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Algae: A Potential Source to Prevent and Cure the Novel Coronavirus – A review

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ABSTRACT: Today the world is exposed to the threat of human survival. The novel coronavirus challenged the human race and made them panic and spreads worldwide. The world scientists are looking for a cure for COVID-19. The primary plants (Microbes and algae) have survived in this world for several millions of years and they have faced many harsh conditions and overcame those. While facing harsh conditions they have managed to develop a lot of metabolites. Algae are with more such metabolites and those can be used against many diseases including viral infections. Carrageenan, Agar, Fucoidan, Laminaran, and Naviculan are some of such metabolites which have the high potentiality to act against the viral infections. Not only these, the microalgal species *Arthrospira platensis* is high in amino acids and vitamins which help in the improvement of immunity power in human beings hence this potentiality can be utilized to fight against novel coronavirus COVID-19. This particular algal species has both immunity improving capacity and also capable of suppressing the viral activities in humans. So this alga can be recommended to use against this pandemic viral infection as a preventive remedy.

Keywords: Antiviral agent, Algae, *Arthrospira*, COVID-19, Pandemic, Seaweed, *Spirulina*.

Abbreviations: SARS-CoV, Severe acute respiratory syndrome-related coronavirus; SARS-CoV-2, Severe acute respiratory syndrome-related coronavirus 2; HIV, Human Immunodeficiency; AIDS, acquired immunodeficiency syndrome; HRV, Human RhinoVirus; GS, Galactan Sulphate; DENV, Dengue virus; HPV, Human papillomavirus; HSV, Herpes simplex virus; HAV, hepatitis A virus; AMV,Alfalfa mosaic virus; RMLV, Rauscher murine leukemia virus;IAV, Influenza A virus; HBV, Hepatitis B virus; HCMV, Human cytomegalovirus; VSV, Vesicular stomatitis virus; EMCV, Encephalomyocarditis virus; RSV, Respiratory syncytial virus.

I. INTRODUCTION

Respiratory illness is caused by many viruses which include coronavirus, a member of the viral family Coronaviridae. The coronavirus is not a common human pathogen and it is well found in many animals and has caused several infections to the animals [1, 2]. Even though these viruses cause diseases in animals they didn't miss to affect human beings, and during 1960 two coronaviruses (HCoV-229E & HCoV-OC43) were found to cause common cold in human beings for the first time [3-10]. After these, another coronavirus got evolved to affect the human race which was named SARS-CoV (Severe acute respiratory syndrome-related coronavirus). SARS-CoV was highly dangerous than the previous two and it was causing deadliest pneumonia in the human race [11-15]. In 2019, another outbreak happened with the deadliest disease-causing coronavirus (COVID-19 Coronavirus/2019- nCoV/ SARS-CoV-2) and due to that, the world faces the pandemic situation [16, 17]. The vaccine for this virus not yet developed and world research centers are looking for a cure. In a part of that, this article deals with some of the potential sources of antiviral agents that could be established against the world pandemic COVID-19.

II. MATERIALS AND METHODS

This study is entirely based on the literature survey. Many earlier researchers have been reported the potentiality of the algae as a source of antiviral agents. In this study, we are compiling some of such potentialities together to give hint for the world researcher to focus on algal sources to develop an antiviral agent for Covid-19.

III. RESULTS AND DISCUSSION

The name algae is not a valid classification name, rather it stands for the group of widely ranged morphological dissimilar organisms. Some of the algal members show the antiviral properties [18]. The first report of marine algal polysaccharides as a potential source against viral infections was exposed in the year 1958 by Gerber and the team [19]. After this, the exploration of algal components against viral agents flourished exponentially [20-22].

A. Marine algal sources

Marine seaweeds and microalgae produce sulfated polysaccharides that are useful against the viral particles. Researches show the potential effect of sulfated polysaccharides as antiviral agents. Neushul (1990) studied thirty-nine species of marine red algae for the potentiality of using as an antiviral agent and found thirty-six tested seaweed extracts had positive effects against the viral infection [23]. The study showed three non-reactive extracts and seven mild reacted algal extracts while twenty-nine algal species collected from central & southern California showed the active response against the viral infections. This study

highlights the potentiality of the seaweeds as antiviral agents [23].

The potential antiviral properties of the aqueous extract of marine seaweeds *Neodilsea americana* and *N. integra* were proved and patented (U.S. patent numbers 4,162,308 and 4,162,309) by Calvin and Ellis in 1979 [24]. After that Nonomura [25], patented (U.S. patent number 4,522,814) the technology to use the alga *Cryptosiphonia woodii* as an antiviral agent and also he well exhibited the clinical efficiency too against the Herpes simplex virus. Neushul in 1988 [26], patented the method for using the Sulfated polysaccharides and carrageenan against the retroviral infections which also included deadliest human pathogen HIV (AIDS).

The Human RhinoVirus (HRV) causes the common cold in human and Iota Carrageenans were found to prevent this virus from entering and replicating in the host cells which is usually happening in the nasal mucosa of human [27]. Also, Carrageenan is most tested and proved polysaccharides against the viral infections [28-33]. Carrageenans proved to be active against the non-enveloped and enveloped viruses by inhibiting their binding and internalization on host cells during the initial stages of infections [27, 29]. Galactan Sulphate (GS) is an external polysaccharide extracted from the marine red algae. *Agardhiella tenera* was used for extracting GS and tested against the viral infections HIV-1 and HIV-2, and it was proved to be an active antiviral agent [34].

Ahmadi *et al.*, (2015) summarized the active antiviral properties of different metabolites produced from various algae against different viral infections. Carrageenan, Galacton and seaweed extract from Red algae show potential antiviral properties against many human pathogenic viruses (Influenza virus, DENV, HSV-1, HSV-2, HPV, HRV, HIV, DENV, HAV, AMV, RMLV). Alginate (HIV, IAV, HBV), Fucan (HSV-1, HSV-2, HCMV, VSV, Sindbis virus, HIV-1), Laminaran (HIV) extracted from Brown seaweeds also has antiviral properties. Naviculan extracted from the Diatom species *Navicula directa* has the potential antiviral activity against HSV-1 and HSV-2. Polysaccharides extracted from marine dinoflagellates (*Gyrodiniumim pudicum* and *Cochlodinium polykrikoides*) showed potential antiviral activities against viral infections (EMCV, Influenza A, and B viruses, RSV-A, RSV-B, parainfluenza-2). Calcium spirulan extracted from Blue-green alga, *Arthrospira platensis* is effective against HSV-1, measles, mumps, influenza, polio, Coxsackie, HIV-1, HCMV. Nostaflan isolated from *Nostoc flagelliforme* is active against HSV-1, HSV-2, influenza A virus, human cytomegalovirus [35].

B. Blue Green Algal Sources

Patterson and team in (1993) screened 694 Cyanophyta (Blue green algae) members for antiviral activity against HIV-1 and 529 taxa against HSV-2 and RSV. The initial screening showed seventy-two taxa with active activity against HIV-1, while 131 taxa showed weak activity. Extracts of fifty-two taxa showed more than 90% of reduction activity against HSV-2, while thirteen taxa showed the same activity against RSV [36].

This study shows the high potentials of Cyanophyta members as the antiviral agent. The most commonly consumed and cultivated alga is *Spirulina* (*Arthrospira platensis*), which also shows high antiviral activities. Yakoot and Salem (2012) did clinical trials (with 30 patients) of *A. platensis* against the viral infections and concluded that they have potential therapeutic use against the viral infection and also they suggested the need for further human trials with more samples [37].

The methanolic extract of BGA-*Spirulina maxima* reported the activity against type II Herpes Simplex Virus (HSV-2) infections [38]. Winter and team (2014) [39] recommended *Arthrospira platensis* as a food supplement to reinforce antioxidative status after studying the effects of *A. platensis* on HIV patients. It was found that the oral intake of *Spirulina* can prevent from the Influenza A-virus in mice [40].

In another study, *Spirulina platensis* (*Arthrospira platensis)* showed effective antiviral activity against human pathogenic viruses. The water extract of *Spirulina* inhibited the replications of HIV-1 in T-cells and PBMC (Peripheral Blood Mono-Nuclear Cells). The minimal (0.3 & 1.2 µg/ml) concentration of *Spirulina* extract itself showed almost 50% of Inhibition [41].

C. Analysing the Antiviral potentiality

The survey clearly shows that algae have a high potential for antiviral activity. The sulfated polysaccharides are the most viable source of antiviral agents from marine algae [28-34]. The activity against the sulfated polysaccharides on the respiratory disease-causing viruses shows the potentiality of sulfated polysaccharides. Hence these sulfated polysaccharides from marine algal sources can be explored to produce the vaccine against the new COVID-19. From the previous studies, it is proved that the sulfated polysaccharides from marine algae could be used against the enveloped RNA viruses it could be well exploited against the novel coronavirus which is also belongs to the same group. The enveloped RNA viruses like HIV RSV, Influenza type viruses had been inhibited by the algal polysaccharides in several studies [28-35]. Hence it is possible to produce antiviral drugs from marine algae for treating novel coronavirus COVID-19.

The outbreak of COVID-19 is going uncontrollably around the world, finding a vaccine and producing it globally may take a certain time period. The global pandemic situation has shut down the entire human race under the roof. Even though the previous outbreak of SARS-CoV was deadliest one, the spreading range was less compared to the new SARS-CoV-2. Even though the lethal rate less compared to the previous outbreak the spreading goes beyond the control. Every day the numbers of infected peoples are getting increased, so the first step is needed to be taken towards the prevention. In order to achieve that most of the nations has locked down themselves, which is somewhat helping also.

In this study it is found that the *Arthrospira platensis* the blue-green alga has the potential activity against enveloped RNA viruses, hence it may be used against the novel coronavirus as a preventive measure.

Abdo *et al.*, (2012) after screening antiviral activities of several freshwater microalgae concluded that the methanol and aqueous extracts of *Spirulina* is the most

viable antiviral agents while comparing to other sources [42]. Calcium spirulan (Ca-SP), and an aqueous extract of *A. platensis* showed potential antiviral activity against influenza A virus, HIV-1, HSV-2, human cytomegalovirus, mumps virus, and the measles virus [38, 43-45]. The purified form of allophycocyanin inhibited viral-plaque formation and EV71 RNA synthesis [46], these results show the inherent potential of *Spirulina* to cure the COVID-19.

Anti-influenza viral studies of *Arthrospira platensis* cold extracts showed better activity. The authors found that the *Spirulina* extracts react at the early stage of infection and reduce the viral load and help in the increase of survival rate in the flu infected organisms. They also highlighted that *Spirulina* could be the better therapeutic drug against the flue viral outbreaks [47]. From this study, it is evident that the *Spirulina* has the potentiality to decrease the viral load in the infected person. Hence this study supports the proposal of using *Spirulina* for supporting the health improvement of COVID-19 infected persons.

In the matter of improvement of immunity power, the human trials show that the undernourished normal and HIV infected kids showed better health after the intake of raw *Spirulina* (*Arthrospira*) with their normal diets in Africa [48-53]. *Spirulina* (*Arthrospira*) can be used as the immunity booster to the non-infected peoples to prevent the infections of SARS-CoV-2. *Spirulina* (*Arthrospira*) has the potential capacity to increase the immunity power to suppress viral infections [54]. The alga *Spirulina* (*Arthrospira*) exhibits a multifunctional role which makes it, an ideal natural drug with high therapeutic and prophylactic values [55]. By consuming *Spirulina*, people can get improved heath which will support them in fighting against the novel coronavirus.

IV. CONCLUSION

The algal polysaccharides and other components can be utilized for the development of the antiviral agents against the novel coronavirus, COVID-19. The sulfated polysaccharides have the high potential to act against viral infections. At the same time, the development of vaccines and commercializing such vaccine would take a certain time for completing the clinical trials and other international standard procedures. But in order to face the current global pandemic situation, we would like to suggest the oral intake of *Arthrospira platensis* a blue-green alga which is commonly known as *Spirulina*-a single-cell protein. This alga has the antiviral potential and also it is clinically proved to improve viral infected patient's health, hence it can also improve the health of the COVID-19 patients. Since this alga is a widely used food supplement, using this alga as a preventive remedy will not cause any problem and at the same time, it may result in the improvement of Patient's health and immunity power.

V. FUTURE SCOPE

Prevention is better than cure hence the fight against novel coronavirus needs immediate action plans. The governments can supply raw *Arthrospira* powders to every family so that all will improve their immunity power. By improving immunity we can prevent the infection by the novel coronavirus.

In isolated wards of infected patients the intake of *Arthrospira* raw powder/tablets can be administered and monitored for the viral load change in the blood of the infected patients.

To develop a vaccine against the COVID-2019, researchers can focus on the molecules present in the marine algae, which have been discussed in this article.

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