Original Article

Derivation of an empirical relation between the size of the nanoparticle and the potency of homeopathic medicines

Subrata Kar1,2, Poonam Bandyopadhyay1,2, Sweta Chakraborty1, Monalisa Chakrabarty1,2, Biplab Kumar Paul1,2 Sarbari Ghosh1,3, Ruma Basu1,4, Sukhen Das1,2,5, Durga Sankar Bhar1, Rajkumar Manchanda6, Anil Khurana6, Debadatta Nayak6, Papiya Nandy1*

1Centre for Interdisciplinary Research and Education, Kolkata-700 068, India
2Physics Department, Jadavpur University, Kolkata-700 032, India
3Vidyasagar Evening College, Kolkata, India
4Physics Department, Jogamaya Devi College, Kolkata 700 026, India
5Indian Institute of Engineering Science and Technology, Howrah 711103, India
6Central Council for Research in Homeopathy, New Delhi
*Corresponding author: pnandy00@gmail.com

Abstract
Homeopathic medicines are often prescribed at ultra-high dilutions and it is a clinically observed fact that the medicinal effect of the drug remains even at these high dilutions. The increase in potency of a medicine due to potentization is still debatable from physicochemical point of view. Out of various hypotheses to explain this phenomenon, a recent hypothesis, advanced by us and supported by others, is that the size of the constituent particles decreases and eventually achieves nano dimension due to potentization.

From the experiments performed by our group, the size of nanoparticles (NPs) of Cuprum metallicum, Zincum oxydatum, Aurum metallicum, Ferrum metallicum and Aconitum napellus (6cH, 30cH and 200cH) has been estimated. A general mathematical expression of the form \( y = a x^n \) has been derived which relates the size of NPs (y) with the corresponding potencies (x).

There is no method to calculate the accurate potency of the homeopathic medicine, as the potency of a medicine depends to some extent on the method of preparation, for which a standardized procedure is warranted. Also, while handling a medicine, the solvent might evaporate causing a change in the potency. Thus by measuring the size of the NPs and using our proposed standard curve, the potency may be estimated.

Keywords: Nanoparticles, homeopathy, high dilution, size vs potency, nano dimension

Introduction
The fact that homeopathic medicines, propounded in 1796 by Samuel Hahnemann, are active at ultra-high dilutions (UHD) (even beyond Avogadro constant) and that effect of one medicine is different from another medicine of apparently zero concentration has thrown challenges to the scientific community at large. To prepare medicines of higher dilution, one ml of the mother tincture is diluted with 99 ml of strong alcohol and given 10 “succussions” or “jerks” to prepare 1cH potency. In this way by successive dilution and succussions (together termed as potentization), homeopathic potencies are prepared. Few hypotheses have been
The formation of high-dilution metallicum oxydatum medicines, viz., Aconitum napellus, Cuprum metallicum, Ferrum metallicum, Zincum oxydatum and Aconitum napellus, as measured experimentally by us of five different medicines, viz., Cuprum metallicum, Zincum oxydatum, Aurum metallicum, Ferrum metallicum and Aconitum napellus, at three different potencies, 6C, 30C and 200C, we have fitted a geometric curve to this given set of bivariate data by least square method.

Methodology

All the data presented here are the outcome of experiments performed by us. To determine the size of the NPs, we have used high-resolution transmission electron microscopy (HRTEM), FESEM and DLS, following the standard procedures as mentioned in the respective references. Briefly, for FESEM (Model FEI Quanta 250, USA) sample at different potencies (6C, 30C and 200C) was casted on a clean glass cover slip and was directly placed on carbon-coated grid, sputter-coated with gold and then observed. DLS measurements of homeopathic samples were performed using a Nano-ZS 90-Malvern instrument (Model DLS-nano ZS, Zetasizer, Nano series, USA) employing a 4 mW He–Ne laser (λ ¼ 632.8 nm) equipped with a thermostatic sample chamber.

Results and Discussions

The particle sizes for all the five medicines at three potencies were measured several times. The average values of these measurements along with the standard deviation and the equation of the fitted curves are given in Table 1.

The observed sizes of the NPs are taken as the y variable and the potencies 6C, 30C and 200C as x variable and are plotted as shown in the following diagrams: Cuprum metallicum (Fig. 1a), Zincum oxydatum (Fig. 1b), Aurum metallicum (Fig. 1c), Ferrum metallicum (Fig. 1d) and Aconitum napellus (Fig. 1e).

The form of the equation \( y = ax^n \) is same for all medicines while the parameter values \((a\) and \(n\)) are specific for each medicine. The fit in each case is exceptionally good with non-linear correlation coefficient, R-squared being very close to 1 in all cases. Here R is the non-linear correlation coefficient which

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Table 1: Experimental values of average particle sizes against potency of five different homeopathic medicines and the corresponding fitted equations.

Comparison of our result with that reported by Rajendran shows a difference in the values of the size of the particle of Ferrum metallicum, though the general trend i.e., attaining nano-dimension at higher potency remains the same. There might be some underlying reason for this observation which is a further question for exploration.

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**Figure 1** Experimental values of the size and potencies for a) *Cuprum metallicum*, b) *Zincum oxydatum*, c) *Aurum metallicum*, d) *Ferrum metallicum* and e) *Aconitum napelles*; x axis=potency, y axis=size of nanoparticles.

The nature of the curves is found to remain the same for all the medicines, but the parameters $a$ and $n$ vary for different medicines, making the fitted curve characteristic of respective medicine. Hence for a particular potency, the size of the constituent NPs can be estimated by referring to the respective curve. The study proposes that the size of the particles of a medicine differs from that of another at the same potency and it decreases as the dilution increases.

The values of $R^2$ for all the five medicines show that the fitted geometric curves approximate the experimental ones very closely.

**Conclusion**

Our earlier works have confirmed that the size of the NPs reduces with increase in potency. Here we have summed up the results obtained with different medicines at different potencies and have been able to derive a general mathematical expression of the form $y=ax^n$.

The present study proposes that

a) The size of the constituent particles of a homeopathic medicine bears a definite polynomial relation with the potency of the medicine, without implying any casualization. It is a
predictive relationship and statistical dependence is not sufficient to indicate a causal relationship. The knowledge of the potency of the medicine will give an estimate of the size of the constituent particles.

b) Each homeopathic medicine has a characteristic curve for size versus potency.

c) The knowledge of the potency of the medicine will give an estimate of the size of the constituent particles.

Conflict of Interest
The authors report no conflict of interest.

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References
1. Anick DJ, Ives JA. The silica hypothesis for homeopathy: physical chemistry. Homeopathy 2007; 96: 189-95.
2. Elia V, Napoli E, Germano R. The 'memory of water': an almost deciphered enigma. Dissipative structures in extremely diluted aqueous solutions of the homeopathic medicine. Homeopathy 2007; 96(3): 163-69.
3. Nandy P, Bhandary S, Das S, Basu R and Bhattacharyya S. Nanoparticles and membrane anisotropy. Homeopathy 2011; 100(3): 194.
4. Chikramane PS, Kalita D, Suresh AK, Kane SG, Bellare JR. Why extreme dilutions reach non-zero asymptotes: A nanoparticulate hypothesis based on froth dilution. Langmuir 2012; 28: 15864-75.
5. Ghosh S, Chakrabarty M, Das, S, Basu, R, Nandy P. Effect of different potencies of nanomedicine Cuprum metallicum on membrane fluidity – a biophysical study. Am. J. Hom. Med. 2014; 107(4): 161-69.
6. Bandyopadhyay P, Nandy P, Basu, R, Dhar DS, Das, S. Effect of dilution on thermovoltage generation using homeopathic nanomedicine Zincum oxydatum. International Journal of Innovative Research in Science Engineering and Technology 2015; 3(6): 226-30.
7. Kar S, Chakrabarty M, Nandy P, Basu, R. Characterization and Hemocompatibility of Aurum metallicum for its potential use as therapeutic injectables. Complementary Therapies in Medicine (Under review)
8. Chatterjee A, Paul BK, Gayen A, Das S, Nandy P. Effect of potency of homeopathic Nanomedicines on electrical properties of thin film of PVDF-HFP. Proceedings International conference on advances in Bioprocess Engineering and Technology 2016. (accepted for presentation)
9. Chakrabarty M, Ghosh S, Das S, Basu R, Nandy P. Effect of different potencies
of nanomedicine Aconitum napellus on its spectral and antibacterial properties. International Journal of Innovative Research in Science Engineering and Technology 2015; 3: 6861-67.

10. Rajendran ES. An evaluation of Avogadro’s number in the light of HRTEM and EDS studies of high dilutions of Ferrum metallicum 6, 30, 200, 1M, 10M and 50Mc. Int J of High Dilution Res. 2015; 14(3):3-9.

11. Chakraborty M, Das S, Manchanda RK, Basu R, Nandy P. Application of nanomedicine Cuprum metallicum as an agent for remediation of an azo dye, methyl orange and study its associated antimicrobial activity. Int. J. Environmental Sciences 2015 (In press).

12. Goon, Gupta and Dasgupta: Fundamentals of Statistics, Vol 1, The World Press Private Limited, 1975.