

Original paper

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

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Highlights

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The signature of 2 homeopathic medicines, even in highest dilutions, is identified using NMR relaxations time's measurements.

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Discriminant analysis between a simple dilution and homeopathic potentizations.

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Two homeopathic potentized medicines present specific NMR signals.

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 looking 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 $DI = f(\text{dilution})$ 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 τ_c and an average spin-spin distance d . Our experiments thus points to a considerable slowing down of molecular movements ($\tau_c > 1300$ ps or $T = 224\text{--}225$ K) around water molecules up to a distance of 3.7 \AA , values. It was also possible to rule out other possible mechanisms of relaxation (diffusive motion, ^{17}O - ^1H 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 evidence a clear memory effect upon dilution/potentization of a substance (water, lactose, copper, gelsemium) reflected by different rotational correlation times and average $\text{H}\cdots\text{H}$ 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.