Original Article

Effect of *Cuprum metallicum* potentised through both serial dilution and succussion in comparison to succussion alone on *Escherichia coli* bacterial system and electrical properties of poly (vinylidene fluoride-co-hexafluoropropylene) polymer

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Abstract

Background: Homoeopathic medicines are traditionally potentized by serial dilution followed by succussion. Respective roles of these two components need to be assessed and explored for which the present study was undertaken. **Objective:** To compare the effect of the medicine *Cuprum metallicum (Cup. met.)* potentised through both serial dilution and succussion with succussion alone on selected biological and physical systems. **Method:** Starting with the medicine *Cup. met.* at 6C, we potentized it further to 30C and 200 C by serial dilution, followed by succussion (Set A). The same medicine at 6C was also potentized to 30C and 200C by using succussion alone (Set B). The antibacterial property of these two sets was compared on *E. coli*, a biological system and electrical properties on polymer matrix PVDF-HFP (widely used as charge separator) a physical system. **Results:** Field Emission Scanning Electron Microscopy shows that the particles get more agglomerated at higher potency in Set B. Antibacterial effect of *Cup. met.* in Set B at 30C and 200C was observed to be more significant as compared to Set A. Effect of *Cup. met.* on polymer matrix in Set A varied significantly with the potency as compared to Set B wherein less beta phase crystallization was produced followed by no significant change in electrical properties. **Conclusion:** Comparison of results using the medicine *Cup. met.* in two experimental set ups shows that serial dilution with succussion makes an important difference between the two sets.

Keywords: *Cuprum metallicum*, *Escherichia coli*, Polymer film, Potentisation, Serial dilution, Succussion

Introduction

Homoeopathic potentisation of Hahnemannian era constituted of serial dilution followed by either trituration or succussion or both depending on the type of drug substances. In the preparation of potencies from solid drug substances, decimal and centesimal scales are used. In the preparation of liquid drug substances, manufacturing of homoeopathic medicines is from the mother solution (tincture) by serial dilution and succussion (mechanical agitations) in one of the three potency ranges, decimal (1:9), centesimal (1:99), or fifty-millesimal. Solid insoluble materials (e.g., *Cuprum metallicum* [*Cup. met.*]) are triturated with lactose in the ratio of 1:10 till the 6X potency, after which, the liquid dilutions are carried out. The liquid dilutions are prepared by the Hahnemannian method[1] till the 200C potency and the Korsakovian method for potencies beyond 200C.

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Potentisation, the most vital part of preparation of homoeopathic medicine, transforms the starting material to a therapeutically active one. It has got two components: (a) Serial dilution and (b) vigorous vertical jerking, known as succussion.

The paradox created debate between practicing homoeopaths and rationalists, as they felt that there is no medicine present

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at very high dilution.[2] However, as the effectiveness of high potencies is experienced by the practicing homoeopaths and countless patients, more positive opinions started accumulating, backed by different models, in favour of the therapeutic effect of these medicines at high potency.

The question naturally arises, why do, in the preparation of homoeopathic medicine, we dilute instead of concentrating.[3] We have, for the first time, shown that there is a difference between the effects of two kinds of potentisation: serial dilution, followed by succussion, and only succussion.

Recently, it has been realised that it is not only the dilution, but the succussion followed after each dilution, which is responsible for these effects at high potency. By means of vigorous shaking, a large amount of mechanical energy is transferred, This energy breaks the drug associates and reduces the size to nanodimension.[4-6] This reduction in size increases membrane permeability.[7]

The empirical relation between potency (X) and the size of the drug aggregates (Y) is given by the following equation:[8]

$Y = aX^{-n}$

Where *a* and *n* are characteristic constants of different medicine.

It has been experimentally proven that extreme homoeopathic dilutions retain starting materials.[9] To understand the extreme dilutions from a biological perspective, it has been shown that metal concentration as low as fg/ml increases the intracellular protein synthesis.[10] It has also been shown that the particles develop a coat of silica, and a hypothesis has been proposed that all types of metal and inorganic salt-based homoeopathic medicines consist of silicate-coated nanostructures dispersed in the solvent.[11]

Hence, the term potentisation indicates the qualitative and quantitative increase in medicinal power as compared to mere dilution. And thus, Homoeopathy is seen as nanomedicine.[12] The increase of the activity of the drug with potentisation arises as the surface area increases manifold and the number of points of contact with the living fibre increases. At the same time, the process of succussion is responsible for inducing electrical nature due to domain formation as predicted by quantum electrodynamics (QED). Due to this, the physicochemical properties of the vehicle medium change drastically, as the effect of QED starts playing a major role.[13-18]

According to Hahnemann, a small dose of medicine, when potentised, is also very powerful. This not only reduces the toxic effect of overdose but also forms intimate mixture of the medicine with the vehicle due to vigorous shaking. This is intended to avoid aggravation of the disease and increase the activity of the medicine as the medicine acts '*not atomically but dynamically'*. Dilution is essential for getting the dynamising effect of succussion and that '*all the shaking in the world will not dynamize an undiluted substance'*.

Thus, potentisation (dilution, followed by succussion) affects both the drug material of a homoeopathic medicine and the medium as follows:

- From *classical point of view*, due to succussion, the drug material achieves nanodimension and nanoparticles are formed. This reduces the toxic effect and increases the activity due to the increase in aspect ratio[4-8]
- From *quantum mechanical point of view,* it changes the electrical nature of the polar medium through the formation of coherent domains of the solvent molecules, which provides quasi-free electrons and increases the stored electrical energy of the medium.[13-18]

This establishes the electrical nature and the mode of action of homoeopathic medicine. Perhaps, this electrical energy which is stored in the system is the so-called dynamic power of the homoeopathic medicine as envisaged by Dr. Hahnemann.

The question then naturally arises is, as to how to compare the role of dilution and succussion in potentising a medicine. In the present study, the experiment is conducted to observe and compare the effect of serial dilution and succussion to succussion alone using homoeopathic medicine, *Cup. met.* on the biological and physical systems, whereas in our earlier study,[7] the standard potentised *Cup. met.* has been used. This medicine is used because of its good dispersion in different polymers and good antibacterial and conductive properties which can be utilised as a dielectric charge separator in high charge storage system. In addition, the formation of the film using this polymer is an easy, low-cost and simple solution casting technique.

Methods

For both the biological and physical systems, we have used control, where *Cup. met.* was not used. That the presence of the drug is responsible for the observed effect is justified as the vehicle medium of 91% ethanol had been evaporated in both cases within a very short span of time. Hence, the presence of drug only is responsible for the observed effects.

Preparation of the two sets of homoeopathic medicine

For making potencies by trituration with lactose in porcelain mortar and pestle, a mechanical device manufactured by F. Kurt Retsch KG from Germany was used. During potentisation in centesimal scale with ethyl alcohol, each step of potentisation was done manually in neutral (USP III) glass bottles using new bottle in each step. The whole operation was done following the Good Manufacturing Practice.

Potencies of *Cup. met.* were prepared from pure copper powder, first by trituration with lactose up to 6X potency, converting the same into liquid 8X (=4C) potency and potentising the 4C potency by dilution (with 91% ethanol) followed by succussion up to 6C potency. This 6C potency was taken as the starting material for our study.[19]

Set A: The potencies of *Cup. met.* were prepared in the method described in the Homoeopathic Pharmacopoeia of India

(HPI). The method may be elaborated as one part of copper metal powder (99.6% pure) was triturated mechanically with 9 parts of 80 mesh lactose powder of pharmacopoeial (HPI, British Homoeopathic Pharmacopeia [BHP] and United States Homoeopathic Pharmacopeia [HPUS]) quality for 1 h to produce 1X potency. The same 1X potency of *Cup. met.* was again triturated with lactose in the same way and proportion to yield 2X potency. This method of trituration was continued till we got 6X potency of *Cup. met.*

One part by weight of this *Cup. met.* 6X was dissolved in 50 parts by volume of distilled water (purified water of HPI/BHP/HPUS standard) to which 50 parts by volume of ethyl alcohol (91%) was added, and the mixture was given ten succussions to get 8X (=4C) potency. Henceforth, potentisation was done by diluting one part of the previous potency with 99 parts of ethyl alcohol and giving the mixture ten succussions (shaking strongly with downwards stroke) always in a new glass bottle, one-third volume of which was kept empty for proper shaking, to get the next potency in centesimal scale. This process of serial dilution and succussion was carried out till 6C initially, as 6C is taken as the starting material in both the groups (Set A and Set B).

- Set A: Serial dilution and succussion was carried out as stated above till 200C as per the standard method of potentisation
- Set B: Here starting from 6C potency, further potentisation was done without further dilution by succussing the 6C potency, making it equivalent to 30 and then further succussion to make it equivalent to 200C potency.

The schematic diagram for the preparation of these two sets of medicine is shown in Figure 1.

Effects of these two sets of potentised medicines were compared for the antibacterial property on Gram-negative bacteria *Escherichia coli*[20] and on the electrical properties of a polymer matrix poly (vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP).[21-24]

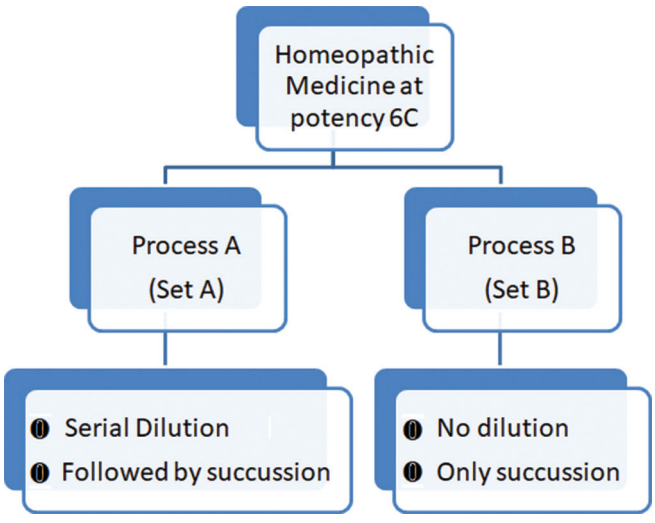

Figure 1: The two sets of potentisation: Set A and Set B

Antibacterial effect of *Cuprum metallicum*

Fresh culture of *E. coli* in nutrient broth was treated with *Cup. met.* at required potency, prepared as in Set A and Set B in 91% alcohol and left overnight.[20] The alcohol was allowed to evaporate gradually. There was a possibility of the bacteria being affected by the alcohol present in the medicine. However, this effect should be same for all the potencies of the medicine used. And hence, it was inferred that the final outcome was the effect of the potency of the medicine.

The vehicle control was 91% alcohol. In order to make sure about the reproducibility, all the experiments with Set A and Set B at the potencies 6C, 30C and 200C were repeated at least 3–4 times.

Cuprum metallicum–poly (vinylidene fluoride-co-hexafluoropropylene) composite film preparation technique

The *Cuprum metallicum*-doped composite films were synthesised by low-cost and simple solution-casting fabrication technique. In a typical synthesis process, 100 mg of PVDF-HFP (Sigma Aldrich, USA, 3050 Spruce St., St. Louis, MO 63103, 400 Summit Drive, Burlington, MA 01803) was dissolved into 2 ml of dimethyl sulfoxide (Merck, India, 8th Floor, Godrej One, Pirojshanagar, Eastern Express Highway, Vikhroli (E) Mumbai - 400 079, India) and mixed together under vigorous stirring at 50°C for 4 h. Measured amount of freshly prepared *Cup. met.* at a specific potency was obtained from Hahnemann Publishing Company, India (Near Sealdah Fly-Over & Koley Mrkt, Kolkata, West Bengal 700012), and was added to the solution and stirred for another 2 h at 50°C. Afterwards, the whole solution was sonicated three times for 10 min each at 50°C with 30 min of time interval for the complete removal of the air bubbles from the solutions. Finally, films were obtained by casting the whole mixture in clean dry Petri dishes and solvent was evaporated in an oven at 80°C for 24 h. The films were then coated by silver paste on both sides for electrical measurements.[21-24] The synthesised films had the thickness in the range of 50–55 μm as measured using a digital micrometer. The schematic diagram for the preparation of *Cup. met.* PVDF composite films is shown in Figure 2.

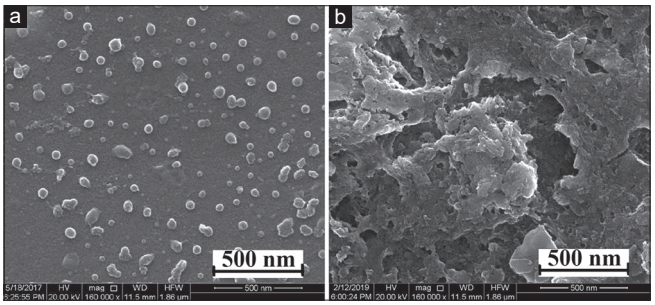

Figure 2: Field emission scanning electron microscope images of poly (vinylidene fluoride-co-hexafluoropropylene) doped 200C *Cup. met.* medicine of (a) Set A[22] and (b) Set B

Field emission scanning electron microscope analysis of pure *Cuprum metallicum* medicine of Set A and Set B potentisation

To examine the microstructure, 20 drops of each medicine was dried in a cover slip and finally made to pass through the experiment under the microscope namely FEI-F50 (Netherlands).

Measurement of electrical properties

The dielectric properties were investigated using a LCR meter (HP model 4274A, Hewlett Packard, USA, 99 Washington Street, Melrose, MA 02176-6024). The dielectric constant (ε_r), tangent loss (tanδ) and AC conductivity (σ_{ac}) were recorded in the frequency range of 20 Hz–2 MHz at room temperature.

Results

Field emission scanning electron microscope analysis of pure *Cuprum metallicum* medicine of Set A and Set B potentisation

The field emission scanning electron microscope (FESEM) microstructural overview of pure *Cup. met.* at 200C as obtained from two different potentisation processes of Set A and Set B is shown in Figure 3a and b, respectively. Figure 3a shows the morphology and microstructure of pristine 200C *Cup. met.* of Set A.[22] The microstructure of the sample confirmed a very good and homogeneous distribution of the nanoparticles on the surface of the glass cover slip. The particles are more scattered, are well separated and also homogeneously distributed, maintaining an intermolecular distance. This is due to the very high dilution at 200C.

On the other hand, Figure 3b shows the microstructure and morphology of the pristine 200C *Cup. met.* of Set B, where only succussion is done without dilution. The microstructure of the sample confirmed an evidence of large number of densely packed agglomerated particles having very low dimension embedded in the surface of the glass cover slip.

In the dilute medium, particles are scattered [Figure 3a]. However, in the absence of dilution, nanoparticles created due to succussion get agglomerated [Figure 3b].

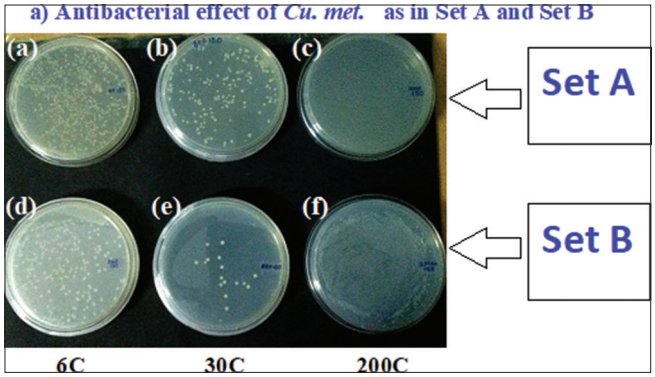

Figure 3: Antibacterial effect of *Cup. met.* for Set A (a) 6C, (b) 30C and (c) 200C[20] and Set B (d) 6C, (e) 30C and (f) 200C

Antibacterial effect of *Cuprum metallicum*

The antibacterial effect shown in Figure 4a (6C), Figure 4b (30C) and Figure 4c (200C) is for the potentised medicine *Cup. met.* namely as in Set A,[20] whereas Figure 4d (6C), Figure 4e (30C) and Figure 4f (200C) are for Set B of *Cup. met.* From the figure, we realise that for Set A, the antibacterial effect is more for drug at 30C, compared to that for 6C.[20] The effect becomes more for drug at 200C. The reason for this is perhaps as at higher potency, the size of the drug particles becomes smaller[8] and the penetration through membrane barrier is more, giving rise to higher antibacterial effect.[20]

In Set B, as there is no dilution, the amount of drug available is same for all potencies from 6C to 200C, a larger number of nanoparticles are produced by succussion and the antibacterial effect is more here for 30C and 200C compared to that in Set A.

For Set B, at 200C, the figure indicates that in the presence of significant number of drug molecules, a large number of nanoparticles are created through succussion, which agglomerate, as is evident from the FESEM, and are incapable to penetrate the bacterial membrane.

Field emission scanning electron microscope morphological investigation of poly (vinylidene fluoride-co-hexafluoropropylene)-*Cuprum metallicum* nanocomposite films

Figure 5a-c shows the evidence of densely packed and good dispersion of nanoparticles embedded in the polymer matrix. From the critical observation, it can be seen that with increasing potentisation, the polymer matrix had an increasing crystallisation and reached maximum enhancement of electroactive β-polymorph at 200C potency for the medicine of Set A.

Figure 6a and b shows the evidence of significant number of nanoparticles which got agglomerated at higher potency of Set B and embedded in the PVDF-HFP matrix. This is due to the high number of succussions at 30C and 200C.

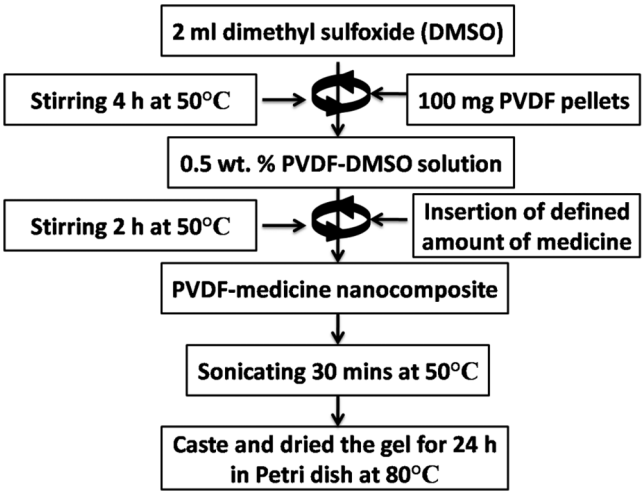

Figure 4: The schematic diagram for the preparation of *Cup. met.*–poly (vinylidene fluoride-co-hexafluoropropylene) composite films

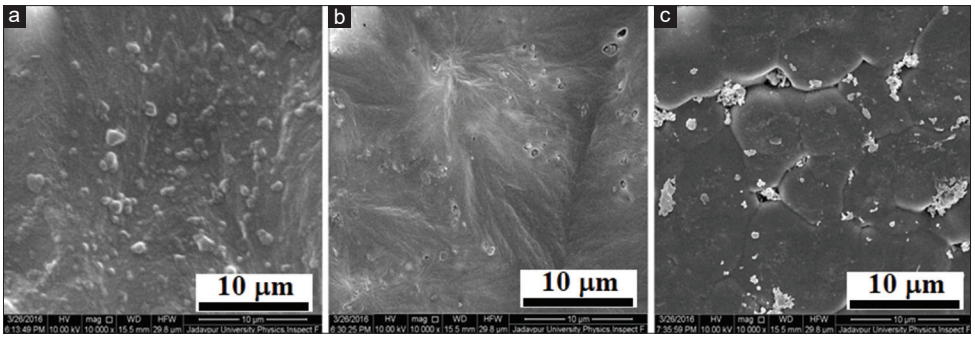

Figure 5: Field emission scanning electron microscope microstructural overview for Set A of poly (vinylidene fluoride-co-hexafluoropropylene) doped *Cuprum metallicum* (a) 6C, (b) 30C and (c) 200C[22]

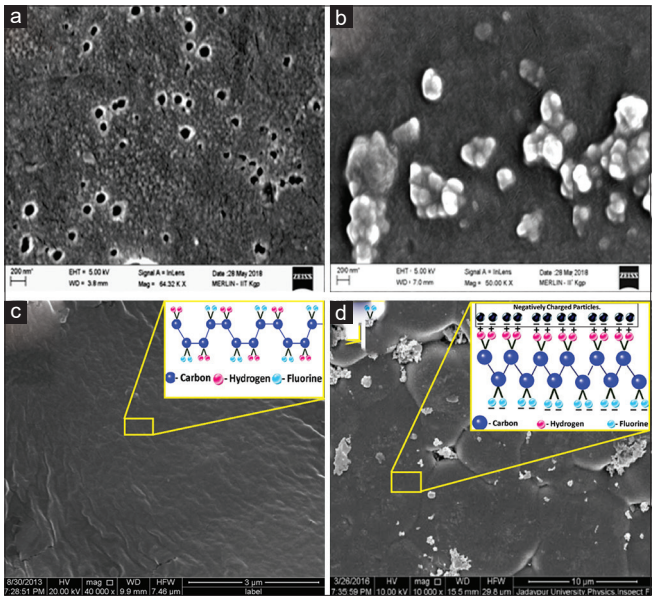

Figure 6: Field emission scanning electron microscope microstructural overview for Set B of poly (vinylidene fluoride-co-hexafluoropropylene) doped *Cup. met.* (a) 30C, (b) 200C and (c) microstructure of poly (vinylidene fluoride-co-hexafluoropropylene) doped *Cup. met.* of 200C and the crystal structure of α-polymorph (inset graph) and (d) microstructure of *Cup. met.* of 200C embedded poly (vinylidene fluoride-co-hexafluoropropylene) and the crystal structure of β-polymorph (inset graph).[22] 6C is the starting material both for Set A and Set B and is not shown separately

Thus, from the FESEM investigation, it can be clearly concluded that, for the Set A medicine [dilution followed by succussion – Figure 5a-c], there is no significant agglomeration with very good dispersion and distribution due to high dilution of the medicine, whereas for the Set B medicine [without dilution, only succussion – Figure 6 (a and b)], there is agglomeration of embedded nanoparticles in the PVDF matrix, which results in less β-phase crystallisation. The inset graph of Figure 6c shows the crystalline α-polymorph where the hydrogen and fluorine dipoles are packed in antiparallel way with the carbon atoms, whereas the inset graph of Figure 6d shows the positively charged CH_2 dipoles of PVDF-HFP interacted with the negatively charged nanoparticles, leading to the alignment of stabilised β-chains which have been shown in the inset graph of Figure 6d and Figure 7. From chemistry point of view, a clear electrostatic interaction mechanism was also explained by the theory of β-phase nucleation in our previous publications.[22-24] Based on this theory, when the positively or negatively charged nanoparticles are added to the host solution, the opposite (partially negative CF_2 or positive CH_2) dipoles are oriented towards the surface of the nanoparticles, which perform as substrates for β-phase nucleation. This mechanism leading to the alignment of stabilised PVDF-HFP chains in longer all trans-conformation, results in electroactive β-phase.[23-24]

Measurement of electrical properties of polymer matrix: effect of potentised *Cuprum metallicum* in Set A and Set B

For Set A, *Cup. met.* enhances the more electroactive β-phase of the polymer matrix, enhancing the conductivity and dielectric constant and reducing the tangent loss of the medium.[21-25]

For the polymer matrix, when many more agglomerated nanoparticles are available as in the case of Set B, the arrangement of the β-polymorph in the matrix gets destroyed, which becomes less electroactive and reaches a stable nature. Hence, the electrical properties cannot be further enhanced.

Figure 8 shows the variation of the dielectric constant, tangent loss and electrical conductivity of the composite material as a function of frequency. All the details regarding measurement procedure have been reported by us earlier in various reputed journals.[21-26] In Set A, the number of drug particles decreases with dilution and the size decreases with succussion.[8] Hence, the particles are more scattered and well separated and also homogeneously distributed, maintaining an intermolecular distance between the particles, which enhances the nucleation of β-polymorph, resulting in very good dielectric performance.[21-25] In Set B, the number of drug associates remains constant, but the size decreases with succussion, enhancing the agglomeration in the polymer matrix. Thus, the increasing agglomeration and the encapsulation of drug material by silicates will increase and the mobility of the particles will be inhibited, keeping the electrical properties unaltered.

Hence, the outcome of these two experiments using Set A and Set B on *E. coli* and polymer matrix has been quite interesting. The generation of larger number of nanoparticles in Set B

plays a major role and changes the usual pattern obtained with Set A. As in both the cases the solvent had been evaporated to dryness to make films, we can rule out the effect of vehicle medium on the observed phenomena. The presence of copper in the film had been verified earlier.[24,26]

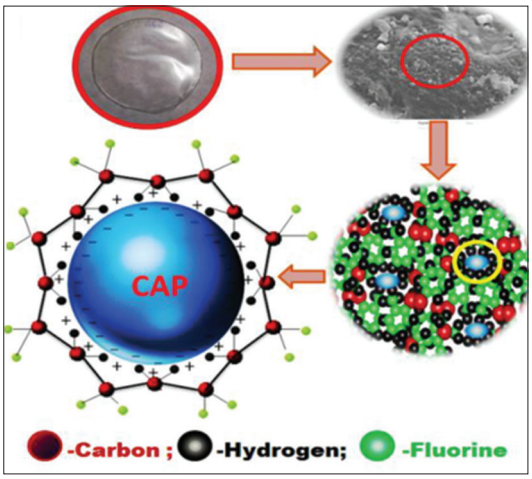

Figure 7: The schematic representation for nucleation of β-polymorph in poly (vinylidene fluoride-co-hexafluoropropylene)[24]

Discussion

The results using Set A and Set B have been summarised as follows:

Antibacterial effect of the medicine *Cuprum metallicum* on *Escherichia coli*

In Set A, the number of drug particles decreases with dilution and the size decreases with succussion, enhancing the membrane permeability, and the growth is inhibited, as expected. However, for Set B, when there is no dilution, the amount of drug available is same for all potencies from 6C to 200C and a larger number of nanoparticles are produced by succussion and the antibacterial effect is more here for 30C and 200C compared to that in Set A.

Effect of *Cuprum metallicum* on the electrical properties of poly (vinylidene fluoride-co-hexafluoropropylene) matrix

- For Set A, the effect varied significantly with potency (i.e., with dilution). Here, the number of drug associates decreased with dilution and the size decreased with succussion, enhancing the mobility of the particles, which enhances the electroactive beta phase of the polymer matrix, enhancing the conductivity and good dielectric performance

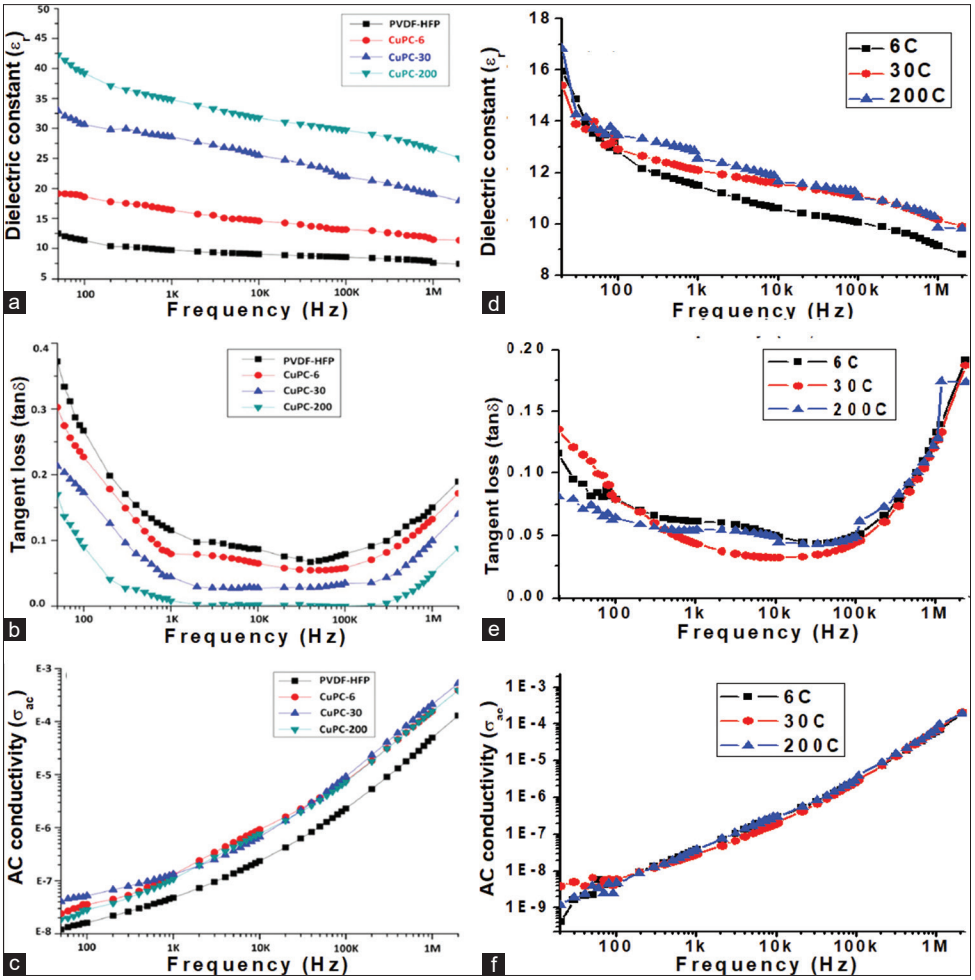

Figure 8: Effect of *Cup. met.* on the electrical properties of polymer matrix (a), (b), (c) for Set A[22] and (d), (e), (f) for Set B

- For Set B, no significant change in electrical properties with change in potency is observed. Here, the number of drug associates remains constant, but the size decreases with succussion, enhancing the surface area. Thus, the effect will be twofold: the number of nanoparticles will increase, increasing the possibility of agglomeration and restricting the movement of charged particles, and also due to the encapsulation of drug material by silicates, the mobility of the particles will be inhibited. Both these factors will keep the electrical properties unaltered.

The difference between the two results gives an indication about the role of dilution and succussion in the process of potentisation of homoeopathic medicines and their impact on the biological and physical systems.

From the conducted experiments, it is observed that in case of Set B, when there is no serial dilution and only succussion, the total number of drug associates remains the same at all potencies, and a large number of nanoparticles are created due to succussion, which produced more significant antibacterial effect in both 30C and 200C of Set B, as compared to Set A where the maximum antibacterial effect was exhibited only at 200C. In Set B, the electrical properties of the polymer matrix remained unaltered with potency of *Cup. met.* as compared to Set A, where serial dilution with succussion was carried out. Here, the particles were more scattered and well separated and also homogeneously distributed, maintaining an intermolecular distance between the particles. This enhanced the nucleation of β-polymorph results in very good dielectric performance, which signifies the role of dilution as in Set A.

We agree with the principle of Homoeopathy, where it is always advocated to use the minimum dose, which means that the lower the concentration of the drug, better is the result. For higher concentration of the drug, the functioning of the medicine will be inhibited, which may be due to the re-agglomeration of nanoparticles of the drug material or due to saturation of the holding/absorption points in the system.

Higher number of succussions would ensure proper formation of the drug nanoparticles of different degree while bringing these remedies into the range of hormetic biological action.[10]

Conclusion

Our experimental results show that the drug *Cup. met.*, potentised by serial dilution, followed by succussion, can produce significant effect on both bacterial system and polymer matrix. However, by increasing the potency by succussion only, a large number of nanoparticles are created which produce significant change in lower potencies, monitoring the effect of the medicine in both biological and physical systems chosen. Due to proximity, these nanoparticles may agglomerate again to make bigger particles. Thus, while succussions are necessary for the potentisation, the role of dilution seems equally important.

Further experimentations are required using different drugs to identify the appropriate and most effective way of the degree of dilutions i.e., the critical level of dilution.

We would like to mention here that to the best of our knowledge, this experiment is the first of its kind to find out the role of succussion and dilution to potentise the starting material to a therapeutically active one.

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The results from References 22 and 24 were quoted here for the sake of comparison, and the authors express their thanks for the permission received from *Springer Nature* as follows:

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Conflicts of interest

None declared.

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ई–कोलाई बैक्टीरिया प्रणाली और PVDF HFP बहुलक के विद्युतिय गुणों पर अकेले उत्तरावर्धन की तुलना में क्रमिक विलयन और उत्तरार्धन दोनों के माध्यम से प्रबलित क्यूप्रम मेटालिकम का प्रभाव।

पृष्ठभूमि : होम्योपैथिक दवाओं को पारंपरिक रुप से क्रमिक विलयन के पश्चात उत्तरावर्धन प्रक्रियाओं द्वारा शक्तिकृत किया जाता है। इन दो घटकों की प्रतिक्रियात्मक भूमिकाओं के आंकलन और अन्वेषण की आवश्यकता हेतु अध्ययन किया गया।

उद्देश्य : अकेले उत्तरावर्धन की तुलना में क्रमिक विलयन और उत्तरावर्धन दोनों के माध्यम से प्रबलित क्यूप्रम मेटालिकम का चयनित जैविक और भौतिक प्रणालियों पर दवा के प्रभाव का तुलनात्मक अध्ययन।

विधि : शुरुआत में क्यूप्रम मेट 6C को लिया, क्रमिक विलयन के पश्चात उत्तरावर्धन द्वारा इसे 30C और 200C तक बढ़ा दिया गया (सेट ए)। इसी दवा को 6C से 30C और 200C तक अकेले उत्तरावर्धन प्रक्रिया द्वारा शक्तिकृत किया गया(सेट बी) ई कोलाई पर दवा के जीवाणुरोधी गुणों का प्रभाव एक जैविक प्रणाली और बहुलक मैट्रिक्स PVDF-HFP जो व्यापक रुप से चार्ज विभाजक के रुप में उपयोग किया जाता है, के प्रभाव की तुलना भौतिक प्रणाली से की गई।

परिणाम : फील्ड एमिशन स्कैनिंग इलेक्ट्रॉन माइक्रोस्कोपी से पता चलता है कि क्यूप्रम मेट के सेट बी एंटीबैक्टीरियल प्रभाव में कणों को उच्च क्षमता पर अधिक एग्लोमेरेट किया जाता है। सेट ए की तुलना में सेट बी में क्यूप्रम मेट, 30 सी और 200 सी की जीवाणु रोधी प्रभावोत्पादकता अधिक महत्वपूर्ण पाई गई। सेट ए में पॉलिमर मैट्रिक्स पर सेट बी की तुलना में क्यूप्रम मेट की पोटेंसी के प्रभाव में महत्वपूर्ण परिवर्तन हुआ। जिसमें कम बीटा चरण क्रिस्टलीकरण का उप्पादन हुआ, विद्युतिय गुणों में कोई महत्वपूर्ण परिवर्तन नहीं हुआ।

निष्कर्ष : दवा क्यूप्रम मेट का उपयोग करके दो प्रयोगात्मक सेट अप के परिणामों की तुलना करने पर पता चलता है कि क्रमिक विलयन और उत्तरावर्धन के दो सेटों के बीच एक महत्वपूर्ण अंतर होता है।

Effet du Cuprum metallicum dilué à la fois par dilution en série et par succussion par rapport à uniquement la succussion sur le système bactérien E. Coli et les propriétés électriques du polymère PVDF-HFP

Contexte : Les médicaments homéopathiques sont traditionnellement dilués par une dilution en série suivie d'une succussion. Les rôles respectifs de ces deux composantes doivent être évalués et explorés et c'est la raison pour laquelle la présente étude a été entreprise. **Objectif :** Comparer l'effet du médicament Cuprum metallicum (*Cup. met.*) dilué à la fois par dilution en série et succussion avec succussion seule sur des systèmes biologiques et physiques sélectionnés. **Méthode :** Ayant démarré l'expérience avec le médicament *Cup. met.* à 6°C, nous l'avons davantage dilué à 30°C et à 200°C par dilution en série, suivie d'une succussion (Ensemble A). Le même médicament à 6°C a également été dilué à 30°C et à 200°C uniquement par succussion (Ensemble B). La propriété antibactérienne de ces deux ensembles a été comparée sur E. coli, un système biologique et les propriétés électriques ont été comparées sur la matrice polymère PVDF-HFP, un système physique, utilisée couramment comme séparateur de charges. **Résultats :** La microscopie électronique à balayage à émission de champ montre que les particules deviennent plus agglomérées à une dilution plus élevée dans l'ensemble B. L'effet antibactérien de *Cup. met.* dans l'ensemble B à 30°C et à 200°C s'est avéré être plus significatif par rapport à l'ensemble A. L'effet de *Cup. met.* sur la matrice polymère dans l'ensemble A variait considérablement selon la dilution alors que dans l'ensemble B, moins de cristallisation en phase bêta a été produite et aucun changement significatif dans les propriétés électriques n'a suivi. **Conclusion :** La comparaison des résultats lors de l'utilisation du médicament *Cup. met.* dans deux montages expérimentaux montre que la dilution en série avec succussion donne lieu à une différence sensible entre les deux ensembles.

Efecto de Cuprum metallicum potenciado a través de diluciones y sucusiones seriadas en comparación con la sucusión sola con un sistema bacteriano de E. coli y las propiedades eléctricas del polímero PVDF-HFP

Fundamento: Los medicamentos homeopáticos se potencian mediante diluciones seriadas seguidas de sucusión. Es necesario estudiar y examinar los respectivos roles, por lo que efectuó el presente estudio. **Objetivos:** Investigar el efecto del medicamento *Cuprum metallicum* (*Cup. met.*) potenciado mediante diluciones seriadas y sucusiones en comparación con la sucusión sola utilizando sistemas biológicos y físicos seleccionados. **Método:** El procedimiento se inició con el medicamento Cup. met. a la 6C. Se fue potenciando a la 30C y 200 C mediante diluciones seriadas seguidas de sucusión (set A). El mismo medicamento a la 6C también fue potenciado a 30C y 200C utilizando únicamente la sucusión (set B). Las propiedades antibacterianas de estos dos sets se compararon con un sistema biológico, E. coli, y un sistema físico, las propiedades eléctricas sobre una matriz de polímero PVDF-HFP (sistema ampliamente utilizado como separador de cargas). **Resultados:** La Microscopia de Barrido Electrónico de Emisión de Campos mostró que las partículas se aglomeran a una potencia superior en el Set B. Se constató que el efecto antibacteriano de Cup. met. en el set B a 30C y 200C era más significativo en comparación con el set A. En el Set A, el efecto de *Cup. met.* en la matriz de polímeros varió significativamente con la potencia, en comparación con el set B, en el que la cristalización de la fase beta fue inferior y no se siguió de un cambio significativo en las propiedades eléctricas. **Conclusiones** La comparación de los resultados utilizando el medicamento *Cup. met.* en dos preparaciones experimentales muestra que la dilución seriada con sucusión da lugar a una diferencia importante entre los dos sets.

Wirkung des potenzierten Arzneimittels Cuprum metallicum durch fortlaufende Verdünnungen und Schüttelschlägen im Vergleich zum alleinigen Schütteln überprüft an zwei verschiedenen Systemen mit E. coli und den elektrischen Eigenschaften des PVDF-HFP Polymers

Hintergründe: Der klassische Potenzierungsweg homöopathischer Arzneimittel verläuft mit verschiedenen Schritten der Verdünnung und nachfolgendem Schütteln. In dieser Arbeit sollen die entsprechenden Rollen beider Komponenten beurteilt und untersucht werden. **Zielsetzung:** Vergleich der Wirkung des Arzneimittels Cuprum metallicum (*Cup. met.*), welches durch fortlaufende Verdünnungen und entsprechenden Schüttelschlägen oder duch alleinigem Schütteln potenziert und an ausgewählten biologischen und physikalischen Systemen überprüft wurde. **Methode:** Als Ausgangssubstanz wurde das Arzneimittel Cup. met. C6 benützt, welches auf C30 und C200 durch die entsprechenden Verdünnunge und Schüttelschlägen hochpotenziert wurde (Set A). Das gleiche Arzneimittel (C6) wurde auch auf C30 und C200 durch alleiniges Schütteln hochpotenziert (Set B). Die antibakteriellen Eigenschaften dieser beiden Sets wurden mittels einem biologischen System (*E. coli*) und einem physikalischen System (elektrische Eigenschaften der polymerischen Matrize PVDF-HFP, ein als Chragentrenner weitläufig benütztes System) untersucht. **Ergebnisse:** Durch Feldelektronenmikroskopie zeigte sich, daß die Partikel im Set B bei höheren Potenzen Agglomerate aufwiesen. Die antibakterielle Wirkung von *Cup. met.* (C30 und C200) im Set B war signifikanter im Vergleich zum Set A. Die Wirkung von *Cup. met.* auf die polymerische Matrize im Set A erwies signifikante Variationen je nach Potenz. Hingegen im Set B ergab sich eine geringere Krystallisation in der Beta-Phase, der keine signifikante Veränderung der elektrischen Eigenschaften folgte. **Fazit:** Der Vergleich der Ergebnisse dieser beiden Versuchsaufbaue mit dem Arzneimittel *Cup. met.* zeigt, daß die fortlaufenden Verdünnungen und entsprechenden Schüttelschlägen einen großen Unterschied zwischen beiden Sets darstellen.

透過連續稀釋和震盪，對比單獨進行震盪，加能的銅金屬（Cup. met.）對大腸桿菌系統及PVDF-HFP聚合物電性能的效果

背景：順勢療法藥物在傳統上是先透過連續稀釋，然後再進行震盪，來達至加能。這兩個組成過程的各自作用需要進行評估和探討，本研究就是針對這兩個過程部分進行。

目的：透過在選定的生物和物理系統上進行連續稀釋和震盪，以及單獨進行震盪，以比較順勢療法藥物銅金屬（Cup. met.）的效果。

方法：開始時使用6C層級的銅金屬（Cup. met.），我們透過連續稀釋進一步將其加能到30C和200C，然後進行震盪（A組）。同樣的藥物在6C時，只進行震盪將其加能至30C和200C（B組）。在大腸桿菌生物體系和聚合物基體PVDF-HFP（廣泛用作電荷分離器）物理體系上比較了這兩種抗菌劑的抗菌性能。

結果：場發射掃描式電子顯微鏡顯示，在 B 組中，粒子在較高的加能下更易凝聚。在 B組中，當銅金屬（Cup. met.）處於30C 和 200C層級時，其抗細菌效果比 A 組更爲顯著。與B組相比，A組銅金屬（Cup. met.）對聚合體基質的效果隨著加能而變得顯著，B組中產生的 β 相結晶較少，而電性則沒有顯著變化。

在兩組實驗設置中使用銅金屬（Cup. met.）的結果比較表明，連續稀釋伴震盪的加能法對於兩組設置有重要區別。