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NATURE OF THE OF POLYMORPHISM OF SALT CRYSTALS IN THE ASPECT OF ARBORIZATION DIAGNOSTIC METHOD

ABSTRACT. Background. A method of medical diagnostics, called arborization (or ferning), is widely used. Despite this, nature of arborization of biological liquids remains unclear. As it is not enough, we tried to reveal the physical basis of arborization. **Objective.** To make known the physical and chemical bases of salts polymorphism, including arborization. **Results.** It was found that a crystal shapes that had been formed upon evaporation of saline solutions depends on the value of the electric potential of such solutions also on the value of the electric charge of the surface on which crystals are formed. It has been particularly found that the evaporation of solutions with positive electric potential is accompanied by the formation of cubic crystals and the evaporation of solutions with negative electric potential is accompanied by the formation of needle-like crystals. It was shown that the cubic crystals of NaCl, the basic salt component of human biological fluids, are formed on the positively charged surface of activated carbon. It was also shown that the needle-shaped crystals of NaCl are formed on the negatively charged surface of silica gel. **Conclusion.** Various forms of the crystals formed during evaporation of biological liquids of women, reflect the cyclic change in electric potential in such liquids during the menstrual cycle.
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Пивоваренко Ю.В. Природа полиморфизма солевых кристаллов в аспекте диагностического метода арборизации.
Реферат. Форма солевых кристаллов, образующихся после высыхания биологических жидкостей человека, является диагностическим показателем. Вместе с тем, сама природа полиморфизма солевых кристаллов, в частности – причина образования ими древовидных или папоротниковидных кристаллов (арборизация, или феномен папоротника, соответственно), остаётся невыясненной. Ввиду такого явного несоответствия, выяснение природы полиморфизма кристаллов биологически значимых солей, в первую очередь – хлорида натрия, основного солевого компонента биологических жидкостей человека, представляется принципиально важным. Цель работы. Проверка гипотезы об электрической природе полиморфизма солевых кристаллов, в частности – их арборизации. Установлено, что форма кристаллов, образующихся после высыхания солевых растворов, в частности – растворов хлорида натрия, зависит от знака электрического потенциала таких растворов, а также – от знака электрического заряда поверхности, на которой сформировались кристаллы. В частности, установлено, что при высыхании солевых растворов, приготовленных на воде с отрицательным потенциалом, образуются кристаллы древовидной формы (арборизация). Выводы. Полиморфизм солевых кристаллов, в частности – кристаллов хлорида натрия, основного солевого компонента большинства биологических жидкостей человека, имеет электрическую природу. Разная форма кристаллов, образующихся при высыхании биологических жидкостей женского организма, отражает изменение электрического потенциала таких жидкостей в течение менструального цикла.
Ключевые слова: арборизация, феномен папоротника, метод арборизации.

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Introduction

Evaporation of body liquids women is accompanied by the formation of crystals of different shapes. The shape these crystals depends on the stage of the menstrual cycle. Cubic or orthorhombic crystals are formed in the step preceding ovulation, as well – in the step after ovulation; arbor-shape crystals are formed in the ovulation step (fig. 1). This crystal polymorphism is the basis of a method of medical diagnostics, called arborization or ferning [1-6].

Despite the widespread use of this method in gynecology [5, 6], nature arborization of female biological liquids, as salt polymorphism as a whole, remains unclear.

1 – 9 and 10 – 14
days of menstrual cycle

Fig. 1. The crystals formed by the evaporation of the female body liquids in the first half of menstrual cycle [6].

Analyzing conditions under which arborization observed or not observed, we have hypothesized that crystal polymorphism has electric nature.

Purpose

Demonstrate the experimental results, confirming our hypothesis.

Materials and methods

Electrolysis of salt solutions was performed at a potential difference between the anode and cathode compartments of the electrolyzer 9 – 100 mV.

Water with a positive electrical potential received at the bubbed oxygen or by passing through a pad of silica gel [7].

Water with a negative electrical potential received at the bubbed hydrogen or by passing through a pad of activated carbon [7].

The electric potential of water and water solutions was measured as the potential sedimentation [8].

Salts and sorbets were purchased from Ukrreachim (Ukraine).

Results and discussion

First we have carried out the electrolysis of NaCl, the basic salt component of human biological liquids, and examined crystals formed in the evaporation of liquids from the anode and cathode compartments of electrolyzer. It has been found that the evaporation of solutions from the anode compartment is accompanied by the formation of cubic crystals and the evaporation of solutions from the cathode compartment is accompanied by the formation of arbor-shaped crystals (Fig. 2).

The similar dependence was also established for other salts (Fig. 3) and some soluble biopolymers, including human serum albumen.

It is known that activated carbon absorbs aqueous H^+ and the silica gel – aqueous OH^- [7]. Therefore, we also studied the crystals formed during the drying of the activated carbon and silica gel, which were pre-wetted with water solution of NaCl. In course of such experiments we observed the formation of cubic crystals on the surface of activated carbon (Fig. 4, left), and fibers on the surface of silica gel (Fig. 4, right).

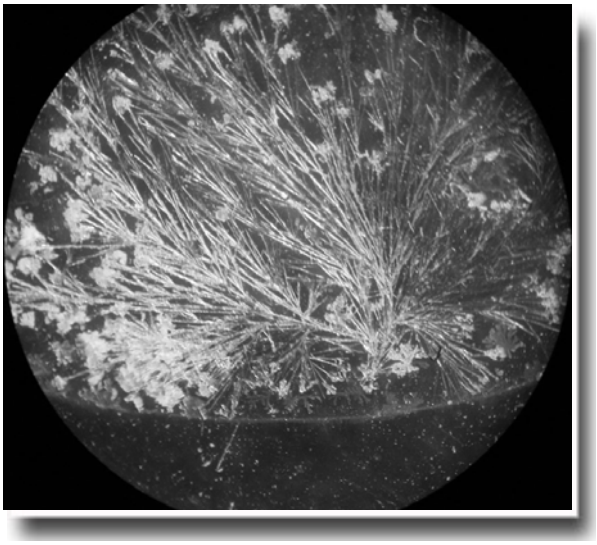

Fig. 2. The arbor-shaped crystals formed by evaporation of NaCl solution from cathode compartment electrolyzer.

Since anodic solutions and surface of the wet activated carbon are rich in H^+ and cathode solutions and surface of the wet silica gel are rich in OH^-, we examined crystal formation in the presence of the corresponding acids and alkalis. For example, we studied the shapes of crystals formed by the evaporation NaCl solutions, which contain HCl or NaOH. In all these experiments, we have seen the formation of too small cubic crystals or unstructured films. Based on obtained results, we concluded that forms of salt crystals, which form during the evaporation of electrode solutions, do not reflect the difference in pH of these solutions. In the same time, we came to conclusion that the various forms of crystal reflect the difference in the signs of the electric potential of electrode solutions or difference in sign of the surface charge wet sorbet.

Indeed, pH of plasma, which is also analyzed by method of arborization, may vary in the range: 7,35 ± 0,04 [7]. Thus we also concluded that the

different shape of the crystals formed during evaporation of biological liquids women (fig. 1) reflect the change in electric potential in such liquids during the menstrual cycle. In our opinion, this is important for deeper understanding of the nature of the changes that accompany the menstrual cycle.

Fig. 3. KH_2PO_4 crystals. Left: the cubic crystals formed by evaporation of solution from anodic compartment electrolyzer. Right: the arbor-shaped crystals formed by evaporation of solution from cathode compartment electrolyzer.

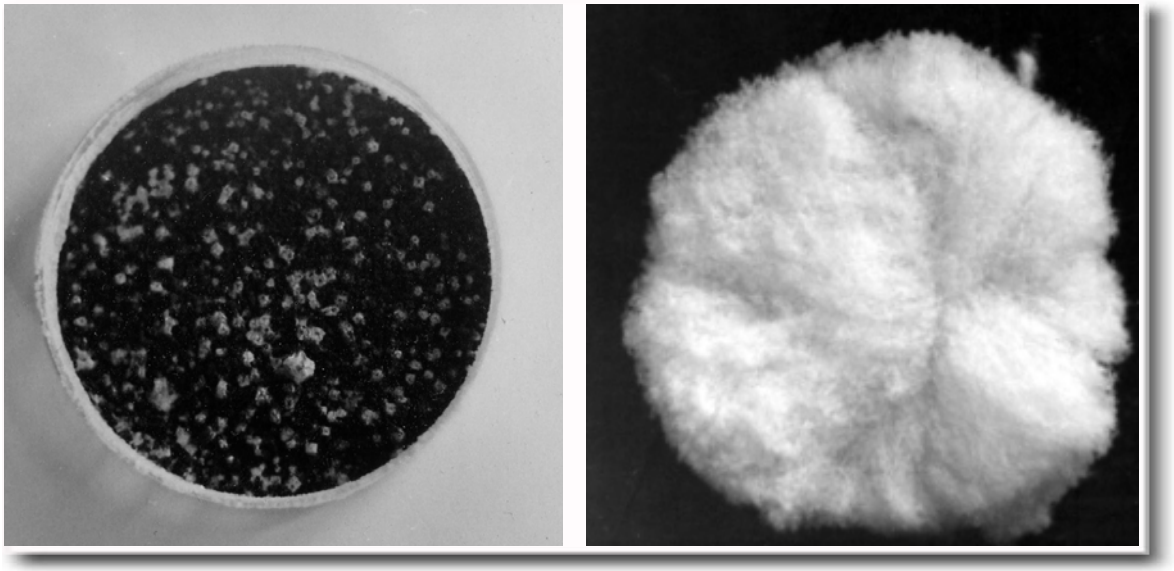

Fig. 4. NaCl crystals. Left: the small cubic crystals formed on positively charged surface of activated carbon. Right: the needle-shaped crystals formed on negatively charged surface of silica gel.

Need to say separately that the traditional explanation of arborization is based on the statistical theory of DLA (Diffusion Limited Aggregation), which does not take into account the electric potential of medium [9].

We expect that our findings will be useful to all physiologists and medics, who use the arborization for the diagnosis, including ophthalmologists and neuroscientists [10-12].

Conclusion

Shape of the crystals formed during evaporation of salt solutions depend both on the sign of electric potential of the solution, and on the sign of the electric charge of the surface on which the formation

of salt crystals. Cubic or rhombic crystals are formed by evaporation of salt solutions with a positive electric potential or (and) on the positively charged surfaces. Arbor-shaped crystals are formed by evaporation of salt solutions with a negative electric potential or (and) on the negatively charged surfaces.

Arborization physical basis is the negative electrization.

Changing the electric potential of the internal environment of the growing organism, it is possible to influence the formation of its nervous system.

Various forms of the crystals formed during evaporation of biological liquids women, reflect the cyclic change in electric potential in such liquids during the menstrual cycle.

Prospects for further investigations

Using the established dependence, we hope to explain the morphology of neurons, in particular – arborization their axons. Based on our results (Figure 2), we hypothesize that the main body of neurons has a more positive potential with respect to the axons. To test this hypothesis, it is necessary to create an electric potential gradient in the salt solutions. To solve this problem, we propose to use the light.

As is known, the positive charges are moving in the direction of the light, which is defined by the Pointing vector [13]. At the same time, the negative charges move against the Pointing vector, i.e., against the direction of light. Thus, focusing the light at the point on the surface of the salt solution can create a local area with a more positive charge (potential). Obvious advantage of this method is that it avoids the introduction of impurities into working solutions.

Using this method, we received salt solutions containing the desired charge (potential) gradient. The similar crystal structures are formed after drying the salt solutions containing the described gradient of electric charges (potentials) (Figure 5). For focusing the light we used a conventional lens; we focused light for 2 min.

Fig. 5. Dry solution of Na2SO4; area, which was prefocused light, cross marked.

As it is evident from Figure 5, area with a more positive charge forms a center, from which diverge salt needles. Because, the result partly confirms our hypothesis, we plane to continue similar ecsperiments. We hope also to get the results that fully explain neuron arborization.

Need to say additionally that arborization of sympathetic ganglion cells was earlier explained by their interactions with neurotrophic molecules, which reduce intracellular transport [10-12]. This explanation is based on the statistical theory of DLA [9], which ignores the distribution of electric potentials in neurons.

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Пивоваренко Ю.В. Природа поліморфізму сольових кристалів в аспекті діагностичного методу арборизації.

Реферат. Форма сольових кристалів, що утворюються після висихання біологічних рідин людини, є діагностичним показником. Водночас, сама природа поліморфізму таких кристалів, зокрема, причина утворення ними деревовидних або папоротьовидних кристалів (арборизація або феномен папороті, відповідно), залишаться нез'ясованою. Через таку, вочевидь наявну невідповідність, з'ясування природи поліморфізму кристалів біологічно значущих солей, насамперед – хлориду натрію, основної сольової складової більшості з біологічних рідин людини, вбачається принципово важливим. Мета роботи. Перевірка гіпотези про електричну природу поліморфізму сольових кристалів, зокрема – їх арборизації. Встановлено, що форма кристалів, що утворюються за висихання сольових розчинів, зокрема – розчинів хлориду натрію, залежить від знаку електричного потенціалу таких розчинів та від знаку електричного знаку електричного заряду поверхні, на якій сформувались кристали. Зокрема, встановлено, що кристали деревовидної форми (арборизація) утворюються після висихання сольових розчинів, приготованих на воді з негативним потенціалом. Висновки. Поліморфізм сольових кристалів, зокрема – кристалів хлориду натрію, основного сольового компонента більшості біологічних рідин людини, має електричну природу. Різна форма кристалів, що утворюються після висихання біологічних рідин жіночого організму, відбиває зміну електричного потенціалу таких рідин протягом менструального циклу.

Ключові слова: арборизаці*я,* феномен папороті, метод арборизації.