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Research Paper

Therapeutic Plants Used During COVID-19 Pandemic in Rajasthan, India

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ABSTRACT

The havoc creating COVID-19 pandemic on the planet Earth since the beginning of the year 2020 was caused by a virus named as SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus). It continued to take numerous human lives till the end of the year 2022 with its lethal mutative forms; despite the development of anti-COVID vaccinations. Several symptoms related to disturbances in respiratory, digestive and neuronal systems were observed. As traditional medicine always remains a priority for treatment/prevention of several infectious diseases, COVID-19 was no exception. In several parts of the world, people started taking plant based remedies to combat with the pandemic. In the present study, an attempt was made to know about the contribution of plants for treatment/prevention of COVID-19 among the people of Rajasthan. For this purpose, a questionnaire was created on Google Forms and responses from 108 individuals were collected during the months of July-September, 2022. All the participants were vaccinated with double doses of anti-COVID vaccines and 27 were once infected with COVID-19 during the pandemic period. Notably, 86.11% individuals responded that the plants were useful to them in prevention and/or treatment of COVID-19 symptoms. Mainly, 13 Angiosperm plants were used against COVID-19. Ocimum tenuiflorum, Zingiber officinale and Tinospora cordifolia were maximally utilized plants. Interestingly, these plants have also shown antiviral potential as demonstrated in recent scientific studies. The results not only show the efficacy of the plants but also indicate towards the medicinal utility of plants as inculcated in deep belief system of people of Rajasthan.

KEYWORDS: SARS-CoV-2, *Tinospora cordifolia*, Zingiberaceae, Long Pepper

INTRODUCTION

Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV-2) caused Coronavirus Disease-19 (COVID-19) which was declared as pandemic by World Health Organization (WHO). Its first case was reported in Wuhan, China in December, 2019[1]. Symptoms of COVID-19 were variable but often included fever, cough, headache, fatigue, breathing difficulties, loss of smell, and loss of taste[2,3]. SARS-CoV-2 is a member of Beta Coronavirus and is similar to earlier detected coronaviruses, namely, the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) and Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV), in its clinical spectrum and pathogenic nature[1,4].

In a close, unprotected environment, exposure with individuals having COVID-19 infection, the virus is

primarily disseminated through droplets and aerosols. After an average incubation period of 5–6 days following infection, an infected person may have pathological signs such moderate respiratory issues and fever. According to several case reports, mortality rates increase with age, with persons over 80 having the highest rate. Moreover, persons over 60 having other co-morbid conditions such as chronic respiratory diseases, diabetes, cardiovascular diseases, hypertension, and cancer also had higher mortality rates[5].

The control of coronavirus outbreaks required the use of sanitizers, social isolation, immunization, wearing gloves and face masks, among other preventative measures[6]. Later on, several COVID-19 vaccines were validated for use by WHO such as Pfizer, Covaxin, Covishield, Moderna, Sputnik V, Johnson & Johnson and SinoVac[7]. However, many traditional medicinal formulations were also used for treatment of COVID-19 in several parts of world.

For example, Alami *et al.*[8] did an online survey and found that the Moroccan people used a variety of medicinal plants to prevent COVID-19. The most widely used plants were *Allium cepa, Allium sativum, Curcuma xanthorrhiza, Olea europaea, Zingiber officinale, Thymus maroccanus, Eucalyptus globulus, Foeniculum vulgare, Mentha pulegium, Phoenix dactylifera, Thymus satureioides, Rosmarinus officinalis,* and *Pimpinella anisum.*

Khadka *et al.*[9] also conducted an online survey on 774 respondents in Nepal and collected data related to medicinal plants used during COVID-19. It was observed that during COVID-19, both the use of medicinal plants and the associated beliefs were rose and a total of 63 medicinal plant species were utilized to prevent COVID-19.

Similarly, a questionnaire-based online survey on home remedies employed during COVID-19 was carried out among a large population (n=531) of individuals from various countries and age groups (13-68 years). The survey revealed that 71.8% of people took *kadha* (herbal decoction) to prevent the viral infection and to increase immunity. The majority of people (86.1%) believed that *kadha* had no side effects. Spices are helpful in improving immunity and to treat coronavirus or other viral infections. This was believed by 93.6% respondents. *Tulsi* drops, vitamin C, and *chyawanprash* were used as the most important immune-boosters[10].

Indians have utilized spices and herbs for their particular flavor as well as for their antiviral, antibacterial, antioxidant, and immunity-boosting effects since ancient times[10]. One of the oldest medical systems in the world, Indian Traditional System of Medicine has been a fundamental part of providing health care to human civilization since its inception. The department of Ayurveda, Unani, Siddha, Yoga, and Homoeopathy (AYUSH) is working extensively in India to promote traditional medicine[11].

Indian Winter Cherry, Black Cumin, Heart Leaved Moonseed, Holy Basil, Ginger, Black Pepper, Garlic, Indian Gooseberry, Cinnamon, Turmeric, and Flax seeds have been used for centuries as herbal remedies for a variety of diseases. In India, these are used frequently in cooking and are found in every home's kitchen[12]. Similar to this, there are some traditional Indian formulations that are widely used in India as a part of daily nutritional supplements, like *Triphala, Chyawanprash*, etc. Regardless of religion, community, or financial status, Indian community uses at least one of these plants and formulations on a daily basis. These herbs and formulations have been proved scientifically for their immunomodulatory, antioxidant, and anti-infective properties, which might be one of the reasons behind the lower death rate of Indians per million of population due to COVID-19 even with minimum health infrastructure.

Scientific evidence for the antioxidant, immunomodulatory, and anti-infective characteristics of these herbs and preparations suggests that they may contribute to the decreased death rate of Indians per million people from COVID-19 though having poor health infrastructure[13].

Singh *et al.*[14] reported some prominent Indian traditional medicinal herbs such as *Achyranthes bidentata, Ocimum tenuiflorum, Cinnamomum cassia, Tinospora cordifolia, Cydonia oblonga, Justicia adhatoda, Embelia ribes, Withania somnifera, Momordica charantia, Camphor, Zingiber officinale,* and Kabusura kudineer, which were being used against SARS-CoV-2 infection. Tovar *et al.*[15] did a questionnaire based survey in Western Colombia and determined the most popular species which were *Zingiber officinale* Roscoe, *Citrus x limon* (L.) Osbeck, *Gliricidia sepium* (Jacq.) Walp, *Eucalyptus globulus* Labiil and *Matricaria recutita* L.

In view of this, the present online study has been planned to find out the role of plants in prevention or treatment of COVID-19 among people of Rajasthan.

MATERIALS AND METHODS

For this purpose, a set of 15 questions (both open and close ended) was prepared by Google Form developer and circulated to the eligible participants as per the study protocol (age between 30-75 years) during the months of July-September 2022 through social media tools such as Facebook and Whatsapp messengers and also through emails. They were invited to respond to the survey. Prior informed consent was obtained from the respondents and assurance was given for their data privacy. Besides, the basic demographic details, queries related with COVID-19 vaccination status; COVID-19 infection and hospitalization history, use of plants for prevention or treatment of COVID-19, impact of plants on COVID-19 symptoms etc. were asked to the respondents. The data was finally retrieved from 108 people who were residents of different localities in Rajasthan and provided information about the variables asked in the form. The data, thus obtained was analyzed using descriptive and inferential statistics and mainly represented as number and percentage.

RESULTS AND DISCUSSION

Out of the 108 respondents, 52 (48.1%) were females and 56 (51.8%) were males. Among them, 27 respondents were infected with COVID-19 and out of which 26 were infected once, one (0.93%) was infected twice and no one was infected thrice. Out of these COVID-19 infected respondents, 13 were males and 14 were females. Among them, five males and four females were from the age group of 30-45 years and eight males and 10 females belonged to the age group 46-75 years.

Among the infected respondents, only four (two males, two females) got hospitalized and all felt that using plants helped them in treatment. Out of the hospitalized respondents, three belonged to the age group of 45-65 years and only one was from the age group of 30-45 years.

Interestingly, all the respondents took both the doses of COVID-19 vaccine and only 31 (28.71%) respondents took the 3rd dose of vaccine (Figure 1). Among the respondents of age group 30-45 years, 39 individuals got 2nd dose and 13 got 3rd dose of vaccine. Among the age group of 46-65 years, 38 got 2nd dose of vaccine and 17 got 3rd dose of vaccine. Only one respondent from the age group 65-75 years received all the three doses of anti-COVID vaccine (Figure 2).

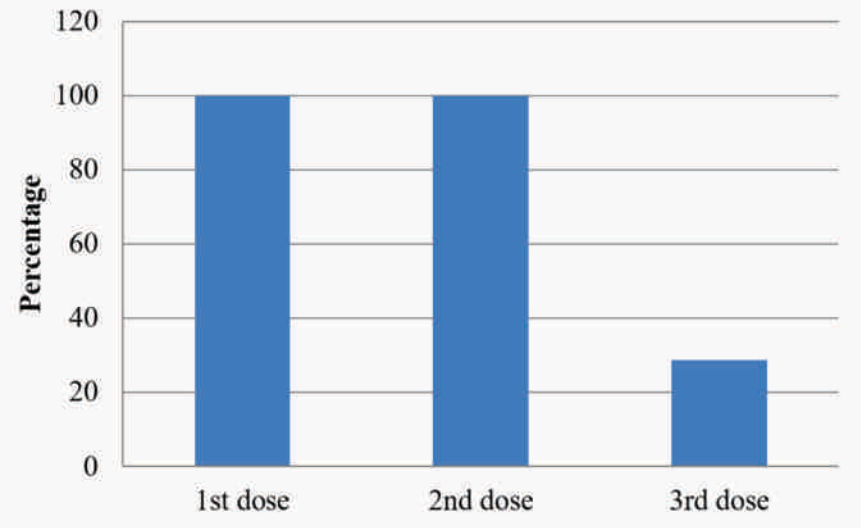

Figure 1: Percentage of respondents who took first, second and third dose of COVID-19 Vaccine (n=108)

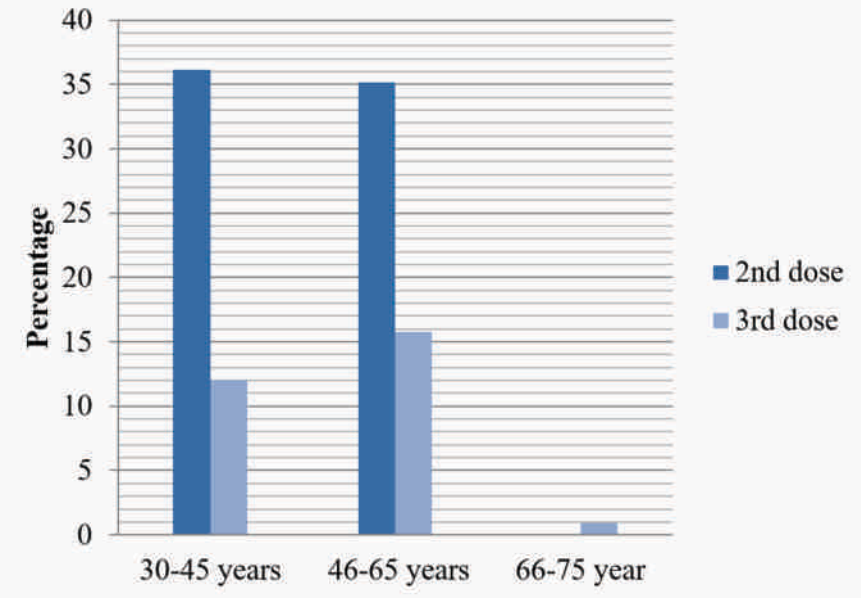

Figure 2: Percentage of individuals who received COVID-19 vaccine according to age groups (n=108)

Notably, 86.11% (45 males and 48 females) of the total participants used 13 Angiosperm plant species (Table 1) for prevention from COVID-19. The two plants belonged to Monocotyledons and rest was Dicotyledons. The plant *Zingiber officinale* was used in both fresh and dry form and hence, counted only once. Moreover, 19 individuals used plants for the purpose of treatment of COVID-19.

Table 1: Plants used by people of Rajasthan for prevention/ treatment of COVID-19

S.No.	Common Name	Local Name	Botanical Name	Family	Plant Part Used
1.	Black Grape Raisins	*Munakka*	*Vitis vinifera* L.	Vitaceae	Fruit
2.	Black Pepper	*Kali Mirch*	*Piper nigrum* L.	Piperaceae	Fruit
3.	Cinnamon	*Dalchini*	*Cinnamomum verum* J. Presl	Lauraceae	Inner bark
4.	Clove	*Laung*	*Syzygium aromaticum* (L.) Merr. & L.M.Perry	Myrtaceae	Flower bud
5.	Dry Ginger	*Sonth*	*Zingiber officinale* Roscoe	Zingiberaceae	Rhizome
6.	Ginger	*Adrakh*	*Zingiber officinale* Roscoe	Zingiberaceae	Stem
7.	Heart Leaved Moonseed	*Giloe*	*Tinospora cordifolia* (Willd.) Hook.f. & Thomson	Menispermaceae	Stem
8.	Holy Basil	*Tulsi*	*Ocimum tenuiflorum* L.	Lamiaceae	Leaves
9.	Indian Winter Cherry	*Ashwagandha*	*Withania somnifera* (L.) Dunal	Solanaceae	Leaves
10.	Lemon	*Nimbu*	*Citrus limon* (L.) Osbeck	Rutaceae	Fruit
11.	Long pepper	*Pippali*	*Piper longum* L.	Piperaceae	Fruit
12.	Mace	*Javitri*	*Myristica fragrans* Houtt.	Myristicaceae	Seed coat
13.	Nutmeg	*Jayfal*	*Myristica fragrans* Houtt.	Myristicaceae	Seed
14.	Turmeric	*Haldi*	*Curcuma longa* L.	Zingiberaceae	Rhizome

It was observed that the most frequent plant used was Holy Basil (87.96%) followed by Ginger (76.85%), Heart Leaved Moonseed (69.44%), Black Pepper (68.51%), Turmeric (64.81%), Lemon (63.88%), Clove (53.70%), Dry Ginger (52.77%), Cinnamon (50%), Black Grape Raisins (36.11%), Indian Winter Cherry (27.77%), Long pepper (20.37%), Nutmeg (14.81%) and Mace (13.88%) (Figure 3). Similarly, Singh et al.[10] shown that the Holy Basil *(Tulsi)* was the most used in form of drops among respondents from various countries. Also, Ginger was most widely used in Western Colombia and Nepal as shown by Tovar *et al.*[15] and Khadka *et al.*[9] respectively. The most common families of the therapeutic plants were Zingiberaceae followed by Piperaceae, Myristicaceae, Lamiaceae, Menispermaceae, Rutaceae, Myrtaceae, Lauraceae, Vitaceae and Solanaceae (Table 1). Interestingly, 86.11% respondents felt that plants helped in prevention or treatment of COVID-19 symptoms (Figure 4).

Lim *et al.*[16] have shown that the four medicinal plants *(Azadirachta indica, Vernonia amygdalina, Nigella sativa,* and *Eurycoma longifolia)* depicted pleiotropic effects that may be used to manage COVID-19 through their antiviral, anti-inflammatory, and immunomodulatory effects. Chopra *et al.*[17] have shown the positive impact of Indian medicinal plants in COVID-19 having phyto-constituents with anti-pyretic, anti-inflammatory, antiviral, and immune-modulating properties and thus, the plants such as *Ocimum sanctum, Tinospora cordifolia, Citrus limon* and *Allium sativum* could be inspected as therapeutic agents against COVID-19.

Namdeo[18] suggested several herbs play an important role in enhancing the immunity by increasing the number of good bacteria in the body such as *Withania somnifera, Tinospora cordifolia, Allium sativum, Azadirachta indica, Emblica officinalis, Curcuma longa, Zingiber officinale, Panax ginseng, Ocimum tenuiflorum, Echinacea perpurea, Aloe barbadensis* and many more.

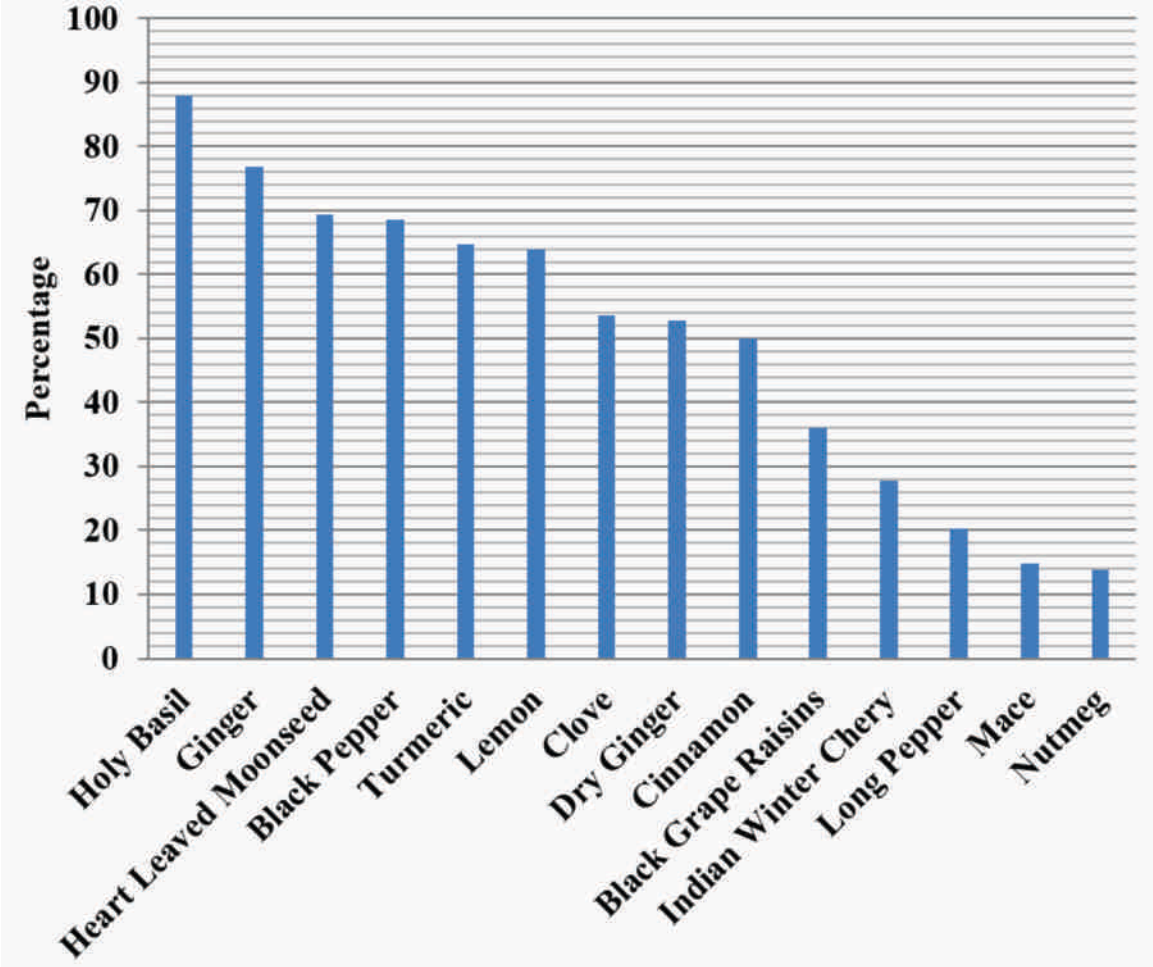

Figure 3: Frequency percentage of plants used for prevention / treatment of COVID-19 in Rajasthan

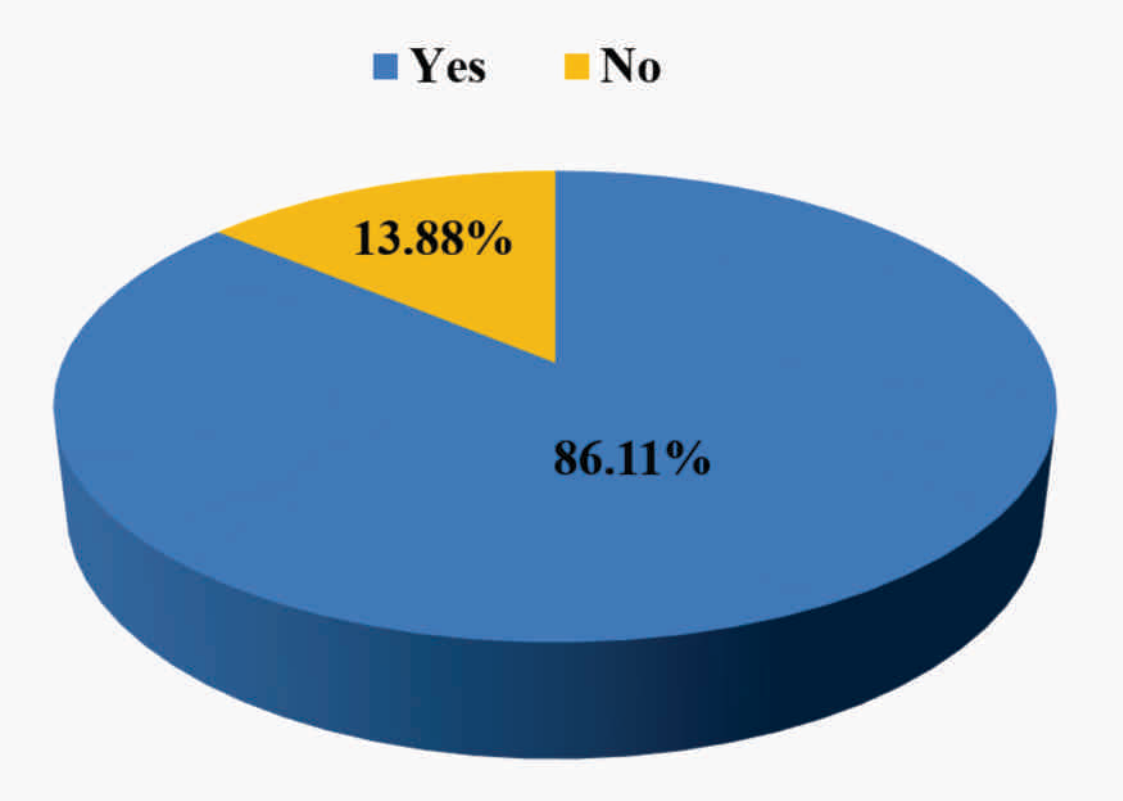

Figure 4: Responses in percentage on using the plants helped in prevention or treatment of COVID-19 symptoms (n=108)

A positive reply of the query regarding using the plants during COVID-19 helped in prevention or treatment of symptoms was given by 86.11% respondents showing that the plants helped them in prevention and/or treatment of COVID-19 symptoms. Seven individuals mentioned that they also used *Neem (Azadirachta indica),* three used *Ajwain (Trachyspermum ammi),* two used *Kadha,* and one each used Papaya *(Carica papaya)* leaves, *Pudhina (Mentha piperita), Bael Patra (Aegle marmelos), Vasa (Justicia adhatoda), Mulethi (Glycirrhiza glabra), Chirayata (Swertia chirayta), Talispatra,* Green tea, and Rose against COVID-19 in addition to the list of plants given in the form.

Patel *et al.*[19] identified a total of 38 Indian edible plant species having potential against different viruses such as inhibition against various RNA viruses. There are phyto-constituents in many of them that may have anti-coronavirus properties.

Li *et al.*[20] have shown that isorhamnetin, glyasperin, acetoside, and several flavonoid compounds may prevent and/or be effective in management of COVID-19 by reducing the host cytokine storm, targeting the viral infection, providing organ protection and regulating the immune response. These bioactive natural ingredients may aid in the development of dietary supplements or functional foods for the treatment of COVID-19 (either alone or in combination). Jalal *et al.*[21] discussed the evidence of zinc supplementation in boosting the immunity and recovery of patients with COVID-19 and proposed a list of medicinal plants having bioactive molecules with antiviral activities such as quercetin, curcumin, allicin, resveratrol, baicalin, lycorine, glycyrrhizin, punicalagin, and other secondary metabolites.

Khanna *et al.*[22] have shown that Traditional Chinese medicine and Ayurveda both use a variety of herbal remedies. These formulations contain a large number of phytochemicals, including tannins, saponins, terpenoids, alkaloids, polyphenols, flavonoids, phenols, polysaccharides, proteins, peptides, lipids, and which have a variety of roles in the body's defense against viral invasion, replication, penetration, assembly, expression, and release.

Phumthum *et al.*[23] compiled 1230 uses of 491 plants from 31 Karen villages and 19 Hmong villages, as well as collected new ethnomedicinal information for treatment of WHO listed mild COVID-19 symptoms such as muscle pain, rash, fever, sore throat, cough, diarrhea, headache, and conjunctivitis from six Hmong villages. The common use of 60 species was observed.

By using various herbal extracts and purified molecules, natural products can be utilized alone or in combination as alternative therapies to cure or prevent COVID-19 infection. These compounds can directly inhibit the replication of SARS-CoV-2 or its entry. Their structural details may also provide directions for the formation of anti-SARS-CoV-2 treatments[24]. Noureen *et al.*[6] have shown that the use of natural immunity boosters strengthens against the possible attack of COVID-19 and/or other viral diseases and stops spread of coronaviruses.

Ahmed and Hughes[25] reported 16 plant species namely, *Allium sativum, Andrographis paniculata, Artemisia herba-alba, Artemisia vulgaris, Azadirachta indica, Camellia sinensis, Citrus limon, Curcuma longa, Eucalyptus globulus, Euphorbia hirta, Glycyrrhiza glabra, Mangifera indica, Nigella sativa, Psidium guajava, Syzygium aromaticum,* and *Zingiber officinale* which were the most frequently used traditional phytomedicine used for prevention and treatment of COVID-19 across various geographic locations.

A plant's phyto-constituents are potentially beneficial in prevention and treatment of several diseases. Many phyto-constituents have also shown to interfere with COVID-19 pathogenesis by inhibiting replication of SARS-CoV-2 and its entry in host cells. *In silico* screening and molecular docking of several plants has been done and revealed their potential against SARS-CoV-2. Lupeol and betulin were suggested as the potential ligands for SARS-CoV-2 spike proteins by Ambrose *et al.*[26] after conducting a docking-based virtual screening of 50 putative phytoconstituents against the spike glycoprotein of the wild-type and the Delta variant of SARS-CoV-2.

Among the plants that are used for prevention/treatment of COVID-19 in the present study, a molecular docking study on *Tinospora cordifolia*[27], *Withania somnifera*[27,28], *Ocimum sanctum*[27], *Citrus limon*[29,30], *Azadirachta indica*[31], *Carica papaya*[32], *Piper nigrum, Syzygium aromaticum* and *Zingiber officinale* Roscoe[33], *Cinnamomum verum*[34], *Piper longum*[35], *Glycyrrhiza glabra*[36] and *Myristica fragrans*[37] have revealed their strong potential against COVID-19. Besides, *in vitro* studies on *Curcuma longa*[38], *Vitis vinifera*[39], Red Rose[40] and their derivatives have shown to possess antiviral activity validated by pharmacological evaluations. However, large scale clinical studies are required for *in vivo* validation of anti-SARS-CoV-2 efficacy of these medicinal plants.

CONCLUSION

Traditional medicine had been a big rescue in prevention and treatment of several diseases. During COVID-19 pandemic, the use of traditional medicine, especially plant based remedies were also used by the people. The present study reveals the use of 13 medicinal plants by the people of Rajasthan for the prevention and/or the treatment of COVID-19. *Ocimum tenuiflorum, Zingiber officinale* and *Tinospora cordifolia* were maximally utilized plants. Interestingly, all the respondents involved in the study were vaccinated with double doses of Anti-COVID vaccine. However, they were positive about utilizing plants for prevention/treatment purpose from COVID-19. The limitation of the present study is that it has a small sample size. Hence, in future, studies with large sample size as well as including respondents from outside Rajasthan could be carried out to obtain the statistically conclusive results regarding consumption of plants for betterment from COVID-19 symptoms.

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