R_{ligand} (cm^3Mole^{-1})	Polarizability Constant(α) Mol^{-1}
1.	50 %	0.05	0.931619	1.3645	29.47979145	$1.14971x10^{-23}$
2.		0.04	0.931313	1.3641	22.30776861	$8.70003 x10^{-24}$
3.		0.03	0.930791	1.3638	15.09182824	$5.88581 x10^{-24}$
4.		0.02	0.930771	1.363	0.727476098	$2.83716 x10^{-25}$
5.	45%	0.05	0.935306	1.3641	29.29931	$1.14267 x10^{-23}$
6.		0.04	0.932063	1.364	22.27702	$8.68804 x10^{-24}$
7.		0.03	0.928652	1.3638	15.14609	$5.90697 x10^{-24}$
8.		0.02	0.926306	1.3625	0.768247	2.99616 x10-25
9.	40%	0.05	0.949412	1.3638	28.71543	$1.12 x10^{-23}$
10.		0.04	0.946701	1.3633	21.76058	$8.49 x10^{-24}$
11.		0.03	0.944769	1.363	14.71029	$5.74 x10^{-24}$
12.		0.02	0.943487	1.3623	0.59933	$2.34 x10^{-25}$
13.	35%	0.05	0.95592	1.3635	28.43979	$1.11 x10^{-23}$
14.		0.04	0.95425	1.3631	21.50995	$8.39 x10^{-24}$
15.		0.03	0.95383	1.3625	14.46996	$5.64 x10^{-24}$
16.		0.02	0.95279	1.362	0.509297	$1.99 x10^{-25}$

In present study measured values of density and refractive index of gibberellic acid in concentration range from 0.05M – 0.01M in ethanol - water at temperatures 303K. are given in Table No. 1 The values of densities and refractive indices of gibberellic acid in ethanol – water binary solution increases with increase in concentration. "The increase in concentration means increase in molar mass of gibberellic acid and hence density increases. The increase in refractive index with increase in concentration is due to decrease in angle of refraction or increase in angle of incidence. The densities of gibberellic acid solutions increased with increase in concentration in a given solution, which is because of strengthening of solute-solvent interactions. The refractive index of various solutions shows a linear relationship" [15] with concentrations of gibberellic acid and is tabulated in Table No.1"concentration dependent quantity, specific refraction that characterizes electronic polarizability of a substance, this increasing magnitude indicates strong solute-solvent interactions" [16].

CONCLUSIONS:

Data obtained in Table No.1 can be interpreted as

1.Higher values of densities of gibberellic acid are due to the relative solvation, corresponding relative volumes of system and molar mass of the gibberellic acid.

2. The values of densities increases as concentration of gibberellic acid increases due to strengthening of solute-solvent interactions.

3. Polarizability increases as molar refraction increases with increases in concentration of gibberellic acid due to dispersion force.

4. This increasing value of refractive indices shows strong solute-solvent interactions.

5. The molar refraction values of gibberellic acid for 0.05M concentration for ethanol water are higher than in 0.01M, shows molar refraction is additive as well as constitutive property.

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