NANOMASK BASED CELLULOSE AND CHITIN/CHITOSAN AGAINST CORONAVIRUS

Afrinal Firmanda

Affiliation: Department of Agroindustrial Technology, Faculty of Agricultural Engineering and Technology, IPB University (Bogor Agricultural University), Bogor, Indonesia

Coronavirus disease 2019 (Covid-19) has been a world crisis since 2019, caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV2). This pandemic requires the World Health Organization (WHO) and the government to issue regulations and policies with shortening the virus growth curve, such as social distancing, lockdowns, mass quarantine, and other policies. On the other hand, policies that are not supported by Covid-19 prevention tools are less effective in applying to the community, especially not following various customs and cultures. So, it is not easy to estimate the time to break the chain of the spread of Covid-19.

WHO recommends using masks as an effort to prevent Covid-19.[1] There has been no scientific and technological innovation that has created a protective mask from coronavirus infection. Plant nanocellulose or bacterial nanocellulose (BC) (about 26.98-55.24 nm in size) has abundant availability. BC produced from *Acetobacter xylinum* (small amount, easy to cultivate) can save production and purification costs (low concentrations of NaOH and H_2O_2) with a considerable production amount. BC has high mechanical strength, high purity, surface area high, high crystallinity, barrier properties, non-toxic, biodegradable, biocompatible, and eco-friendly. Nanometer-structured masks based on cellulose and chitin/chitosan fibers expect promising medical mask materials against the coronavirus uses a nanofiltration approach, and the antimicrobial/antiviral properties of chitin/chitosan.

Coronaviruses spread and transmit via respiratory droplets.[2] Virus-carrying droplets are usually larger with a particle diameter of about 5-10 µm.[3] SARS-CoV2 is generally round with a diameter ranging from 60-140 nm and a distinctive spiky tip of about 9-12 nm based on transmission electron microscope analysis.[4] Therefore, the mask's pore size must be made smaller than the droplet size and particle size of SARS-CoV2 and combined with active materials to kill the coronavirus.

The electrospinning method produced nanofibers measuring 3 nm-10 µm with a very high surface-mass ratio.[5] Filters from polyvinylidene fluoride (PVDF) nanofiber diameter 84, 191, 349, and 525 nm) ward off the coronavirus in a 100 nm aerosol.[6] High-efficiency filtration with a 300-400 nm diameter and a membrane with a 150-350 nm diameter has successfully been prepared from cellulose acetate.[7,8] Also, nanocellulose acetate electrospun and PVDF coated with polypropylene spun bond produce a nanomask coating that meets N95 respirator requirements.[9] The treatment decreased the pore size of the cellulose acetate nanofiltration membrane from 0.63 to 0.30 nm.[10]

Many studies were conducted to observe the performance of nanocellulose as a filter for particles in the air. Electrospun cellulose acetate for aerosol filters (solid and liquid) with fiber diameter ranging from 0.1-24 µm and filter thickness between 7-51 µm was tested based on the

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1 (World Health Organization (WHO), 2020)

2 (Pan, Zhang, Yang, Poon, & Wang, 2020)

3 (World Health Organization (WHO), 2020)

4 (Zhu, et al., 2020)

5 (Park, 2010)

6 (Leung & Sun, 2020)

7 (Omollo, Zhang, Mwasiagi, & Ncube, 2014)

8 (Kim, Han, Sim, Cheon, & Park, 2015)

9 (Akduman, 2019)

10 (Su, Yang, Teo, & Chung, 2010)

influence of fiber diameter, density, and thickness of the membrane.[11] A nanofiber-based face mask consisting of 1 layer with a nanostructure in the middle and 2 layers of non-woven covering was successfully made using the electrospinning technique.[12] Filtration masks (2 layer BC diaphragm and 1 BC stenlization layer) were also studied.[13] Nanofiltration masks that can trap chemical agents from nanofibers are also made by dissolving polysulfones (18% concentration) in dimethylacetamide/acetone (9:1).[14] Thus, cellulose nanofiber-based masks are very likely to be composited with antiviral agents.[15]

Chitin/chitosan nanofiber is also a potential material for the Covid-19 antiviral mask. Chitin consists of nanofibers with a width of 10-20 nm, a high aspect ratio, and a uniform structure produced from crab and shrimp's exoskeleton.[16] In particular, chitin's approach with 1,1,1,3,3,3-hexafluoro-2-propanol produces chitin nanofibers with a diameter of up to 3 nm.[17] The acetylated chitin produces nanofibers.

Chitosan as a nanomask medium is very advantageous as an air filter. The nanofilter media was successfully made from chitosan/polyethylene oxide electrically onto a non-woven polypropylene substrate, where filtering efficiency is closely related to fiber size and chitosan content.[18] The transparent air nano filter of chitosan nanofibers can capture PM2.5 at a higher level (>98.23%) and is antibacterial against *Escherichia coli* (96.5%) and *Staphylococcus aureus* (95.2%).[19] Nanofiber chitosan is also used as a mask for filtering air pollutants, with a diameter of about 100-500 nm.[20] The effect of diameter and uniformity of polyurethane/chitosan nanofibers as filtration and antimicrobial activity against nanoaerosol and *Escherichia coli* were also studied.[21] The addition of nanosilver in chitin-nanofiber showed higher antimicrobial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, and influenza A viruses.[22] Also, chitosan nanoparticles containing nucleocapsid proteins from bovine coronavirus have the potential as a vaccine.[23]

The antiviral activity of chitosan nanofiber and HTCC (N-[(2-hydroxy-3-trimethylammonium)propyl] chitosan chloride) was investigated.[24] The composite of HTCC/graphene electrospun in water can remove porcine parvovirus up to 99%. Meanwhile, chitosan nanofiber was only able to eliminate 50% of the virus. The average diameter of electro-chitosan fibers ranges from 80-130 nm. HTCC/graphene nanofibers can be used as nano/microfiltration membranes to remove viruses by adsorption.[25] The addition of affinity ligands to electro-fiber can increase the binding of viruses such as peptide ligands to eliminate porcine parvovirus.[26] The activity of HTCC and HM-TCC chitosan polymers as corona antiviral was also studied.[27] HTCC chitosan polymer is made by reacting chitosan with glycidyl trimethylammonium chloride. Furthermore, HTCC was further modified by substituting it with a hydrophobic group (dodecyl group) to produce HM-HTCC. HTCC and HM-HTCC polymers could inhibit the replication of the HCoV-NL63 coronavirus.

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[11] (Chattopadhyay, Hatton, & Rutledge, 2016)

[12] (Patent No. WO/2016/128844, 2016)

[13] (China Patent No. CN101589854A, 2019)

[14] (Li & Gong, 2015)

[15] (China Patent No. CN101294313A, 2008)

[16] (Ifuku & Saimoto, 2012)

[17] (Zhang & Rolandi, 2017)

[18] (Desai, et al., 2009)

[19] (Liu, et al., 2019)

[20] (Shahvaziyan, Sajadinaenii, & Maleknia, 2013)

[21] (Mohraz, et al., 2019)

[22] (Nguyen, et al., 2014)

[23] (Sun, et al., 2012)

[24] (Bai, Electrospun chitosan nanofibers for virus removal, 2012)

[25] (Bai, Mi, Xiang, Heiden, & Heldt, 2013)

[26] (Heldt, Gurgel, Jaykus, & Carbonel, 2008)

[27] (Patent No. EP2849763B1, 2013)

Compared with medical masks, this nanomask innovation contains useful biopolymers to filter viruses and even reduce their growth. The materials used are very cheap and abundant. Meanwhile, the production costs will depend on the production method chosen. So, cellulose and chitin/chitosan-based nanofibers' composite shows promising nanomask production against the coronavirus, sustainable, dan eco-friendly.

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