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Permanent physico-chemical properties of extremely diluted aqueous solutions of homeopathic medicines

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The purpose of this study was to obtain information about the influence of successive dilutions and succussions on the water structure. ‘Extremely diluted solutions’ (EDS) are solutions obtained through the iteration of two processes: dilution in stages of 1:100 and succussion, typically used in homeopathic medicine. The iteration is repeated until extreme dilutions are reached, so that the chemical composition of the solution is identical to that of the solvent. Nine different preparations, were studied from the 3cH to 30cH (Hahnemannian Centesimal Dilution). Four of those were without the active principle (potentized water). Two different active principles were used: *Arsenicum sulphuratum rubrum* (ASR), As_4S_4 , 2,4-dichlorophenoxyacetic acid (2,4D). The solvents were: a solution of sodium bicarbonate and of silicic acid at 5×10^{-5} M (mol/l) each, and solutions of sodium bicarbonate 5×10^{-5} , 7.5×10^{-5} and 10×10^{-5} M (mol/l) in double-distilled water. The containers were Pyrex glass to avoid the release of alkaline oxide and silica from the walls. Conductivity measurements of the solutions were carried out as a function of the age of the potencies. We found increases of electrical conductivity compared to untreated solvent. Successive dilution and succussion can permanently alter the physico-chemical properties of the aqueous solvent. But we also detected changes in physio-chemical parameters with time. This has not previously been reported. The modification of the solvent could provide an important support to the validity of homeopathic medicine, that employs ‘medicines without molecules’. The nature of the phenomena here described remains still unexplained, nevertheless some significant experimental results were obtained. *Homeopathy* (2004) 93, 144–150.

Keywords: conductivity; succussion; ageing; homeopathy

Introduction

Since time immemorial water has attracted scientists attention. This substance, despite its apparent simpli-

city, behaves in a fascinating and often surprising manner. Recent studies on the physico-chemical properties of water provide evidence that the most studied liquid by far, water, still exhibits unexpected properties.^{1–7} Lobyshev and co-workers have shown that very low concentrations and electromagnetic fields can produce large-scale realignments of its structure, which can be either reversible or irreversible.⁸ One can deduce from these studies that water and aqueous solutions are complex systems, capable of auto-organization as a consequence of small perturbations

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of various kind.⁸ An important paper concerning the effect of dilution on molecules has been published by Samal and Geckeler.⁹ They observed that the clusters size of fullerene-cyclodextrin, β -cyclodextrin, sodium chloride, sodium guanosine monophosphate, and a DNA oligonucleotide increase, paradoxically, with decreasing concentration.

We have shown that the physico-chemical properties of extremely diluted solutions (EDS) are different from those of pure untreated water, notwithstanding the identical chemical composition of the two liquids.^{10–12} The same conclusions are inferred by Lo.^{13,14} Rey¹⁵ has shown that the structure of hydrogen bonds in pure water is different from that of an extremely diluted solution obtained by an iterative procedure of successive dilutions and succussions, not identical as expected.

These issues are important because of the hypothetical therapeutic powers of the EDS of *homeopathic medicine*, 'medicines without molecules'. The absence of molecules in the active principle obviously excludes the possibility of them taking part, directly, in any action. Scant attention has been paid to the solvent, water, the structure of which is still subject to numerous studies and not fully clarified yet. The EDS were studied to test the validity of the hypothesis that the particular preparation technique and/or the initial presence of molecules of solutes, of various nature, could lead to an alteration of the 'structure' of the solvent. Our present contribution continues the programme aimed at understanding the properties of solutions that have undergone cycles of dilution and succussion. Here, we report a study that employs electrical conductivity measurements. In a preceding paper¹² we showed that the presence of impurities is very important in determining a different physico-chemical behaviour after the preparation procedure we described. Because of this, some EDS were prepared using as solvent solutions with a low and known contents of sodium bicarbonate and silicic acid (5×10^{-5} M [mol/l]) each or sodium bicarbonate alone (5×10^{-5} , 7.5×10^{-5} and 10×10^{-5} M [mol/l]) in double-distilled water. Thus we take into account the 'chemical contributions' to the measured physico-chemical parameters and to subtract them. At the same time the probability of being able to differentiate between the physico-chemical behaviour of the mixed untreated solvent and that of the EDS was greatly increased. The observed phenomenon provides new information on the physical nature of the liquid state of water and leads us to conclude that the structure of the solvent can be permanently altered by the procedure used in preparing the solutions.

Experimental

Materials

The solutes were Carlo Erba, Sigma or Fluka products, of the highest purity commercially available. The

solutions of the various solutes (NaHCO_3 , SiO_2) were prepared by mass using twice distilled water. The EDS were prepared using as solvent a solution of sodium bicarbonate or/and silicic acid: 5×10^{-5} – 10×10^{-5} M (mol/l). The containers used were of Pyrex glass treated with a $\text{H}_2\text{SO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ mixture followed by a washing procedure with twice distilled water. The procedure was iterated until the conductivity of the waste water reached that of pure double-distilled water.

Procedures

The procedure by which EDS are obtained is the following.¹⁶ The starting point is a 1% (mass) solution; to prepare, for example, the 2,4-dichlorophenoxyacetic (2,4D) dilutions (2,4D 3cH–30cH), 1 g of 2,4D is added to 99 g of the solvent, in this case an aqueous solution of sodium bicarbonate 5×10^{-5} M (mol/l). After the mechanical treatment, namely succussion, the solution is called '1 centesimal hahnemannian', or 1cH in short, and the name of the solution starts with the name or formula of the solute or a simple abbreviation of it. So in the preceding example, 2,4D 1cH is obtained. The process of succussion consists in a violent shaking of the solution by means of a mechanical apparatus. In order to prepare the 2 centesimal hahnemannian (2,4D 2cH), 1 g of the 1cH solution is added to 99 g of the solvent used and the resulting solution is again succussed. These two processes, dilution 1:100 and succussion, are iterated many times. The apparatus used in the succussion step is a DYNA HV 1 by Debofar N.V.S.A. Belgium or a vortex. In a single succussion process 50–500 vertical strokes are given to the vessel containing the solution at the frequency of 0.83 Hz. In the case of the vortex the time varied from 20 to 100 s.

After preparation, the EDS were stored at room temperature. The samples were then tested at different ages, varying from several days to several months.

Samples of two different solutes were prepared: *Arsenicum sulphuratum rubrum* (ASR) and 2,4-dichlorophenoxyacetic acid (2,4D). Four of the preparing procedures started with the solvent without active principle, potentized water, W.

Methods

Conductivity measurements

Systematic measures of electrical conductivity χ ($\mu\text{S cm}^{-1}$) were performed on the EDS. Conductivity data were collected with a YSI conductivity instrument, model 3200 (cell constant 1 cm^{-1}). The cell constant was measured daily, using a KCl standard solution. The values of conductivity were determined at $25 \pm 0.1^\circ\text{C}$.

Results

In Tables 1–9, we report the active principle, the degree of dilution, the solvent used, the procedure of dynamization, the age of the EDS and the experimental excess conductivity χ^E ($\mu\text{S cm}^{-1}$), the difference between the conductivity of the samples and that of the solvent. The χ^E is substantially positive and increases with the age of the samples. Each of the nine preparation procedures shows an increasing trend as function of age. In all of the preparations the procedure of successive dilutions and succussions modified this physico-chemical property. Our new method for preparing EDS, the use of water containing low and known quantities of sodium bicarbonate and/or silicic acid, greatly enhances the probability of obtaining an ‘active’ dilution, ie a solution whose physico-chemical properties are different from that of the solvent. After 2–4 months the excess conductivity χ^E ($\mu\text{S cm}^{-1}$) reaches values far beyond the experimental error (estimated at 2%). In fact the χ^E reaches values ranging from 0 to 10 ($\mu\text{S cm}^{-1}$), double the conductivity of the solvents. We did not find a simple or clear correlation, valid for every preparation,

Table 1 Excess conductivity of the EDS of arsenicum sulphuratum rubrum (ASR), at 25°C. Solvent: aqueous solution of NaHCO_3 and H_4SiO_4 both $5 \times 10^{-5} \text{ M}$ (mol l^{-1}). Conductivity of the solvent: 5.0 ± 0.1 ($\mu\text{S cm}^{-1}$)

	System ^a				
	χ^{Eb}	χ^{Eb}	χ^{Eb}	χ^{Eb}	χ^{Eb}
	Age (days)				
	21	171	178	232	382
ASR 5cH	-0.6	-0.5		-0.2	1.3
ASR 6cH	0.4	2.3	2	4.8	7.1
ASR 7cH	0.4	0.5		2.1	2.3
ASR 8cH	0.3	3.1		4.0	5.0
ASR 9cH	0.3	2.1	1.7	2.8	2.3
ASR 10cH	0.2	3.2		6.3	8.1
ASR 11cH	0.2	3.4		4.6	9.4
ASR 12cH	0.4	2.8	2.4	4.1	4.1
ASR 13cH	0.3	1.1		2.4	3.0
ASR 14cH	0.4	1.3		1.8	2.0
ASR 15cH	0.5	4.6		6.9	
ASR 16cH	0.5	2.2		3.0	3.1
ASR 17cH	0.4	5.4	5.4	6.8	6.6
ASR 18cH	0.4	1.9		3.6	10.2
ASR 19cH	0.2	4.3		6.7	8.3
ASR 20cH	0.3	2.4		6.2	6.6
ASR 21cH	0.5	3.7		5.6	10.7
ASR 22cH	0.5	1.1		1.8	2.8
ASR 23cH	0.4	2.6		3.3	4.5
ASR 24cH	0.3	0.7		1.8	1.9
ASR 25cH	0.4	2.3		5.1	
ASR 26cH	0.5	4.2		5.0	7.9
ASR 27cH	0.2	0.8		1.7	2.0
ASR 28cH	0.1	0.7		2.1	3.2
ASR 29cH	0.2	0.3		0.7	3.8
ASR 30cH	0.1	4.9	4.6	6.4	9.9

^aDynamization method: vortex, 20s. Solvent: aqueous solution of NaHCO_3 and H_4SiO_4 both $5 \times 10^{-5} \text{ M}$ (mol l^{-1}). Conductivity of the solvent: 5.0 ± 0.1 ($\mu\text{S cm}^{-1}$). Active principle: arsenicum sulphuratum Rubrum: ASR.

^bExcess conductivity ($\mu\text{S cm}^{-1}$).

Table 2 Excess conductivity of the EDS of arsenicum sulphuratum rubrum (ASR), at 25°C. Solvent: aqueous solution of NaHCO_3 and H_4SiO_4 both $5 \times 10^{-5} \text{ M}$ (mol l^{-1}). Conductivity of the solvent: 5.0 ± 0.1 ($\mu\text{S cm}^{-1}$)

	System ^a		
	χ^{Eb}	χ^{Eb}	χ^{Eb}
	Age (days)		
	171	232	387
ASR 5cH	0.3	0.3	1.7
ASR 6cH	2.2	4	4.5
ASR 7cH	2.1	3.8	4.6
ASR 8cH	1.3	2.6	2.6
ASR 9cH	3.8	4.6	1.8
ASR 10cH	1.8	2.4	3.6
ASR 11cH	0.3	2.3	1.6
ASR 12cH	2.1	3.5	3.3
ASR 13cH	1.5	2.7	3.7
ASR 14cH	1.4	2.3	2.7
ASR 15cH	2.9	3.2	3.9
ASR 16cH	2.5	5.2	8.7
ASR 17cH	1.3	3.6	4.0
ASR 18cH	2	3.4	4.2
ASR 19cH	2.3	5.1	9.5
ASR 20cH	0.6	2.3	3.8
ASR 21cH	2.1	3.8	4.6
ASR 22cH	0.8	1.5	2.0
ASR 23cH	3.4	4.9	5.3
ASR 24cH	0.1	0.8	1.4
ASR 25cH	0.1	1.1	1.6
ASR 26cH	0.1	1.7	4.3
ASR 27cH	1.7	3	4.8
ASR 28cH	1.7	3	5.8
ASR 29cH	0.7	1.4	2.7
ASR 30cH	3.3	5.3	8.4

^aDynamization method: succussion: 150 strokes, 0.83 Hz, (18s). Solvent: aqueous solution of NaHCO_3 and H_4SiO_4 both $5 \times 10^{-5} \text{ M}$ (mol l^{-1}). Conductivity of the solvent: 5.0 ± 0.1 ($\mu\text{S cm}^{-1}$). Active principle: arsenicum sulphuratum rubrum.

^bExcess conductivity ($\mu\text{S cm}^{-1}$).

Table 3 Excess conductivity of the EDS of arsenicum sulphuratum rubrum (ASR), at 25°C. Solvent: aqueous solution of NaHCO_3 $7.5 \times 10^{-5} \text{ M}$ (mol l^{-1}). Conductivity of the solvent: 7.5 ± 0.1 ($\mu\text{S cm}^{-1}$)

	System ^a			
	χ^{Eb}	χ^{Eb}	χ^{Eb}	χ^{Eb}
	Age (days)			
	104	166	208	327
ASR 6cH	4.7	8.4	12.2	
ASR 9cH	0.5	1.9	3.2	5.3
ASR 9cH	0.1	0.5	1.2	0.8
ASR 12cH	-0.3	1.0	2.5	2.6
ASR 12cH	0.4	0.5	1.8	1.9
ASR 12cH	-0.3	0.7	1.1	0.8
ASR 30cH	-0.6	0.2	2.2	3.3
ASR 30cH	1.3	3.0	4.3	4.6
ASR 30cH	0.3	1.5	1.8	2.9
ASR 30cH	-0.2	0.7	1.6	1.1

^aDynamization method: succussion: 100 strokes, 0.83 Hz, (12s). Solvent: aqueous solution of NaHCO_3 $7.5 \times 10^{-5} \text{ M}$ (mol l^{-1}). Conductivity of the solvent: 7.5 ± 0.1 ($\mu\text{S cm}^{-1}$). Active principle: arsenicum sulphuratum rubrum.

^bExcess conductivity ($\mu\text{S cm}^{-1}$).

linking the nature of the active principle, the number of strokes during succussion and the degree of dilution. Some differences appear to be related to the prepara-

Table 4 Excess conductivity for the EDS of potentized water, at 25°C. Solvent: aqueous solution of NaHCO₃ 7.5 × 10⁻⁵ M (mol l⁻¹). Conductivity of the solvent: 7.5 ± 0.1 (μS cm⁻¹). Active principle: none

	NS ^b	System ^a				
		χ ^{E^c}				
		Age (days)				
		93	97	152	188	304
W 3cH	100	4.2		10.3	14.5	
W 6cH	100	1.1		2.9	4.9	6.6
W 9cH	100	-0.3		0.0	0.7	0.5
W 9cH	100	0.1		2.0	2.8	3.5
W 12cH	100	0.7		-7.5	3.7	2.7
W 12cH	100	1.5		2.9	2.0	3.6
W 12cH	100	0.8		1.5	1.7	1.5
W 12cH	100	0.1		1.3	1.8	1.2
W 30cH	100	0.1		1.2	1.8	2.5
W 30cH	100	0.4		1.3	2.4	3.6
W 30cH	100	0.1		0.9	1.4	1.6
W 30cH	100	1.5		4.1	5.8	10.6
W 30cH	100	-0.6		-0.2	0.4	0.1
W 30cH	100	1.0		3.6	4.5	7.9
W 30cH	100	0.8		1.4	3.0	3.7
W 30cH	100	-0.2		0.5	1.4	1.4
W 30cH	150	5.8	6.2	11.4		
W 30cH	200	4.2	4.6	7.4		
W 30cH	250	1.2	1.8	2.2		
W 30cH	300	4.8	6.8	5.8		
W 30cH	350	2.9		4.9		
W 30cH	400	2.0	3.2	4.0		
W 30cH	450	1.4		2.3		
W 30cH	500	1.8		3.2		

^aDynamization method: succussion: 100 strokes, 0.83 Hz, (12s). Solvent: aqueous solution of NaHCO₃ 7.5 × 10⁻⁵ M (mol l⁻¹). Conductivity of the solvent: 7.5 ± 0.1 (μS cm⁻¹). Active principle: none.

^bNS: number of strokes, 0.83 Hz.

^cExcess conductivity (μS cm⁻¹).

tion procedure, and to depend on the degree of dilution or the method of dynamization, but the correlation is not yet clear (see for example Table 4).

The only clear and simple behaviour common to all samples, is the increase of the parameter χ^E as a function of time. An example of this behaviour is reported in Figure 1, using selected data from Table 1. The increase of the parameter reaches the 100% of the initial value. To obtain similar values of the excess conductivity, in the hypothesis of ‘chemical contributions’, would require a doubling of the concentration of the electrolytes. We think that such a difference is too high to suppose a systematic error. This result confirms the analogous one concerning the variation of the parameter Q^E (J kg⁻¹), as a function of the age, for the potencies and for the control solvent, referring to different preparation procedures and/or active principles.¹² As shown the parameter, Q^E (J kg⁻¹), increases in function of the age for the potencies while remaining constant for the control solvent.

Discussion

We have previously reported that when mixing the EDS with aqueous solutions of sodium hydroxide

Table 5 Excess conductivity for the EDS of potentized water, at 25°C. Solvent: aqueous solution of NaHCO₃ 7.5 × 10⁻⁵ M (mol l⁻¹). Conductivity of the solvent: 7.5 ± 0.1 (μS cm⁻¹). Active principle: none

	NS ^b	System ^a			
		χ ^{E^c}	χ ^{E^c}	χ ^{E^c}	χ ^{E^c}
		Age (days)			
		84	92	146	314
W 3cH	20	-0.1	-0.4	1.0	
W 6cH	20	-0.1	1.2	1.2	3.0
W 9cH	20	0.1	0.9	1.2	2.0
W 9cH	20	0.6	0.1	0.7	0.2
W 12cH	20	0.8	0.3	0.6	1.0
W 12cH	20	-0.1	-0.5	0.7	1.0
W 12cH	20	0.3	-0.2	0.4	1.0
W 12cH	20	0.7	0.2	0.5	0.7
W 30cH	20	0.6	-0.4	0.8	1.3
W 30cH	20	0.8	0.3	0.8	1.8
W 30cH	20	0.7	0.2	0.5	0.3
W 30cH	20	0.0	-0.5	0.0	0.0
W 30cH	20	0.5	0.0	0.4	1.4
W 30cH	20	-0.2	-0.7	-0.1	-0.1
W 30cH	20	-0.1	-0.6	-0.1	1.5
W 30cH	20	0.4	0.1	1.0	4.5
W 30cH	30	0.4	-0.1	0.6	1.6
W 30cH	40	-0.2	0.2	1.0	
W 30cH	50	0.8	0.8	1.6	
W 30cH	60	0.1	0.1	1.1	
W 30cH	70	0.6	1.2	1.8	
W 30cH	80	1.1	1.2	1.8	
W 30cH	90	0.6	0.6	1.7	
W 30cH	100	-0.1	-0.1	1.3	
W 30cH	120	0.5	0.5	2.0	

^aDynamization method: vortex, (20s). Solvent: aqueous solution of NaHCO₃ 7.5 × 10⁻⁵ M (mol l⁻¹). Conductivity of the solvent: 7.5 ± 0.1 (μS cm⁻¹). Active principle: none.

^bNS: number of seconds.

^cExcess conductivity (μS cm⁻¹).

0.01 mol kg⁻¹, an excess heat of mixing is detected compared to mixing with untreated solvent. The experimentally measured excess heats shows the process to be exothermic. Our hypothesis was that the EDS have a larger number of aggregates of water molecules than untreated water. During the mixing with the extremely diluted solution, the Na⁺ and OH⁻ ions would hydrate more efficiently than in water, exploiting, the aggregates of water molecules found in the solvent, with a consequent increase of the exothermic heat of mixing. Mixing with strong acids or bases seems to be a necessary condition in order to differentiate between the calorimetric behaviour of EDS and reference solvents. The hypothesis that H⁺ and OH⁻ ions, characterizing acids and bases, and water are a necessary condition for obtaining the heats in excess, is not to be excluded.

The results reported in this paper reinforce the hypothesis of water molecules aggregates and the role played by the H⁺ and OH⁻ because of the higher conductivity of the EDS compared to solvent. In fact the excess conductivity is substantially positive. The main parameters that characterize the EDS we employed in this work are: nature of solute, degree of

Table 6 Excess conductivity for the EDS of 2,4-dichlorophenoxyacetic (2,4 D) at 25°C. Solvent: aqueous solution of NaHCO₃ 10 × 10⁻⁵M (mol⁻¹). Conductivity of the solvent: 10.0 ± 0.1 (μS cm⁻¹)

	System ^a					
	NS ^b	χ ^{Ec}	χ ^{Ec}	χ ^{Ec}	χ ^{Ec}	
	Age (days)					
	81	91	150	185	298	
2,4 D 3cH	100		-0.2	-0.1	0.8	8.0
2,4 D 6cH	100	-0.3	-1.4		-0.4	-0.2
2,4 D 9cH	100	-1.1	-1.5		-0.3	-0.4
2,4 D 12cH	100	-0.5	-1.1		-0.1	-0.3
2,4 D 30cH	100		-1.5		-0.7	-0.6
2,4 D 30cH	100	-0.9	-1.3		-0.5	-0.5
2,4 D 30cH	150		-1.0	-0.8	0.1	
2,4 D 30cH	200		-0.5	-0.3	0.5	4.6
2,4 D 30cH	250		-0.1		1.3	1.9
2,4 D 30cH	300	-0.4	-1.2	-0.4	0.0	-0.9
2,4 D 30cH	350		-0.5		0.0	-0.7
2,4 D 30cH	400		-0.1		0.2	0.0
2,4 D 30cH	450		-0.2		0.3	1.3
2,4 D 30cH	500		2.2		3.0	7.4

^aDynamization method: succussion, 100 strokes, 0.83 Hz (12s). Solvent: aqueous solution of NaHCO₃ 10 × 10⁻⁵M (mol⁻¹). Conductivity of the solvent: 10.0 ± 0.1 (μS cm⁻¹). Active principle: 2,4-dichlorophenoxyacetic (2,4D).

^bNS: number of strokes.

^cExcess conductivity (μS cm⁻¹).

Table 7 Excess conductivity for the EDS of potentized water, at 25°C. Solvent: aqueous solution of NaHCO₃ 10 × 10⁻⁵M (mol⁻¹). Conductivity of the solvent: 10.0 ± 0.1 (μS cm⁻¹). Active principle: none

	System ^a				
	NS ^b	χ ^{Ec}	χ ^{Ec}	χ ^{Ec}	
	Age (days)				
	79	91	147	182	
W 6cH	100		-0.3	0.6	2.1
W 9cH	100	-1.2	-1.0	0.0	0.2
W 9cH	100		-0.7	-0.3	0.7
W 9cH	100		0.0	1.3	2.9
W 12cH	100		-0.1	0.2	2.2
W 12cH	100	-0.6	-0.8		0.9
W 12cH	100		-0.4		1.2
W 30cH	100		-0.7	-0.2	1.0
W 30cH	100		-1.1	-0.4	0.4
W 30cH	100		-0.8	-0.2	0.7
W 30cH	100	-0.8	-1.0	0.4	0.9
W 30cH	100		-0.3	0.3	1.3
W 30cH	100		-0.4	1.8	4.4
W 30cH	100		-1.1	-0.3	0.6
W 30cH	100	-0.9		-0.9	0.2
W 30cH	150		-0.8	-0.2	0.6
W 30cH	300		-0.4	-0.2	2.0
W 30cH	350		-0.2	0.5	1.6
W 30cH	450		0.6	2.0	4.9
W 30cH	500		-0.5	0.0	1.3
W 30cH	600		-0.5	0.5	1.7
W 30cH	200	0.3	0.7	2.7	3.7
W 30cH	300		0.6	1.7	4.5
W 30cH	400		-0.5	0.9	2.1

^aDynamization method: succussion, 100 strokes, 0.83 Hz (12s). Solvent: aqueous solution of NaHCO₃ 10 × 10⁻⁵M (mol⁻¹). Conductivity of the solvent: 10.0 ± 0.1 (μS cm⁻¹). Active principle: none.

^bNS: number of strokes.

^cExcess conductivity (μS cm⁻¹).

Table 8 Excess conductivity for the EDS of 2,4-dichlorophenoxyacetic (2,4 D), at 25°C. Solvent: aqueous solution of NaHCO₃ 10 × 10⁻⁵M (mol⁻¹). Conductivity of the solvent: 10.0 ± 0.1 (μS cm⁻¹)

	System ^a				
	NS ^b	χ ^{Ec}	χ ^{Ec}	χ ^{Ec}	
	Age (days)				
	90	146	187	309	
2,4 D 3cH	20	2.8	4.2	5.6	5.5
2,4 D 6cH	20	-1.0	-0.3	-0.5	-0.9
2,4 D 9cH	20	-1.0	-0.3	-1.0	-0.8
2,4 D 12cH	20	-0.8	-0.4	-0.8	
2,4 D 30cH	20	-1.0	-1.0	-0.7	
2,4 D 30cH	30	0.6	2.1	2.2	3.2
2,4 D 30cH	40	0.8	1.2	1.9	3.1
2,4 D 30cH	50	2.3	4.6	4.9	
2,4 D 30cH	60	1.9	4.3	5.5	3.9
2,4 D 30cH	70	1.4	2.5	2.7	
2,4 D 30cH	80	0.8	2.3	2.2	1.9
2,4 D 30cH	90	1.2	2.1	2.4	6.7
2,4 D 30cH	100	1.5	3.1		
2,4 D 30cH	10	0.9	1.8		

^aDynamization method: vortex, (20s). Solvent: aqueous solution of NaHCO₃ 10 × 10⁻⁵M (mol⁻¹). Conductivity of the solvent: 10.0 ± 0.1 (μS cm⁻¹). Active principle: 2,4-dichlorophenoxyacetic (2,4 D).

^bNS: number of seconds.

^cExcess conductivity (μS cm⁻¹).

Table 9 Excess conductivity for the EDS of potentized water, at 25°C. Solvent: aqueous solution of NaHCO₃ 10 × 10⁻⁵M (mol⁻¹). Conductivity of the solvent: 10.0 ± 0.1 (μS cm⁻¹). Active principle: none

	System ^a				
	NS ^b	χ ^{Ec}	χ ^{Ec}	χ ^{Ec}	
	Age (days)				
	92	145	167	312	
W 3cH	20	-0.9	-0.3		-0.5
W 6cH	20	-1.0	-0.2		-0.4
W 9cH	20	-0.8	-0.3		-0.2
W 12cH	20	-0.6	-0.5		-0.2
W 30cH	20	-0.5	0.0		-0.4
W 30cH	30	1.0	2.1		
W 30cH	40	1.6			
W 30cH	50	2.5			
W 30cH	60	1.6			
W 30cH	70	1.5			
W 30cH	80	2.7			
W 30cH	90	2.6			
W 30cH	100	4.1			
W 30cH	10	0.9		3.7	

^aDynamization method: vortex, (20s). Solvent: aqueous solution of NaHCO₃ 10 × 10⁻⁵M (mol⁻¹). Conductivity of the solvent: 10.0 ± 0.1 (μS cm⁻¹). Active principle: none.

^bNS: number of seconds.

^cExcess conductivity (μS cm⁻¹).

dilution, number of strokes during succussion, age of samples. Each of those factors could influence the EDS in different ways and quantity.

When the same sample is tested at different ages, the excess heat is greater as the age of the sample increases, with increases of more than 100% while the

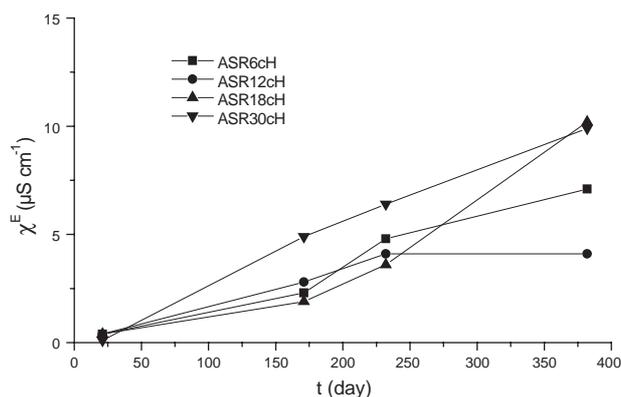


Figure 1 Excess conductivity of extremely diluted solution vs. the age of the samples at 25°C. Preparation of arsenicum sulphuratum rubrum in aqueous solution of NaHCO₃ and H₄SiO₄ both 5 × 10⁻⁵ M (mol l⁻¹). Selected potencies from Table 1.

solvent remains unvaried.¹² The same occurs for the conductivity. This temporal evolution is slow, occurring over a period of months since the preparation. The varying value of the physico-chemical parameters as a function of time seems to be a feature of the EDS. By controlling every parameter affecting a preparation, maybe it will be possible in the future to better the qualitative and/or quantitative reproducibility of the phenomenon under examination.

We made EDS from different solutes with dilution ranging from 3cH to 30cH. A correlation between initial solute and dilution, and the physico-chemical behaviour is not yet clear from our data. Since the containers employed to prepare and store the EDS are made of Pyrex glass, no detectable release of impurity from the containers at room temperature occurs.¹² The presence of ions in the solvent seems necessary to 'activate' the potencies in the sense that they exhibit a different thermodynamic picture from that of the solvent, the chemical composition of which is identical. For these reasons we do not use pure double-distilled water, but a solution of sodium bicarbonate and/or silicic acid of known and controlled concentration. When containers made of dark glass were used, the release of alkaline oxides could alter the composition of the systems and care had to be taken to take into account its chemical contribution via quantitative chemical analysis.

Solutions that underwent the dilution cycle, but not succussion, do not differ from the control solvent. Succussion thus appears necessary to activate the different physico-chemical behaviour of the EDS.

Conductivity measurements show a systematic higher value of the electrical conductivity of EDS compared to control. In water, the high mobility of H⁺ and OH⁻ ions under a gradient of electrical potential is explained through the 'hopping' mechanism as proposed by Grotthus.¹⁷ A higher structuring of the solvent could favour this mechanism, leading to a higher value of the conductivity in the EDS. To

confirm the hypothesis of a variation of 'water structure' and consequently of the thermodynamic activity of the solvent, caused by structural variations, measurements of e.m.f. in suitable galvanic cells are planned.

Conclusions

The physico-chemical results presented here allow us to hypothesize that iterated dilutions and succussions, is capable of modifying in a permanent way the physico-chemical features of water. There is no doubt, from a strictly chemical point of view, that the EDS are identical to the solvent employed in their preparation: double-distilled water with a controlled concentration of sodium bicarbonate and/or silicic acid. Even when accounting for the contributions coming from the latter substances, the conclusion is that the behaviour of the EDS is measurably different from that of the solvent. A really intriguing phenomenon is the evolution of some physico-chemical parameters with time, this hints at a trigger effect on the formation of molecular aggregates, following the succussion procedure. This effect is not easily reproducible but, once established, would permit a slow growth of thermodynamic or transport parameters, probably due to the increase of the number of aggregates or of their size or both. Hence, a necessary condition to experimentally ascertain variations of the physico-chemical properties of such potencies is the presence of structural variations in the solvent, via water molecules aggregates, in number and size suitable to be revealed by a thermodynamic technique. We hope that the frame outlined in this and our preceding work,¹¹⁻¹³ will elicit enough scientific interest to induce other researches to repeat this kind of experiment. Should those repetitions yield positive results, then the current models of water will probably have to be revised.

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