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Research Article

Sodium chloride as an antitumor agent

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Abstract

It was previously assumed that positive electrization of the human internal environment contributes to cancer. To verify the validity of this assumption, its correlation with the phenomena accompanying cancer is checked. One such phenomenon is cancer-associated hyponatremia, that is, a decrease in the concentration of sodium ions in the blood plasma of cancer patients. So, checking to what extent the stated assumption correlates with cancer-associated hyponatremia, allowed concluding that both positive electrization of the human internal environment and any hyponatremia contribute to cell overhydration. In addition, it has been shown that the ability of sodium ions to positively electrify aqueous media correlates with their ability to retain water. All this, accordingly, led to the conclusion that both positive electrization of the human internal environment and hyponatremia contribute to cell overhydration and, consequently, their transformation into cancer cells. Naturally, all this led to the conclusion that normalizing the content of sodium ions in the blood plasma prevents the occurrence of cancer, while a salt-free diet contributes to its occurrence.

Keywords: cancer; hyponatremia; salt-free diet

Introduction

So, it was previously established that positively charged water (i.e., water enriched with uncompensated protons) has exceptionally high both penetrating and hydration abilities [1-5]; it seems that the fact that positively charged water dissolves even graphite (Figure 1), which is considered water-insoluble [6], should be considered as convincing confirmation of the exceptionally high both hydration and penetration capacities of such water.

Figure 1. This is a solution obtained by vigorously shaking graphite powder with positively charged water. It is noteworthy that sediment does not appear in this solution for many years (it is worth taking into account that graphite is considered insoluble in water [6].

Since positively charged water exhibits both of these abilities in relation to various substances, including biopolymers [1-5], over time, it was assumed that this particular water is capable of overhydration cells, thereby promoting their proliferation [2] and, as a consequence, tumor growth [3-5].
(It should be added here that the hypothesis that it is cell hydration that is the primary factor in carcinogenesis was previously put forward by McIntyre [7-8]; thus, the idea was already in the air that it was the increased hydration of cells that turns them into cancer cells.)
It is worth noting here that probably the most direct confirmation of this assumption was obtained by comparing the UV absorption spectra of DNA and RNA solutions prepared in oppositely charged waters with the UV absorption spectra of aqueous suspensions of lymphocytes from healthy people and patients with B-CCL (this abbreviation stands for B-cell chronic lymphocytic leukemia) (Figure 2) [1, 9].

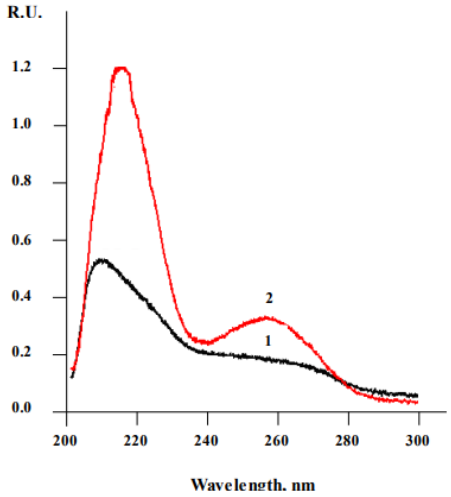

Figure 2. UV absorption spectra of aqueous suspensions of lymphocytes: 1 – suspension of lymphocytes from healthy individuals; 2 – suspension of lymphocytes from patients with B-CCL; both spectra were recorded contra air [7]).

Comparison of these spectra with the UV absorption spectra of DNA and RNA solutions prepared in oppositely charged waters indicates that the nucleic acids of healthy people are in a negatively charged aqueous environment, and the nucleic acids of patients with B-CCL are in a positively charged aqueous environment [1, 9].
Apparently, it is worth adding here that this comparison itself showed the potential possibility of obtaining UV absorption spectra of nucleic acids located in cells.

Despite receiving direct confirmation of this very assumption (Figure 2), additional discussion of its adequacy does not seem superfluous. Therefore, this adequacy is discussed here taking into account the hyponatremia characteristic of cancer patients, that is, the reduced concentration of sodium ions in their blood plasma [10-13].

Discussion

Firstly, it is worth taking into account that sodium ions are characterized by "positive hydration", while potassium ions are characterized by "negative hydration" [14]. To better understand what both of these characteristics mean, it is worth comparing the shapes of the precipitates formed by the sodium and potassium salts of DNA (Figure 3). It is also worth considering that the fibers formed precisely by sodium salts of DNA are highly hydrated [15]. Moreover, one can conclude that it is the high hydration capacity of sodium ions that allows the sodium salts of DNA to aggregate, forming fibers (Figure 3, left); in other words, it is the high hydration capacity of sodium ions that converts sodium salts of DNA into hydro gels with adhesive properties. At the same time, one can conclude that it is the dehydration ability of potassium ions that deprives potassium salts of DNA of the ability to aggregate (Figure 3, right).
Apparently, the concepts of "negative hydration" of potassium ions and "positive hydration" of sodium ions [14] also agree well with the fact that potassium ions penetrate biological membranes much more easily than sodium ions [16-17], although the diameter of the potassium ion is greater than the diameter of the sodium ion, since the diameter of the potassium atom is greater than the diameter of the sodium atom [6].

Figure 3. These are precipitates of the sodium (left) and potassium (right) salts of DNA formed in water with a potential of –300 mV: it is obvious that the precipitates of the sodium salt of DNA form fibers, while the precipitates of the potassium salt of DNA are a fine powder. To increase contrast, a phenazine dye, which is well absorbed by DNA salts, was added to both waters used.

Due to the predominantly negative potential of the intracellular environment [16-17] surrounding DNA in vivo, exclusively water with a negative potential was used here [18].

Finally, it is worth considering that, as a rule, the extracellular environment, including blood, is enriched with sodium ions and has a predominantly positive potential, while the intracellular environment is enriched with potassium ions and has a predominantly negative potential [16-17].

After summing up all these ideas and facts, it seems quite likely that it is the ability of sodium ions to positively electrify the extracellular environment that allows it to retain water; therefore, it is likely that hyponatremia reduces the positive potential of the blood plasma and, as a consequence, its ability to retain water outside the cells, both the blood itself and outside the cells surrounding the vessels, thereby promoting their overhydration. It is no less likely that the ability of potassium ions to negatively electrify the intracellular environment does not contribute to the overhydration of any cells. One way or another, all this is in good agreement with the assumption, the adequacy of which is being verified [3-5].

It is worth noting here that all of the above is in good agreement with the fact that cancer stem cells are highly depolarized compared to normal stem cells [19], as well as with the hypothesis that the intracellular concentration of sodium and other elements is related to mitogenesis and oncogenesis [20]. (In any case, all of the above provides additional arguments in favor of the hypothesis that the electrical potential of the tissue fluids of living organisms determines their hydration abilities and, therefore, is an epigenetic factor [21].

Apparently, it is quite appropriate here to provide additional confirmation of the superiority of the hydrating abilities of sodium ions over the hydrating abilities of potassium ions, if any. To obtain the same confirmation, mix unrefined oil containing free fatty acids with ~0.15 M aqueous solutions of sodium and potassium chlorides and shake vigorously. Over time, it will become clear that the emulsion formed by oil with an aqueous solution of sodium chloride does not separate completely (Figure 4, left), unlike the emulsion formed by oil with an aqueous solution of potassium chloride (Figure 4, right).

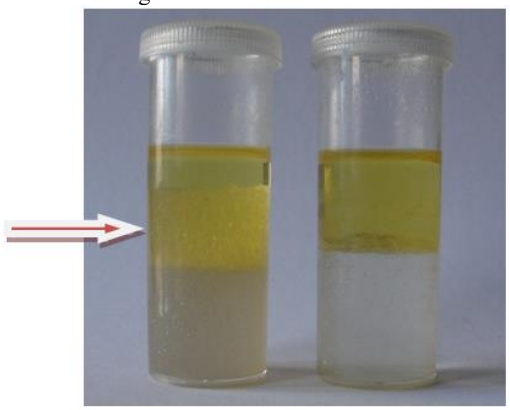

Figure 4. Over time, emulsions obtained by vigorously shaking unrefined oil with ~0.15 M aqueous solutions of sodium chloride (left) and potassium chloride (right) acquire this appearance. It can be seen that sodium ions are much stronger emulsifiers than potassium ions. The arrow indicates a layer of emulsified oil that persists for a long time in the presence of sodium ions.

After this, it is worth considering that blood is actually a water emulsion. If we take this into account together with the result obtained (Figure 4, left), it turns out that it is sodium ions that provide hydration of non-aqueous blood components, thereby maintaining their emulsified state. From the point of view of the topic under discussion, it is important that the emulsifying ability of sodium ions is comparable to the emulsifying ability of positively charged water (Figure 5, left); perhaps the obvious similarity of the right parts of Figures 4 and 5 should also be taken into account.

Figure 5. Suspensions formed by intensive mixing of liquid oils with positively charged water do not delaminate for several hours, retaining a milky white or yellowish colour (left); suspensions formed by intensive mixing of the same oils with negatively charged water separate within minutes (right) [3-5].

Although the above arguments, which are rather purely physicochemical, seem quite convincing, it is also worth considering the possibility of a more biochemical correspondence between the hyponatremia of cancer patients and the hypothesis being tested. In this regard, it is worth analyzing the consequences of excessive hydration of red blood cells, which do not transform into cancer cells because they cannot divide. So, given that sodium chloride retains water in the blood plasma, it is likely that hyponatremia causes overhydration of red blood cells and, therefore, impairs their ability to carry oxygen, thereby causing symptoms of iron deficiency anaemia, which is common in cancer [22-27]. This, in turn,

causes patients with hyponatremia to have to breathe more frequently, which inevitably saturates their body with oxygen gas, which is an obvious precursor to superoxide anions and other reactive oxygen species (ROS), which are now believed to cause cancer [28-30]. So, given this belief, the link between hyponatremia and cancer seems quite clear. Despite this clarity, the involvement of ROS in cancer development is worthy of discussion in terms of the assumption being discussed.

So, it seems quite clear that the generation of mitochondrial superoxide anions [31-35], which are precursors of other ROS, is undoubtedly accompanied by the release of protons:

$$O_2 + H^{\bullet} \rightarrow O_2^- + H^+ \ (1).$$

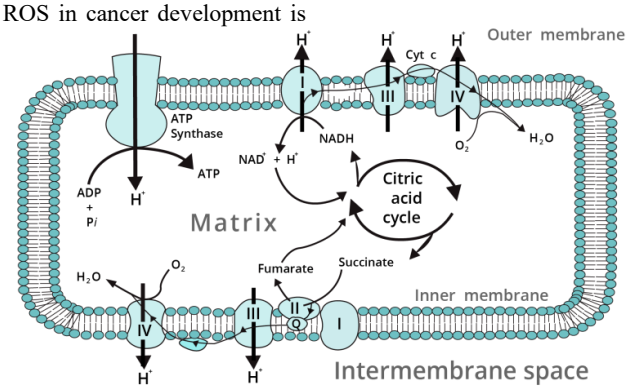

Figure 6. This is a typical diagram of a working mitochondrion: during oxidative phosphorylation, molecular oxygen is converted into superoxide anions and hydrogen atoms into protons, which are released by mitochondria, according to [31-35].

Therefore, in the presence of molecular oxygen, mitochondria become sources of intracellular protons (Figure 6).

This, in accordance with the assumption made, suggests that it is the protons generated by mitochondria in parallel with superoxide anions [1] that directly cause tumor growth; thus, it is likely that ROS are merely by-products accompanying proton generation and are not the root cause of cancer, contrary to what is currently believed [31 – 35].

To complete the discussion, it is worth considering the fact that a decrease in the concentration of salts in aqueous media, including sodium chloride, increases their ability to dissolve gases, including molecular oxygen [6], in the presence of which mitochondria produce both superoxide anions and protons, according to equation [1] and Figure 6.

This, accordingly, suggests that hyponatremia simultaneously promotes the synthesis of superoxide anions and protons in the mitochondria [1], which may be equally responsible for the development of cancer, especially given the catalytic properties of positively charged water [5].

Anyway, it looks like this discussion was very productive. In any case, it was this discussion that demonstrated the absence of fundamental contradictions between hyponatremia in cancer patients and the assumption being discussed. Moreover, it seems that it was this discussion that demonstrated the unity of the mechanisms that cause overhydration of cells both during positive electrization of the human internal environment and during hyponatremia. It is equally important that during this discussion the adequacy of Macintyre's hypothesis [12-13] was confirmed.

Conclusion

Thus, there is no doubt that normalizing the sodium chloride content in the blood plasma of cancer patients makes it possible to restore its ability to retain water and thereby increase the effectiveness of various types of anticancer therapy. Given this, a salt-free diet should be considered as promoting the development of hyponatremia and, therefore, cancer.

Moreover, it can be expected that increasing the concentration of sodium chloride in the human body can stop the development of cancer. In any case, the available experimental data justify such expectations. Thus, it was found that a reduced concentration of sodium chloride in the environment of cancer cells stimulates the division of their DNA, and an increased concentration of sodium chloride in the same environment stops DNA division in cancer cells, but stimulates the synthesis of RNA and peptides in them [36]. All this, in particular, suggests that an increased concentration of sodium chloride in the external environment of cancer cells promotes their differentiation and, as a consequence, transformation into normal cells.

Apparently, it is appropriate to add here that literally hyponatremia can be eliminated with the help of other sodium salts. In this regard, the first thing to suggest is sodium hydrocarbonate, that is, baking soda. So, it is this assumption that takes into account the fact that the buffering properties of human biological fluids are based, at least in part, on the buffering properties of aqueous solutions of hydrocarbonates [37-38]. In terms of the assumption under discussion, it is especially important that it is hydrocarbonate anions that make it possible to permanently remove protons from the human body due to such a reaction:

$$H^+ + HCO_3^- \leftrightarrow H_2CO_3 \rightarrow CO_2\uparrow + H_2O \ (2) \ [6].$$

In any case, it is likely that increasing the buffer capacity of the human body due to additional hydrocarbonates can significantly increase the effectiveness of using hydrogen gas as an anticancer agent [39-40], since it is blood hydrocarbonates that can neutralize the protons undoubtedly produced during hydrogen therapy, according to equation [1]; it seems clear that this assumption is based on equation [2]. It is worth noting here that this assumption is supported by the ability of baking soda to increase the effectiveness of anti-cancer drugs in general [41].

It is worth noting that both sodium chloride and sodium bicarbonate are common and evolutionarily fixed components of the human body [37-38, 42]. This, accordingly, gives every reason to believe that the human body is able to control both, thereby avoiding the undesirable consequences of their overdose.

References

1. Pivovarenko Y. (2018). ±Water: demonstration of water properties, depending on its electrical potential. World Journal of Applied Physics. 3(1);13-18.
2. Pivovarenko Y. (2021). Electrified water as a regulator of cell proliferation. Journal of Oncology Research. 3 (1); 1-10.
3. Pivovarenko Y. (2023). Positively charged water as a tumor growth stimulator. Biomedical Sciences. 9(3); 64-72.
4. Pivovarenko Y. (2023). Again, about the ability of positively charged water to promote cell division. International Journal of Clinical Case Reports. 2(1); 1-9.
5. Pivovarenko Y. (2023). Catalytic properties of positively charged water promoting tumor growth. Journal of Cancer Research and Cellular Therapeutics; 7(5).
6. Nekrasov B.V. (1974). Basics of General Chemistry, 1. Moscow: Chemistry. In Russian.
7. McIntyre G.I. (2006). Cell hydration as the primary factor in

carcinogenesis: A unifying concept. Medical Hypotheses. 66(3); 518-526.
8. McIntyre G.I. (2007). Increased cell hydration promotes both tumor growth and metastasis: a biochemical mechanism consistent with genetic signatures. Medical Hypotheses. 69(5); 1127-1130.
9. Terentyeva Y. and Pivovarenko Y. (2015). UV absorbance of lymphocytes. European Journal of Advanced Research in Biological and Life Sciences. 3(4); 20-24.
10. Onitilo A.A., Kio E. and Doi S.A.R. (2007). Tumor-related hyponatremia. Clinical Medicine & Research. 5(4); 228-237.
11. Castillo J.J., Vincent M. and Justice E. (2012). Diagnosis and management of hyponatremia in cancer patients. The Oncologist. 17; 756-765.
12. Grohé C. (2019). Hyponatremia in oncology patients. Frontiers of Hormone Research. 52; 161-166.
13. Fibbi B., Marroncini G., Naldi L. et al. (2023). Hyponatremia and cancer: from bedside to benchside. Cancers (Basel). 15(4).
14. Samoilov O.Y. (2003). Structure of aqueous solutions of electrolytes and hydration of ions. Negative hydration. Electrochemistry (Moscow). 39(2); 214-219. In Russian.
15. Saenger W. (1984). Principles of Nucleic Acid Structure. New York: Springer Verlag.
16. Penney M.D. (2014). Sodium, water and potassium; Chapter 4; 28-66. in Clinical Biochemistry.
17. Kowacz M. and Pollack G.H. (2020). Cells in new light: ion concentration, voltage, and pressure gradients across a hydrogel membrane. ACS Omega. 5(33); 21024-21031.
18. Pivovarenko. Y. (2020). Influence of glass and air on our perception of DNA. European Journal of Biophysics. 8(1); 10-15.
19. Bautista W., Lipschitz J, McKay A. and Minuk G.Y. (2017). Cancer stem cells are depolarized relative to normal stem cells derived from human livers. Annals of Hepatology. 16(2); 297-303.
20. Cameron I.L., Smith N.K.R., Pool T.B. et al. (1980). Intracellular concentration of sodium and other elements as related to mitogenesis and oncogenesis in vivo. Cancer Research. 40(5); 1493-1500.
21. Pivovarenko Y. (2017). The electric potential of the tissue fluids of living organisms as a possible epigenetic factor. Chemical and Biomolecular Engineering. 2(3); 159-164.
22. Van Belle S.J.-P. (2004). What is the value of hemoglobin as a prognostic and predictive factor in cancer? European Journal of Cancer Supplements. 2(2); 11-19.
23. Gaspar B.L., Sharma P. and Das R. (2015). Anemia in malignancies: pathogenetic and diagnostic considerations. Hematology. 20(1); 18-25.
24. Xu H., Xu L., Page J.H., et al. (2016). Incidence of anemia in patients diagnosed with solid tumors receiving chemotherapy, 2010-2013. Clinical Epidemiology. 8, 61-71.
25. Naoum F.A. (2016). Iron deficiency in cancer patients. Revista Brasileira de Hematologia e Hemoterapia. 38(4); 325-330.
26. Lind M., Vernon C., Cruickshank D. et al. (2022). The level of haemoglobin in anaemic cancer patients correlates positively with quality of life. British Journal of Cancer. 86(8); 1243-1249.
27. Tisserand J., Randrian V., Paccalin M. et al. (2023). Association between iron deficiency and survival in older patients with cancer. Cancers (Basel). 15(5).
28. Aggarwal V., Tuli S.H. Varol A. et al. (2019). Role of reactive oxygen species in cancer progression: molecular mechanisms and recent advancements. Biomolecules. 9(11).
29. Nakamura H. and Takada K. (2021). Reactive oxygen species in cancer: current findings and future directions. Cancer Science. 112(10); 3945-3952.
30. Cheung E.C. and Vousden K.H. (2022). The role of ROS in tumour development and progression. Nature Reviews Cancer. 22; 280-297.
31. Murphy M.P. (2009). How mitochondria produce reactive oxygen species. The Biochemical Journal. 417(1); 1-13.
32. Grivennikova V.G. and Vinogradov A.D. (2013). Partitioning of superoxide and hydrogen peroxide production by mitochondrial respiratory complex I. Biochimica and Biophysica Acta. 1827(3); 446-454.
33. Mailloux R.J. (2015). Teaching the fundamentals of electron transfer reactions in mitochondria and the production and detection of reactive oxygen species. Redox Biology. 4; 381-398.
34. Robb E.L., Hall A.R., Prime T.A. et al. (2019). Control of mitochondrial superoxide production by reverse electron transport at complex I. The Journal of Biological Chemistry. 293(25); 9869-9879.
35. Palma F.R., Gantner B.N., Sakiyama M.J. et al. (2024). ROS production by mitochondria: function or dysfunction? Oncogene. 43; 295-303.
36. Stubblefield E. and Mueller G.C. (1960). Effects of sodium chloride concentration on growth, biochemical composition, and metabolism of HeLa cells. Cancer Research. 20 (11); 1646-1655.
37. Rhoades R.A. and Bell D.R. (2012). Medical Physiology: Principles for Clinical Medicine, 4th Edition. Lippincott Williams & Wilkins.
38. Biga L. M., Bronson S., Dawson S. at al. (2019). Acid-base balance. Chapter 26.4 in Anatomy and Physiology. USA: Co-published by OpenStax and Oregon State University.
39. Li S., Liao R., Sheng X. et al. (2019). Hydrogen gas in cancer treatment. Frontiers in Oncology. 9.
40. Noor M.N.Z.M., Alauddin A.S., Wong Y.H. et al. (2022). A systematic review of molecular hydrogen therapy in cancer management. Asian Pacific Journal of Cancer Prevention, 24(1); 37-47.
41. Yang M., Zhong X. and Yuan Y. (2020). Does baking soda function as a magic bullet for patients with cancer? A mini review. Integrative Cancer Therapies. 19.
42. Pivovarenko Y. (2024). CO_2 as an evolutionarily proven means of protection against adverse external factors. Basic and Clinical Pharmacy Research. 2(1).

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