Nuclear Magnetic Resonance characterization of traditional homeopathically manufactured copper (Cuprum metallicum) and plant (Gelsemium sempervirens) medicines and controls

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Background: NMR proton relaxation is sensitive to the dynamics of the water molecule H2O, through the interaction of the spin of the proton (1H) with external magnetic and electromagnetic fields.

Methods: We measured dilution and potentization processes through measurements of 1H spin-lattice T1 and spin–spin T2 relaxation times. In order to interpret the recorded fluctuations in T1- or T2-values, experimental data were linearized by investigating how the area under a fluctuating time = f(dilution) curve (dilution integral or DI) changes with dilution. Two kinds of fitting procedures were considered: chi-square fitting with a goodness-of-fit probability, and least absolute deviations criterion with Pearson’s linear correlation coefficient.

Results: We showed that fluctuations are not attributable to random noise and/or experimental errors, evidencing a memory effect quantifiable by the slope of the DI = f(dilution) straight line. For all experiments, correlation coefficients were found to lie above 0.9999, against 0.999 for random noise. The discrimination between experimental slopes and slopes associated with random noise data was very good at a five-sigma level of confidence (i.e. probability 3 × 10⁻⁷). Discrimination between experimental slopes at a five-sigma level was possible in most cases, with three exceptions: gelsemium aqua pura v gelsemium dilution (four-sigma); copper aqua pura v gelsemium aqua pura (four-sigma) and copper simple dilution v gelsemium simple dilution (three-sigma). All potentized samples show very good discrimination (at least nine-sigma level) against aqua pura, lactose or simple dilution. It was possible to transform the associated relaxation times into a molecular rotational correlation time \( \tau_c \) and an average spin–spin distance d. Our experiments thus point to a considerable slowing down of molecular movements (\( \tau_c > 1300 \text{ ps} \) or \( T = 224–225 \text{ K} \)) around water molecules up to a distance...
Introduction

Recent studies indicate that homeopathically-prepared medicines (HMs) contain source nanoparticles (NPs), and other, less well-characterized structures. Homeopathy is a traditional medicine used worldwide for more than 200 years. Recent RCT-literature audits continue to confirm a possible specific effect of homeopathic treatments. Nevertheless, sceptics insist that HMs are placebos containing no active material in any form. This debate about plausibility and evidence can only be settled by fundamental research. Sceptics tend to focus on dilutions beyond Avogadro’s number derived from bulk source material and ignore the actual manufacturing process, which is more than simple dilution. It is instead a step-by-step trituration in lactose (for water insoluble material) or potentization (for water soluble material), a process also called “dilution-dynamization”. The well-defined trituration process (Ph-Eur 4.1.2) is performed with a 100% porcelain spatula, mortar and pestle. The lactose is added part by part and it takes a full hour for one trituration, arriving at a final dilution of one part start-

of 3.7 A, values. It was also possible to rule out other possible mechanisms of relaxation (diffusive motion, $^{17}$O-$^1$H relaxation or coupling with the electronic spin, $S = 1$, of dissolved dioxygen molecules).

Conclusion: There is clear evidence that homeopathic solutions cannot be considered as pure water as commonly assumed. Instead, we have evidenced a clear memory effect as pure water as commonly assumed. Instead, we have evidenced a clear memory effect upon dilution/potentization of a substance (water, lactose, copper, gelsemium) reflected by different rotational correlation times and average H · H distances. A possible explanation for such a memory effect may lie in the formation of mesoscopic water structures around nanoparticles and/or nanobubbles mediated by zero-point fluctuations of the vacuum electromagnetic field as suggested by quantum field theories. The existence of an Avogadro’s ‘wall’ for homeopathically-prepared medicines is not supported by our data. Rather it appears that all dilutions have a specific material configuration determined by the potentized substance, also by the chemical nature of the containers, and dissolved gases and the electromagnetic environment. This sensitivity of homeopathically-prepared medicines to electromagnetic fields may be amplified by the highly non-linear processing routinely applied in the preparation of homeopathic medicines. Future work is needed in such directions. The time is now ripe for a demystification of the preparation of homeopathic remedies. Homeopathy (2017) 106, 223–239.

Keywords: Nuclear Magnetic Resonance (NMR) relaxation; Copper; Cuprum metallicum; Gelsemium sempervirens; Water; Homeopathy; Potentization; Dynamization

Materials and methods

Rationale: We chose copper as the initial source material for HMs because it has already been characterized by previous authors, because of the well-known role of copper in the mitochondrial enzyme cytochrome c oxidase, and because there is an extensive homeopathic literature published on this homeopathic medicine including a randomized controlled trial. In order to obtain data to compare with those from a metal, we chose a plant tincture, Gelsemium sempervirens, as a soluble second source material; this was because there is a precise definition of this stock, as well as an extended homeopathic literature including references to objective epigenetic changes caused by this homeopathic medicine. For both medicines, particles were identified even in very high homeopathic potentizations.
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