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Ayurveda and its Medicinal Plants: Halting the Surge of Covid-19

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ABSTRACT

Meteoric and noxious outbursts of Corona virus disease 2019 (COVID-19) has shaken the health care systems worldwide. It rapidly transforms into a pandemic and affected the millions of people globally. The conventional system of medicine is combating the diseases with its full potential but owing to absence of any appropriate and certain treatment, it fell short enough to curb it. According to World Health Organization there are currently 62 novel corona virus vaccine candidates, all over the world. But, only two have crossed the stage of preclinical trials and reached the stage of clinical trial. In such scenario, it's become imperative to develop multi dimensional strategies and inclusion of other effective medicinal system like Ayurveda. It possesses a plethora of medicinal plants having immunomodulatory, antioxidant, antiviral and antipyretic properties which can be utilized in the management of COVID-19. It also provides various daily life regimens that can enhance immunity and preserve health. The present study attempts to compile the huge number of medicinal plants mentioned in various ayurvedic treatises that can be effectively used in management of disease. Ministry of Ayush, Govt. of India is efficiently putting forward this legacy and has taken many measures to combat the disease. Based on previous studies and time tested efficacy, it can be inferred that Ayurvedic medicinal plant and its advocacies can provide a potential breakthrough to combat COVID-19. Therefore, Trans disciplinary and Inter disciplinary researches should be initiated to explore more and effective options.

Keywords: Ayurveda, COVID- 19, Immunity, Medicinal plants, Ministry of Ayush.

INTRODUCTION

In present synopsis of world, fidgety schedules and paced up lives leads people to usually eat as per their comfort and leisure, rather than what is propitious and salubrious. Often, people around the globe eat wild animals like bats, snakes, pangolin etc. and sea foods taste pleasure but remain oblivious about the health risks that this type of eating customs might propound. Recently, in December 2019, pneumonia like case of unknown aetiology was reported in Wuhan, Hubei Province, China. Its clinical features were found to be very identical to viral pneumonia. On analysing the different samples taken from patients respiratory tract, experts at Chinese Centre for Disease Control (CCDC) testified the disease as pneumonia and subsequently designated as Novel Corona virus Pneumonia (NCP) and novel corona virus was identify as causative agent [1].

A Public Health Emergency of International Concern (PHEIC) related to 2019-nCoV (novel Corona Virus) outbreak was declared by World Health Organization (WHO) on 30th January 2020. On 12th February, WHO officially named the 2019-nCoV pathogen as SARS-CoV-2 and the resulting disease as Corona virus Disease 2019 (COVID-2019) [2]. The concerned virus was designated as Severe Acute Respiratory Syndrome corona virus- 2 (SARS-CoV-2) by International Committee on Taxonomy of Viruses (ICTV). On March 11th, COVID-19 was officially averred as a Pandemic by WHO.

The corona virus disease 19 (COVID-19) is peculiar and unprecedented in several aspects and has shaken the health care systems worldwide. The earlier evidences and knowledge acquired from the outburst of epidemics like Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) turns out to be insufficient. The conventional system of medicine is combating the diseases with its full potential but it felt short enough to curb it. So, a need of multi level strategies and inclusion of other effective medicinal system like Ayurveda is imperative.

Ayurveda is focussed on preserving the health of individual along with mitigation of ailments. To achieve these aims, Ayurveda not only includes medications but also emphasizes and advocates various daily and seasonal regimens. Classical texts of Ayurveda have well elaborated the management of epidemic like situations and considered immunity as a key factor to halt its spread. In the present study, we have

attempted to precisely review the nature and course of COVID-19 and endeavoured to illuminate the strength of Ayurveda as it possesses a plethora of medicinal plants having immunomodulatory, antioxidant, antiviral and antipyretic properties which can be utilized in the management of COVID-19. This article also shed light on other measures described in Ayurveda to maintain the health along with the efforts done by Ministry of Ayush, Govt. of India to combat the disease.

MATERIALS AND METHODS

A comprehensive literature search was performed using the keywords 'COVID 19, Ayurveda, Immunity and Medicinal plants in combination with 'Immunomodulatory, Antioxidant, Antiviral and Antipyretic activity in PubMed, Scopus, Google Scholar, Science Direct and Web of Science for published literature and required data was obtained. Classical texts of Ayurveda were also screened for *Rasayana* concept along with epidemic management.

RESULTS

COVID19: The Novel Epidemic

Corona viruses are enveloped, single positive stranded RNA viruses with a diameter of 80-120nm belonging to the subfamily Coronavirinae. The word Corona signifies the crown-like spikes on the outer surface of the virus; due to which concerned virus was assigned as Corona virus. The genome of CoV was found to be in the length range of 26 to 32 kilobases and presumably the largest viral RNA proclaimed [3-4].

It is classified into four types [5]

1. α-coronavirus (α-COV)
2. β-coronavirus (β-COV)
3. δ-coronavirus (δ-COV) and
4. γ - coronavirus (γ-COV**).**

Previously, six types of corona viruses were known to cause disease in humans. SARS-CoV-2 belongs to β-corona virus. SARS-CoV-2 is the seventh virus of the corona virus's family that have potential to infect humans [6]. This virus has various promising organisms as natural, intermediate and final hosts. This stages immense difficulties in preventing and treating the infection. This virus possesses greater ability to transmit and infect in comparison to SARS and MERS, albeit of having lesser mortality rate [7].

COVID-19 Outbreak Status: Morbidity, Mortality and Recovery

- According to WHO, as of May 28, 2020 till 10.50 am, 5556679 confirmed cases and 351866 deaths due to corona virus disease 2019 (COVID-19) had been reported worldwide [8].
- Ministry of Health and Family Welfare, Govt. of India have reported a number of 86110 active cases, 4531 deaths due to COVID 19 and 67691 patients were cured /discharged [9].

Epidemiology

The epidemic struck off in China, with a geographical core in Wuhan, Hubei. Most of the cases were threaded to Huanan Seafood Market of Wuhan, which trades in fish and a wide range of live animal species including poultry, pangolin, marmots, bats and snakes [10]. Chinese Centre for Disease Control and Prevention (CCDC) analysed the throat swab samples and identified the causative agent as Severe Acute Respiratory Syndrome Corona virus 2 (SARS-CoV-2) on 7th January 2020. It is a highly infectious virus with around 2 hours survival time in air. The incubation period is generally 4–8 days. All age groups are reported to be susceptible to the virus, of which patients with co-morbidities like Diabetes, liver and kidney ailments are more prone to undergo severe illness [11, 12, 13].

A cruise named Diamond Princess was quarantined in early February 2020 after a disembarked passenger diagnosed corona positive. However, on Feb 26, 2020, the rate of increase in cases geared up in the world than China. Substantial outburst of cases was started evantuating in Italy, USA and Iran leading to geographical magnification of the epidemic. Clinical studies conducted on admitted patients have reported that patients generally shows symptoms associated with viral pneumonia, usually cough, pyrexia, sore throat, fatigue and myalgia at the onset of COVID 19 [14, 15, 16, 17, 18].

Pathophysiology

SARS-CoV-2 is composed of a single-stranded ribonucleic acid (RNA) structure that appertains to the Coronavirinae, sub family of Coronaviridae. Sequence analysis of SARS-CoV-2 has revealed a structure common to that of other corona viruses. Similarity has been observed in its genome and a previously identified corona virus strain that lead to the SARS epidemic in 2003 [19]. On the aspect of structure, the SARS-CoV-2 has a precisely specified composition consisting of fourteen binding residues that interact with human angiotensin-converting enzyme directly. It has been reported that due to greater similarity of receptor-binding domain (RBD) in Spike-protein, angiotension-converting enzyme 2 (ACE2) is used by SARS-CoV-2 as receptor [20].

Corona virus enters into the cell and infect by primarily identifying the respective receptor on the target cell by using S protein on its surface. In structure model analysis, SARS-CoV-2 was found to bind ACE2 with more than 10 times affinity of SARS-CoV [21]. These kinds of outcomes further elucidate the speedy transmission potential of the SARS-CoV-2 in humans in comparison to SARS-CoV.

Transmission

Three conditions viz. Source of infection, Transmission route and Susceptibility contribute to wide spread of virus as documented by various epidemiological researches [22].

1. Source of Infection

Bats are envisaged as natural hosts of novel corona virus, whereas snakes and pangolins are notion as intermediate hosts. Study conducted at Wuhan institute of virology reported that the gene sequence of Bat corona virus and SARS-CoV-2 is approximately 96.2% identical, using sequencing technology [23]. It alluded that possible host of SARS-CoV-2 are bats. In another study, it has been reported that the Pangolin isolated SARS-CoV-2 and the virus strains currently infecting humans have shown a resemblance of 99%, by molecular biological detection, macro-genomic sequencing, and electron microscopy. The study concluded pangolin as potential Intermediate host for SARS-CoV-2 [24].

2. Route of transmission

Body fluid droplets and close contacts are considered as primary mode of transmission for SARS-CoV-2 and the most frequent transmission mode is close contact. Researchers have also detected SARS-CoV-2 in the samples of saliva, stool, urine and gastrointestinal tract along with aerosol transmission. Evidences of bioinformatics [25] suggested that digestive tract can be a possible route of infection as RNA of SARS-CoV-2 was found in gastrointestinal tissues of patients of COVID-19 [26]. Besides, tears and conjunctival secretions of covid-19 patients have also shown the presence of virus [27]. Currently, COVID-19 patients are envisaged as chief infectious source.

3. Susceptibility

People living in poor hygienic conditions, people with weak immunity or with immune compromised state, elderly citizens especially male are highly prone to this virus in comparison to other groups. Individuals with chronic underlying diseases like diabetes, hypertension, heart disease, etc**.** are also more prone to get infected [28].

Prevalence

Prevalence of a disease can be indicated by the average number of secondary infection that a patient may engender in a vulnerable population devoid of any intervention and referred as Basic Reproduction Number (R_0) [29]. The R_0 for novel corona virus varies among different research teams. In a study, R_0 of novel corona virus was estimated to be 2.47-2.86 by applying SEIR model [30]. By using the IDEA model, Majumdar and his colleagues have evaluated R_0 as 2.0-3.3 [31].

The population which is generally susceptible to SARS-CoV-2 was found to be in the median age of 47.0 years (IQR, 35.0 to 58.0). Age group of 30 to 79 years comprises 87% of case patients, patients aged 80 years or older and female patients contributed to 3% and 41.9% of the total cases respectively [32, 33]. The combined case-fatality rate (CFR) was 2.3%, but CFR in age group of 70 to 79 years and those aged 80 years or above had a CFR of 8.0% and 14.8% respectively [34]. This showed that male citizens of aged 70 or more are and person having chronic underlying diseases (hypertension, diabetes, heart disease etc**.**) are more susceptible to this virus [35].

Clinical Presentation

The most common clinical symptoms [36, 37] observed are:

- Pyrexia/Fever (87.9%)
- Dry cough (67.7%)
- Fatigue/tiredness (69.6%) and
- Myalgia (34.8%), whereas diarrhoea (3.7%) and vomiting (5.0%) were rare.

Moreover, patients with other ailments are susceptible to various complications like acute heart injury, respiratory distress syndrome and secondary infections [38]. Some evidences have reported that COVID-19 can also cause organ damage beside lungs. A study conducted on 214 COVID-19 patients of COVID-19, neurological manifestations have been observed in 78 (36.4%) patients [39].

Radio-Graphical Features

In general, similarity was observed in the radio-graphical features in patients of COVID-19 to the patients of community-acquired pneumonia [40]. Various specific imaging characteristics found in COVID-19 pneumonia are as follows [41]:

- Predominant ground glass opacity (65%)
- Consolidation (50%)
- Smooth or irregular thickening of interlobular septa (35%)
- Air bronchogram (47%),
- Thickening of adjoining pleura (32%), with involvement of peripheral and lower lobe chiefly**.**

Laboratory Findings

Reported findings of laboratory examinations for COVID 19 are as following [42, 43]:

- Lymphopenia was reported in 82.1% of patients.
- Thrombocytopenia was found in 36.2% of patients.
- Besides, raised levels of Lactate dehydrogenase (LDH), C-reactive protein（CRP), and Creatinine kinase were observed in majority of patients.

Patients with SARS-CoV-2 also showed [44]:

- Lower oxygenation index
- Raised levels of Interleukin 6 and Interleukin 10
- Decrease levels of CD8+T and CD4+T cells

Prevention

- Researchers have proven that the vulnerability to infection of lower respiratory tract may be prevented by vitamin C under specific conditions [45].
- A study suggested that the ability to resist SARS-CoV-2 may be boost up by supplementation of vitamin D as well as vitamin E [46].
- Maintaining good personal hygiene, a healthy lifestyle and adequate nutritional intake may boost immunity [47, 48].
- Protective measures like wearing medical masks, PPE, social distancing, adequate rest and good ventilation can effectively prevent SARS-CoV-2 infection [49].
- Avoiding traverse to high risk zones, contact with symptomatic individuals and the consumption of meat from COVID-19 affected regions etc [50, 51].
- Bespoke Inc, a Japan based company has launched a chatbot *(Bebot)* powered with artificial intelligence that provides up-to-date information regarding the corona virus outbreak [52].
- Government of India have also launched a live tracking app named as *Corona Kavach* which was later upgraded to *Arogya Setu*. It maps the user's location through GPS to assess whether they are at a high-risk geographical zone or not [53].

Management

- The patients having infection of SARS-CoV-2 are provided primarily symptomatic treatment at this moment and focussed on following modalities:

1. Anti viral treatment

- At first, the case study of COVID 19 patient treated with remdesivir and having better outcomes was reported by Holshue *et al.*[54].
- In vitro, Chloroquine significantly inhibited the virus and showed immune-modulating activity [55].
- Chloroquine was found to be efficacious in managing patients of COVID-19 [56].
- It was found that Arbidol, an indole derivative obstruct viral fusion against viruses of hepatitis C as well as influenza A and B [57]. It was proven to possess antiviral effect on SARS-CoV in experimental cells [58].
- Additionally, Nucleoside analogues, Lopinavir/Ritonavir, Neuraminidase inhibitors as well as peptide EK1 may also be selected as antivirals for managing COVID- 19 [59].

2. Immuno-enhancement modalities

- Synthetic recombinant interferon α has found to be effecacious in managing patients of SARS [60].
- Intravenous immunoglobulin considered to be the safest immunomodulator suitable for long-term use in all age groups and could also succour to inhibit the production of pro-inflammatory cytokines and enhances the production of anti-inflammatory mediators [61].
- Thymosin alpha-1 (Ta1) can effectively control the advancement disease and act as immunity booster for SARS patients [62].

3. Convalescent Plasma Therapy

It is possibly a better way to alleviate disease course for patients infected severely as there are no vaccines and specific drugs [63].

4. Auxiliary Blood Purification Treatment

It may be utilized in eliminating cytokine storm, alleviating inflammatory factors, maintaining acid-base as well as electrolyte balance and in regulating capacity load of patient in a sophisticated manner [64].

5. Vaccines: Future Scope

As per the report of WHO [65], there are currently 62 novel corona virus vaccine candidates, all over the world. Out of these, only two have crossed the stage of preclinical trials and reached the crucial stage of clinical trial.

- The remaining 60 vaccine candidates, in which one is developed by the joint venture between pharmaceutical company *Codagenix* and *Serum Institute of India*, are still in the preclinical stage.
- A study funded by *National Institute of Allergy and Infectious Diseases* (NIAID), *National Institute of Arthritis and Musculoskeletal and Skin Diseases* (NIAMS), and *National Cancer Institute* (NCI), conducted at University of Pittsburgh have reported that Micro needle corona virus vaccine initially named as *PittCoVacc* triggers immune response in mice [66].
- The two vaccines which are under clinical trials, Chinese firm *CanSino Biological Inc.* and the *Beijing Institute of Biotechnology* have collaboratively developed the first one.
- The second potential vaccine, named "mRNA-1273", has been developed by a pharma giant, *Moderna* under the sponsorship of *National Institute of Allergy and Infectious Diseases* (NIAID), United States of America.
- *Johnson and Johnson* has revealed that it is working with the *US Department of Health and Human Services* and is expected to obtain special use authorisation for its vaccine by early 2021 [67].
- *Israel's Institute for Biological Research* (IIBR) has designed a monoclonal neutralising antibody, which can neutralise novel corona virus effectively [68].
- Italian scientists at *Spallanzani Hospital* have declared to develop a vaccine that effectively generated antibodies in mice and may work on human cells [69].
- Phase-1 human clinical trial was initiated by *Oxford University* on its vaccine *ChAdOx1 nCoV-19* on April 23 [70].

Ayurvedic Apprehension of Infectious Diseases and Pandemics

Ayurveda is the most ancient and applied medical doctrine of human civilization. Various basic principles described in Ayurveda are still rational as today's medical science. Some of them could be equally germane to the realm of epidemiology. *Acharya Charaka* have mentioned that, although individuals differ in their physical constitution, strength, food habits, age, immunity etc., they do get affected with disease owing to vitiation of some factors that are common to all those who inhabit in that community. *Vayu* (Air), *Jala* (water), *Desh* (land), and *Kala* (season) are the factors that are similar to all the individuals in a community. Vitiation of these components causes the manifestation of disease that have similar symptoms among all inhabitants leading to widespread of disease known as *Janapadodhwansa* [71]. This description of aetiology is precisely represents the mode of endemics, epidemics and pandemic as well. e.g COVID 19.

The concept of disease manifestation or outbreak can be understood by "Epidemiological Triad. i.e. Agent, Host and Environment. *Acharya Charaka* [72] has described all the three components. He has categorized these etiological factors into two different classes' i.e.

- *Niyata Hetu*
- *Aniyata Hetu.*

The inevitable factors that commonly affect all the individuals in a particular community are a categorised under *Niyata Hetu*. It includes the catastrophic effects like landslides, earthquakes, and tsunami of heavenly bodies.

Aniyata Hetu is comprises disastrous factors like-

- *Pragyaparadha* (terrorism, evil deeds, accidents etc.)
- *Shastra prabhavaja* (nuclear blasts, wars, riots etc.)
- *Abhisyangaja* (ramifications of virus, bacteria, parasites and unhygienic condition) and
- *Abhishapaja* (curse or Negative energies).

These factors affect the wide population and leads to the outbursts of diseases known as *Janapadodhwansa Rogas. Acharya Sushruta* [73] has also mentioned the concept of microorganism that causes disease in

humans. In epidemiological triad, the agent factor primarily comprises the different types of microorganism and pathogens that can cause disease. He has mentioned following different modes of disease transmission [74]:

- *Gatrasansparshata* (by physical contact)
- *Nihshwasata* (expired air/breathe)
- *Saha bhojanata* (eating with others in same plate)
- *Sahashayyasanata* (sharing a bed, sexual contact)
- *Vastramalyanulepnata* (sharing clothes, garlands, and cosmetic paste)

These factors are very much pertinent and responsible for spreading the infectious diseases like SARS, MERS & COVID 19.

Preventive Measures Advocated in Ayurveda [75] for Endemics

- *Shodhana* (biopurification)
- *Rasayana sevana* (use of immunomodulatory compounds)
- *Dincharya palana* (daily regimen)
- *Ritucharya palana* (seasonal regimen)
- *Achara Rasayana sevana* (pursuing good and ethical deeds)
- Advanced collection of potent medicines.

Potentials of Ayurveda in the Management of Covid 19

After many studies conducted worldwide to know the pathophysiology and treatment of Novel Corona Virus Disease, it has been concluded that the effective line of treatment can be the drugs having the following properties:

- Anti-viral
- Immuno-modulatory and
- Antipyretic

India is considered as the Botanical Garden of the World specifically in the reference of medicinal herb. Ayurvedic system of medicine possesses a wealth of single drug and formulations for treating various disorders. A huge number of drugs having Immuno modulatory, anti oxidant, antipyretic and antiviral properties are mentioned in classical treatise of Ayurveda. Many of these drugs have been investigated on modern science parameters and promising results were reported. Some of Ayurvedic medicinal plants which can be the panacea in the management of various viral infections and COVID 19 are listed below:

Table 1: Most promising Medicinal plants and Phytochemicals screened against SARS-CoV-2 [76].

S.No.	Plant source	Phytochemical name
1.	*Psorothamnus arborescens*	5,7,3',4'Tetrahydroxy2'-(3,3dimethylallyl) isoflavone
2.	*Myrica cerifera*	Myricitrin
3.	*Hyptis atrorubens Poit*	Methyl rosmarinate
4.	*Phaseolus vulgaris*	3,5,7,3',4',5'hexahydroxy flavanone-3-O-beta-Dglucopyranosid e
5.	*Phyllanthus emblica*	(2S)Eriodictyol-7O-(6''-O-galloyl)-beta-D glucopyranosid
6.	*Fraxinus sieboldiana*	Calceolarioside B
7.	*Camellia sinensis*	Myricetin 3-O-beta-Dglucopyranoside
8.	*Glycyrrhiza uralensis*	Licoleafol
9.	*Amaranthus tricolor*	Amaranthin

Table 2: Plants showing Antiviral Activity against Various types of Viruses [77].

Name of Virus	Name of Plant	Family of plant
Severe Acute Respiratory Syndrome-Associated Corona Virus	*Lycoris radiate*	*Amaryllidaceae*
Corona Viruses	*Echinacea*	*Asteraceae*
Rhinoviruses		
Bovine Corona Virus and Bovine Rotavirus	*Camellia sinensis*	*Theaceae*
Influenza Virus	*Allium oreoprasum*	*Alliaceae*
	Androsace strigilosa	*Saxifragaceae*
	Asparagus filicinus	*Asparagaceae*
	Bergenia ligulata	*Saxifragaceae*
	Chaenomeles sinensis	*Rosaceae*
	Camellia sinensis	*Theaceae*
	Cistus incanus	*Cistaceae*
	Echinacea	*Asteraceae*
	Emblica officinalis	*Euphorbiaceae*
	Geranium sanguineam	*Geraniaceae*

	Myrica rubra	*Myricaceae*
	Nerium indicum	*Apocynaceae*
	Punica granatum	*Punicaceae*
	Verbascum Thapsus	*Scrophulariaceae*
Influenza A (H3N2) and (H1N1)Viruses	*Prunus mume*	*Rosaceae*
	Sambucus nigra	*Adoxaceae*
Influenza A (H3N2) and B Viruses	*Scutellaria baicalensis*	*Lamiaceae)*
Influenza A (H3N2) Virus	*Elsholtzia rugulosa*	*Lamiaceae*
	Hypericum japonicum	*Hypericaceae)*
H1N1,H9N2,H5N1	*Andrographis paniculata*	*Acanthaceae*
H1N1,H6N1	*Curcuma longa*	*Zingiberaceae*
Avian, Human and Equine strains of Influenza A Virus	*Geranium sanguineum*	*Geraniaceae*
Parainfluenza Virus- Type 3,Vaccinia Virus, Vesicular Stomatitis Virus and Human Rhinovirus Type 3	*Allium sativum*	*Liliaceae*
Adenovirus	*Caesalpinia pulcherrima*	*Fabaceae*
	Ardisia squamulosa	*Myrsinaceae*
	Camellia sinensis	*Theaceae*
	Ocimum basilicum	*Lamiaceae*
	Serissa japonica	*Rubiaceae*
Respiratory Syncytial Virus	*Blumea laciniata*	*Asteraceae*
	Elephantopus scaber	
	Echinacea	
	Laggera pterodonta	
	Mussaenda pubescens	*Rubiaceae*
	Schefflera octophylla	*Araliaceae*
	Scutellaria indica	*Labiatae*
	Selaginella sinensis	*Selaginellaceae*
Human Immunodeficiency Virus	*Phyllanthus amarus*	*Euphorbiaceae*
	Zingiber officinale	*Zingiberaceae)*

Table 3: List of plants having Immuno-modulatory properties and their Chemical constituents [78]

S.No.	Botanical Name	Part used	Chemical constituents
1.	*Achillea millefolium C.Koch*	Leaves	Flavonoids, polyacetylenes, coumarins, alkaloids, triterpenes
2.	*Aloevera Tourn.ex Linn.*	Leaves	Anthraquinone glycosides
3.	*Andrographis paniculata Nees.*	Leaves	Diterpenes
4.	*Asparagus racemosus Wild.*	Roots	Saponins, sitosterols
5.	*Abutilon indicum linn.*	Whole plant	Flavonoids, triterpenoids
6.	*Alternanthera tenella Colla.*		Flavonoids, triterpenes
7.	*Actinidia macrosperma C.F.Liang*	Fruits	Alkaloids and saponins
8.	*Acacia catechu Willd.*	Leaves	Flavonoids and quercetin
9.	*Allium hirtifolium Boiss.*	Herb	Thiosulfinates, flavonoids
10.	*Acanthopanax sessiliflorus (Rupr.& Maxim.)*	Shoots and roots	Biopolymers
11.	*Apium graveolens Linn.*	Leaves, seeds	Flavonoids, coumarins
12.	*Artemisia annua Linn.*	Herb	Artemisinin
13.	*Boswellia serrata spp.*	Gum resin	Triterpenes, ursanes
14.	*Botryllus schlosser*	Tunicates	Cytokines
15.	*Bidens pilosa L.*	Flowers, leaves	Polyacetylenes
16.	*Boerhaavia diffusa*	Herb	Alkaloids
17.	*Byrsonima crassa Nied.*	Leaves	Flavonoids, tannins, terpenes
18.	*Bauhinia variegate Linn.*	Roots, bark, buds	Flavonoids, beta-sitosterol, lupeol

19.	*Couroupita guianensis Aubl.*	Fruits, flowers	Steroids, flavonoids, phenolics
20.	*Cissampelos pareira Linn.*	Roots	Hayatine alkaloid
21.	*Chlorophytum borivilianum Sant.F*		Sapogenins
22.	*Cordia superba Cham.*	Leaf, fruit, bark	Alpha-amyrin
23.	*Cordia rufescens A.DC*		
24.	*Cleome gynandra Linn.*	Leaf, seeds, roots	Hexacosanol, kaempferol
25.	*Citrus natsudaidai Hayata*	Fruits	Auraptene, flavonoid
26.	*Calendula officinalis L.*	Flowers	Polysaccharides, proteins, fattyacids, carotenoids, flavonoids, triterpenoids
27.	*Camellia sinensis L.*	Leaves	(-)Epigallocatechin gallate, quercetin, gallicacid
28.	*Cannabis sativa*		Cannabinoids
29.	*Carpobrotus edulis L.*	Flowers, fruit	Alkaloids
30.	*Centella asiatica Linn.*	Herb	Triterpenoid, saponins
31.	*Cistanche deserticola*		Polysaccharide
32.	*Crinum latifolium Andr.*		Alkaloids
33.	*Evolvulus alsinoides Linn.*		
34.	*Euphorbia hirta linn.*		Quercitol, myricitrin, gallic acid
35.	*Eclipta alba L.*	Leaves	Triterpenoid, glucosides
36.	*Echinacea angustifolia*	Flowers	Polysaccharide
37.	*Gymnema sylvestre R.Br.*	Leaves	Sapogenins
38.	*Ganoderma lucidum (Fr.) P.Karst.*	Whole plant	Flavonoids and triterpenes
39.	*Genus Ardisia*	Shrub, Branches and Leaves	Peptides, saponins, Isocoumarins, quinines and alkylphenols
40.	*Genus Aristolochia*	Leaves	Aristolochic acid
41.	*Haussknechtia elymatica*	Herb	Phenolics
42.	*Hibiscus rosa sinensis Linn.*	Flowers	Cyclopropanoids
43.	*Hyptis suaveolens (L.) Poit.*	Leaf, flowers	Lupeol, beta-sitosterol
44.	*Heracleum persicum Desf.*	Shurb	Flavonoids, furanocoumarins
45.	*Larrea divaricata DC.*	Herb	Lignans
46.	*Lycium barbarum Linn.*	Fruits	Polysaccharide-protein complexes
47.	*Lagenaria siceraria Mol.*	Leaves, fruit	Cucurbitacin, beta-glycosidase
48.	*Morus alba Linn.*	Fruits, leaves, bark	Flavonoids, anthocyanins
49.	*Murraya koenigii (L) Spreng.*	Leaves	Coumarin, carbazolealkaloids, glucosides
50.	*Matricaria chamomilla*	Flowers	Protein
51.	*Mollugo verticillata L.*	Herb	Quercetin, glycosides and triterpenoid
52.	*Moringa oleifera L.*	Leaves	Vitamin A,B and C, saponins, carotenoids
53.	*Nyctanthes arbor-tristis L.*	Leaf, seeds	Iridoid glucosides
54.	*Nyctanthes arbor-tristis L.*	Leaf, seeds	Iridoid glucosides
55.	*Ocimum sanctum Linn.*	Whole plant	Essentialoil such as eugenol, cavacrol, derivatives of ursolicacid, apigenin
56.	*Piper longum L.*	Fruits	Alkaloids
57.	*Panax ginseng Wall.*	Fruits, root	Saponins like panaxdiol, ginsenosides panaxtriole, oleanolic acid
58.	*Picrorhiza scrophulariiflora Benth.*	Roots	Iridoid glycosides, amphicoside
59.	*Randia dumetorum Lamk.*	Fruits	Saponins, triterpenes
60.	*Rhodiola imbricate Gray.*	Rhizomes	Phenolics
61.	*Salicornia herbacea*	Herb	Polysaccharide
62.	*Silybum marianum L.*	Flowers	Flavonoids
63.	*Tinospora cordifolia Miers.*	Whole plant	Alkaloidal constituents such as berberine, tinosporicacid
64.	*Terminalia arjuna Roxb.*	Leaves, bark	Flavonoids, oligomeric proanthocyanidins, tannins
65.	*Thuja occidentalis L.*	Leaves	Polysaccharides
66.	*Urena lobata Linn.*	Roots, flowers	Flavanoids
67.	*Viscum album L.*	Leaves and young twigs berries	Viscotoxins, polysaccharides and polyphenols

Table 4: Medicinal Plants with Potential Antipyretic Activity [79].

S.No.	Plant Name	Part used
1.	*Acacia leucophloea*	Stem bark
2.	*Alstonia boonei*	
3.	*Andrographis paniculata*	Whole plant
4.	*Benincasa hispida*	Seeds
5.	*Cadaba trifoliate*	Leaves
6.	*Corchorus capsularis*	
7.	*Capparis zeylanica*	Whole plant
8.	*Chenopodium ambosioides*	
9.	*Crataeva magna*	
10.	*Calotropis gigantean*	Roots
11.	*Clitoria terantea*	
12.	*Clerodendron serratum*	
13.	*Cyperus rotundus*	
14.	*Caesalpinia bonducella*	Seeds
15.	*Cicer arietinum*	
16.	*Cleome rutidosperma*	Aerial parts
17.	*Cressa cretica*	
18.	*Dodonaea angustifolia*	Whole plant
19.	*Leucas lavandulaefolia*	
20.	*Litchi chinensis*	Leaves
21.	*Melia azedarach*	
22.	*Mangifera indica*	Stem
23.	*Nelumbo nucifera*	Rhizome
24.	*Ocimum suave*	Leaves
25.	*Ocimum lamiifolium*	
26.	*Piper nigrum*	Fruit
27.	*Plumeria rubra*	Leaves
28.	*Prosopis cineraria*	Leaves, Fruit
29.	*Phrygilanthus acutifolius*	Flowers
30.	*Tabernaemontana pandacaqui*	Stem
31.	*Teclea nobilis*	Leaves, Fruit
32.	*Tecomaria capensi*	Leaves
33.	*Trigonella foenum-graecum*	
34.	*Tectona grandis*	Root
35.	*Taxus wallichiana*	Leaves, Stem bark
36.	*Vernonia cinerea*	Whole plant
37.	*Zizyphus jujube*	Stem bark
38.	*Zizyphus oxyphylla*	Leaves

Initiatives by Ministry of AYUSH

- Ministry of Ayush under Govt. of India have issued various preventive measures like intake of *Chyawanprasha* (a potent immunity enhancer formulation), *Haldi* (turmeric), *Lehsun* (garlic) etc. along with Yoga, *Pranayama* (breathing exercise), Nasal application of sesame oil, coconut oil or cow's ghee and Meditation [80].
- It releases notification to invite applications for substantiating AYUSH interventions related research studies on SARS-COV-2 Infection under Extra Mural Research (EMR) Scheme [81].
- Ministry of AYUSH formulated a *Kwatha* (decoction) named as *Ayush Kwatha* [82] which intends to promote immunity & health of the population. It is a therapeutic medley of four ayurvedic drugs such as *Tulsi /* Leaves of *Ocimum sanctum* (4 parts), *Dalchini* / Stem bark of *Cinnamomum zeylanicum* (2 parts), Rhizome of *Sunthi* / *Zingiber officinale* (2 parts) and Fruit of *Krishna Marich* / *Piper nigrum* (1 part).
- AYUSH ministry, Ministry of Health & Family Welfare (MoHFW) and the Ministry of Science & Technology have collaboratively launched Clinical research studies on four different Ayurveda interventions viz. *Ashwagandha (Withania somnifera), Yashtimadhu (Glycyrrhiza glabra), Guduchi (Tinospora cordifolia) +Pippali (Piper longum)* and a poly herbal formulation (*AYUSH-64*) in COVID 19 under Council of Scientific & Industrial Research (CSIR) with technical support from ICMR [83].
- A population based study has been initiated by Ministry of AYUSH to study the effect of Ayurvedic interventions in prophylaxis of COVID-19 infection and improvement in Quality of Life in population of high risk. The study will approximately cover 5 lakhs population across the country and carried out through 4 Research Councils of Ministry of AYUSH, National Institutes in 25 states and various State Governments [84].
- Ministry of AYUSH has developed a mobile app named as *Ayush Sanjivani* to generate data of bigger population targeting around 5 million people. The inherent objective of the app is to produce data on acceptance and compliance of Ministry of AYUSH recommendations and manoeuvre among the population and its implications in prevention of COVID 19 [85].

CONCLUSION

The neoteric COVID-19 outbreak has been declared an International Health Emergency. Globally, the number of confirmed cases has been continuously rising. It is perhaps evident that quarantine alone may not be amply sufficient to preclude the spread of COVID-19. So,

- We should focus on personal hygiene and social distancing in order to effectively minimise and stop the transmission of virus.
- Meticulous surveillance and monitoring is needed to accurately track and potentially predict its future host adaptation, evolution, pathogenicity and transmission.
- It is crucial to check infection source, cut the route of transmission, and utilize the existing capable drugs to control the disease development in a good manner.
- Trans disciplinary and Inter disciplinary researches should be initiated to explore more and effective options.
- Potential Ayurvedic drugs must be included in the management of COVID 19 and further researches should be initiated in this direction.
- Daily and seasonal regimen advocated in Ayurveda should be included in daily life.
- Consumption of wild animals and birds must be completely banned which are potential host of viruses, as a source of food.

Conflict of Interest: None

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