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Nature-inspired concept to novel dental restoratives

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For thousands of years humanity has been using an inanimate matter to replace missing tooth tissue imitating/mimicking natural organ in appearance and function, what we call biomimetic/biomimicry approach. However this restoring philosophy does not refer to the natural composition of hard tooth tissues. Possibly, there is another one concept of drawing inspiration from nature for the design of future dental materials. Nature-inspired synthesis goes beyond aesthetic/and anatomical similarities, and delves into the mechanistic, physico-chemical features or structure-phase of natural systems. In this context, pure glass-ionomer cements (GICs) might be taken into consideration as a starting material. The results of previous research confirming the possibility of creating apatite – enamel-like tissue in GIC are promising. The concept of different calcium phosphate nanocrystals inclusion/glass filler substitute in GIC compound seems to be forward-looking. However, the search for synthetic nature-inspired mesomaterials with a structural-phase composition analogous to enamel/dentine/cementum, transforming into the original host hard tissues, should focus on elongated HAp control for creating and organizing into enamel prisms, and the interwoven alignment of perpendicular clusters/bunches in a picket-fence resembling three-dimensional order. In this respect, the future role of polyelectrolyte organic matrix based on tooth polypeptides crosslinked with modified analogues of natural adhesives is still undiscovered.

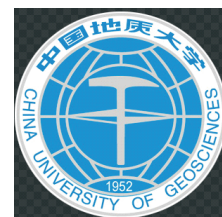
Keywords: nature-inspired design, enamel, dentine, hydroxyapatite, collagen, adhesive, egg shell, coral, conifer resin, seafood glue, gecko, beetle, horned frog.

Literature:

1. Kupka T, Lin HM, Stobinski L, Chen C-H, Liou W-J, Wrzalik R, Flisak Z, Experimental and theoretical studies on corals. I. Toward understanding the origin of color in precious red corals from Raman and IR spectroscopies and DFT calculations. *J Raman Spectrosc* 2010; 41: 651-658.
2. Kupka T'T', Karolus M, Fryc M, The newest clinical version of glass-polyalkenoate restorative biomaterial infused with 3Y-TZP nanocrystals. *J Appl Biotechnol Bioeng* 2018;5(6):338?340.
3. Perera AS, Coppens M-O, Re-designing materials for biomedical applications: from biomimicry to nature-inspired chemical engineering. *Phil Trans R Soc* 2018; 377: 1-21.
4. Kupka T'T', Egg shells, conifer resins, seafood glues, gecko or beetle foot, or maybe *Ceratophrys ornata* mucus? Nature-inspired dental biomaterials. XIX Conference on Biomaterials and Mechanics in Dentistry. Ustron, Poland, 10-13.10.2019, abstr. 21, p. 37.



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Background.

Active teeth caries disease is still a public health problem and the most prevalent infectious pathological process of digestive system found in the oral cavity in humans. The paradigm of modern active caries decay management is a bioactive restoration with remineralizing and adhesive attributes using metal- or monomer-free biomaterial. Today, looking for such a tooth-coloured dental biomaterial, pure glass-ionomer cement (GIC) may seem to appear like a mainstream of evaluating restoratives that was accepted by the World Health Organization (WHO) in 1994 as Basic package of Oral Care (BPOC). Tomorrow, nature-inspired synthesis will probably go beyond aesthetic/and anatomical similarities, and delves into the mechanistic, physico-chemical features or structure-phase of natural hard tooth tissues.

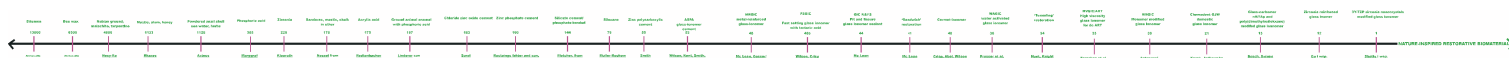
Objective

The aim of our preliminary report is the statement of a hypothesis that nature-inspired bioengineering is able to synthesize a new hard-tooth-integratable biomaterial with composition and internal structure identical to enamel, dentine and cementum.

Method

Analysis of interdisciplinary literature data.

Keywords: nature-inspired design, enamel, dentine, hydroxyapatite, collagen, adhesive, egg shell, coral, conifer resin, seafood glue, gecko, beetle, horned frog.



Conclusion

The results of previous research confirming the possibility of creating apatite – enamel-like tissue in GIC are promising. The concept of different calcium phosphate nanocrystals inclusion/glass filler substitute in GIC compound seems to be forward-looking. However, the search for synthetic nature-inspired mesomaterials with a structural-phase composition analogous to enamel/dentine/cementum, transforming into the original host hard tissues, should focus on elongated HAp control for creating and organizing into enamel prisms, and the interwoven alignment of perpendicular clusters/bunches in a picket-fence resembling three-dimensional order. In this respect, the future role of polyelectrolyte organic matrix based on tooth polypeptides analogues crosslinked with modified analogues of natural adhesives is still undiscovered.

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