Spices and herbs: Potential antiviral preventives and immunity boosters during COVID-19

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A severe acute respiratory syndrome is an unusual type of contagious pneumonia that is caused by SARS coronavirus. At present, the whole world is trying to combat this coronavirus disease and scientific communities are putting rigorous efforts to develop vaccines. However, there are only a few specific medical treatments for SARS-CoV-2. Apart from other public health measures taken to prevent this virus, we can boost our immunity with natural products. In this article, we have highlighted the potential of common spices and herbs as antiviral agents and immunity boosters.

A questionnaire-based online survey has been conducted on home remedies during COVID-19 among a wide range of peoples (n=531) of different age groups (13-68 years) from various countries. According to the survey, 71.8% of people are taking kadha for combating infection and boosting immunity. Most people (86.1%) think that there is no side effect of kadha while 13.9% think vice versa. A total of 93.6% of people think that spices are helpful in curing coronavirus or other viral infection as well as boosting immunity. Most people are using tulsi drops, vitamin C, and chyawanprash for boosting their immunity. Therefore, we conclude from the survey and available literature that spices and herbs play a significant role against viral infections.

KEYWORDS
antiviral, bioactive compounds, coronavirus, herbs, immunity boosters, SARS-CoV-2, spices

1 | INTRODUCTION

In December 2019, the people of Wuhan city of the Hubei province of China were suffered from deadly “SARS-CoV-2” like pneumonia which was later named coronavirus disease (COVID-19) by the World Health Organization (WHO) (Wang, Wang, Ye, & Liu, 2020). The COVID-19 cases are increasing day by day, and there have been 37,423,660 confirmed cases of COVID-19 in more than 200 countries, including 1,074,817 deaths up to October 12, 2020. (https://covid19.who.int/). The WHO declared it initially a public health emergency of international concern and later pandemic where the COVID-19 symptoms include fever, sneezing, diarrhea, dry cough, malaise, respiratory distress, and shortness of breath. This virus (SARS-CoV-2) is a member of beta-coronavirus and is found similar to earlier coronavirus severe acute respiratory syndrome coronavirus (SARS-CoV) and the Middle East respiratory syndrome coronavirus (MERS-CoV), in its pathogenicity and clinical spectrum (Gurunathan et al., 2020).

Coronaviruses (CoV) (family: Coronaviridae) are enveloped viruses containing non-segmented, positive-stranded genomic RNA. These viruses are pleomorphic particles ranging from 80-220 nm in diameter. The genome size of coronaviruses ranges from 26-32 kilobases (MacLachlan & Dubovi, 2017). It has better genome sequence vis-à-vis to the SARS-CoV compared to MERS-CoV, but the amino acid sequence is different from the other coronavirus, especially in the region of 1ab polyprotein and S-protein or surface glycoprotein (Kannan, Ali, Sheeza, & Hemalatha, 2020). Their entire replication cycle takes place in the cytoplasm. Coronaviruses can cause several of diseases, including bronchitis, hepatitis, gastroenteritis, and even death in birds, humans, and other animals (Chafekar & Fielding, 2018). The coronavirus has been found to attack all types of people,
especially elderly patients having diabetes, hypertension, cerebral infarction, chronic bronchitis, Parkinson’s disease, chronic obstructive pulmonary disease, cardiovascular disease, and cancer (Deng & Peng, 2020; Guan et al., 2020; Huang et al., 2020). Coronaviruses (CoVs) enter into the host cell through interaction between the S protein of the virus species and the receptor of the host cell. It will bind with the angiotensin-converting enzyme 2 receptor from the host cell to create a suitable habitation for viral replication (Walls et al., 2020).

Natural-derived compounds constantly become a worthy therapeutical alternative against several diseases, including viral infections, because they are innately better tolerated in the human body. According to a study, from 1940 to 2014, 49% of all small molecules approved by the U.S. Food and Drug Administration (FDA) were natural products or their derivates (Newman & Cragg, 2016).

Herbal exploration is continually performed, also to diminish coronavirus-related disease (Islam et al., 2020). Spices and herbs have been extensively studied globally due to their high antioxidant and antimicrobial activity in certain spices and their beneficial effects on humans. Spices contain many bioactive compounds that include flavonoids, phenolic compounds, sulfur-containing compounds, tannins, alkaloids, pheno- lic diterpenes, and so on (Devi, Umasanker, & Babu, 2012; Panpatil, Tattari, Kota, & Polasa, 2013; Patra, Jana, Mandal, & Bhattacharjee, 2016; Yashin, Yashin, Xia, & Nemzer, 2017). India has the recognized six systems of medicine, namely, Ayurveda, yoga, Unani, Siddha, naturopathy, and homeopathy (Ravishankar & Shukla, 2007). Ayurveda means the science of life, and it is not only considered as an ethnomedicine but also as a complete medical system for maintaining a healthy and happy living. In India, 20,000 plant species have been recorded, which are having medicinal value, but more than 500 traditional communities use only about 800 plant species for treating different diseases (Dev, 1997).

The outbreak of SARS-CoV-2 led to catastrophic events, as there was little specific treatment known to date for coronavirus. So there is a global need to search for the agents that can act against SARS-CoV-2 as a precautionary measure which boost our immunity during COVID-19. Ministry of AYUSH, India has released an advisory on Ayurveda’s recognized six systems of medicine, namely, Ayurveda, yoga, Unani, Siddha, naturopathy, and homeopathy (Ravishankar & Shukla, 2007). Ayurveda means the science of life, and it is not only considered as an ethnomedicine but also as a complete medical system for maintaining a healthy and happy living. In India, 20,000 plant species have been recorded, which are having medicinal value, but more than 500 traditional communities use only about 800 plant species for treating different diseases (Dev, 1997). A dose of up to 12 g/day of curcumin was known to be safe for human consumption during the clinical trials without showing any side effects (Gupta, Patchva, & Aggarwal, 2013). Shrivastava (2020) reported that the dose of curcumin from 2,500 to 8,000 mg per day for 3 months showed no toxicity from curcumin. Curcumin is a dynamic antiviral that reduces the replication of viruses.

Antiviral activity of curcumin was observed against different viruses including hepatitis viruses, SARS coronavirus, influenza viruses, human immunodeficiency virus (HIV), herpes simplex virus, dengue virus, chikungunya virus, and so on, as listed in Table 1. Curcumin’s antiviral activities can also be evidenced by its ability to regulate various molecular targets that contribute to various cellular events, such as transcription regulation, and the activation of cellular signaling pathways (Joe, Vijaykumar, & Lokesh, 2004). Curcumin’s role in targeting various cellular pathways, further inhibiting the growth, and replication of viruses makes it an ideal candidate as an anti-viral drug. Utomo, Ikawati, and Meiyanto (2020), based on their molecular docking study, reported that the curcumin binds and inhibits the target receptors including SARS-CoV-2 protease, spike glycoprotein-RBD, and PD-ACE2, which are involved in virus infection.

2.1 Curcuma longa L. (turmeric)

Turmeric (Curcuma longa L.) belongs to the family of ginger (Zingiberaceae) and natively grows in India and Southeast Asia. Rhizomes of this plant contain several secondary metabolites including curcuminoids, sesquiterpenes, steroids, and polyphenol as major bioactive substances (Omosa, Midiwo, & Kuete, 2017). Curcumin is a natural polyphenol that is isolated for turmeric (Curcuma longa) and has been used from centuries as a traditional medicine in Asian countries to treat various disorders. Several studies have shown that the curcumin possesses some pharmacological properties such as anti-inflammatory, anti-angiogenic, and anti-neoplastic, without toxicity. Food Drug Administration (FDA) categorized it as “Generally Recognized as Safe.” A dose of up to 12 g/day of curcumin was known to be safe for human consumption during the clinical trials without showing any side effects (Gupta, Patchva, & Aggarwal, 2013). Shrivastava (2020) reported that the dose of curcumin from 2,500 to 8,000 mg per day for 3 months showed no toxicity from curcumin. Curcumin is a dynamic antiviral that reduces the replication of viruses.

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2.2 Zingiber officinale (ginger)

Ginger is one of the important medicinal plants which naturally occur in various countries. Ginger, Zingiber officinale, belongs to family Ocimum basilicum (Tulsi), and so on (Singh, Tailang, & Mehta, 2016). Different spices such as clove, cinnamon, ginger, black pepper, and turmeric are known as immunity boosters along with their antiviral property (Sharma, Gupta, & Prasad, 2017; Shrivastava, 2020; Srivastava, Chaurasia, Khan, Dhand, & Verma, 2020). In this article, we have highlighted the antiviral potential of common spices and herbs mainly curcumin, cinnamon, ginger, clove, black pepper, garlic, neem, giloy, basil used during COVID-19 as depicted in Figure 1. Neem leaves contain various compounds such as zinc, quercetin, vitamin A, vitamin B1, vitamin B2, vitamin B6, vitamin C, vitamin E, and so on, which may boost immunity (Garba & Mungadi, 2019).
Zingiberaceae and the other famous members of this plant family are turmeric, cardamom, and galangal. The plant is indigenous to South-east Asia and is cultivated in several countries including India. Ginger (Zingiber officinale) is known as Sunthi in Ayurveda and the description of the plant appears in the old text like Charaka, Sushruta, Vagbhatta, and Chakra-dutta (Agrahari, Panda, Verma, Khan, & Darbari, 2015).
| Plant parts, extracts and compounds | Virus | Mechanism of action | Reference |
|-----------------------------------|-------|---------------------|-----------|
| **Ginger**                        |       |                     |           |
| Zingiber officinale Rosc (ZOR)    | Influenza A/ Aichi/2/68 (Aichi) virus | Via macrophage activation leading to production of TNF-α. | Imanishi et al., 2006 |
| Ginger essential oil              | Herpes simplex virus | Disrupts virus envelope | Schnitzler, Koch, & Reichling, 2007 |
| Aquatic extract of fresh ginger   | Human respiratory syncytial virus | Blocking viral attachment and stimulate mucosal cells to secrete IFN-β | Chang, Wang, Yeh, Shieh, & Chiang, 2013 |
| Hydroethanolic extract of ginger  | Influenza virus | — | Durra, EL-Barrawy, Sallam, & Mahmoud, 2019 |
| Aquatic extract of ginger         | Chikungunya virus | Inhibition of cytopathic effect and cell viability | Sulochana, Jangra, Kundu, Yadav, & Kaushik, 2020 |
| Bioactive compounds of ginger (gingerol, geraniol, shogaol, zingiberene, zingiberenol, zingerone) | SARS-CoV-2 | Block the S protein from binding to the ACE2 receptor or act as an inhibitor for MPro | Ahkam, Hemanto, Alamsyah, Aliyyah, & Fatchiyah, 2020 |
| **Cinnamon**                      |       |                     |           |
| Procyanidins and butanol extract  | SARS-CoV | Interference of clathrin-dependent endocytosis | Zhuanga et al., 2009 |
| Water extract                     | Human respiratory syncytial virus | Inhibition of viral attachment and internalization | Yeh, Chang, Wang, Shieh, & Chiang, 2013 |
| Silver nanoparticles of cinnamon bark | Avian influenza virus subtype H7N3 | Interaction with viral genome and cellular factors or pathways of host cells required for viral replication | Fatima, Zaidi, Amraiz, & Afzal, 2016 |
| Cinnamaldehyde                    | T2 bacteriophage | Inhibit the replication of T2 bacteriophage | Goldstein & Shumaker, 2019 |
| **Clove**                         |       |                     |           |
| Eugeniin                          | Herpes simplex virus 1 and 2 | Inhibiting DNA polymerase | Kurokawa et al., 1998 |
| Infuenza A virus                  | —     |                     |           |
| Eugenol                           | Inhibit viral replication and reducing infection | Reichling, Schnitzler, Suschke, & Saller, 2009 |
| Clove extract                     | Feline calicivirus, a surrogate for human Norovirus | — | Aboubakr et al., 2016 |
| **Black pepper**                  |       |                     |           |
| Amide alkaloid                    | Hepatitis B virus | Unclear | Hao et al., 2012 |
| Extract                           | Coxackie virus type B3 | Cytopathic effect inhibition | Mair et al., 2016 |
| Piperine                          | Dengue virus | Inhibit Methyltransferase | Nag & Chowdhury, 2020 |
|                                   | Ebola virus | VP35 interferon inhibitory domain |           |
| **Basil**                         |       |                     |           |
| Ursolic acid                      | Coxackievirus | Infection and replication inhibitor | Chiang, Ng, Cheng, Chiang, & Lin, 2005 |
| Essential oil and monoterpenes (camphor and 1,8-cineol) | Enterovirus 71 | — |           |
| Crude extract and terpenoid       | Bovine viral diarrhoea virus | Viral particle inhibitor | Kubiça, Alves, Weiblen, & Lovato, 2014 |
| Rosmarinic acid, Oleamolic acid, Ursolic acid and Methyl eugenol | H9N2 virus | — | Ghoke et al., 2018 |
|                                   | SARS-CoV-2 | Main protease | Kumar, 2020 |
Zanjabeel (Zingiber officinale) is a famous herbal drug in the conventional Unani system of medicine (Bashir & Afrin, 2019). Ginger is a rich source of bioactive compounds such as phenolic groups, alkaloids, and steroids, which have medicinal effect. The chief aromatic agent of the rhizome is the zingiberol with analogues such as the shogoals, paradol, and zingerone. In addition to the main bioactive compounds, ginger also contains other sub-compounds such as 4-gingerol, 6-gingerol, 8-gingerol, 10-gingerols, 6-shogaols, and 14-shogaols (Ali, Blunde, Tanira, & Nemmar, 2008; US Report, 2013). They are reported to demonstrate antiemetic, antipyretic, analgesic, antiarthritic, and anti-inflammatory activities.

It has been proven by many studies that the ginger and its bioactive compounds showed effective antiviral activity against SARS-CoV-2, Influenza virus, Herpes simplex virus, Human respiratory syncytial virus, Chikungunya virus, and so on as shown in Table 2 (Admas, 2020; Dorra et al., 2019; Imanishi et al., 2006; Sulochana et al., 2020). Antiviral activity of lyophilized juice extracted from Zingiber officinale has been studied on the hepatitis C virus at varying concentrations from 5–200 μg/mL. They found that 100 μg/mL dose was effective, which inhibits virus replication that was monitored by amplification of viral RNA segments (Wahab, Adawi, & Demellawy, 2009).

Ahkam et al. (2020) studied the potential of a few bioactive compounds, namely, gingerenone A, gingerol, geraniol, shogaol, zingiberene, zingiberenol, and zingerone from Ginger as anti-SARS-CoV-2 for their interaction to spike and main protease (MPro) protein based on molecular docking study. They found that the bioactive compounds of ginger block the spike (S) protein from binding to the ACE2 receptor or act as an inhibitor for MPro. The S protein is

**Table 2 (Continued)**

| Plant parts, extracts and compounds | Virus | Mechanism of action | Reference |
|-----------------------------------|-------|---------------------|-----------|
| Garlic                            |       |                     |           |
| Sulfur constituents               |       |                     |           |
| Ginger                            |       |                     |           |
| Ajoene, Allyl alcohol and diallyl disulfide |       |                     |           |
| Allicin                           |       |                     |           |
| Allitridin                        |       |                     |           |
| Extract of garlic                 |       |                     |           |
| Neem                              |       |                     |           |
| NIM-76                            |       |                     |           |
| Aqueous extract                   |       |                     |           |
| Bark extract                      |       |                     |           |
| Water extracted polysaccharides   |       |                     |           |
| 3-Deacetyl-3-cinnamoyl azadirachtin |       |                     |           |
| Nimbafavone, Rutin, and Hyperoside |       |                     |           |
| Chloroformic leaf extracts        |       |                     |           |
| Bark extract                      |       |                     |           |
| Azadirachtin                      |       |                     |           |
| Neem terpenoids                   |       |                     |           |
| Giloy                             |       |                     |           |

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Clove has main phenolic compounds such as flavonoids, hidrocinnamic acids, hidroxibenzoic acids, and hidroxiphenylpropens. The main bioactive component of clove is eugenol (Neveu et al., 2010). Eugenol exhibits broad antimicrobial activities against both Gram-positive, Gram-negative, and acid-fact bacteria, as well as fungi. Cloves are well known also for their antiemetic (relieves nausea and vomiting) and carminative properties. Eugenii, a compound isolated from the herbal extracts of S. aromaticum, and Geum japonicum, was identified as anti-Herpes Simplex Virus compound at 5 μg/mL concentration. The inhibitory action of eugeniin is on the viral DNA synthesis by acting as a selective inhibitor of the HSV-1 DNA polymerase and eugenol on viral replication and reducing infection (Kurokawa et al., 1998; Reichling et al., 2009).

2.5 | *Piper nigrum* (black pepper)

Piper is a member of family Piperaeae and famous as the king of spices due to its pungent smell. Black pepper is grown in many tropical regions like Brazil, Indonesia, and India. *Piper nigrum* has significant biological properties and its bioactive compounds are used medicine, preservative, and perfumery. Piperine, a dynamic alkaloid of black pepper, is widely used in the as conventional system of medicine (Ayurveda, Siddha, Unani, and Tibetan). It contains major pungent alkaloid piperine (1-peperoyl piperidine) which is known to possess many interesting pharmacological properties such as antihypertensive, anti-Alzheimer’s, antidepressant, antplatelets, anti-inflamatory, antioxidant, antipycnert, antitumor, antiasthmatic, analgesic, antimicrobial, and so on (Damanhouri & Ahmad, 2014; Jafri et al., 2019; Tiwari, Mahadik, & Gabhe, 2020; Yoo et al., 2019).

Priya and Saravana (2017) evaluated the antiviral activity of *Piper nigrum*in chloroform and methanolic extracts against vesicular stomatitis virus (an enteric virus) and human parainfluenza virus on human cell lines. They found that the anti-viral activity of *Piper nigrum* is higher in chloroform extract due to the presence of higher content of alkaloids. According to molecular docking based study, it has been found that piperine could inhibit methyltransferase of Dengue virus and VP35 interferon inhibitory domain of Ebola virus comparative to commercial antiviral Ribavirin (Nag & Chowdhury, 2020). Rajagopal, Byran, Jupudi, and Vadivelan (2020) in a docking based study reported that the bioactive compounds from black pepper such as piperdardiine and piperaline are considerably active against COVID-19, which can be further used for its treatment.

2.6 | *Ocimum basilicum* L. (basil)

*Ocimum basilicum* L. (OB) is a popular medicinal herb of the family Labiatae which is also known as Sweet basil. The essential oils of these plant materials have been used extensively in food, perfumery, dental and oral products for many years. Basil is a natural spice that possesses antimicrobial activities as many studies have reported. The essential oils of OB have been reported to show activity against a
wide range of bacteria, fungi, and parasites. The different components of OB are used as remedies for treating disorders such as viral ocular, respiratory, and hepatic infections. Ocimum basilicum has been reported to contain several interesting compounds, such as monoterpenoids (carvone, cineole, fenchone, geraniol, linalool, myrcene, and thujone), sesquiterpenoids (caryophyllene and farnesol), triterpenoid (ursolic acid), and flavonoid (apigenin) (Chiang et al., 2005).

Numerous studies showed that the aqueous and methanol extract of leaf and seed oil of basil enhances immune response by increasing T-helper and natural killer cells, lymphocyte count, phagocytic activity, neutrophil count, antibody titer, and so on against the variety of infection as a defense mechanism (Jamshidi & Cohen, 2017; Pattanayak, Behera, Das, & Panda, 2010; Vasudevan, Kashyap, & Sharma, 1999).

Ursolic acid has been reported to inhibit viral infections of herpes simplex virus (HSV)-1 and human immunodeficiency virus (HIV), as well as tumor growth (Nonotny, Vachalkova, & Biggs, 2001). Extracts and selected purified components of OB showed a broad spectrum of anti-DNA and RNA virus activities also. Three phytochemical compounds of tulsi, namely, vicenin, sorientin 4'-O-glucoside 2'-O-p-hydroxy-benzoate, and ursolic acid showed inhibition of main protease of SARS-CoV-2 in a molecular docking study (Shree et al., 2020).

2.7 | Allium sativum L. (garlic)

Allium sativum L. (Garlic) family Liliaceae is originally from Asia but it is also cultivated in other countries, namely, China, North Africa (Egypt), Europe, and Mexico. It has been used as a medicinal agent from thousands of years. This plant is a bulb growing to 25–70 cm with flowers used as a spice and flavoring agent for foods. Garlic is having high nutritive value, improves taste of food, and also helps indigestion. Garlic is having a wide range of pharmacological effects with low toxicity such as antihelminthic, anti-inflammatory, antioxidant, antifungal, and so on (Alam, Hoq, & Uddin, 2016).

Allin (diallyl-dithiosulfinate), which is produced by the garlic enzyme allinase from the allin, has been known for wide-antifungal and antiviral activities. The decreasing order of the compounds having virucidal activity in garlic was ajoene, allicin, allyl methyl thiosulfanate, and methyl allyl thiosulfanate (Gebreyohannes & Gebreyohannes, 2013). Antiviral activity of garlic extract has been studied against influenza virus A/H1N1 in cell culture and it was found that it inhibits the virus penetration and proliferation in cell culture (Mehrbd, Amini, & Tavassoti-Kheiri, 2009). The garlic extract showed inhibitory activity on infectious bronchitis virus (IBV-a coronavirus) in the chicken embryo (Shoja, Langeroudi, Karimi, Barin, & Sadri, 2016).

2.8 | Azadirachta indica (neem)

The neem tree botanically referred to as Azadirachta indica is a fast-growing evergreen herb belonging to the family Meliaceae. The Indian origin traditional medicinal plant neem has been used to treat several acute and chronic diseases in different parts of Asia and Africa from the ancient period. All parts of the neem tree such as seeds, roots, leaves, flowers, and bark have been used in traditional medicine as household remedies against various human ailments. They exhibit insecticidal, antimicrobial, larvicidal, antimalarial, antibacterial, antiviral, and spermicidal effects (Gupta et al., 2013).

Different terpenoids isolated from the bark of this herb include nimbin, nimbidin, nimbolide, limonoids, β-sitosterol, 6-desacetylnimbinene, nimbione, margocin, quercetin, and so on (Alzohairy, 2016). A compound from the extract of neem leaves called “hyperoside” possesses showed potential as a universal drug against influenza strains due to its free radical scavenging property. Hyperoside compound from neem leaf extract along with the chemical drugs LGH, Naproxen, BMS-885838, and BMS-883559 showed best results with conserved residues of nucleoprotein of influenza virus (Ahmad et al., 2016). The neem is an extraordinary plant and United Nations has declared neem as the “tree of the 21st century” (United Nations Environment Programme, 2012).

Due to its already proven antiviral properties and effectiveness, many scientists have started research on neem for discovering drugs against SARS-COV-2. Natural bioactive compounds, namely, methyl eugenol, oleanolic acid, and ursolic acid extracted from tulsi and neem act as inhibitors against SARS-CoV-2. These bioactive compounds function as effective inhibitors of SARS-CoV-2 by binding to the spike glycoprotein, RNA polymerase, and/or its protease which results in the prevention of both viral attachment and replication (Kumar, 2020). Approximately 20 compounds isolated from neem leaves extract showed high binding affinity against COVID-19 main protease protein which is the key protein for viral replication (Subramanian, 2020). Muralikumar, Ramakrishnamacharya, and Seshachalam (2020) screened ligands from Nimba and Amrita (A. indica and T. cordifolia) known as Nimbamritam in silico to evaluate anti-SARS-CoV-2 activity. They found that the ligand interacted and inhibited the residues of spike protease or Mpro protease of SARS-CoV-2.

2.9 | Tinospora cordifolia (giloy)

Tinospora cordifolia (giloy) is a member of the family Menispermaceae and is usually found in Asian counties like India, Sri Lanka, Myanmar, and China. It is a medicinal plant native to India commonly called Guduchiand used in Ayurvedic formulations as a medicine to treat several diseases. Due to its medicinal importance, T. cordifolia has been highly exploited for commercial purposes and used as an effective medicine for therapies against several diseases such as jaundice, urinary disorder, skin diseases, diabetes, anemia, inflammation, allergic condition, and so on (Kumar, 2020; Sonkamble & Kamble, 2015). Different parts of T. cordifolia, such as leaves, stem, root, flower, seed, and so on, have all the above mentioned pharmacological activities. This plant is also used in Ayurvedic “Rasayanas” to improve the immune system and the body’s resistance against infections.
Pruthvish and Gopinatha (2018) reported that the crude extract of dry stem of T. cordifolia showed antiviral activity against herpes simplex virus which was evaluated by MTT assay. Chowdhury (2020) evaluated the five phytoconstituents of T. cordifolia (giloy), namely, berberine, b-sitosterol, coline, tetrahydropalmatine, and octacosanol using molecular dynamics approach. She found that berberine can regulate 3CLpro protein’s function by inhibition and subsequently control viral replication. Tinocordiside, one of the phytochemicals of giloy, showed inhibition of main protease of SARS-CoV-2 in a molecular docking study (Shree et al., 2020). Berberine, Isocolumbin, Magnoflorine, and Tinocordiside compounds isolated from Giloy showed high binding efficacy against all the four key SARS-CoV-2 target surface glycoprotein (6VSB), receptor-binding domain (6M0J), RNA dependent RNA polymerase (6M71), and main protease (6Y84) involved in virus attachment and replication (Sagar & Kumar, 2020).

3 | METHODOLOGY

A questionnaire based online survey has been conducted on home remedies during COVID-19 among people (n=531) of different age groups varying from 13–68 years from countries namely India, United Kingdom, and United States. This survey has covered 17 states (Maharashtra, Tamil Nadu, Rajasthan, Arunachal Pradesh, Gujarat, Uttar Pradesh, Madhya Pradesh, Bihar, Himachal Pradesh, Haryana, Telangana, Assam, Kerala, Punjab, Uttarakhand, Chhatisgarh, and Manipur) and two Union territories of India (Delhi and Chandigarh) which include overall 124 cities.

4 | RESULTS

Out of 531 people who have participated in the survey, 26.6% of people were tested for COVID-19 in which 7.8% of people were found positive as shown in Figure 2a. In the survey, we found that people are boosting their immunity in various ways apart from using sanitizers and wearing masks. Most people (93.6%) think that Indian spices and home remedies are helpful in the treatment of coronavirus or other viral infection as well as boosting immunity.

According to the survey, 71.8% of people are taking kadha (basil, cinnamon, black pepper, ginger, and raisin) prescribed by Ayush Ministry, India as shown in Figure 2b. Many people (52.4%) are taking kadha only one time in a day while 24.1% of people are taking kadha two times in a day. People (68.8%) are using ginger, clove, dalchini, black pepper, and tulsi in their kadha. Mostly people (86.1%) think that there is no side effect of kadha, while 13.9% think and experience the side effects of kadha, that is, acidity in the stomach, heartburn, constipation, diarrhea ulcers in mouth, and high blood pressure (especially in senior citizens). According to Ayurveda, if we take kadha in excess, then it can create problems; otherwise there are no side effects.

FIGURE 2 | Survey Analysis on home remedies during COVID-19. (a) Coronavirus positive cases. (b) Percentage of people taking kadha. (c) Methods of boosting immunity. (d) Natural immunity boosting products [Colour figure can be viewed at wileyonlinelibrary.com]
People (83.1%) are boosting immunity by taking Amla/lemon or other fruits as a rich source of vitamin C. Vitamin C is an antioxidant that serves as an enzyme cofactor for various biochemical and physiological processes in humans (Ngo, Ripper, Cantley, & Yun, 2019). Mostly people are using tuksil drops, chyawanprash, tuksilgoly, and neemgiloy (41.5, 35.7, 29.4, and 26.9%, respectively) for boosting their immunity. Chyawanprash is an Indian Ayurvedic health supplement that is prepared by approximately 50 herbs and spices showing immunity boosting as well as antioxidant properties (Sharma et al., 2019).

As per our survey data, most people are taking kadha only one time a day and they are using ginger, clove, cinnamon, black pepper, and tuksil as main ingredients in kadha. We have analyzed that cinnamon, black pepper, tuksil, and turmeric play vital role against SARS-CoV-2 (COVID-19) as well as other viral infections, which was also supported by some other recent studies mentioned in Tables 1 and 2. Our findings were also well supported by Rastogi, Pandey, and Singh (2020), who proposed the use of Tinospora cordifolia (Giloy), Zingiber officinale (Ginger), Curcuma longa (Curcumin), and Ocimum sanctum (Tuksil) due to their antiviral property. Shrivastava (2020) reported that tuksil leaves increase the level of helper T cells as well as natural killer cells, which helps fight against viral infection. Tuksil is being used for curing pain, pneumonia, diarrhea, cough, and fever of ancient times, which are the common symptoms of COVID-19 (Goothy et al., 2020). Black pepper provides relaxation from sinusitis and nasal congestion, which are the most common symptoms of COVID-19 (Pathak & Khandelwal, 2007). Quercetin, a flavonoid present in black pepper, improves the body's immunity constantly due to its antiviral properties (Yao et al., 2017). Our findings were also well supported by Rajagopal et al. (2020) who recommended the consumption of black pepper and ginper in a daily diet, as it may be helpful in the prevention of coronavirus. According to our survey, people (83.1%) are boosting immunity by taking Amla/lemon or other fruits as a rich source of vitamin C for boosting their immunity.

A randomized controlled trial to carry out in the USA in 167 patients with sepsis-related ARDS indicated that uptake of ~15 g/day of vitamin C for 4 days may decrease mortality in these patients (Flower et al., 2020). A randomized, controlled clinical trial was also performed on patients with confirmed SARS-CoV-2 infection in the ICU at three hospitals in Hubei, China. They have given high-dose intravenous vitamin C, that is, 12 g of vitamin C/50 mL every 12 h for 7 days and found that the high-dose intravenous vitamin C may provide a defensive effect without any side effects in critically COVID-19 patients (Zhang et al., 2020). Utomo et al. (2020) reported that the Citrus sp. exhibits the best prospective as an inhibitor to the development of the SARS-CoV-2.

According to ASSOCHAM, India dipstick study spices export from India went up by 23% during COVID-19 (June 2020) compared with the same month of 2019. Major Indian spices that are transported abroad include pepper, ginger, turmeric, coriander, cumin, fennel, fenugreek, nutmeg, spice oils cardamom, and mint products. The main countries where the spices are being imported include the United States, United Kingdom, Germany, France, Italy, Canada, Australia, UAE, Iran, Singapore, China, and Bangladesh, which shows that the world is benefitted by the magical spices of India.

The coronavirus disease is highly transmittable with no effective antiviral therapy to combat the infection (Guan et al., 2020). However, in our study, we highlighted the role of spices and herbs in the treatment of COVID-19. The survey has been conducted to identify the various home remedies used during COVID-19, which include many spices and herbs.

5 | DISCUSSION

The authors do not have a conflict of interest.

6 | CONCLUSIONS

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CONFLICT OF INTEREST

The authors do not have a conflict of interest.

AUTHOR CONTRIBUTIONS

Dr. Namita Ashish Singh conceived, conducted, and analyzed the questionnaire results of the survey. Dr. Pradeep Kumar was involved in questionnaire analysis, review and editing. The original draft was written by Jyoti, while Dr. Naresh Kumar was involved in the review and editing of the manuscript.

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