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ORIGINAL PAPER

Effect of dielectric dispersion on potentised homeopathic medicines

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Background: **This paper reports dielectric dispersion occurring in potentised homeopathic medicines subjected to variable frequency electric field using an instrumentation method developed by the authors. Oscillations occur in the direction of electric field, and are usually termed longitudinal/acoustic-mode vibrations.**
Methods: **The test material was lactose soaked with homeopathic medicine. Multiple resonance frequencies, forming a frequency-set, were observed repeatedly for each medicine.**
Results: **We report experimental results for three potencies of *Cuprum metallicum* (*Cuprum met*) in the frequency range of 100 kHz–1 MHz. Each exhibits a set of resonance frequencies, which may be termed as its characteristic set. As the frequency-set of each medicine is different from those of others, each medicine may, therefore, be identified by its characteristic frequency-set. This suggests that potentised homeopathic medicines, which are chemically identical with the vehicle, differ from one another in the arrangement of vehicle molecules.** *Homeopathy* (2009) **99**, 99–103.

Keywords: Instrumentation; Dielectric Dispersion; Potentised; Homeopathic medicines

Introduction

No atom or molecule of the original medicinal substance can remain in a homeopathic medicine potentised above 12c, which corresponds to the Avogadro limit (6.022×10^{23}). This leads to the most puzzling question of homeopathy: wherein lies their medicinal value? This question may be handled in two steps: Logical necessities with theoretical analysis and experimental verification.

With respect to the first question we note from different sources that (i) At room temperature ordinary water contains innumerable tiny ice crystals.[1–3] (ii) The forms of these crystals are so varied in number that practically no two are identical.[2] (iii) The shape and size of these molecular clusters are influenced by impurities, ions of other substances and foreign molecules.[2,4] This means that as a potentising vehicle water might contain a large number of coded structures in its hydrogen-bonded network. So, based on the arguments put forward in[5,6] the conclusion is: "*the medicinal value of a potentised homeopathic medicine owes its origin not to chemical presence of the original substance with which shock-dilution starts but to structural modification of the atoms/molecules of the vehicle and creating specific type of macromolecules peculiar to the original substance as well as the degree of dilution carried over*".[7]

Davenas *et al*[8] state that "*water could act as a template for the molecule, for example, by an infinite hydrogen-bonded network, or electric and magnetic fields. At present we can only speculate on the nature of the specific activity present in the highly diluted solutions. ...The precise nature of the phenomenon remains unexplained*". We believe that it is not water template or memory in the usual sense. It is actually induced ordering of molecules of the vehicle.

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But, in essence, this is not incompatible with the 'water memory' concept as stated in.[9] Some important and related views are discussed below.

A concept of 'water polymer' was proposed by Barnard in.[10] He stated that a large number of water molecules can form a long molecular chain, which may be called a water polymer. When solvent molecules dissolve an intruding solute molecule all the water molecules are locked into a particular spatial configuration to form a stereoscopic water polymer entirely characterized by the solute molecule. Then, at each stage of dilution plus succussion self-replication of polymers becomes a feasible proposition.

The term 'induced structural modifications' is used by Mahata in.[11] According to him, *"In the initial stages of dilution only a small percentage of the original medicine will be present in the vehicle and they will produce a specific type of distortion of the hydrogen bonds leading to a specified number of molecules of the vehicle forming a macromolecule. As further dilution is continued these macromolecules... in their turn produce another but related kind of distortion in the hydrogen bonds leading to another but related group of macromolecules. Continuing the dilution process in this way, one gets different macromolecular arrangements in the vehicle for different potencies... These macromolecules may be said to form a family"*.

Chaplin states that *"The 'memory of water' is a concept by which the properties of an aqueous preparation are held to depend on the previous history of the sample. ... There is strong evidence concerning many ways in which the mechanism of this 'memory' may come about"*.[9] His overview demonstrates that, at a simple level, water memory effects do exist. But this is far from proving that they have the features (such as the specificity to 'remember' individually all of the large number of substances used as the bases for homeopathic medicines), which would be required to account for the claimed effects of homeopathy.

Thomas[12] talks of 'digital biology', claiming successful transfer of specific molecular signals to sensitive biological systems and recording, digitizing and replaying these signals using a multimedia computer. From a physical and chemical perspective, these experiments pose a riddle.

Related theoretical publications[13–15] discuss the possible role of active oxygen in the memory of water, the silica hypothesis for homeopathy and the octave potencies convention – a mathematical model of dilution and succussion. Another paper[16] discusses the nature of the active ingredient of homeopathic ultramolecular dilutions in terms of Quantum Physics. Some experimental studies also seem to support the concept of water memory, based on various different methods: the Raman Effect,[17] Ultraviolet–Visible (UV–VIS) spectroscopy,[18] low-temperature thermoluminescence effect and uses well-established physicochemical techniques: flux calorimetry, conductometry, pH-metry and galvanic cell electrodes potential.[19] Chaplin[20] comments that *"...the main evidence against water having a memory is that of the very short lifetime of hydrogen bonds between the water molecules"*. But he adds that *"the lifetime of hydrogen bonds does not control the lifetime of clusters ...but with its molecular content continuously changing"*.

Dielectric Dispersion is described in detail below. Information on size of ordered molecular groups can be obtained from data on their dielectric dispersion. For example, a method has been described to calculate the dielectric dispersion of a solution of globular protein molecules.[21] The protein molecule is considered to have spherical symmetry and the charged residues are thought to be situated in a medium whose dielectric constant increases continuously as a function of the distance from the centre of mass. An automated measurement system, based on a lock-in amplifier, has been developed to expedite the dielectric response of ice.[22] Large scale atomistic molecular dynamics simulations have been employed to investigate the dielectric relaxation of water molecules in an aqueous micellar solution of cesium pentadecafluorooctanoate.[23] These simulations show the presence of a slow component in the moment–moment time correlation function of water molecules.

There are research publications dealing with dielectric dispersion effects in the different types of organic and inorganic materials but not for potentised homeopathic medicines. We have previously applied this technique to potentised homeopathic medicines.[7,24]

Theoretical analysis and its consequences

Dielectric dispersion is the dependence of the permittivity of a dielectric material on the frequency of applied electric field. The phenomenon of dielectric dispersion in its simplest form can be explained by taking a finite linear chain of identical lattice atoms as shown in Figure 1. According to the Lorentz model, the atoms (each of mass m and charge q) are considered to be connected by (conceptual) springs.

They can be forced to oscillate in an alternating electric field producing alternating dipoles. Their motion is affected by friction as a damping force. The equation of motion becomes,

$$(d^2\delta/dt^2) + \gamma(d\delta/dt) + \omega_p^2\delta = (q/m)E \qquad (1)$$

where δ is the displacement of an oscillator atom, γ is the damping coefficient and ω_p is the natural frequency for chain of atoms. If E is an alternating electric field incident on the material, then the solution of the above equation becomes,

$$\vec{\delta} = \frac{q}{m}\cdot\frac{\vec{E}}{\left(\omega_p^2 - \omega^2\right) + j\gamma\omega} \qquad (2)$$

This charge-displacement will produce dipole moment, which is given by the product of charge and displacement.

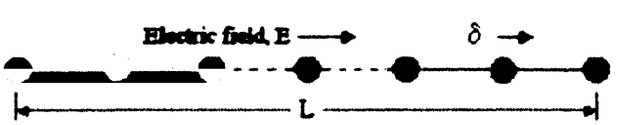

Figure 1 Linear chain of identical atoms.

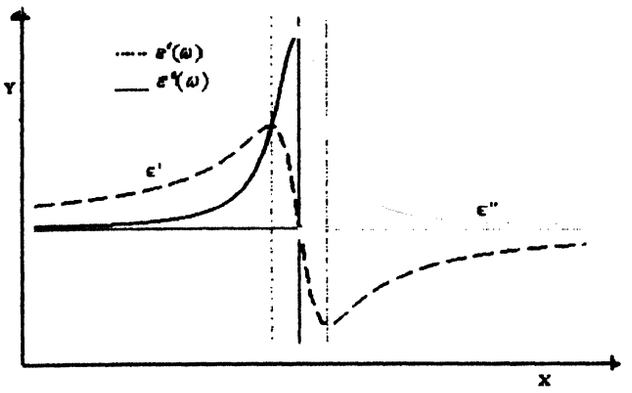

Figure 2 Plot of ε' and ε'' (along *y*-axis) as a function of frequency (along *x*-axis).

Hence the total dipole moment of the chain consisting of N atoms is,

$$\vec{P}(\omega) = \sum_{n=1}^{N} q\vec{\delta} = \left[\frac{q^2}{m}\cdot\frac{1}{\left(\omega_p^2 - \omega^2\right) + j\gamma\omega}\right]\cdot\sum_{n=1}^{N} E_n$$

Here, E_n = electric field on the nth atom. Now, the total dipole moment is related to dielectric function as $\varepsilon(\omega)$ $E = \varepsilon_0 E + P(\omega)$. Here, $\varepsilon(\omega)$ is the complex dielectric function of medium and ε_0 is dielectric constant of the vacuum. Finally we get, $\varepsilon'(\omega) = \varepsilon_0 + (q^2)/(m)\cdot(\omega_p^2 - \omega^2)/((\omega_p^2 - \omega^2)^2 + (\gamma^2\omega^2))$ and $\varepsilon''(\omega) = (q^2)/(m)\cdot(\gamma\omega)/((\omega_p^2 - \omega^2)^2 + (\gamma^2\omega^2))$ as the real and imaginary parts of the complex dielectric function respectively.

For natural frequencies of vibration the length of chain, L is integral multiples of the half-wavelength, $\lambda/2$. The wavelength, λ and frequency, f_0 $(\omega_p/2\pi)$ are related by $\lambda f_0 = c$ = velocity of sound in the media.[25] The electric field is assumed to be time harmonic with frequency ω. Plot of ε' and ε'' (along *y*-axis) as a function of frequency (along *x*-axis) is given in Figure 2. This indicates sharp change of dielectric function of ordered molecular group around the resonance frequency.

The implication of this analysis is: For a linear chain we may have only one fundamental resonance frequency related to its length and velocity of sound in the chain, but for a three dimensional case there will be multiple resonance frequencies forming a frequency-set related to its shape and size. Around each resonance there will be abrupt change of the dielectric function, which is electrically detectable. In other words, an ordered molecular group will be identifiable through the frequency-set detected. Here, the major focus of attention is on these frequency-sets and not on the actual value of the dielectric constant or its derivative with respect to frequency. A medicine will be identifiable, according to this principle, through its characteristic frequency-set.

Experimental arrangement

The principle of the experiment is, if a capacitor, formed with a dielectric material of some kind of ordered molecular group like potentised homeopathic medicine, is excited by a variable frequency alternating electric field, then the current drawn from a constant voltage source by such a capacitor will undergo sharp changes around the resonance frequencies of the ordered molecular group. A block diagram of the experimental arrangement is shown in Figure 3(a). The signal generator used here is Agilent model-8648A having frequency stability better than 1 ppm, a frequency range of 100 kHz–1 GHz and minimum step of frequency variation of 1 mHz. It is interfaced through General Purpose Interface Bus (GPIB) with a Personal Computer (PC) running Agilent-developed VEE Pro software. A user-friendly graphic display is obtained on the PC-screen. The same PC also controls the Agilent Data Acquisition Unit, model 34970A, through another GPIB bus. The sensing block, differential amplifier and the processing circuit are locally fabricated and are as described below.

The Sensing Block comprises of a pair of capacitors. One contains the sample as its dielectric material, which is prepared by soaking powdered lactose with potentised medicine in liquid form (made by M/s Hahnemann Publishing Co., Calcutta) plus distilled water in the ratio of 1:10 and subsequently dried at room temperature. This is called the test or sample cell. The other cell contains lactose soaked with only distilled water and dried up at room temperature. This is called the reference cell. Powdered lactose is used for two reasons: Firstly, a solid substance is easier to handle as a dielectric. Secondly, it is the standard medium for homeopathic medicines from Hahnemann's time. The two outputs of the sensing block are fed to a Differential

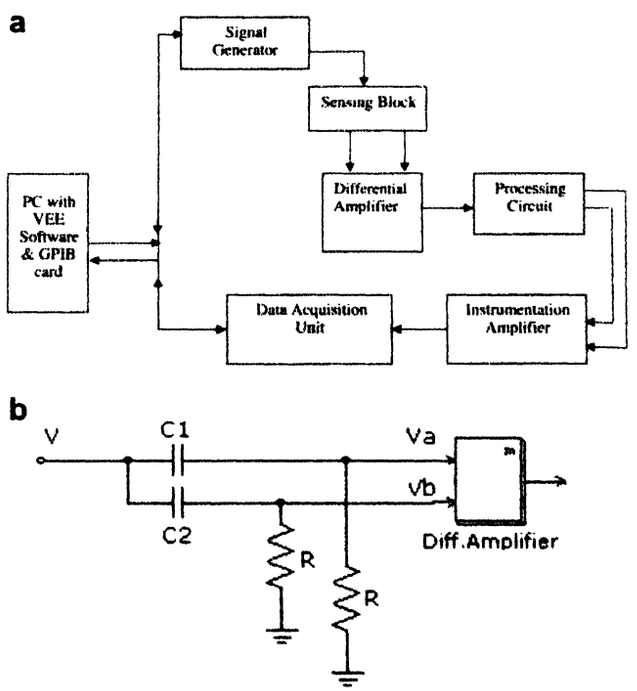

Figure 3 (a) Block diagram of the experimental arrangement. (b) Sending Block V = variable freq. A.C. excitation; C1 = sample cell containing medicine = soaked lactose as its dielectric; C2 = reference cell containing un-medicated lactose as its dielectric; Va and Vb are useful signals fed to differential amplifier.

Table 1 Experimental Results for *Cuprum met*

Sample/potency	*Test conditions*	*Signal frequency (KHz)*		
		Sample-1	*Sample-2*	*Sample-3*
Cuprum met 30	Excitation Signal: −3.1 dB, Sinusoidal.	172.6	174.1	173.3
	Frequency step: 50 Hz.	224.1	223.7	x
	Data scanning rate: 50 ms.	403.5	403.7	404.2
	Test temperature: 25°C	465.0	464.6	465.3
		658.8	659.5	660.1
		741.8	741.6	742.0
		756.3	757.8	x
Cuprum met 200		246.5	247.8	247.6
		329.0	329.1	329.7
		544.8	545.2	545.0
		619.5	619.5	620.0
		724.5	724.7	725.2
		914.3	915.0	x
Cuprum met 1000		571.5	572.0	572.3
		883.6	884.0	883.8

Amplifier using AD8009 Integrated Circuit (IC) chip. This arrangement continuously compares the output of the test or sample cell with that of reference cell used as a control. The sensing block used in the experiment is shown as Figure 3(b).

The Processing circuit comprises of a three stages A.C. amplifier, an analog multiplier, two passive low pass filters and a two-input instrumentation amplifier. A D.C. amplifier is there for increasing the overall gain of the system and serving as a buffer between the instrumentation amplifier and the Data Acquisition unit following it. The circuit as a whole amplifies the weak output of the differential amplifier, improves the signal to noise ratio and gives the final output as a D.C. voltage, which is fed to the Data Acquisition unit. The IC chips AD8009, AD834 and AD524 used for the processing circuit are all manufactured by M/s Analog Devices. The frequency range for the investigations reported in this work is 100 kHz–1 MHz.

Results

To date we have conducted experimental investigations with (a) the reference material, (b) three standard potencies of *Sulphur*: 30c, 200c, 1 M and (c) three standard potencies of *Phosphorus*, 30c, 200c, 1 M and (d) three standard potencies of *Cuprum metallicum* (*Cuprum met*), 30c, 200c, 1 M. Results of (a) (b) and (c) are available in ref.[7,24] Results for (d) are shown in Table 1. Three separate sample cells are prepared for each medicine. The sample cell and the reference cell were placed in the sensing block described above. Molecular presence of copper is totally ruled out for all these potencies. Hence, whatever results are obtained here must be due to change in molecular ordering of lactose caused by ordered molecular groups of the vehicle of potentisation, water. An illustrative peak generated due to the dispersion effect detected by the instrumentation for *Cuprum met* 30 is shown in Figure 4.

Table 1 shows multiple resonance frequencies for each medicine. The essential concept is dielectric dispersion as described in Section 2 for a linear chain of identical atoms. But the actual structure is three dimensional one, consequently, we expect multiple resonance or characteristic frequencies. Thus, 172.6, 224.1, 403.5, 465.0, 658.8, 741.8 and 756.3 kHz represent such 'characteristic frequencies' for one particular sample of *Cuprum met* 30. We found that the frequency-set changes from sample to sample of

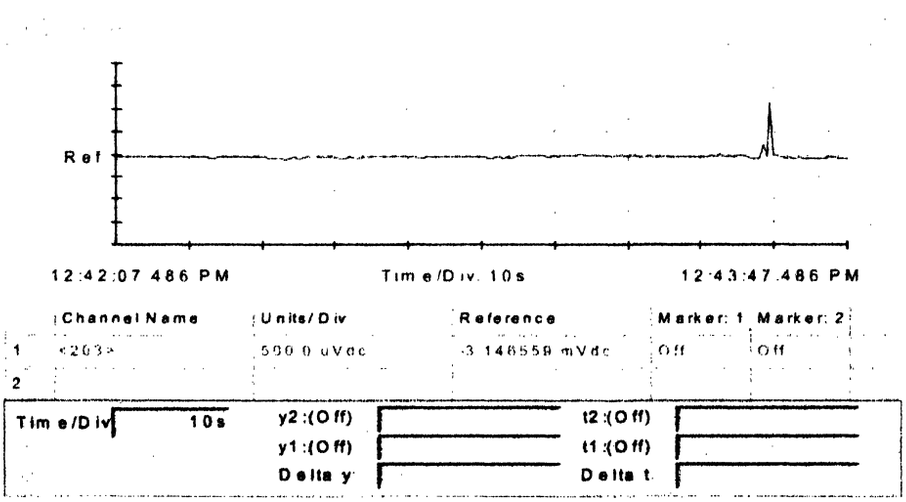

Figure 4 One illustrative peak recorded by Data Acquisition unit.

same medicine and of same potency. Taking a particular frequency, say, 403.5 kHz it changed to 403.7 kHz with the second sample and to 404.2 kHz with the third sample. For standardization possibly we should work with a mean value. But, it must again be stressed that not a single frequency but a 'frequency-set' is required for identification of a medicine. These are indicative of actually induced ordering of molecules of the vehicle.

MATLAB simulation

We conducted a simulation using MATLAB software determine the frequency response of current drawn by a capacitor whose dielectric function is represented by the equation

$$\varepsilon(\omega) = \varepsilon'(\omega) + j\varepsilon''(\omega)$$

where,

$\varepsilon'(\omega) = \varepsilon_0 + (Nq^2)/(m).(\omega_0^2 - \omega^2)/((\omega_0^2 - \omega^2)^2 + (\gamma^2\omega^2))$

and $\varepsilon''(\omega) = (Nq^2)/(m).(\gamma\omega)/((\omega_0^2 - \omega^2)^2 + (\gamma^2\omega^2))$

The simulation result given in Figure 5 shows a sharp change of output at frequency of resonance.

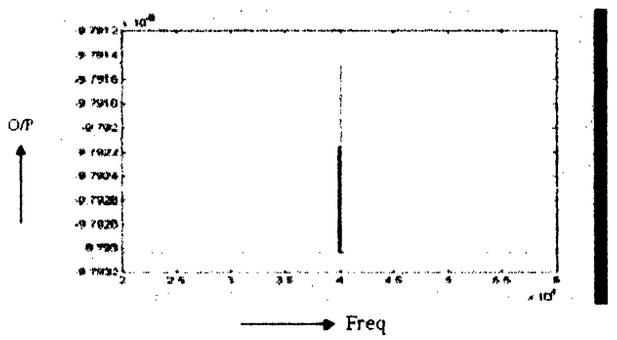

Figure 5 Simulation result showing a sharp change of output at the resonant frequency.

Conclusions

The investigation reported here concerns dilutions where chemical presence of the original substance (with which potentisation starts) is ruled out. We have demonstrated that both medicine and potency factors cause changes in the frequencies of anomalous dielectric dispersion of the vehicle. The effects are observed repeatedly. Dispersion effects and current measurements show differences between same medicine of different potencies or different medicines of same potency, due to vehicle-molecule structure. This technique may be useful in identifying homeopathic medicines.

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