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COVID-19: emerging protective measures

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Abstract. **The COVID-19 (Coronavirus disease 2019) spreads primarily through droplets of saliva or discharge from the nose. COVID-19 is predominantly considered as an unavoidable pandemic, and scientists are very curious about how to provide the best protection to the public before a vaccine can be made available. There is an urge to manufacture a greater number of masks to prevent any aerosol with microbes. Hence, we aim to develop an efficient viral inactivation system by exploiting active compounds from naturally occurring medicinal plants and infusing them into nanofiber-based respiratory masks. Our strategy is to develop fibrous filtration with three-layered masks using the compounds from medicinal plants for viral deactivation. These masks will be beneficial not just to healthcare workers but common citizens as well. In the absence of vaccination, productive masks can be worn to prevent transmission of airborne pathogenic aerosols and control diseases.**

Key Words:
COVID-19 (Coronavirus disease 2019), Medicinal plant, Respiratory mask, Protective measures.

Abbreviations

COVID-19: Coronavirus disease 2019; WHO: World Health Organization; CDC: Centers for Disease Control and Prevention; NIH: National Institutes of Health.

Introduction

The novel coronavirus 2019 (COVID-19), the unexpected pandemic, has caused severe panic among people worldwide. The advent of COVID-19 has kept the whole world on their toes. Countries are maximizing their efforts to combat the virus and minimize infection. However, most of the countries are unprepared for a disease at this magnitude and may not be able to prevent transmission or treat the condition efficiently. In such a situation, a vaccine can greatly reduce morbidity and mortality. But the potential problem will continue to persist until the development of an effective viral vaccine. Therefore, individuals close to the point of an outbreak would be in immediate danger of exposure due to delays in the development of a vaccine. In this pandemic situation, due to delay in vaccine development, there is an urge to manufacture a greater number of respirators and masks to prevent any aerosol with microbes. To reduce the transmission of COVID-19, it may be advantageous to use personal respiratory protective equipment. Since infectious microorganisms may be transmitted by a variety of routes, respiratory and facial protection is required for those that are usually transmitted via droplets/aerosols[1]. Transmission of COVID-19 infection mainly occurs

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through coughing or sneezing where infectious particles (aerosol droplets) of variable size, may be inhaled. Larger studies provide useful information on the management of respiratory infection outbreaks with a high risk of human to human transmission[2]. Centers for Disease Control and Prevention (CDC)[3] and the World Health Organization (WHO)[4] guidelines recommend the usage of medical masks to health care providers during patient care in high-risk situations. Thus, the use of surgical masks, eye protectors and gloves can be considered as appropriate personal protective equipment for prevention of COVID-19. Currently, the efficiency of filtration in respirators and masks depends on the filter characteristics, including fiber diameter, charge of fibers, packing density, filter thickness, as well as particle properties, such as diameter, density and velocity.

Although SARS-CoV-2 is predominantly considered as an unavoidable pandemic, scientists are very curious about how to best protect the public before a vaccine can be made available. The use of N95 respirator requires training prior to use and must be disposed of properly as it is a biohazard. Respirators and masks cannot be reused as re-sterilization is not possible. These factors pose a problem during an epidemic or pandemic situation, as the usage of N95 respirators in huge quantities is impossible and expensive. Additionally, the majority of the respiratory masks have a pore size that is larger than viruses (SARS-CoV-2 = approximately 120 nm), so it is a key challenge for researchers to deactivate the pathogen before entering the system. Hence, scientists have made efforts to develop easy to use, universal virus negation systems. This brings in the research that is focused on the treatment of filters with materials possessing well-known antimicrobial properties. Therefore, we aim to develop an efficient viral inactivation system by exploiting active compounds from naturally occurring medicinal plants and infusing them into nanofiber-based respiratory masks. Our strategy is to develop fibrous filtration with three-layered masks using the compounds from medicinal plants

Table I. Description of Indian medicinal plants and its antiviral property.

Medicinal plant	Active compound	Relevant pharmacological property	Drug/ composition with active compound
Vitex trifolia	Casticin ($C_{19}H^{1}_{8}O_8$)	Immunomodulatory & Anti-inflammatory effect on lungs	US7604823
Punica granatum	Punicalagin ($C_{48}H_{28}O_{30}$)	Inhibited viral glycoprotein & Anti-HSV-1	US2008214656
Euphorbia granulata	Gallic acid($C_7H_6O_5$)	HIV inhibitory	Various compositions
Allium sativum	Allicin ($C_6H_{10}OS_2$)	Proteolytic and hemagglutinating activity and viral replication	DB11780
Acacia nilotica	Quercetin ($C_{15}H_{10}O_7$)	Inhibition HIV-PR	NCT03989271 NCT01708278
Andrographis paniculata	Andrographolide ($C_{20}H_{30}O_5$)	Antiviral potential	US2017354639
Cynara scolymus	Cynaratriol ($C_{15}H_{22}O_5$)	ACE inhibitor	US6117844
Sphaeranthus indicus	Tartaric acid ($C_4H_6O_6$)	Inhibition of Mouse corona virus and Herpes virus -Bronchodilation	Various compositions
Strobilanthes cusia	Lupeol ($C_{30}H_{50}O$)	Inhibitory action towards HCoV-NL63	US2017340650
Vitex negundo	Sabinene ($C_{10}H_{16}$)	Inhibitory action against HIV	US7048953
Ocimum kilimandscharicum	Camphor ($C_{10}H_{16}O$)	Inhibitory action towards HIV-1	DB01744
Clitoria ternatea	Delphinidin-3-O-glucoside ($C_{21}H_{21}O_{12}$)	Antiviral properties	US8609152
Embelia ribes	1,4- benzoquinon($C_6H_4O_2$)	Inhibition of ACE	Various compositions
Hyoscyamus niger	hyoscyamine ($C_{17}H_{23}NO_3$)	Viral Inhibition and Bronchodilator	DB00424
Eugenia jambolana	Ellagic acid ($C_{14}H_6O_8$)	Protease Inhibitor	DB08846
Gymnema sylvestre	Tartaric acid($C_4H_6O_6$)	Inhibition of viral DNA synthesis	DB09459

This table depicts the Indian medicinal plants and its active compounds as a best therapeutic tool to treat various viral diseases such as HSV-1, COVID-19, HCoV-NL63, Mouse corona virus, Herpes virus and so on.

for viral deactivation. Although a wide range of personal protective equipment that provides different degrees of facial and respiratory protection is available, it is apparent that health care workers may have difficulty in choosing the correct type in any given clinical situation[1]. Recently, nanofibers have been made with antimicrobial activities owing to their infused compounds. They destroy the microbes by releasing inactivating chemicals, contact inhibition or immobilization. As medicinal plants have been utilized to develop drugs for various conditions in the past, it may be beneficial to investigate the possible integration of the active compounds of the plants into nanofibers for antimicrobial potential. These infused nanofibers can be assembled into masks for increased protection against viral agents. Recently many common Indian plants have been investigated for their role in disease amelioration[5]. The plants mentioned in Table I are renowned for their antiviral and pulmonary protective potentials. Active compounds from these plants can be incorporated into respiratory masks to furnish them with inherent antiviral properties (Figure 1). This will provide the wearer with an extra mode of protection in addition to the physical barrier. Since most of the viral particles are too small to be held back by the mask, adding antiviral filter layers may be beneficial in weeding out the viruses. The active compounds can be infused into the layers of the masks through the process of electrospinning. The compounds can be mixed with the polymer and then fabricated. This requires a certain level of compatibility between the compound and the polymer. These compounds can be integrated into synthetic, as well as non-synthetic fibers[6]. Interestingly, the fibers can be made from cotton waste as well, making them cost-effective and eco-friendly[7]. Additionally, these materials and active compounds can be modified based on the requirements. By repurposing the known plant compounds, more innovative protective measures can be penned down for their role in the prevention of viral transmission. Usage of these plant infused masks will provide increased breathability due to the porosity of the polymers and will be relatively cheaper to manufacture as well. At a time of

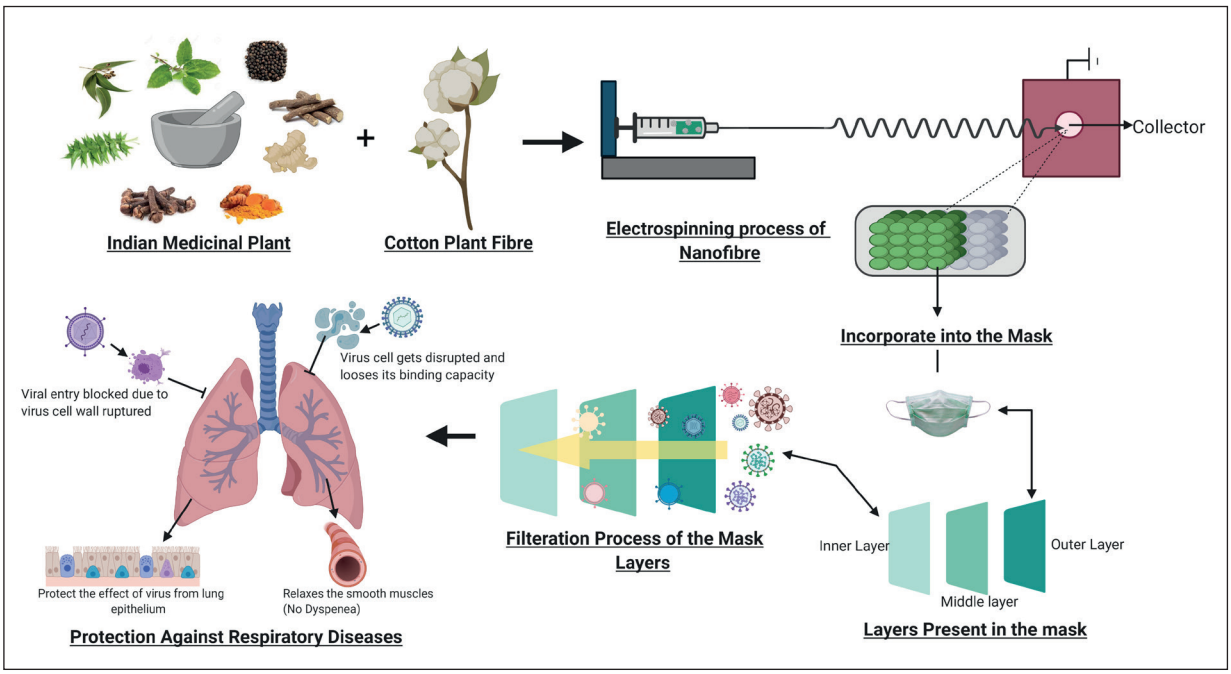

Figure 1. Mask with medicinal plant filter for prevention and deactivation of the viruses. This figure depicts the process involved in the production of the mask with medicinal plant infused filter as a precautionary measure against viruses. **A**, Medicinal plants and fiber will be fused to produce a nanofiber. **B**, Schematic representation of the electrospinning method which will be used for the production of nanofibers mixed with the plants active compound and cotton fiber. **C**, Incorporation of the medical plant and cotton fiber infused nanofiber into the three layers of the mask. **D**, The antiviral filtration efficiency of the mask. **E**, The usefulness of this mask to protect the lung from various virus. The mask will have three layers where the first or outer layer of the mask has the nature to stop the viral attachment. The second or middle layer of the mask has the property to increase the permeability of the viral cell wall leading to cell leakage. The third or inner will provide the smoothing effects to the lungs which get destructed due to the viral infection.

worldwide anxiety, it is imperative to find long term solutions to prevent the transmission of such pandemics. These masks will be beneficial not just to healthcare workers but common citizens as well.

Conclusions

Many countries have taken precautionary measures against the virus, and Government officials in all countries continue to make efforts to minimize human contact by facilitating countrywide shutdowns of public places, as well as various steps have been initiated to ensure the safety of the people, like social distancing and self-quarantine which limits our social interactions. This will reduce the risk of spreading the COVID-19 to people by breaking the transmission chain and the influx of new COVID-19 cases in a given time period. National Institutes of Health (NIH), has mentioned that SARS-CoV-2 could survive for up to three hours maximum as aerosols to a maximum of three days on surfaces. Slowing the spread of the COVID-19 cases will significantly reduce the strain on the healthcare system of the country by limiting the number of people who are severely sick by COVID-19 and need hospital care. It will also give researchers more time to develop the vaccine against COVID-19. So, it's time for all the citizens to join hands together to fight against coronavirus by practicing self-hygiene and social distancing. Let us all wait for the light at the end of the tunnel, in solitude.

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Conflict of Interests

The authors declare they have no conflict of interests.

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