DIELECTRIC DISPERSION OF WEAK ALCOHOLIC SOLUTIONS OF SOME DRUGS AT HIGH FREQUENCIES USING TIME DOMAIN SPECTROSCOPY

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INTRODUCTION

Dielectric investigation of molecules of biological interest yields useful information concerning structural parameters of the molecules and their environment. Some claims are made that certain compounds are effective even at extremely low concentrations. There is, therefore, need for biological investigations on these claims. Jussal et al.[1] conducted some dielectric studies on some drugs in such dilutions using fields in radiofrequeney region. We want to report on a dielectric study of some components in high frequency region. This study is a further extension of previous study[1].

MATERIALS AND METHODS

Materials: Mother tinctures of Arsenic album (As_2O_3) and Euphrasia (Bhandari's); empty phials (1 dram and 2 drams); ethanol, potentiater, pipettes (5 ml and 0.1 ml) zeroburette, beaker, stand, T.D.R. system.

Methods: In order to prepare serial dilutions of Arsenic album, 0.02 ml of mother tincture of drug is added to 1.98 ml of ethyl alcohol to make it 2.00; and succussion[1] is given twice on the potentiater[1]. Always 0.02 ml from the previous phial was added to 1.98 ml of alcohol of the next phial and then succused twice, before taking 0.02 ml of this and dropping it into the next phial. The mother tincture of Arsenic alb. contained 6% alcohol, water, and sugar of milk (lactose). 1.98 ml were measured each time by the same burette and 0.02 ml was added each time by the same pipette. This pipette was rinsed twice with alcohol everytime before use. In case of Euphrasia, the dilutions were prepared by taking 0.05 ml of previous solution and 4.95 ml of alcohol. Other steps remained the same.

Samples from these dilutions were taken to TDS system for dieleetric measurements. The data thus obtained was fed to computer and the results are shown in graphs (Figs. 3 to 11).

We are giving below an introduction to the TDS system that was used for dielectric measurements.

Dielectric measurements were carried out using Time Domain Spectroscopy system (TDS) of Hewlett-Packard Company, USA. The system consists of a 182 C Oscilloscope, a 1815 B plug-in-Unit, a 1817 A sampler, a 1106 B tunnel diode, a 7 mm precision coaxial line with amphenol APC-7 connectors and an omniscribe two-pen script chart recorder. The technique and procedure has been described in detail elsewhere[1,3] and will only be summarised here.

A common arrangement of the TDS System, as shown in Fig. 1 consists of a pulse generator (tunnel diode) which produces a fast-use-time step pulse of the order of 30 ps, a sampler which transforms the high frequeucy input signal into a lower frequency output signal, and an oscilloscope or any suitable display unit which records the resultant waveforms. The sample

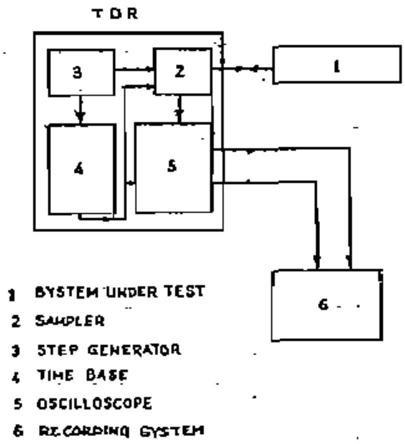


Fig. 1.

uuder test is filled into the coaxial line, terminated in a suitable impedance. This sample is exposed to a traiu of fast-rise-time step pulses which suffers reflectiou and transmission at the air-sample interface. A schematic build-up of the multiple reflection pattern is shown in Fig. 2. The pulse from the step generator passes through the sampler where it is detected aud shown as step 'A' in the figure. As this incident pulse reaches the air-sample interface, a part of it gets reflected and is detected in the sampler producing another signal marked 'B'. The transmitted part travels through the length of the same to the other end of the coaxial line which may be terminated in (a) open-circuit (b) short-circuit and (c) 50 ohm impedance. In open-circuit termination the pulse is reflected back in phase. This pulse again suffers reflection and transmission at the sample-air interface. The transmitted part is detected in the sampler producing another signal marked 'C'. These multiple reflections continue till the entire energy gets absorbed at the sampler. The shapes of the pulse, when the coaxial line is terminated in short-circuit and 50 ohm impedance, are also shown in Fig. 2.

Let U(t) and V(t) represent the input and output functions and H(t) represent the time response of the system. Mathematically the relation between V(t) and U(t) is given by the convolution integral:

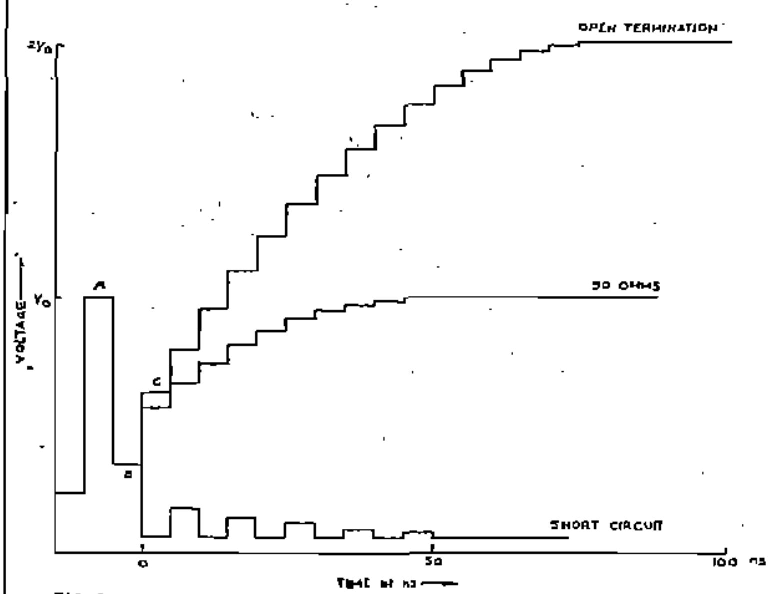


FIG.2.

$$V(t) = \int_{-\infty}^{t} U(t-t')\ H(t')\ dt' \qquad \ldots \quad (1)$$

In frequency domain the above expression can be written as

$$V(f) = S_{11}\ (f)\ U(f) \qquad \ldots \quad (2)$$

where V(f) and U(f) are the Fourier transforms of V(t) and U(t) respectively and $S_{11}(f)$ is the total reflection coefficient. The relation between total reflection coefficient and the complex dielectric permittivity (ϵ^*) can be obtained from transmission line theory and is given as:

$$S_{11} = \rho\ \frac{1-\exp\ [-(2jwd/c)\ \sqrt{\epsilon^*}]}{1-(\rho^*)\ 2\ \exp\ [-(2jwd/c)\ \sqrt{\epsilon^*}]} \qquad \ldots \quad (3)$$

where $\rho^* = \dfrac{1-\sqrt{\epsilon^*}}{1+\sqrt{\epsilon^*}}$; $\epsilon^* = \epsilon' - j\ \epsilon''$.

'd' is the length of the sample, 'ω' is the angular frequency, (c) is the velocity of light, ρ^* is the reflection coefficient, ϵ' is the relative dielectric constant and ϵ'' is the relative loss factor.

The recorded wave forms were digitized and Fourier transformation of the data we performed using Samulon's formula for descrete Fourier transformation. The complex permittivity values were obtained from equation 3 using Newton-Raphson's iterative algorithm[5]. These mathematical operations were performed by a computer programme in FORTRAN-IV language using H.P. 21-MX series computer in the Department of Biophysics, AIIMS, New Delhi.

RESULTS AND DISCUSSION

Figs. 3, 4 and 5 show the relative permittivities and relative loss factors plotted against frequency for solvent (alcohol), mother tincture solutions for

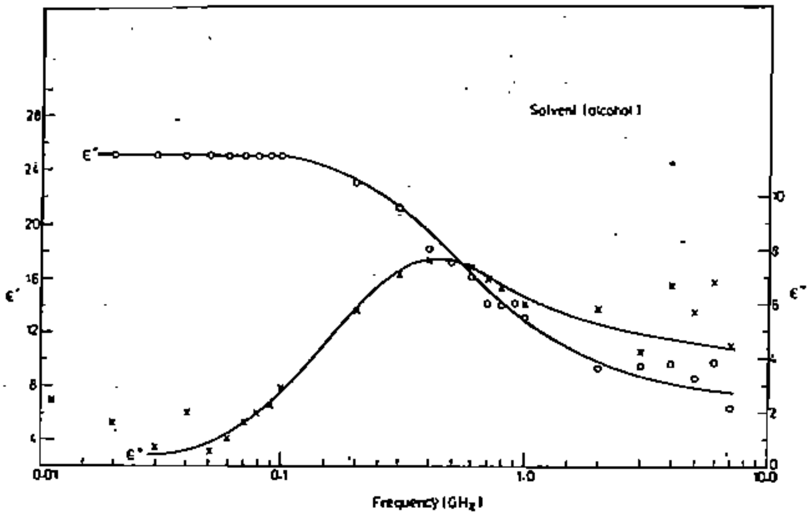


FIG. 3

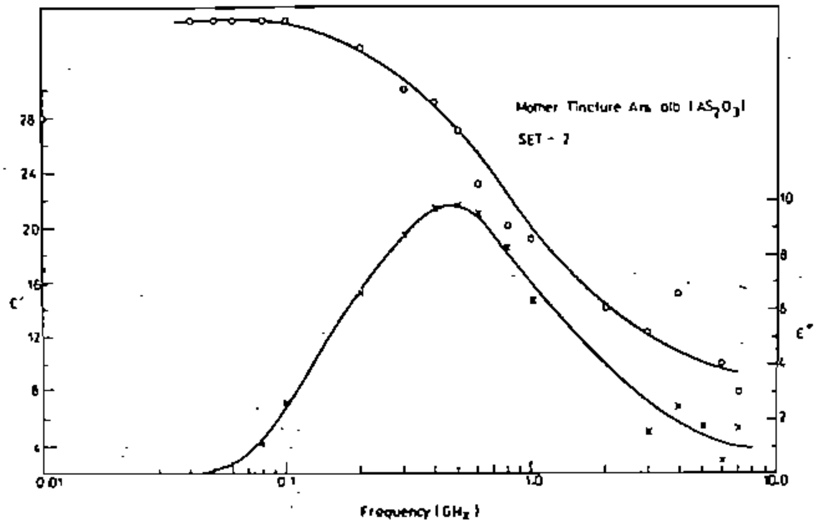


FIG. 4

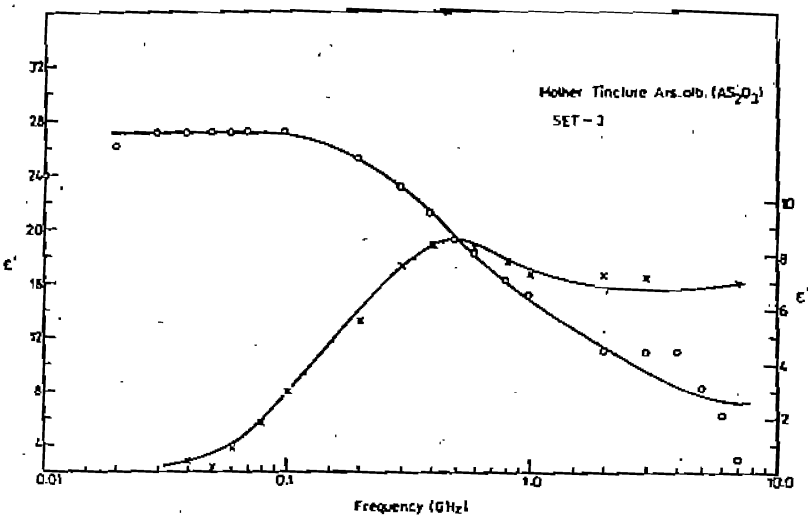


FIG. 5.

set 2 and 3 respectively. Fig. 11 shows the area under the curve (reflected) pulse from the sample with respect to serial dilutions of lactose solution. The per cent change in dielectric constant (ε') with respect to the serial dilutions of Ars. alb. (As_2O_3) at 0.1072×10^9 Hz. is shown in Fig. 6. Fig. 7

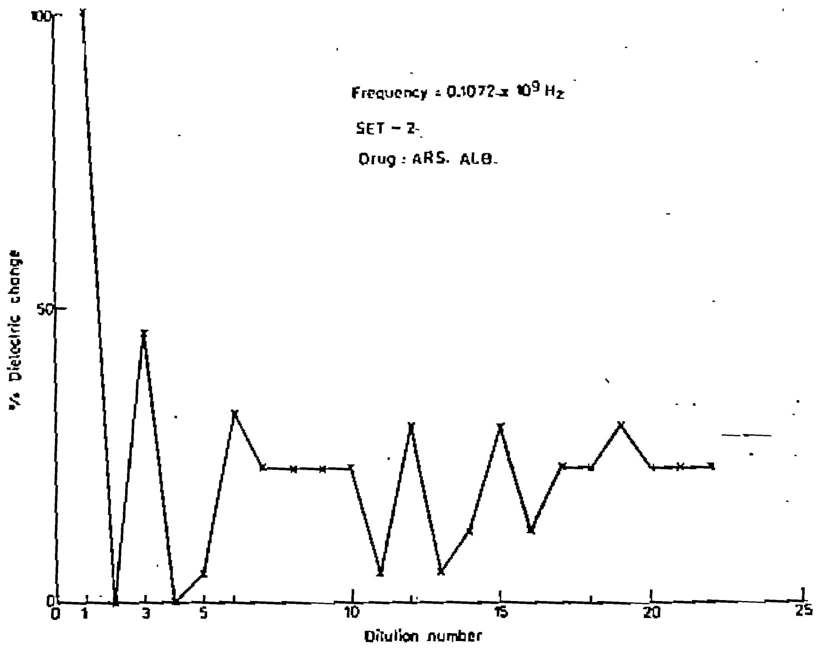


FIG. 6.

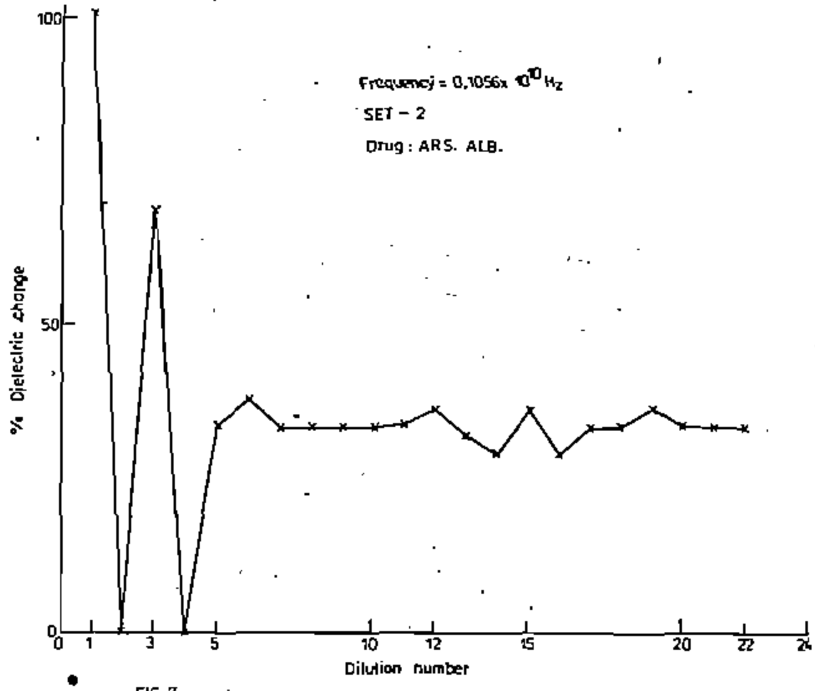
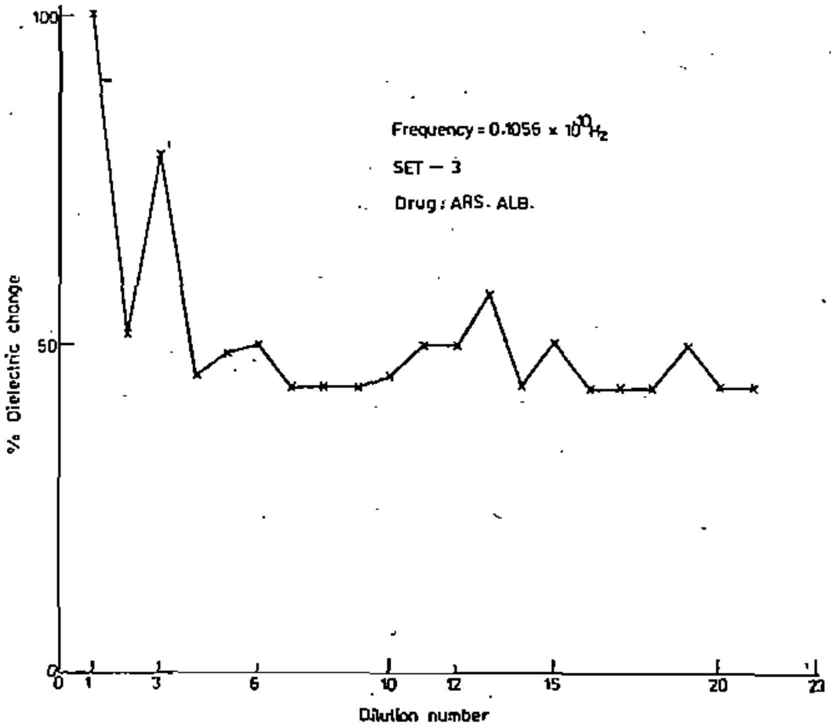
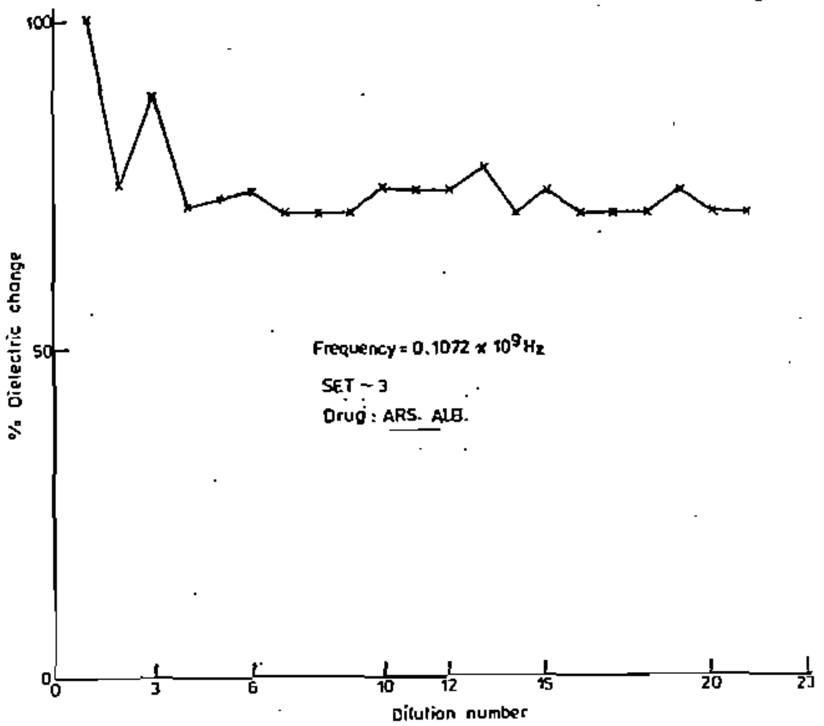


FIG. 7.

depicts the per cent change of dielectric constant with respect to serial dilutions of the same drug (Ars. alb.) at 0.1056×10^{10} Hz. Figs. 8 and 9 show this *per cent change of dielectric constant* in case of serial dilutions of the same drug at 0.1056×10^{10} Hz. and 0.1072×10^{9} Hz. In Fig. 10, we have plotted the area under the ourve (reflected pulse from the sample) with respect to serial dilutions of Euphrasia. In this Figure also we observe the same type of fluctuations of dielectric permittivity with respect to the serial dilutions of the drug.

Values of ϵ' and ϵ'' for frequencies between 0.01 and 6 GHz show marked differences between those relating to the mother tincture of Arsenic album (Figs. 4 and 5) and the solvent (Fig. 3). When the dispersion of dielectric constant at 0.1056×10^{9} Hz. is plotted against dilutions of Arsenic album as described, following phenomena are noted: (a) Sharp fall in the dielectric constant at second dilution and a rise on third dilution at both frequencies, but not similar. This reflects a change in dielectric permittivity which may be an indication of micellisation induced by succussion given when the first second and third dilutions are made and indicate phase changes induced by solvophobic forces; (b) later changes occur which are different for different frequencies. One could see whole variation as abnormal as one can take a stranger view that the variations after third dilution are due to experimental variation. Then the first three dilutions show statistically a


Frequency = 0.1056 × 10^10 Hz
SET — 3
Drug : ARS. ALB.
% Dielectric change
Dilution number
100
50
0
0
1
3
6
10
12
15
20
23
FIG. 8.


Frequency = 0.1072 × 10^9 Hz
SET — 3
Drug : ARS. ALB.
% Dielectric change
Dilution number
100
50
0
0
3
6
10
12
15
20
23
FIG. 9.

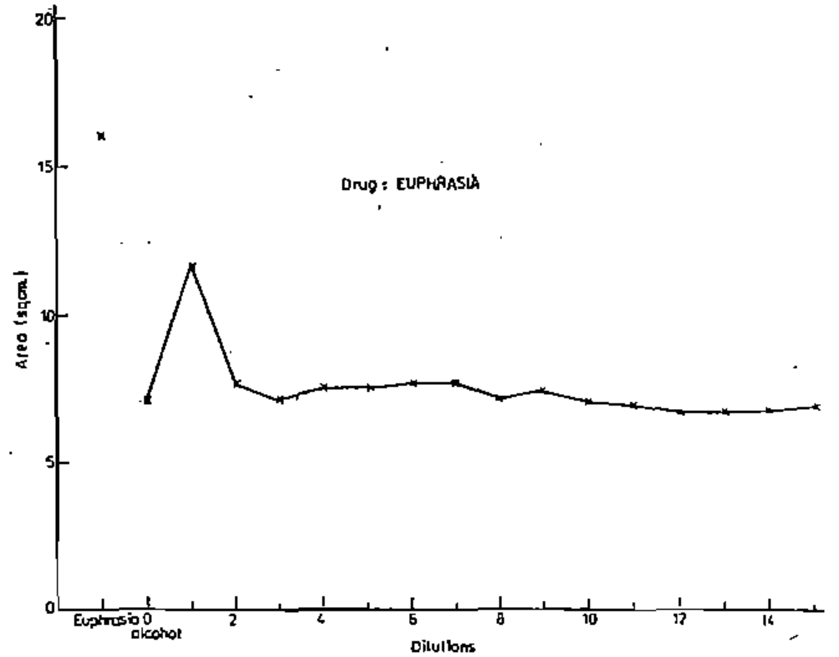


FIG.10.

significant and anomalous behaviour, and indicate variations in size of aggregations and dielectric properties which may imply alteration in the bulk properties of the solutions.

In case of set 2 at Fig. 6 the Standard Deviation (SD) of the readings corresponding to 5th to 22nd dilutions of Arsenic alb. equals to 8.67 and Standard Error (SE) equals to 2.04. This clearly indicates that the first three points in this figure are definitely significant with a similar view with respect to the rest of data points, which are considered here as random fluctuations because of experimental error. Also in Fig. 7 the S.D. and S.E. of the 5th to 22nd dilutions of the same drug are 2.29 and 0.539 respectively; and the readings for the first 4 serial dilutions of the drug are significant.

In case of set 3 (Fig. 8) the S.D. and S.E. are 4.04 and 0.957 respectively. In this figure also the readings of the first 3 dilutions are significant. In case of set 3 (Fig. 9) the S.D. and S.E. of readings corresponding to 4th to 21st serial dilutions for the same drug are 2.108 and 0.496 respectively and here also the readings corresponding to first 3 serial dilutions are significant. In case of lactose (Fig. 11), the S.D. and S.E. of first to 16th dilutions are equal to 0.07 and 0.02, which shows that there is no significant change in the dielectric property of this substance. Here it is interesting to note that there is no change in the dielectric property of lactose solution at 16th dilution which was given fifty succussions.

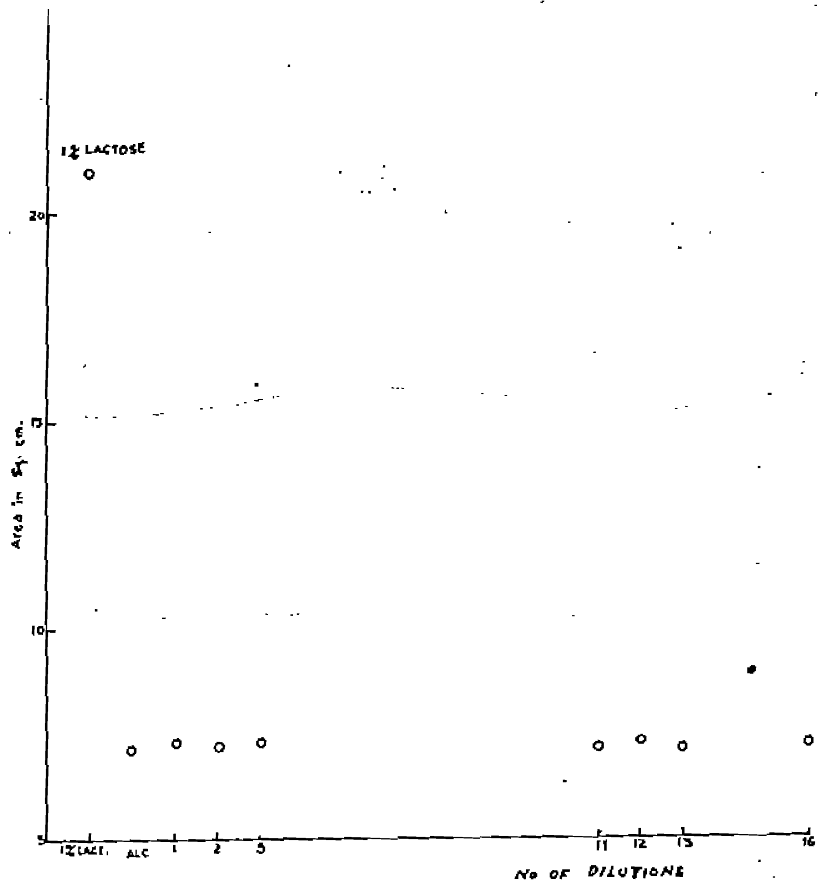


Fig. 11

A study of change in integral amount of variation in dielectric constant at various dilutions in Euphrasia compared with mother tincture of Euphrasia and alcohol also show marked variation and indicate a qualitative difference at first dilution. This organic compound increases the dielectric constant significantly at first dilution as compared with mother tincture at frequency of test, as expected. The values of S.D. and S.E. of the readings of serial dilutions from 3 to 15 are 0.335 and 0.10 and the readings of first and second dilutions are significant.

A proper quantitative evaluation of forces awaits further study.

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a privilege of a few top-flight physicians. Can it not be taken to the common homoeopaths? The clinical Homoeopathy in teaching institutions should be demonstrated in the hospital on these lines to preserve the excellent medical science without extinction.

The bridegroom may forget the bride,
Was made his wedded wife yestereen;
The monarch may forget the crown,
That on his head an hour has been;
The mother may forget the child,
That smiles so sweetly on her knee;
But I'ld remember thee Hahnemann,
And all that thou hast done for me.

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