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Water in Health, Disease and Power Generation: From Literature to Hypotheses

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Abstract

Water not only plays a very important role in sustaining our lives through routine matters like drinking, cooking, washing, bathing, agricultural work, etc, but, when properly treated, may also play the role of healer or curative agent, though this is not explainable by conventional science. Electrical power can also be generated from water. This paper searches for the properties behind these aspects of water. The putative curative power of water seems to be manifested through its allotrope-like (allotrope means "different physical forms having the same chemical composition") forms left induced by solutes in aqueous dilutions followed by succussion. Quantum Electrodynamics (QED) is adopted here as a tool for explaining these puzzling phenomena. In the process, an amazing specialty of water — electric power generation from it, seemingly with great technological promise — is also explained. Experimental investigations conducted by a number of researchers support the outcomes. This article will be relevant to medicine, biology, and electric power generation.

Introduction

This article aims to support the fact that water influences our lives in many ways, like preservation of health, health recovery and electric power generation. Water is an essential item in our day-to-day lives — essential for sustenance of life. Some specialties of water are blessings to life. Sea water is saline and unfit for drinking — but melted ice is always salt-free and drinkable (Sergeev, 1973). This is because salts do not fit within the hollows of the lattice structure (a regular repeated three-dimensional arrangement of atoms, ions or molecules) of ice — and, thus, the salts dissolved in water are expelled while water freezes to ice. This property of water is utilized in cold countries to acquire salt by freezing sea water. Thus, salt is obtained as a residue either by freezing or evaporating sea water. This specialty of water helps human beings in both warm and cold climates.

Inorganic molecules do not structurally fit within ice and their large molecules (dissolved in water) get crushed and expelled from ice (Sergeev, 1973) — but organic molecules are not damaged by water when it freezes. This is why we can preserve food items like vegetables, meat, fish, etc in refrigerators. Water is a life-preserving substance for us.

When liquid water solidifies to ice it becomes lighter and floats in it, unlike other liquids whose solid forms are heavier and sink in their liquid forms. Furthermore, ice

is not a good conductor of heat or electricity. As such, we find frozen ice over liquid water. Water, having a maximum density at 4°C, moves to the bottom with oxygen dissolved in it. This sustains aquatic animals in the polar region. The ice cover, so to speak, protects the aquatic animals. Their lives benefit from the forms of water both in summer and winter. Here, water acts as a preserver of aquatic life. Water has the highest value of specific heat — the highest amount of heat required to raise the temperature by 1°C as compared to other substances. It means that water has the highest heat storing capacity. So, in solar heaters water becomes the natural choice for heat storage.

Often in explaining something as very easy, we say that it is as clear as water, devoid of any complexity. Chemically, water is a very simple substance — just H_2O. Still, it is a very puzzling substance. One of the most incomprehensible natures of water is reflected in its putative medicinal value. "Let water serve as medicine for you," this is the translation of a Rigvedic verse (Rig Veda, year unknown). We do not know how our ancient sages came to this conclusion, but we must accept that appreciation of a possible medicinal value of water started from the time of Rig Veda — assumed to be composed nearly 4000 years ago. We observe with wonder that modern science is now approaching this concept. It is discussed below in the context of high potency homeopathic medicines, which are chemically — but not physically — equivalent to plain water.

Extremely diluted homeopathic medicines are chemically nothing but water. Even so, they cure diseases implying that they have medicinal values. However, how can we explain the potential medicinal value of water? People of this century are not ready to accept Vedic statements indiscriminately. They want scientific proof. As such, the problem for us is whether water can carry any information about the solute dissolved in it that may even be subsequently diluted away. What is the theory behind it? Is it validated experimentally?

A lot of research on water has already been carried out (Chaplin, 2020) as listed in a website on water structure and science. It lists more than 4800 references on water. As of September 2, 2020, this website has 309 web pages, 4,838 references, >30,000 links, >320,000 words, >1,500 images, and >120 3-D visualization and animation files. It enlists 75 anomalous properties of water. Some of them are very intimately connected with life and its sustenance, which we stated at the start of this section. Yet, the functions and structure of water are not fully understood. So, research on water continues.

In this context, our next focus of attention is how extremely diluted homeopathic preparations, that are chemically equivalent to water, can become medicines. For this, the methodology adopted by us comprises three steps: (i) Logical necessities for water to carry the therapeutic value in high dilutions, (ii) Development of a theory, (iii) Validation of the theory by planned experiments. If water is understood, then homeopathy will also be understood. It is addressed in the next two sections dealing with its physical properties — **Theory of Aqueous Dilution** and **Experimental Methodology used by different authors**.

That electrical energy can be extracted from water is a recent finding that is explainable by Quantum Electrodynamics (QED)theory (Del Giudice, 2012). It is taken up in the section on **Electrical property study**.

Theory of Aqueous Dilution

Here we present the essence of QED pertaining to how we can have solute-specific structures of water in aqueous dilutions. Firstly, we note that as per QED, at a temperature below a critical value, an ensemble of a large number of water molecules can enter into a collective coherent oscillation between a pair of internal energy levels of its components, in tune with a non-vanishing electromagnetic field, density of water satisfying the requirement for this purpose (Del Giudice, 2012). Such an ensemble is called a Coherent Domain (CD). They could acquire energy from the environment but cannot release it thermally. Hence, they would have a long lifetime (Del Giudice, 2010).

Secondly, we note that the CDs would have a channel to release their acquired energy: through impurities or deliberately added "guest molecules" not exceeding one percent (Del Giudice, 2010). Allow E1 to be the unexcited energy level of a guest molecule and E2, another higher allowed energy level. One can deduce that, when a nearby water CD reaches the energy level E2 by absorbing energy from the environment, it resonantly transfers energy E = (E2-E1) to the guest molecule. In this process, the water CD would get de-excited by losing the same amount of energy and settling at energy level E1 — a level characterizing the guest molecules. The energy transfer

diagram will look like *Figure 1*.

This would be an information transfer (in terms of characteristic energy) from the "guest molecule" to the water CD. Subsequently, this guest molecule could lose the acquired energy thermally or otherwise and again participate in the energy transfer process. Participation of other guest molecules would also be possible. The oscillatory regime associated with CDs and guest molecules would allow the onset of a **coherence among coherence domains** that would tune together with the oscillations of single CDs under the influence of the environmental electromagnetic field (Konovalov *et al*. 2014). This would give us an extended coherence domain — a Dissipative Structure. Let us name it DS1.

In the next stage of succussed dilution, these dissipative structures (DS1) could act as "new guest molecules" and participate in energy transfer with the water CDs, where succussion is supposed to force the dissipative structures (DS) and CDs to come close to one another and thereby aid the energy transfer process. The allowed energy level of the new guest molecules might not be the same as E2. Let us call this E3. Let a water CD reach this energy level by absorbing energy from the environment, as described before. This water CD would then resonantly transfer energy (E3-E1) to the new guest molecule (DS1). So, in this next step of dilution and agitation, the CD would again settle at energy level E1 and form another group of dissipative structures (say, DS2) having another allowed energy level, say E4. The process would continue as long as the stepwise dilution and agitation (SDA) procedure is continued. So, the newly formed dissipative structures of every stage would bear the imprint of the original guest molecule through E1, while the energy levels E3, E4 etc. would allow some variation of structure through dilutions. Thus, it would be an information transfer along with some structural variations. The dissipative structures at different stages would, therefore, get somewhat altered, yet be solute-specific. We might also note that up to 12cH potency there would be two types of guest molecules — solute molecules and dissipative structures. Beyond 12cH, however, there would be only dissipative structures, and they would continue to carry out the process as before. Original solute molecules would not be necessary then. As such, the Avogadro limit would lose its relevance.

Furthermore, we have to keep in mind that when the starting material is a complex chemical compound, it will have different component parts having different allowed energy levels. It follows that each of them would enter into the energy transfer process with different water CDs, as outlined in *Figure 1*. After de-excitation, these CDs would have energy levels characterizing the component parts. In other words, energy-wise these CDs would represent the component parts of the starting material. Subsequently, these CDs would combine together to form a DS — energy-wise mimicking the starting material, leading to some kind of signalling process with the living systems.

Based on the above, we propose: *Succussed serial dilutions in water may carry information about the solute via solute-specific water structures.*

Experimental Methodologies used by Different Authors

Our experimental methodology proposal was as follows: prior to our arrival at the above hypothesis through QED, we took into consideration some hitherto ignored specialties of water (obtained empirically), such as the existence of innumerable tiny ice-like structures having no particular form floating in bulk water at room tempera-

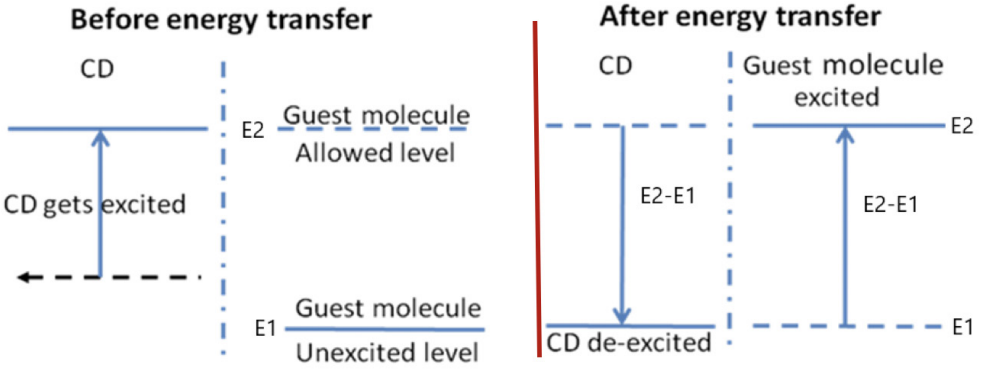

Figure 1. Energy transfer diagram.

ture and susceptible to influence of other substances (Finkelnburg, 1964; Sergeev, 1973; Ho 2017).

Indirect evidence of this concept was attempted from experiments using a Nuclear Magnetic Resonance (NMR) spectrometer and an Anomalous Dielectric Dispersion Detector (ADDD) — an instrument developed by us. Then, we tried to get the direct evidence from experiments using the Atomic Force Microscope (AFM) supported by QED theory. This is how we got indirect and direct evidence of this concept through our three-pronged experimental investigations using NMR spectrometer, ADDD and AFM in addition to Dynamic light scattering (DLS) study, Thermo-Luminescence effect, and Raman spectroscopy. Overall, we see a convergence towards the structural concept as explained hereafter. Let us view them one after another.

NMR study: Change of structure will be associated with change in bond strength, which, in its turn, will be associated with change of proton resonance frequency of bonds involving hydrogen (in ethanol of potentized homeo-medicines), which can be detected by an NMR instrument. We employed a 90 MHz Varian EM 390 NMR spectrometer for studying the frequency variation of CH_3, CH_2 and OH bonds of ethanol for this purpose. We carried out experiments with Sulphur and Aurum metallicum, both with potencies 30cH, 200cH and 1000cH prepared in ethanol (Mahata, 1983).

Dielectric Dispersion study: This technique detects the size of a molecular cluster of water in potentized medicines through its resonance frequency, when subjected to an electric field. Then, the size is calculated from the equation

$$Resonance\ freq = \frac{velocity\ of\ sound\ in\ the\ medium}{2 \times (Length\ of\ the\ cluster)}$$

[This equation is for a linear chain of identical atoms. Even so, it represents the basic idea.]

Medicines studied with this technique were *Arnica montana* and *Anacardium orientale*, each of potencies 30cH and 200cH (Mahata, 2012) and Cuprum metallicum and Graphites of potencies 6cH and 30cH (Mahata, 2013).

AFM study: We turned to the method of Atomic Force Microscopy (AFM) study for getting photographs of the solid structures, left after evaporation of liquid samples — potentized medicines with extra in situ dilution with distilled water. Such structures, called Dissipative Structures (DS), are predicted by QED. The permanence of these structures (Elia *et al*. 2014) made experimental verification quite simple. Just evaporate one drop of the sample onto a glass slide and get its AFM image. Here we used the Bruker multimode 8 Scanning Probe Microscope (SPM). The medicines were Silicea, Cuprum Metallicum, and Natrum Muriaticum, all of potencies 6cH and 30cH (Maity *et al*. 2019; Maity *et al*. 2021).

Furthermore, we found a review article (Elia *et al*. 2015) that asserts experimental evidence of DS of tremendous persistence (surviving even drying or lyophilization) in liquid water induced by low-energy physical perturbation (succussion). The assertion has the theoretical support of QED coherent calculations (Del Giudice *et al*. 1988; Arani *et al*. 1995). The review article also mentions that at room temperature liquid water is a mixture of coherent (coherence domain — CD) and incoherent water. However, theoretical justification for the specificity of the DS to the starting material is not addressed here, which we have done in the section on **Theory of Aqueous Dilution**.

Dynamic light scattering (DLS) study: It is available as a tool for studying water structures formed in dilute aqueous solutions. Hundreds of compounds are studied by AI Konovlov and his group using this tool (Konovalov, 2012; Konovalov, 2013). He found nanosized (up to 400 nm) molecular ensembles in highly diluted water solutions (HDWS) of Biologically Active Compounds under the influence of two effectors: solutes and external (natural) electromagnetic fields and that consist of water molecules mainly (up to 500 million). He calls them as nanoassociates, found to form from dilution of 10^6 onwards. Seemingly, they are material carriers of HDWS bioeffects.

A group led by Papiya Nandy tried to find an empirical relation between the size of nanoparticles and potency for five medicines of three potencies (Kar *et al*. 2015). The relation had the form $y=ax^{\wedge n}$, where *y* stands for size of nanoparticle, *x* for potency and *a* and *n* are variables specific to the medicine. The relations had a good match with the data obtained by using field emission scanning electron microscope (FESEM), dynamic light scattering (DLS), and high-resolution transmission electron microscope (HRTEM). The medicines were Cuprum metallicum, Zincum Oxydatum, *Aurum Metallicum*, Ferrum Metallicum and *Aconitum napellus*. The potencies chosen were 6cH, 30cH and 200cH.

Thermo-luminescence study: Louis Rey used the thermo-luminescence technique to study the effect of a di-

luted-away solute in an aqueous solution. In this technique, the material is "activated" by irradiation at low temperature, with UV, X-rays, electron beams, or other high-energy subatomic particles. This causes electrons to come loose from the atoms and molecules, creating "electron-hole pairs" that become separated and trapped at different energy levels. Then, when the irradiated material is warmed up, it releases the absorbed energy as the trapped electrons and holes come together and recombine. This causes the release of a characteristic glow of light, peaking at different temperatures depending on the magnitude of the separation between electron and hole (Rey, 2003).

Rey dissolved lithium chloride (LiCl) in water and diluted it in steps of one hundred-fold with vigorous stirring as in the preparation of homeopathic remedies to a concentration of 10^{-30} gm per centilitre (Rey, 2003). He compared it with a control that was diluted in the same way without any dissolved solute. The samples were then frozen and activated with irradiation. The thermo-luminescent glow was reduced, indicating that the effect of LiCl persisted even in this dilution. Rey's work suggests that a solute can modify the hydrogen-bonded network of water and that this modification remains even when the solute molecules have been diluted away.

Raman spectroscopy study of potentized medicines (Sarkar *et al*. 2016) shows intensity variations in stretching bands of CH and OH groups of potentized substances, Sulphur and Natrum muriaticum in three dilutions — 30cH, 200cH and 1000cH compared to controls. The intensity variation is very likely to effect changes in the structure of molecular aggregates of the vehicles.

Electrical property study: The literature reports generation of electrical voltage and power from water, which is explainable by QED. Using a U-shaped glass tube, where one arm contains bi-distilled water and the other arm ethyl alcohol (91%), the arms being separated by a platinum foil, voltage is generated across two platinum electrodes and a DC power in nano-Watt was also measured (Bandyopadhyay *et al*. 2017). The generated voltage lasted for many hours and the magnitude of both voltage and power increased with vigorous shaking of the alcohol poured in one arm of the U-tube, separated from the other arm.

Considering the absence of any significant chemically measurable quantities of ionic solutes in this system, this phenomenon could be explained by the principle of QED. The QED model predicts that self-organization takes place in water and other polar liquids (Bono *et al*. 2012) and the existence of these large supramolecular clusters have been observed (Ho, 2014). These molecules would be distributed over a coherent phase (CP) and a non-coherent phase (NCP).

As the name implies, all molecules in CP coherently oscillate between quantum energy levels. In the presence of an ambient electromagnetic field, part of these CP molecules would be organized in domains. In one type of domain, CP molecules coherently oscillate between their ground electronic state |a> and a well-defined excited state |b>. The electrons are firmly bound in the |a> state, whereas in the |b> state, the electrons are nearly free, *i.e.* these are quasi-free electrons. To free an electron from these quasi- free states, only a small amount of energy would be sufficient (Germano *et al*. 2012). These coherent domains that would be composed of electronically excited molecules are denoted as CD_{elec}. Under appropriate conditions, these electrons could be released (Del Giudice, 2013).

Furthermore, the CP molecules would coherently oscillate between two rotational states (Del Giudice *et al*. 2006). These molecules would be organized in coherent domains (CD_{rot}). These molecules would be ferroelectrically ordered, as their electric dipoles are aligned and, due to this alignment, the domains would have a net dipole moment. According to Yinnon *et al*. (2009), succussions would break up these domains. CD_{Elec} reassembles very quickly. The broken domain pieces of CD_{rot} could be regarded as Electric Dipole Aggregates (EDA), which enhance stabilization of CD_{Elec}. This would explain why the generated electric voltage increases with succussion.

Other authors (Germano *et al*. 2012; Germano *et al*. 2013) also report electric power generation from water. They use bi-distilled water for both the semi-cells of the U-tube with some nafion pieces, which are synthetic polymers with ionic properties, added to one and a small amount of hydrogen peroxide to both the semi-cells. Germano's work shows the increase of voltage and power generation due to the addition of nafion pieces and hydrogen peroxide. However, they fall to low values over 3-4 days.

Bandyopadhyay *et al*. (2017) used somewhat different semi-cells as stated above; voltage and power generated are different in the two cases. The point to note, however, is that these authors demonstrate an increase of voltage and power due to vigorous shaking of alcohol, whereas

Germano reports enhancement of these parameters with addition of nafion to one semi-cell and H_2O_2 to both the semi-cells. This is because nafion provides the required ionic characteristics.

Other models: The formation of stable water nanostructures/dissipative structures in aqueous dilutions surpassing Avogadro limit was confirmed experimentally also by using Fourier-transform infrared spectroscopy (FT-IR spectroscopy), Ultraviolet visible spectroscopy (UV-vis spectroscopy), fluorescence microscopy (FM) and Atomic Force Microscopy (Elia *et al*, 2014). That it is supported by QED is discussed in a subsequent paper (Elia *et al*. 2015).

However, the question remains: Are the structures found in these super dilutions specific to the starting material? If so, what is the theory behind it?

It is our daily experience that super dilutions of homeopathy surpassing the Avogadro limit are endowed with therapeutic values related to the starting materials. Here, however, we have nothing else except these structures to which therapeutic values can be ascribed. Thus, we need to explain how these structures become specific to the

Sample	**CH_2 & OH peak positions in terms of δ in ppm**	**CH_3-2nd peak position in terms of δ in ppm**
Sulphur – 30cH	3.833 (1.6)	2.333 (11.4)
Sulphur – 200cH	3.222 (2) 3.967 (3.5)	2.333 (10)
Sulphur – 1000cH	3.533 (7.3)	2.333 (16.4)
Aurum met- 30cH	3.80 (2.6)	2.333 (17.9)
Aurum met- 200cH	3.333 (2.0) 3.933 (2.8)	2.333 (16.7)
Aurum met- 1000cH	3.633 (3.3)	2.333 (17.5)

Note: Here, ppm stands for parts per million and 1 ppm is 90 Hz for our instrument. Relative heights of absorption peaks are represented by numbers within parentheses.

Table 1. NMR absorption data of Sulphur and Aurum Metallicum. Reproduced with permission of Mahata, author of (Mahata, 1983).

Material	**Resonance frequency in MHz**		
	First Day	**Second Day**	**Third Day**
Control H_2O	25.6643	25.8336	**25.6643**
H_2O	25.495	Before adding Arn 30cH	
H_2O +Arn 30cH	25.1564	24.8178	**24.8178**
H_2O	25.495	Before adding Arn 200cH	
H_2O+Arn 200cH	24.9871	24.6485	**24.6485**
H_2O	26.0029	Before adding Anc 30cH	
H_2O +Anc 30cH	25.41035	25.1564	25.1564
H_2O	25.6643	Before adding Anc 200cH	
H_2O +Anc 200cH	25.1564	24.9871	**24.9871**

Table 2. Resonance frequencies of *Arnica montana* and *Anacardium orientale*

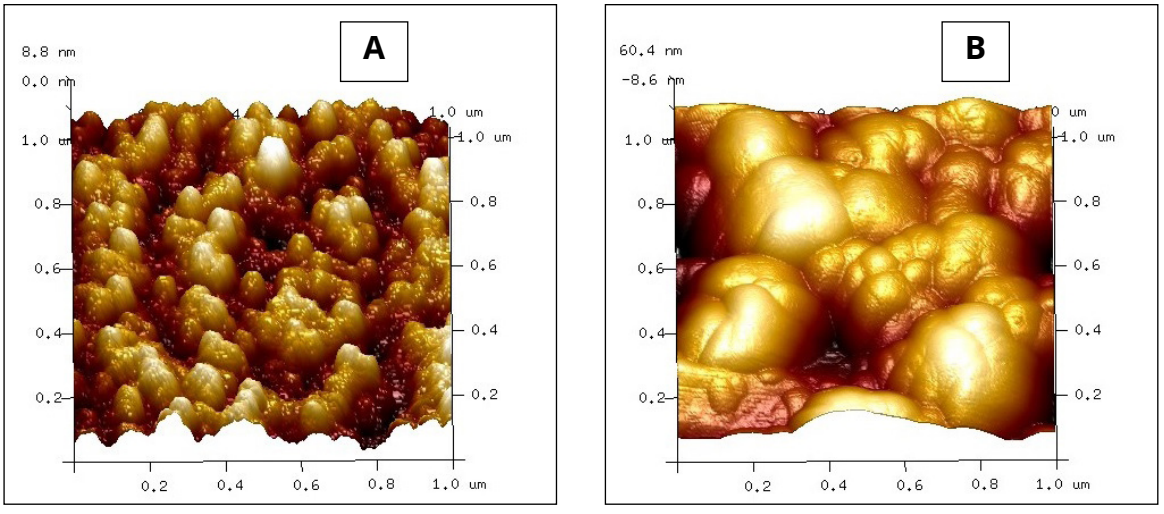

Figure 2. AFM images for: (a) Silicea of dilution 10^{12} + in situ dilution of 200 (left), (b) Silicea of dilution 10^{60}+in situ dilution of 200 (right). Both in 1 µm frame (Reproduced with permission of Int J Complement Alt Med).

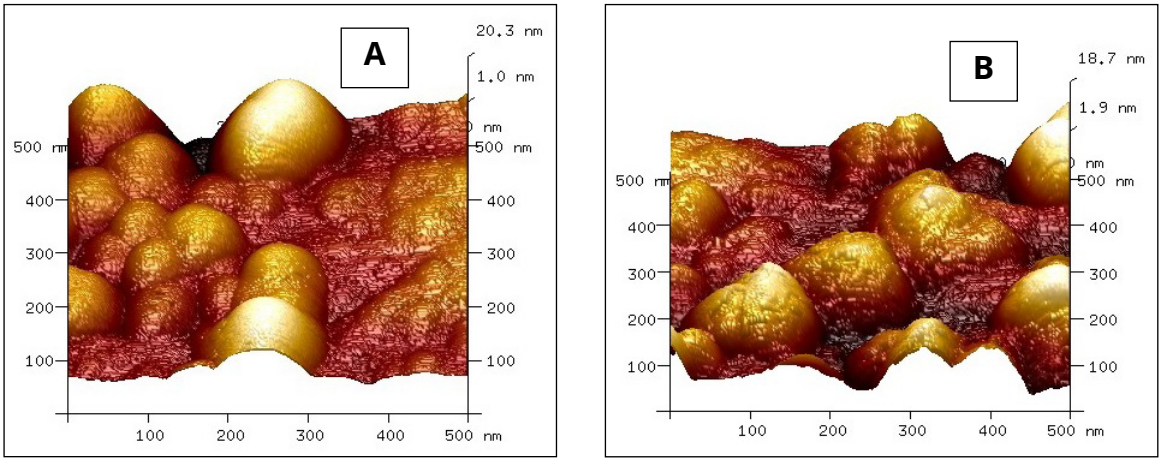

Figure 3. AFM images for: (a) Cuprum Met of dilution 10^{12} + in situ dilution of 200 (left); (b) Cuprum Met of dilution 10^{60} + in situ dilution of 200 (right). Both in 0.5 µm frame (Reproduced with permission of Int J Complement Alt Med).

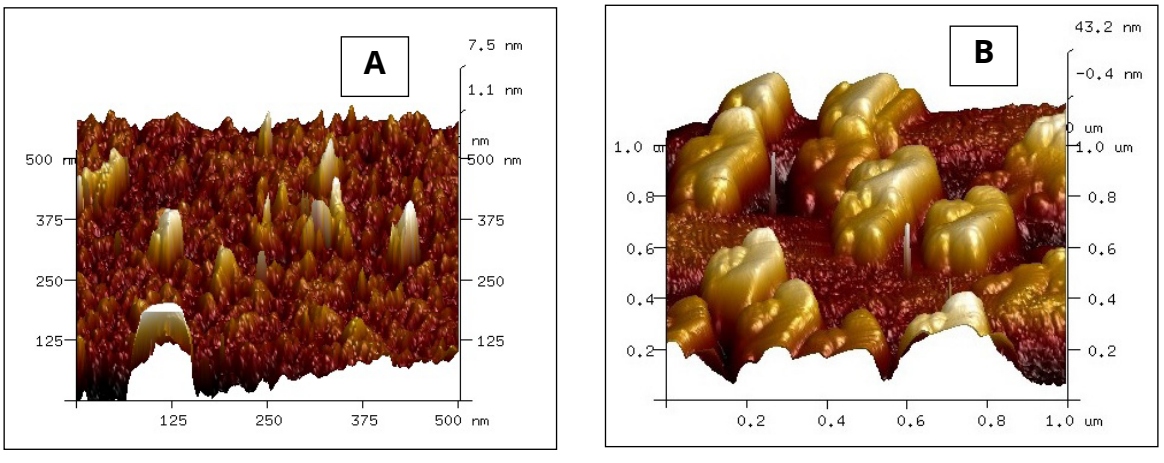

Figure 4. AFM images for: (a) Natrum muriaticum of dilution 10^{12} + in situ dilution of 200 in 0.5 µm frame (left); (b) Natrum muriaticum of dilution 10^{60} + in situ dilution of 200 in 1.0 µm frame (right). (Reproduced with permission of Int J Complement Alt Med).

starting materials. We have addressed this issue in the section **Theory of Aqueous Dilution**.

Discussion About the Results Obtained by These Models

Here, we will provide results pertaining to water in disease and in power generation, because water in health is so familiar to us. The results are as follows.

NMR Results: As mentioned above we studied six medicines, namely, Sulphur and Aurum Metallicum, both with potencies 30cH, 200cH and 1000cH prepared in ethanol having CH_3, CH_2 and OH bonds (Mahata, 1983). The results are reproduced here in the form of *Table 1*.

For both Sulphur and Aurum Metallicum, the NMR spectra revealed considerable shifts of OH-bonds of potentized medicines prepared in ethyl alcohol containing approximately 10 to 15% of water. For each of the six medicines we obtained different resonance frequencies for CH_2 and OH bonds. However, shifts in the CH_2 bond were less, and no perceptible alteration of the CH_3 bond was found. Here, we note that variation in strength of the OH bond itself can alter the structure of water clusters. The results show general agreement with our theoretical concept — solute-specific structures of clusters of vehicle molecules.

Dielectric Dispersion Results: *Table 2* reproduces the resonance frequency data for *Arnica montana* and *Anacardium orientale* of potencies 6cH and 30cH (Mahata, 2012). For these medicines the resonance frequencies were in the 25 MHz region, implying that the water clusters had dimensions in the micron range. Similar results were reported from a study of Cuprum Metallicum and Graphites of potencies 6cH and 30cH in Mahata, (2013). The resonance frequencies of all of them were different from each other and the control (distilled water), suggesting that they had different structures. They indirectly point to the specificity of the structures to the medicine and potency.

AFM Results: We reproduce here (Maity *et al*. 2019) six AFM images of the nanostructures of six homeopathic medicines — Silicea, Cuprum metallicum and Natrum muriaticum each of potency 6cH and 30cH in *Figures 2 to 4*. All the pictures are different from each other and from control solutions. They are quite convincing for providing a visual proof of the structural model (Maity *et al*. 2019; Maity *et al*. 2021), with solute reminiscent nanostructures present in potentized substances. This is akin to identifying a person by his/her photograph.

We find that each of the three above methods suggests, in its unique way, formation of water structures specific to the starting material and potency. The structures are like allotropes of water. In explaining the results, we shifted our focus from chemical formulae to physical structures where we found information about medicine in potentized substances.

DLS Results: This technique as applied on several chemicals (Konovalov, 2012; Konovalov, 2013) reveals that so called nanoassociates or dissipative structures appear on the scene from a dilution of approximately 10^6. They studied almost a hundred compounds and reported the

Sl. No.	Medicine	Medicine dependent constants *a*	*n*
1	Cuprum met	61.01	-0.91
2	Zincumoxydatum	449.2	-1.01
3	Aurum met	764.5	-0.51
4	Ferrum met	341.4	-0.39
5	Aconitum nap	333.2	-0.51

These results are a vindication of the structural model proposed by us.

Table 3. a and n values of equation $y=ax^{\wedge n}$ for different medicines.

sizes of nanoassociates through a number of graphs in different dilutions. Side by side, we found the work of Kar *et al*. (2015) giving an empirical correlation of the form $y=ax^{\wedge n}$ (as mentioned in section **Dynamic light scattering study**) between the nanoparticle size and the potency for five medicines, namely, Cuprum Metallicum, Zincum Oxydatum, Aurum Metallicum, Ferrum Metallicum and *Aconitum napellus* with potencies of 6cH, 30cH and 200cH. The fitting values of a and n for the five medicines are shown in *Table 3*.

Thermo-luminescence result: Experiments were carried out with sodium chloride (NaCl) and LiCl diluted in D_2O to 10^{-30} gm/centiliter (Rey, 2003). These salts are known to suppress hydrogen bonds when present in gross form. The thermo-luminescence glow that comes from heavy hydrogen bonding in D_2O at about 166K is reduced in NaCl and LiCl dilutions well beyond the Avogadro limit. That means the bond-weakening effect continues even in material absence of these salts. The glow was unambiguously different for the control D_2O, dilutions of NaCl and LiCl. More importantly, despite their dilution beyond the Avogadro limit, the emitted light was specific to the original salts dissolved initially. Rey hypothesizes that this phenomenon results from a marked "structural change" in the hydrogen bond network initiated at the onset by the presence of the dissolved ions and maintained during the dilution process. So according to Rey it is physical structure, not chemical composition, that carries forward the effect.

Raman spectroscopy result: Sarkar *et al*. (2016) report on the Raman spectroscopy study of Sulphur and Natrum muriaticum of potencies 30cH, 200cH and 1000cH. This study calculates the ratios of strong to weak (ratio R1) and broken to weak (ratio R2) hydrogen bonds from the intensity ratios of the Raman Spectra at 3200 to 3420 cm-1 and 3620 to 3420 cm-1 respectively. Medicines are characterized in terms of these ratios. Actual values and variation-patterns of R1 and R2 with potency are different for the two medicines. These data give an idea about the water structure of ultra-high diluted medicines. Thus, Raman spectroscopy is claimed to show differences in drugs at ultra-high dilutions of Sulphur and Natrum muriaticum through structural changes of vehicle molecules.

Electrical property result: Here we report the extraction of electric power from water (Bandyopadhyay *et al*. 2017; Germano *et al*. 2012; Germano *et al*. 2013). This phenomenon owes its origin to domain formation in polar liquids as predicted by QED. The electrolytes used by the two groups are not exactly the same as mentioned in the section **Electrical property study**, as the other group used nafion in one of the chambers. Still, voltage and power generation are close to each other as measured, by using sensitive electrometers. However, they fall with time in all these cases, though quite slowly in terms of hours. Nevertheless, this opens a possibility of low-cost electrical power generation and its wide range of possible applications. This perspective has been supported by experimental evidence (Bandyopadhyay *et al*. 2017).

Discussion About the Physical Aspect

This article firstly tries to build up a theory of aqueous dilution and then follows a systematic approach for experimental verification. Hence, for explaining the high dilution controversies of homeopathy, our orientation was primarily a three-pronged experimental approach — NMR study, Dielectric Dispersion study and AFM study, despite the fact that other researchers have developed other models with the same purpose, such as, for instance, DLS, Thermo-luminescence and Raman spectroscopy studies. So, altogether, we reviewed six kinds of experimental works trying to solve the age-old problem. The answer seems to lie in water-structures.

Extraction of electrical power from water is theoretically supported by QED from the onset. The electrolyte used here is nothing but water — plentily available in nature. We feel that it has a promising future. Commercial batteries running with water will be a great achievement. In a time of growing demand for energy and protection of the environment, new technologies like this for getting electrical energy from eco-friendly alternative energy sources certainly are a major objective of present-day research. New technologies like this for getting electrical energy need to be further explored.

Mechanism Proposals

The mechanism of action of homeopathic medicines is yet to get a satisfactory explanation. This is so because of the lack of chemical ingredients in high-dilution medicines. They can be now understood as water-structures — CDs and DSs like allotropes of water. Here we discuss the possible structural interaction between these water structures and biomolecules, with reasoning and then some experiments conducted by us and others which

seem to support the proposal.

Firstly, let's take a hint from Nature. All healthy biomolecules fit within the hollows of water structures and are not damaged when water freezes, enabling us to preserve food items in the refrigerator. On the other hand, the reaction of water towards the molecules whose form does not fit the structure of ice is quite different — it breaks the larger molecules and drives away the small ones. For this reason, the ice in the Arctic Ocean is fresh-water ice — free from all salts (Sergeev, 1973). As such, it may safely be assumed that suitably structured water molecules may bend near-matching biomolecules to get a desired fit and may bring them to their healthy state. It is demonstrated by the work of a Russian scientist (Sergeev, 1973) that damaged biomolecules are found to be repaired by bringing them to their healthy state with the help of tiny ice crystals. By freezing onto curved molecules, the icicles straighten them out, giving them their usual configuration. This reference also talks about beneficial effects (like faster growth and higher immunity) on young birds and animals fed with melted-ice (called live water) rich with ice crystals. Vlasovand Trifinov (1977) mentions beneficial effects of melted ice on young chickens. Structural interaction between medicine molecules and biomolecules is already an established fact in mainstream medicine.

Interaction between biomolecules and water is a two-way process, since biomolecules also influence the structure of cell water (Chaughule, 1978). Water of diseased human cells seems to be rather disordered as compared to water of healthy cells (Damadian, 1971, Hollis *et al*. 1973, Chaughule *et al*. 1974, Ranade *et al*. 1976). Thus, one may propose that homeopathy probably works on this type of interaction mentioned by Sergeev, in 1973, as described in the previous paragraph.

The template/structural principle plays a dominant (and probably, the most significant) role in biological metabolic processes. One finds that protein synthesis in cells is affected according to the template principle (Kamshilov, 1974). It is only natural to expect that this principle will have a role in the curative process as well. This is a broad understanding of structural principle.

High dilution homeopathic preparations are devoid of their identifying chemicals. However, they seem to have their identifying physical structure. Thus, structural interaction is seen as the only probable action-mechanism and some experiments support this proposal. Using an ADDD (as explained above) fabricated by our group, frequency domain signatures were found for aqua diluted bio-samples (blood serum) of patients and ideal homeopathic medicines for them (Chattopadhyay *et al*. 2016a, Chattopadhyay *et al*. 2016b). The results showed that a patient benefited when the resonance frequencies of the patient's bio-sample matched with that of the remedy indicated through case-taking, that is, the two frequencies were close to one another. This was strongly indicative of their structural matching.

Anisur R. Khuda-Bukhsh (Khuda-Bukhsh, 1997) suggested the regulation of gene expression to be one of the major mechanisms by which homeo-drugs work. He gives an overview of the mechanism (Khuda-Bukhsh, 2003), where he advocated that one of the main mechanisms and pathways through which the potentized homeopathic drugs act could be by regulation of expression of some specific and relevant genes. In another review article (Khuda-Bukhsh, 2014), he comes forward with evidence in support of his hypothesis according to which homeopathic remedies carry specific "signals" that can be identified by specific receptors and can act as a trigger to turn "on" or "off" some relevant genes, initiating a cascade of down-stream gene actions to alter and correct the gene expressions that had gone wrong to produce the disorder/disease condition. Evidence of the gene regulatory hypothesis is also available from other publications of his group (Das *et al*. 2011, Saha *et al*. 2012, Saha *et al*. 2013, Khudabukhsh *et al*. 2014). Body-cells' identification of homeo-drugs and consequent alteration/correction of gene expression could be hypothesized as expressions of a structural principle. So, these findings also seem to advocate a structural principle, though the wording is different.

Discussion About Bioactivity

Bioactivity of homeopathic medicine surpassing the Avogadro limit is another contentious issue. The problem before the researchers is the absence of starting material in the medicine in question. To solve this problem, we have brought in the template/structural principle, already accepted in mainstream medical science, extending it to the situation where the medicine in question has a physical/structural identity instead of a chemical one.

The formation of CDs in plain water and DSs in perturbed water have experimental evidence (Elia *et al*. 2015). CD-formation does not require succussion but formation of

DSs needs it (Konovalov, 2012; 2013; Konovalov *et al*. 2014). Thus, DSs might exist in homeopathic dilutions, and might be involved in their bio-effects, which point towards biological effects of aqueous structures. The answers are not yet conclusive, however, and there is room for more discussion and studies. We feel that this issue may be effectively sorted out in the near future, by experiments at the cellular level involving effects of water-structures on DNA/RNA in vitro/in vivo.

Conclusion

Water may be structured, but still, it is water. Its use as a curative agent and source of electrical power are two surprising putative issues. The **Theory of Aqueous Dilution** presented above seems to offer a theoretical explanation for the specificity of water-structures to the starting material. The results obtained from studies in which the six kinds of experiments are mentioned, as explained above, seem to provide experimental support to the structured-water theory.

AFM provides us 3-D images of solid residues of potentized medicine. These images will enable us to verify and identify potentized medicines akin to manual identification of persons from the photographs of their faces. Further correlation between a medicine and its AFM image may be obtained by Image Identification technique. The putative curative action could be obtained from a medicine having physical/structural identity, even though no distinctive chemical identity could be present. Thus, the hypothesis in which the structured serial dilutions in water could carry and transfer information about the solute via solute-specific water structures for influencing biomolecules can find scientific support.

The second issue, though surprising, is not controversial. As elaborated in the section on **Electrical property study**, the results are theoretically sound and experimentally confirmed. Although the phenomenon is relatively new, one expects that the present knowledge will be socially useful in the near future.

Conflict of interest

None.

Discussion with Reviewers (DWR)

Reviewer: The greater the credit and value of a hypothesis, the more disconnected it is from questions considered dogmatic. Many facts discredited by science are at the origin of frontier research areas — such as homeopathy and the healing power of water itself. However, because they are facts, they generate phenomena that can be described in the language of classical science. In scientific articles it is important that the hypotheses are based on these phenomena, avoiding dogmatic foundations.

Authors: We agree. Our approach is free from the dogma that a medicine must have its own distinct chemistry. Water structures may also serve as medicine. Initially, the phenomena on which this hypothesis was based were some hitherto ignored specialties of water — existence of innumerable tiny ice-like structures having no particular form floating in bulk water at room temperature and susceptible to the influence of other substances (Finkelnburg, 1964; Sergeev 1973; Ho, 2017). Theoretical support for the phenomena came later from QED. By an extension of Del Giudice's work we have shown that dissipative structures formed in water can be specific to the starting guest molecules in different stages of succussed serial dilution. Here, the Avogadro limit does not pose any problem.

Reviewer: What is the critical temperature needed to produce these CDs? Can a CD be formed and be stable at room temperature and under normal conditions? Consider that the laboratory environment is different from "normal daily life" conditions.

Authors: To our knowledge, the exact value of critical temperature is not given by any researcher. However, Elia *et al*. (2015) reports that "at room temperature, liquid water is a mixture of coherent and incoherent water: at 0°C the percentages are 50% and 50%; at 30°C they are 40% coherent and 60% incoherent." Furthermore, the poster presentation by Prof. V. Elia (Elia *et al*. 2016, DOI:10.13140/RG.2.2.19598.15684) contains a thermogravimetric graph that shows about 90% of solid residues at 100°C, which reduces to 0% at about 650°C. Thus, the CDs can safely get formed and exist at room temperature and under normal conditions.

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