Editorial corner – a personal view

Can biopolymers act as antiviral agents?

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In the past few years, some viral diseases have caused harm to human health and threatened with constant outbreak, such as human immunodeficiency virus (HIV), herpes simplex virus (HSV), influenza virus, Ebola, Zika virus, and recently Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), which is responsible for coronavirus disease 2019 (COVID-19). It was shown that the survival rate of SARS-CoV-2 on different surfaces, such as cardboard, stainless steel, plastics, glass, ceramics, wood, latex gloves, and surgical masks is high, and it can survive for few hours up to several days (<https://hub.jhu.edu/2020/03/20/sars-cov-2-survive-on-surfaces/>). For disinfecting surfaces, ethanol 70%, solution of sodium hypochlorite, or household bleach are proposed. However, their stability is low and some of them are toxic or can cause severe dehydration of skins.

Considering this, development of alternatives to the present options must be a high priority to meet challenges of controlling the spread of novel pandemic viruses. Antiviral biopolymers can be the best candidates owing to their low cost, versatility, processability, nontoxicity, and degradability. Moreover, antiviral biopolymers have potential to be used for designing long-lasting disinfecting materials, which can make surfaces with strong antiviral properties. Among different kinds of biopolymers, polysaccharides and their derivatives possess antiviral activities. Many factors can affect the antiviral properties of polysaccharides and their activity strongly depends on their structures. Through some chemical modification methods, the antiviral properties of polysaccharides can be improved obviously (<https://doi.org/10.1016/j.ijbiomac.2018.04.056>).

Sulfated polysaccharides with sulfate groups on the glycosyl groups are the most studied class of antiviral polysaccharides. Degree of sulfation, specific positioning of sulfates, molecular weight, hydrophobic and hydrogen bonding interactions are the most important parameters for antiviral activity of sulfated polysaccharides (<https://doi.org/10.1093/glycob/cwn092>).

N-carboxymethylchitosan-N-O-sulfate was developed for inhibition of the propagation of HIV-1 in cultured T-cells and Rausher murine leukemia virus in cultured mouse fibroblasts ([https://doi.org/10.1016/0006-291X\(91\)91443-G](https://doi.org/10.1016/0006-291X(91)91443-G)). CNC carrying tyrosine sulfate mimetic ligands was developed for inhibition of alphavirus infection. Sulfated CNC did not cause significant *in vitro* cytotoxicity to Vero (B) cells or human corneal epithelial (HCE-T) cells, even within the 100% virus-inhibitory concentrations (<https://doi.org/10.1021/bm500229d>). HIV-1 and HIV-2 can be inhibited effectively at very low concentrations of dextran sulfate (DS) with no significant cytotoxicity on MT-4 cells (<https://doi.org/10.1177/095632029200300104>). Chitosan was also sulfated through regioselective method. The regioselective introduction of sulfate group(s) at O-2 and/or O-3 caused a potent anti-HIV agent showing a higher antiviral activity than 6-O-sulfated derivative ([https://doi.org/10.1016/S0008-6215\(97\)10081-7](https://doi.org/10.1016/S0008-6215(97)10081-7)). Sulfated chitoooligosaccharides (SCOSs) with different molecular weights were synthesized by a random sulfation reaction and their antiviral activity against HIV-1 was studied. SCOS III (M_w 3–5 kDa) was found to be the most effective compound to inhibit

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HIV-1 replication (<https://doi.org/10.1016/j.carres.2009.12.017>). Low-molecular-weight *O*-acylated derivatives of λ - and κ -carrageenans were synthesized from native polysaccharides and their antiviral properties against HIV-1 was investigated. The results showed that they increase the anti-HIV-1 activity of the polysaccharides, while minimizing the native anticoagulant properties. It was also reported that the butanoylated derivatives with 0.55–0.70 mol of butanoyl and 1.5 mol of sulfate per monosaccharide residue of λ -carrageenan exhibited higher antiviral activity ([https://doi.org/10.1016/S0144-8617\(99\)00083-1](https://doi.org/10.1016/S0144-8617(99)00083-1)). In general, due to the characteristics of long-lasting efficiency and low toxicity, biopolymers like polysaccharides can be good candidates to be used as antiviral agents for coating of the surfaces in different

areas for capturing and/or deactivating the viruses. Polysaccharides have potential to provide a form of protection during the current pandemic and to help saving the world!

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