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Raman spectroscopy shows difference in extreme dilutions of three drugs with respect to their free OH groups and hydrogen bond strength

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Abstract

Each homeopathic drug is unique with respect to its specific symptoms. There must be physico-chemical correlates for the uniqueness and specificity of a remedy. Using

vibrational and Raman spectroscopy and also DSC we discovered that the physical basis of uniqueness relates to two factors like hydrogen bond strength of the OH group and free water molecules. We have already established that potencies of *Sulphur*, *Natrum mur*, *Calcarea carb*, *Sepia*, *X-ray* and *Magnetis* differ from each other with respect to these two factors. The present study aims at further confirming the results in three potencies of three more drugs like *Merc cor*, *Nux vom* and *Silicea* by Raman Spectroscopy. The potencies studied were 30 cH, 200 cH and 1000 cH. Raman spectra of the potencies were obtained in the wave number region of 2400-4000 cm^{-1} . The intensity ratio at vibration frequencies between 3200 and 3420 (R1) and that between 3620 and 3420 (R2) was calculated for each potency of each drug. Raman spectra shows difference in intensities in different potencies of the drugs. The three potencies of each drug show positive relationship with

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respect to both R1 and R2 values. For each potency the R2 value is much lower than R1 value. R1 values reflect the relative number of OH groups with strong and weak hydrogen bonds. R2 suggests the relative number of OH groups with broken and weak hydrogen bonds. So in all the three drugs tested the higher is the potency rank (30<200<1000) the stronger is the H-bond of the OH groups and the more abundant is the free water molecules. However, H-bond strength of OH predominates over free OH groups or free water molecules. The potencies of other drugs so far studied follow their own pattern of variation with respect to R1 and R2.

Key words : *Merc cor, Nux vom, Silicea*, high dilution, H-bond, free OH, Raman spectra.

Introduction

Extremely diluted drugs, which very often cross the Avogadro number, have

been used in homeopathy with therapeutic success for more than 200 years. The solvent medium of these drugs is aqueous ethanol, and the centesimal potencies of the drugs are prepared by successive dilution of the mother tincture with aqueous ethanol 1:100 followed by mechanical agitation or succussion [1]. The drugs at ultra high dilution (UHD), though chemically identical, maintain their identity and specificity with respect to their therapeutic effect. The purpose of the present study is to decipher the physical basis underlying the therapeutic specificity of UHDs. In a series of experiments we have demonstrated that UHDs of a drug could be differentiated by vibrational and Raman spectroscopy [2-7] as well as by differential scanning calorimetry or DSC [7,8].

All these studies point to the fact that water structures carry the identity of original drugs in their UHDs. The identity in a UHD can be resolved into two factors, namely the quantity of

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free OH groups or free water molecules and the hydrogen bond strength in the OH groups. We propose that these two factors characterize a drug at UHD. The homeopathic drugs, so far studied by us such as *Sulphur*, *Natrum mur*, *Calcarea carb*, *Sepia*, *Nux vomica*, *X-ray* and *Magnetis poli ambo*, show differences from each other and also from their diluent medium aqueous ethanol with respect to the quantity of free water molecules and hydrogen bond strength in the OH groups. In the present study we analysed three homeopathic drugs like *Mercurius corrosivus* (*Merc cor*), *Nux vomica* (*Nux vom*) and *Silicea* by laser Raman Spectroscopy with a view to finding out their free water molecules and hydrogen bond strength. The potencies of each drug studied are 30cH, 200cH and 100cH or 1M.

Materials and methods

Medicines

Three potencies like 30cH, 200cH and 1000cH of each of the three

homeopathic drugs *Merc cor*, *Nux vom* and *Silicea*, purchased from the market at Kolkata, were products of Dr. Reckeweg, Germany. The potencies were in 90% ethanol as mentioned in their labels. Appropriate volume of sterile distilled water was added to each potency so as to make the ethanol content 0.03M. The optical density of all the test samples was measured by a UV-VIS spectrophotometer and found to be same. The purpose was to equilibrate all the test samples with respect to ethanol content. The total test samples were nine.

Raman spectra

Raman scattering measurements of all the samples were taken at 23°C using a micro-Raman setup (Lab Ram HR, Jobin Yuon) equipped with an Argon laser of wavelength 488 nm and CCD detector. The spectra of potency samples were obtained in the wave number region of 2400-4000 cm^{-1} , and analysed at

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suitable baseline correction. The experiments were repeated thrice, and the results were similar. The data from the second experiment are reported here.

In a solution of ethanol and water, OH band undergoes changes in integral intensity and contour shape. The intensity ratio of vibrational frequencies at 3200 and 3420 cm^{-2} (R1) provides information about the relative number of OH groups with strong and weak hydrogen bonds. The ratio of intensities at 3620 and 3420 cm^{-1} (R2) reflects the relative number of OH groups with broken and weak hydrogen bonds [9,10]. We have calculated the two ratios R1 and R2 from the Raman spectra of each of the 9 test samples.

Results

Raman spectra of the 30th potency of each of three drugs *Mercor*, *Nux vom* and *Silicea* are presented in figures 1,2,3, respectively. All the

potencies of each drug show difference in intensities with respect to their ranks like 30, 200 and 1000. The sharp peaks of high intensities belong to CH stretching band of ethanol present in each sample. The broad dome-shaped peaks of lower intensities belong to OH stretching band of both water and ethanol (Figs, 1,2,3).

Intensity ratios

The ratios R1 and R2 of the three potencies of each drug show marked difference from each other (Figs. 4-9). The three potencies of *Mercor* show a positive relationship with respect to both R1 and R2 values (Figs. 4,5) such as 30<200<1000. Similar is the situation with the potencies of *Nux vom* (Fig. 6,7) and *Silicea* (Fig. 8,9). The results obtained with R1 and R2 values for the three potencies of each drug are presented in histograms in Figs. 10 (*Mercor*) 11 (*Nux vom*) and 12 (*Silicea*). The R2 values are much lower

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than R1 values in each potency of each drug. However, there is a rising trend with respect to potency rank for each drug (Figs. 10,11,12).

Discussion

When a molecule is placed in a static electric field its positively charged nucleus is attracted to the negative pole and the negatively charged electrons attracted to the positive pole. This produces an induced dipole moment in the molecule, which is then polarized.

The intensity of Raman scattering, which varies in different potencies of drugs studied, is proportional to the electric dipole-electric dipole polarizability of change. Raman spectra are dependent on the vibrational energy levels of the ground electronic states of the samples (Wikipedia 2016). So different potencies observed here show distinct variation relating to the electric dipole-dipole

polarizability of water ethanol molecules.

Intensity ratio

In this study both R1 and R2 values show positive relationship with respect to potency ranks (Figs. 4-9). This means that the higher is the potency rank the stronger is the hydrogen bond and more abundant is the free water molecules. Again in all the drugs tested the R2 values are much lower than R1 values (Figs 10-12). This indicates that the hydrogen bond strength (R1) dominates over the number of free water molecules (R2).

In our earlier study we observed that potencies of *Sulphur*, *Natrum mur* and *Calcareo carb* show negative relationship with respect to R1 values. This means the lower is the potency the stronger is the H-bond of the OH group [7,8]. In case of *Sepia*, the higher is the potency rank, the stronger is the H-bond of the OH group [7]. In case of

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Sulphur and *Natrum mur* the higher is the potency rank the more abundant is the free OH group or free water molecules [5]. In case of *X-ray* and *Magnetis Poli Ambo* the potency ranks do not follow any specific pattern of relationship although they show distinct variation from each other [8]. All these results very clearly show that each homeopathic potency maintains its unique identity with respect to two factors, hydrogen bond strength of the OH group and quantity of free water molecules. Since the process of preparation of potencies is same for all homeopathic drugs, it can be assumed that the starting material in a mother tincture is the main factor which induces variation in potencies.

Conclusion

1. The three potencies 30 cH, 200 cH and 1000 cH of each of three drugs *Merc cor*, *Nux vom* and *Silicea* show positive relationship between the

potency ranks and H-bond strength of the OH group, and that between the ranks and free water molecules. The higher is the potency rank the stronger is the H-bond of the OH group and more abundant is the free water molecules.

2. Hydrogen bond strength of the OH group in all the potencies studied dominates over the quantity of free water molecules.

Conflict of interest

None declared

Acknowledgement

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Figures

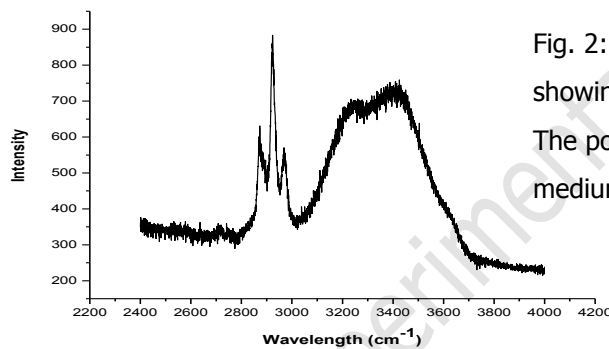


Fig. 1: Raman spectra of *Merc cor* 30 cH showing sharp peaks of CH stretching vibration and broad peak of OH stretching vibration. The potency is in aqueous ethanol medium with 0.03M ethanol content.

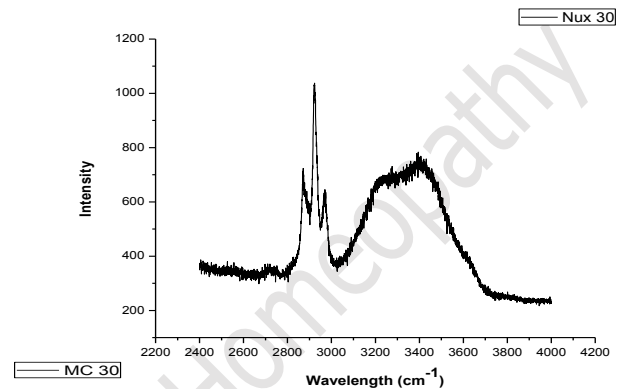


Fig. 2: Raman spectra of *Nux vom* 30 cH showing CH and OH stretching bands. The potency is in aqueous ethanol medium with 0.03M ethanol content.

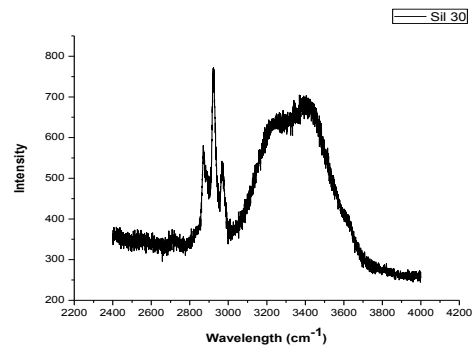


Fig. 3: Raman spectra of *Silicea* 30 cH showing CH and OH stretching bands. The potency is in aqueous ethanol medium with 0.03M ethanol content.

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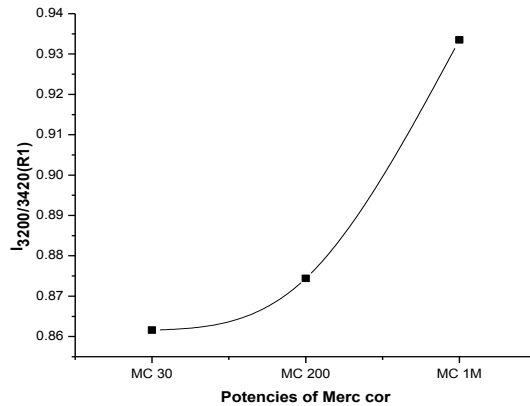


Fig. 4: Intensity ratio I_{3200}/I_{3420} (R1) calculated from the Raman spectra of *Merc cor* 30 cH, 200 cH and 1000 cH in 0.03M ethanol. R1 shows positive relationship with potency ranks 30<200<1000.

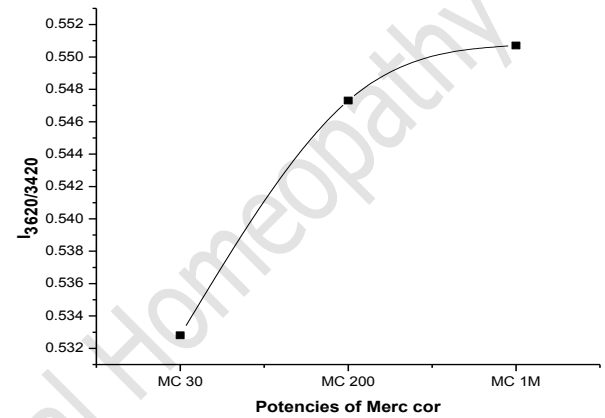


Fig. 5: Intensity ratio I_{3620}/I_{3420} (R2) obtained from the Raman spectra of *Merc cor* 30 cH, 200 cH and 1000 cH in 0.03 M ethanol. R2 shows positive relation with potency ranks 30<200<1000.

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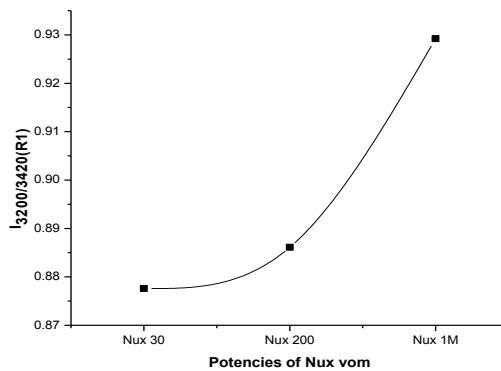


Fig. 6: Intensity ratio I_{3200}/I_{3420} (R1) calculated from the Raman spectra of *Nux vom* 30 cH, 200 cH and 1000 cH in 0.03M ethanol. R1 shows positive relationship with potency ranks $30 < 200 < 1000$.

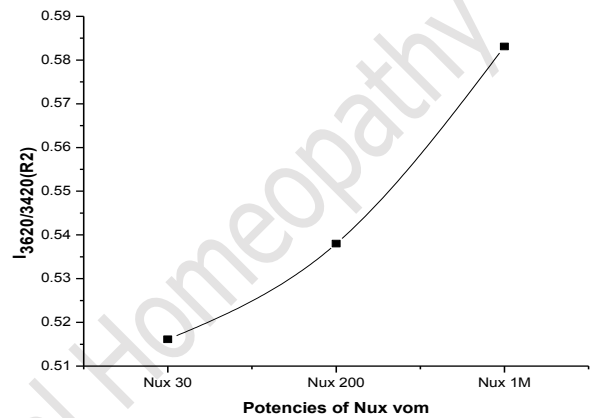


Fig. 7: Intensity ratio I_{3620}/I_{3420} (R2) obtained from the Raman spectra of *Nux vom* 30 cH, 200 cH and 1000 cH in 0.03 M ethanol. R2 shows positive relation with potency ranks $30 < 200 < 1000$.

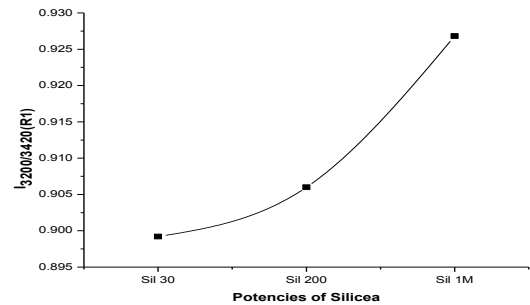


Fig. 8: Intensity ratio I_{3200}/I_{3420} (R1) calculated from the Raman spectra of *Silicea* 30 cH, 200 cH and 1000 cH in 0.03M ethanol. R1 shows positive relationship with potency ranks $30 < 200 < 1000$.

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200 cH, 1000 cH in 0.03M ethanol.
R2 < R1.

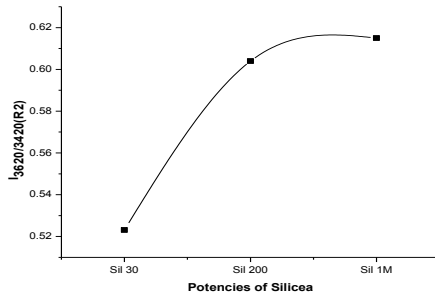


Fig. 9: Intensity ratio I_{3620}/I_{3420} (R2) calculated from the Raman spectra of *Silicea* 30 cH, 200 cH and 1000 cH in 0.03M ethanol. R1 shows positive relationship with potency ranks 30 < 200 < 1000.

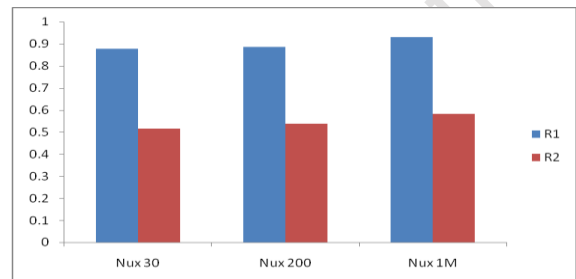


Fig. 11: Histogram showing intensity ratio R1 and R2 values obtained from the Raman spectra of *Nux vom* 30 cH, 200 cH, 1000 cH in 0.03M ethanol. R2 < R1.

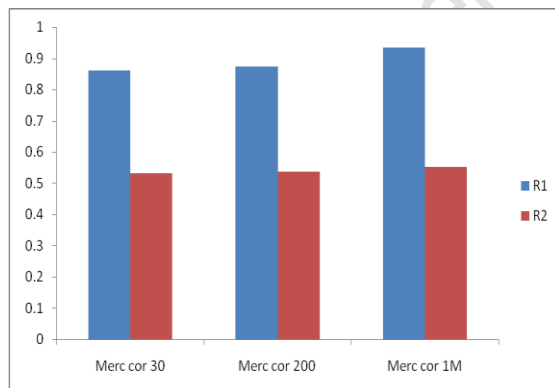


Fig. 10: Histogram showing intensity ratio R1 and R2 values obtained from the Raman spectra of *Merc cor* 30 cH,

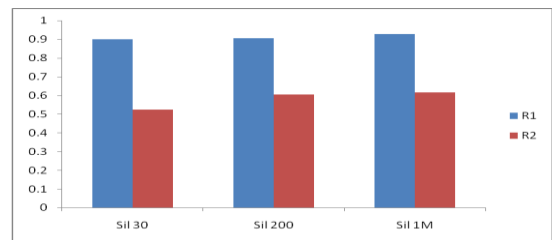


Fig. 12: Histogram showing intensity ratio R1 and R2 values obtained from the Raman spectra of *Silicea* 30 cH, 200 cH, 1000 cH in 0.03M ethanol. R2 < R1.

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