



Traditional Medicinal Plants to Strengthen Immunity during COVID- 19: A Ray of Hope

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Abstract

Coronavirus disease 2019 (COVID-19) is caused by coronavirus 2 (SARS-CoV- 2). Symptoms include cough, fever, shortness of breath, pneumonia, muscle pain and multi organ failure. Via respiratory droplets the infection spreads from one person to another. For the prevention of COVID-19 alternative medicine home remedies using traditional medicinal plants, are being recommended. The aim of this systematic scoping research survey was to focus attention to have a research policy to identify, and summarize the scientific evidences promoting the use of traditional medicinal plants for the treatment of COVID-19 and for boosting immune system. By systematic planning, reduce use of high cost treatment to these low cost remedies. A comprehensive research survey was performed in two phases: phase 1 (qualitative phase) for development of a questionnaire and phase 2 (quantitative phase) for validation of the questionnaire. In addition, freewheeling searches of government health ministries and government websites was done to gain the available information. Records available until March 20, 2021 were considered. Results were summarized for prevention or treatment of COVID-19 patients in Islamabad and Rawalpindi. Screening (primary and secondary) of the records and data extraction from the eligible sources and patients were done by a single person followed by a random check by the second and third reviewers. Overall, 124 patients were identified and their data was collected. Different herbal medicinal plants were explored by different patients as home remedies in the research survey. Several herbal medicinal plants options are proposed in this research survey to collect more and more data for the prevention or treatment of COVID-19. However, their efficacy and safety still needs scientific validation through rigorous randomized controlled trials. This research may help inform decisions about the importance of research and development in traditional medicinal plants for COVID-19 prevention and treatment. Findings indicate that half of the participants (50.41%) reportedly had a stable weight followed by one-third participants (31.71%) experiencing weight gain during COVID-19. Half of the participants (50 %) maintained a regular meal pattern and added these traditional medicinal plants ingredients to their daily meals (48.39 %).

Keywords: Traditional Medicines, Severe Acute Respiratory Syndrome-related Coronavirus 2 (SARS-CoV-2), COVID- 19, Immunity booster; Antiviral, Medicinal plants

1. Introduction

Due to the massive spread of novel coronavirus SARS-CoV-2, which has led to more than 15.78 million confirmed cases and about 0.64 million deaths as of July 26, 2020, the world is in great misery (Srivastava et al., 2020). Moreover, persons with compromised immune systems are found to be the easy targets of COVID-19, including elderly persons, children, and patients with pre-existing comorbidities such as cancer, diabetes, and respiratory disorders, etc. (Felsenstein & Hedrich, 2020). Due to high mortality associated with COVID-19, the whole world is struggling to discover effective therapeutic solutions either by developing new antiviral drugs or by repurposing existing antiviral and other drugs. The commercially available antiviral medicines, including remdesivir alone or in combination with chloroquine, hydroxychloroquine, and interferon-alpha, are found to show some potential against SARS-CoV-2 infections (Khan et al., 2021). The development of safe and effective vaccines against COVID-19 is the most promising remedy for controlling this SAR-CoV-2 outbreak and enormous research efforts are in progress in this direction. According to WHO, on 14th August 2020. Potential antiviral and immune booster herbal medicines, extracts and formulations can be good remedy which can help in lowering down the global mortality rate related to COVID-19 in the present scenario of lack of any proven medicines/vaccines for COVID-19 cure. Thus, we are discussing about various medicinally important plants and herbs which can serve as boon in the fight against COVID-19 and boost immune system. These include *Allium sativum* (Garlic, Lahsun), *Zingiber officinalis* (Ginger, Adrakh), *Nigella sativa* (Black Cumin, Black seed, Kalonji), *Cinnamomum verum* ('true cinnamon', Sri Lankan or Ceylon cinnamon), *Glycyrrhiza glabra* (Licorice, Licorice), *Piper Nigrum L.* (Black Pepper, Kaali Mirch), *Ocimum sanctum* (Holy Basil, Tulsi), *Citrus paradise* (grapefruit), *Syzygium aromaticum* (Clove, Laung), *Curcuma domestica* (Turmeric, Haldi), *Allium cepa* (Onion, pyaz). These plants are known to be rich in dietary fibers, antioxidants, vitamins, proteins, carbohydrates, amino acids, alkaloids, minerals, steroids, antiviral, antibacterial phytochemicals which will help in killing the invaded viruses and also helps in revitalizing the immune system. Results initially show different herbs that may be helpful in prevention and treatment of COVID-19.

2. Method

The present research survey is based on data collected by population studies using medicinal plants for preventing contagious COVID-19. The information was collected by direct interrogation as well as electronic databases including, whatsapp calls and comprehensive questionnaire form using keywords related to COVID-19 and traditional herbal medicine etc. to get knowledge about the medicinal plants with their traditional use to treat COVID-19 affected 124 patients (including male and female of age between 20 to 60) in different areas of Islamabad and Rawalpindi. The research data date was up to 20th March, 2021 and found different medicinal plants that provide treatment measures for COVID-19. Table 1. In this study, a mixed methods design was used for development and validation of the questionnaire. A standardized methodology was implemented

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in two phases: phase 1 (qualitative phase) for development of a questionnaire and phase 2 (quantitative phase) for validation of the questionnaire. Fig.1

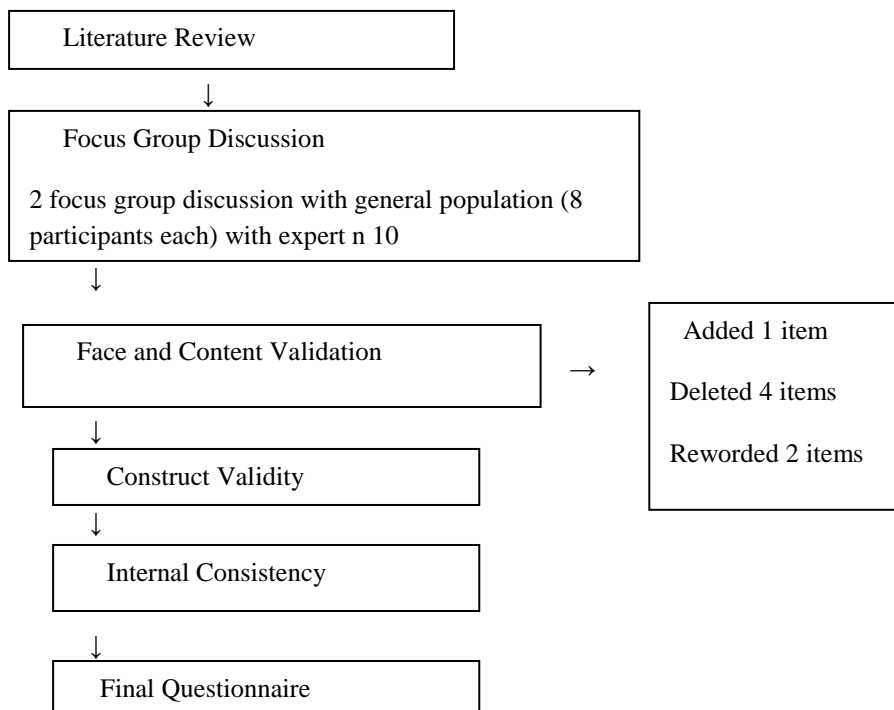


Fig.1: Flowchart for questionnaire development and validation.

The final questionnaire after the expert evaluation and pre-testing for content and face validity and establishing internal consistency has three sections and is freely available for use. Section A comprises questions relating to general information and demographic data, self-reported anthropometric data and one question of change in weight status during COVID-19. Section B consists of two parts with twenty-four items in each. Part A (A1 to A24) assesses the baseline lifestyle-related behaviours such as eating habits, physical activity and food craving, and Part B (B1 to B24) evaluates changes in different lifestyle-related behaviours during the pandemic. The domain on eating behaviour consists of eleven home traditional medicinal plants remedies other than normal eating habits. The domain on physical activity pattern has six items focusing on different components of activity such as aerobic exercise, involvement questions taking traditional medicinal plants in diet during covid. Two items were for changing in food craving, one item for daily routine levels and two items for change in behaviours towards consumption. Section C has six items assessing the perceived COVID-19 specific reasons for changes in diet towards use of traditional medicinal plants during covid.

3. Results

3.1. *Allium sativum* (Garlic, Lahsun)

In the history of mankind lahsun is one of the most significant and common of all plants which are marked. The chemical constituents of garlic majorly consist of sulphur based compounds which are responsible for its peculiar smell and taste which includes vinyl dithiin, diallyl polysulfides, S-allyl cysteine, alliin, ajoene, and few non-sulphur compounds like enzymes, saponins, maillard reaction products and flavonoids. Further, it has been reported by many researchers that garlic extract has various remarkable medical effects, which help in curing various types of diseases like cardiovascular issues, cancer, common cold, influenza virus, and powerful anti-inflammatory and antiviral properties (Zhang et al., 2020). Garlic has been known for ages for its protective capacity against diseases along with its immune-boosting activities. Its antibacterial, antiviral, and antifungal properties are well-known; hence, it is effective against various bacterial, viral, and fungal pathogens. Garlic is rich in antioxidants properties with free radicals. The antiviral property may be helpful in reducing the severity of colds, flu, or COVID-19 infection. Hence, garlic boosts the immune system and helps in fighting against viruses and other diseases. It contains allicin, which is a broad-spectrum antibiotic (Schoeman & Fielding, 2019).

3.2. *Zingiber officinalis* (Ginger, Adrakh)

Zanjabeel or Adrak is also known as *Zingiber officinale* Roscoe. Among other, it's also a very important medicinal plant which belongs to the family of Zingiberaceae, respectively. Its chemical constituents include gingerols along with (Pradhan et al., 2013)-gingerol (1-[4'-hydroxy-3'-methoxyphenyl]-5-hydroxy-3-decanone) and 1-3% weight of volatile oils, which attribute to its unique flavor and fragrance, as well as zingerone. These chemicals have antimicrobial activities for various bacteria, fungi, and viruses. The presence of one of the antioxidant compounds in ginger root helps in fighting infections, enhancing the normal metabolic activities in the human body, and eliminating toxins to shield against the harmful effects of bacteria, viruses, and other diseases. Ginger has potential anti-inflammatory as well as immune-boosting characteristics. Thus, ginger has proven to be a powerful immune-boosting plant with special antiviral properties (Pradhan et al., 2013).

3.3. *Nigella sativa* (Black Cumin, Black seed, Kalonji)

Nigella sativa is known for its broad therapeutic value. It is reported to cure different health disorders, including influenza, bronchitis, conjunctivitis, intrinsic hemorrhage, diabetes, jaundice, fever, anorexia, gastrointestinal problems, rheumatism, asthma, bronchitis, and cough, etc. (Forouzanfar et al., 2014). The main active phytochemical present in black cumin is thymoquinone, which is responsible for most of its therapeutic properties. The seeds have shown viricidal properties. Regarding its implications as antiviral properties, black cumin, particularly *Nigella sativa* oil, has demonstrated activity against various deadly viruses, including hepatitis C virus (HCV) and HIV (Shamim Molla et al., 2019).

3.4. *Cinnamomum verum* ('true cinnamon', Sri Lanka or Ceylon cinnamon)

For its medicinal and culinary uses since ages *Cinnamomum verum* is the widely used spice. It is native to Southern India and Sri Lanka but also distributed in many Asian, Australian, Caribbean and African countries. It is widely used in industrial products like chewing gums, candies, mouthwash, toothpaste and in food preparations. It is also used to treat headache, asthma, bronchitis, inflammation, cardiac disorders and diarrhea. Cinnamaldehyde, eugenol, caryophyllene, cinnamyl acetate and cinnamic acid are the major compounds found in its essential oil. These compounds show a wide range of pharmacological activities including wound healing, anti-inflammatory, Antioxidant, antidiabetic, anticancer, antimicrobial, anti-HIV, anti-anxiety, and antidepressant properties, etc. (Singh et al., 2021).

3.5. *Glycyrrhiza glabra* (Liquorice, Licorice)

Liquorice or licoricean, herbaceous perennial plant is the common name of *Glycyrrhiza glabra* belongs to bean family Fabaceae. It is effectively used as anti-diabetic, antifungal, skin whitening, antiviral, antibacterial, anti-inflammatory, antioxidant, anti-ulcer, anti-tussive as well as an anti-diuretic agent. Liquorice root glycyrrhizin is the main constituent which is sweetened in taste. It is also known as glycyrrhizic acid or glycyrrhizinic acid, with chemical formula $C_{42}H_{62}O_{16}$. The phytoestrogens namely chalcones, isoflavaneglabridin and isoflaveneglabrene are also present in the roots of liquorice. The glabridin has an anti-platelet and anti-inflammatory characteristic that restrict the activity of cyclooxygenase. The root of this plant has medicinal values and been utilized for curing various problems related to Chronic obstructive pulmonary disease, asthma cough and colds etc. Glycyrrhizin, a triterpene saponin, can be a potential phytochemical against COVID-19 (Damle, 2014). It is also reported in a review about the scope and antiviral activity of various bioactive molecules present in *Glycyrrhiza glabra* (Hossain et al., 2014).

3.6. *Piper nigrum* L. (Black Pepper, Kaali Mirch)

In almost all cooking worldwide, *Piper nigrum* L. is also referred to as the king of spices due to the extensive use of its dried unripe fruit (Joshi et al., 2018). Moreover, this plant is enriched with more than 600 different phytochemicals, including alkaloids/amides, lignans, terpenes, neolignans, etc., having various beneficial biological activities and medicinal properties. Antiviral, antioxidative, antibacterial, antithyroid, antitumor, anti-inflammatory, antipyretic, immune, and vaccine bioavailability-enhancing properties are among the many beneficial biological functions of peppercorn and various secondary metabolites of *Piper nigrum*. The biological role of black pepper has been very extensively and nicely reviewed (Ahmad et al., 2012). Its key alkaloid components, piperine and 10 piperamides, can be potential phytochemicals with proven antiviral properties, particularly against viruses responsible for infections in the respiratory tract, which can help in the fight against COVID-19, a respiratory tract infection (Mair et al., 2016).

3.7. *Ocimum sanctum* (Holy Basil, Tulsi)

Tulsi, also called holy basil, is an indigenous plant and is highly renowned for its medicinal properties in Ayurvedic and Siddha medicinal systems. Many in-vitro and in-vivo reports on animals and humans have proven its therapeutic potential as anti-carcinogenic, antibacterial, anti-inflammatory, antidiabetic, immune system booster, antiviral, and cardioprotective, etc. (Jamshidi & Cohen, 2017). In Ayurveda, Tulsi is denoted as the "Elixir of Life" for its healing capability and promising potential in curing different health ailments, including rheumatism, bronchitis, pyrexia, asthma, gastric and hepatic disorders, skin diseases, parasitic and microbial infections, etc. Regarding its role in controlling COVID-19, *Ocimum sanctum* (Tulsi) is already being used for diarrhea, curing pain, cough, and fever, which are common symptoms related to COVID-19 (Goothy et al., 2020). To treat pneumonia, Tulsi is described as the best medicine. Scientific evidence is available revealing the antiviral properties of Tulsi against both DNA viruses [herpes viruses (HSV), hepatitis virus, adenoviruses (ADV)] and RNA viruses (enterovirus 71, coxsackievirus CVB1) (Chiang et al., 2005). The main active antiviral ingredients in the Tulsi extract are found to be apigenin and ursolic acid. Tulsi is reported to help in recovering from asthma and improving respiratory parameters. Tulsi plays a major role in boosting the immune system, assisting the human body in fighting against unwanted microbial strangers, including bacteria and viruses.

3.8. *Citrus paradise* (grapefruit)

Grapefruit (*Citrus paradisi*) is an important member of *Citrus* genus from family Rutaceae. It has been used as a traditional medicine in many countries as anti-inflammatory, antibacterial, anti-fungal, antioxidant, astringent, antimicrobial, antiviral and preservative. It has also been used for lowering cholesterol, cancer prevention, cleansing, rheumatoid arthritis, detoxification, heart health maintenance, cellular regeneration, Lupus nephritis and weight loss. Internal fruit peel is used to treat ulcers, malaria, and for gastroprotective effects (Burham, 1984), and this action is attributed to the antioxidant activity of citrus flavonoids found in grapefruit, such as naringenin. This major flavonoid has exhibited potent antibacterial and anti-*Helicobacter pylori* activity in vitro and was also recently implicated in cytoprotection against injury induced by algal toxins in isolated hepatocytes (Reagor et al., 2002; Giamperi et al., 2004; Bae et al., 1999; Blankson et al., 2000). Due to increased expression of prostaglandin biosynthesis, naringenin, the bioactive component, showed gastroprotective activity and also exhibited anticancer activity against human breast cancers. The therapeutic efficacy of citrus fruits, which contain different classes of polyphenolic flavonoids, has been shown to decrease the risk of coronary thrombosis and myocardial infarction by inhibiting platelet aggregation (Motilva et al., 1994; So et al., 1996; Folts, 2002; Zayachkivska et al., 2005). Citrus fruit peel is 1,000 times sweeter than sucrose (Surana et al., 2006; Gupta et al., 2011).

3.9. *Syzygium aromaticum* (Clove, Laung)

For ages, clove (*Syzygium aromaticum*) has been one of the precious spices used as a food preservative and for many therapeutic applications. This plant is rich in protein, carbohydrates, vitamins (A, C, E, and K), riboflavin, dietary fibers, thiamin, folate, niacin, and minerals. It is also a rich source of phenolic constituents like eugenol acetate, eugenol, thymol, gallic acid, and β -caryophyllene and has enormous potential for food, cosmetic, pharmaceutical, and agricultural applications (Gülçin et al., 2012; Kurokawa et al., 1998). It exhibits antitumor, analgesic, antiviral, antioxidant, antifungal, anti-inflammatory, and antibacterial activities.

3.10. *Curcuma domestica* (Turmeric, Haldi)

Curcuma domestica, also known as turmeric, is a perennial herb belonging to the family Zingiberaceae (ginger). Turmeric powder mainly consists of carbohydrates, protein, fat, dietary fiber, minerals, essential oils, and curcuminoids. The main phytochemicals include diarylheptanoids such as bisdemethoxycurcumin, curcumin, and demethoxycurcumin (Chaurasia, 2001). Major essential oils present in turmeric include germacrone, turmerone, atlantone, and zingiberene. The domestic sales of turmeric have also increased due to its antiviral effects. Turmeric helps in fighting infections, and its anti-inflammatory quality relieves individuals in cases of cold and flu. It aids in the natural cleansing of the respiratory tract. Curcumin is very helpful in boosting the immune system. Curcumin improves the breathing process in patients with bronchial problems such as sinusitis and sinus during respiration, inhibits inflammation, and relieves congestion and pain during respiration (Benzie & Wachtel-Galor, 2011). Turmeric rhizome is a common home remedy used daily in food and sometimes as a drug against cough, cold, and throat infections. It has antiseptic properties with substantial antifungal, antibacterial, and antiviral activities (Jinu, 2019).

3.11. *Allium cepa* (Onion, pyaz)

Around the world *A. cepa* is a well-known traditional nutraceutical and medicinal plant that is cultivated and used. Onions have potential anti-inflammatory, anti-cholesterol, anticancer, and antioxidant properties, contain phenolics and flavonoids. Onions contain vitamins B1, B2, and C, along with potassium and selenium, 89% water, 1.5% protein. It also contains flavonoids (mostly quercetin), polysaccharides such as fructosans, saccharose, peptides and essential oil. Onion contains numerous sulfur compounds including mono, di, and tri-sulfides; thiosulfates cepaenes; S-oxides; S, S-dioxides; and thiosulfonates; and sulfoxides. Onion is highly nutritional and its dietary use lower down toxigenicity of oils, improves digestion and mental health. Onion has potential in treating stomach cancer, cardiovascular disease and hyperglycemia. Onion contains an important antioxidative, which reduces hepatocytes apoptosis in streptozotocin-induced diabetic rat i.e., quercetin that is derived from *Allium cepa* on aldehyde oxidase low-density lipoprotein. Onion has great ethnomedicinal importance as a native remedy used against diabetes and related complications. Red and white varieties of *Allium cepa* have demonstrated antimicrobial and antioxidant activities. These are commonly used in traditional Asian spices and are of significant health importance (Upadhyay, 2016).

Table 1: Traditional Herbal Medicinal plants used as effective remedy to treat coronavirus disease

| S.No | Biological Source | Common Names | Family | Parts Used | Duration of use |
|------|----------------------------|---------------------------|--------------------------|---------------------------------|-----------------|
| 1 | <i>Allium Sativum</i> | Garlic juice | Alliaceae | Bulbs | 10-15 days |
| 2 | <i>Zingiber Officinale</i> | Ginger | Zingiberaceae | Rhizome | 10-24 days |
| 3 | <i>Nigella sativa</i> | Kalonji | Ranunculaceae | Seeds | 15-30 days |
| 4 | <i>Cinnamomum verum</i> | Cinnamon Darchini | Lauraceae | Bark | 15-30 days |
| 5 | <i>Glycyrrhiza Glabra</i> | Licorice | Fabaceae | Roots | 10-15 days |
| 6 | <i>Piper Nigrum L</i> | Black Pepper, Kaali Mirch | Lamiaceae | Fruit | 10-15 days |
| 7 | <i>Ocimum sanctum</i> | Tulsi | Lamiaceae | Leaves | 15-30 days |
| 8 | <i>Citrus paradise</i> | Grapefruit, Chakotra | Rutaceae | Fruit/juice | 10-15 days |
| 9 | <i>Syzygium aromaticum</i> | Clove, Laung | Myrtaceae | small reddish brown flower buds | 5-10 days |
| 10 | <i>Curcuma domestica</i> | Turmeric,haldi | Zingiberaceae | Rhizome powder | 10-12 days |
| 11 | <i>Allium cepa</i> | Onion, Pyaaz | Alliaceae/Amaryllidaceae | whole | 15-30 days |

4. Descriptive statistics of survey result

The response of the participants for the items listed in Sections A, B and C is given in Supplementary Table 2. Findings indicate that half of the participants (50.41%) reportedly had a stable weight followed by one-third participants (31.71%) experiencing weight gain during COVID-19. Half of the participants (50 %) maintained a regular meal pattern and added these traditional medicinal plants ingredients to their daily meals (48.39 %). A large proportion of the participants (70 %) refrained from consuming high fat, salt and sugar foods and sugar sweetened beverages on a routine basis. It was found that only 37.10 % participants engaged in regular moderate intensity aerobic exercises (doing activity that increases breathing and heart rate) for more than 5 d per week. A majority of participants reported a good response after taking traditional medicinal plants during covid.

Table 2: Demographic characteristics of participants

| Characteristics | Value | |
|--------------------------------|-------|-------|
| Gender | | |
| Age(years) | 20-60 | |
| Male | 53 | 42.74 |
| Female | 71 | 57.26 |
| Socio-economic status | | |
| Upper | 40 | 32.79 |
| Upper middle | 55 | 45.08 |
| Lower middle | 17 | 13.93 |
| Upper lower | 10 | 8.20 |
| Marital status | | |
| Married | 72 | 58.06 |
| Single | 50 | 48.32 |
| Divorced | 2 | 1.61 |
| Family status | | |
| Nuclear | 88 | 70.97 |
| Extended | 17 | 13.71 |
| Joint | 19 | 15.32 |
| Anthropometric parameters | | |
| Self –reported height (cm) | 161.1 | 22.6 |
| Self-reported weight(kg) | 67.7 | 12.7 |
| BMI (kg/m ²) | 25.3 | 4.6 |
| Women BMI (kg/m ²) | 25.6 | 5.2 |
| Men BMI (kg/m ²) | 24.9 | 3.6 |

Values are presented as mean and so or numbers and percentage.

5. Conclusions

A unique feature of the developed questionnaire is that it assesses the reasons for changes in the corrective/faulty eating activity and sleep practices. To our knowledge, there is no available questionnaire that addresses these factors related to changes in lifestyle eating habits during COVID-19. Factors such as less eating out, preference of home cooked food, involvement in at home workouts during quarantine and availability of time were associated with desirable eating and activity behaviours during COVID-19. Besides, the fear of coronavirus infection, lack of knowledge and motivation, lack of access to fruits and vegetables were prime reasons for adapting unhealthy lifestyle eating practices that led to compromise immune system badly. The scope of useful application of this questionnaire is manifolds in the current scenario. First, the questionnaire can be used to identify the risk factors related to increasing dual burden of malnutrition and obesity during COVID-19 pandemic. Second, it can be utilised as a tool to gather data on use lifestyle home remedies as medicinal plants while screening lifestyle-related disorders such as hypertension, diabetes, non-alcoholic fatty liver in regular clinical practices at the assessment stage. Third, it can be used for future research to assess the impact of COVID-19 on lifestyle eating behaviours, results of which can help dr clinical practitioners and policy makers to formulate COVID-19 specific recommendations to promote healthy lifestyle- related behaviours by adapting traditional medicinal plants remedies in routine eating habits. Some limitations of this study are – inadequate representativeness from lower socio-economic strata, although efforts were made to include a diverse population; possibilities of reporting bias due to web-based survey; inability to establish predictive and concurrent validity which would require a long-term follow-up

Medicinal plants and natural products are still considered promising alternatives to prevent or treat several diseases. Since the outbreak of the COVID-19 pandemic in December 2019, various traditional herbal medicines have been used and resulted in positive health effects among COVID-19 patients, mainly in China. In the present research, we have discussed the possible potential uses of medicinal plants and/or natural products to prevent or even treat COVID-19. Although the studies evaluating the anti-SARS-CoV-2 effects of medicinal plants are still insufficient and relatively immature, some natural products with IC₅₀ below 10 µM could be considered as promising anti-SARS-CoV-2 agent. While available studies offer several indications that these plant derived products may help in fighting COVID-19, further studies should be carried out to evaluate the clinical usefulness of such products against COVID-19 infection. Furthermore, the bioavailability of natural products with possible anti-SARS CoV-2 effects such as tannins should be considered besides the need for clinical validation of their usefulness and safety. The herbal mixtures, medicinal plants, or natural products with possible anti-SARS-CoV-2 effects must be evaluated through prospective and interventional studies. A combination of natural products or herbal mixtures with validated anti-COVID-19 drugs may constitute a promising preventive and therapeutic alternative to be assessed. Medicinal plants as sources of active molecules against COVID-19. [35]

At this COVID-19 pandemic situation, various studies reveal that those people having strong immunity has higher recovery rate against COVID-19. Since it further needs clinical trials to investigate whether Ayurvedic products completely cure the COVID-19 or it could only be used to in minimizing the risk of viral infection and reduces the mortality rate. From long time, we are aware of the beneficial properties of Ayurvedic and medicinal plant products utilizing to cure infectious and other diseases. Since these botanical plants having low cost, minimum toxicity and almost found everywhere in country, it has potential to enhance immunity to fight against COVID-19 and other infectious disease and play an important role to fully

recover from COVID-19 in Pakistan and in most of countries in the world. After this pandemic there is a need to prepare a research policy to investigate the role of traditional medicinal plants that take part in combating and minimizing symptoms of COVID-19 in patients.

References

- Ahmad, N., Fazal, H., Abbasi, B. H., Farooq, S., Ali, M., & Khan, M. A. (2012). Biological role of *Piper nigrum* L. (black pepper): A review. *Asian Pacific Journal of Tropical Biomedicine*, 2(3), S1945-S1953.
- Bae, E. A., Han, M. J., & Kim, D. H. (1999). *In vitro* anti-*Helicobacter pylori* activity of some flavonoids and their metabolites. *Planta Medica*, 65(5), 442-443.
- Benarba, B., & Pandiella, A. (2020). Medicinal plants as sources of active molecules against COVID-19. *Frontiers in Pharmacology*, 11, 1189.
- Benzie, I. F. F., & Wachtel-Galor, S. (2011). *Herbal Medicine: Biomolecular and Clinical Aspects* (2nd ed.). CRC Press/Taylor & Francis.
- Blankson, H., Grotterød, E. M., & Seglen, P. O. (2000). Prevention of toxin-induced cytoskeletal disruption and apoptotic liver cell death by the grapefruit flavonoid, naringin. *Cell Death & Differentiation*, 7(8), 739-746.
- Burham, B. O. (1984). Chemical constituents of selected Sudanese medicinal and aromatic plants. *Master's Thesis, Sudan Academy of Science*.
- Chaurasia, J. P. (2001). *Betelvine Cultivation and Management of Diseases*. Scientific Publishers (India).
- Chiang, L. C., Ng, L. T., Cheng, P. W., Chiang, W., & Lin, C. C. (2005). Antiviral activities of extracts and selected pure constituents of *Ocimum basilicum*. *Clinical and Experimental Pharmacology and Physiology*, 32(10), 811-816.
- Damle, M. (2014). *Glycyrrhiza glabra* (Liquorice)—A potent medicinal herb. *International Journal of Herbal Medicine*, 2(2), 132-136.
- Felsenstein, S., & Hedrich, C. M. (2020). COVID-19 in children and young people. *The Lancet Rheumatology*, 2(9), e514-e516.
- Folts, J. D. (2002). Potential health benefits from the flavonoids in grape products on vascular disease. *Flavonoids in Cell Function*, 95-111.
- Forouzanfar, F., Bazzaz, B. S., & Hosseinzadeh, H. (2014). Black cumin (*Nigella sativa*) and its constituent (thymoquinone): A review on antimicrobial effects. *Iranian Journal of Basic Medical Sciences*, 17(12), 929.
- Giamperi, L., Fraternali, D., Bucchini, A., & Ricci, D. (2004). Antioxidant activity of *Citrus paradisi* seeds glyceric extract. *Fitoterapia*, 75(2), 221-224.
- Goothy, S. S., Goothy, S., Choudhary, A., Potey, G. G., Chakraborty, H., Kumar, A. H., & Mahadik, V. K. (2020). Ayurveda's holistic lifestyle approach for the management of coronavirus disease (COVID-19): Possible role of Tulsi. *International Journal of Research in Pharmaceutical Sciences*, 16-18.
- Gülçin, İ., Elmastaş, M., & Aboul-Enein, H. Y. (2012). Antioxidant activity of clove oil—A powerful antioxidant source. *Arabian Journal of Chemistry*, 5(4), 489-499.
- Gupta, V., Kohli, K., Ghaiye, P., Bansal, P., & Lather, A. (2011). Pharmacological potentials of *Citrus paradisi*: An overview. *International Journal of Phytotherapy Research*, 1(1), 8-17.
- Hossain, M. D., Urbi, Z., Sule, A., & Rahman, K. M. (2014). *Andrographis paniculata* (Burm. f.) Wall. ex Nees: A review of ethnobotany, phytochemistry, and pharmacology. *The Scientific World Journal*, 2014.
- Jamshidi, N., & Cohen, M. M. (2017). The clinical efficacy and safety of Tulsi in humans: A systematic review of the literature. *Evidence-Based Complementary and Alternative Medicine*, 2017.
- Jinu, J. (2019). Therapeutic potential of *Withania somnifera*: A report on phyto-pharmacological properties. *International Journal of Pharmaceutical Sciences Research*, 4, 2131-2148.
- Joshi, D. R., Shrestha, A. C., & Adhikari, N. (2018). A review on diversified use of the king of spices: *Piper nigrum* (black pepper). *IJPSR*, 9(10), 4089-4101.
- Khan, Z., Karataş, Y., Ceylan, A. F., & Rahman, H. (2021). COVID-19 and therapeutic drugs repurposing in hand: The need for collaborative efforts. *Le Pharmacien Hospitalier et Clinicien*, 56(1), 3-11.
- Kurokawa, M., Hozumi, T., Basnet, P., Nakano, M., Kadota, S., Namba, T., Kawana, T., & Shiraki, K. (1998). Purification and characterization of eugenin as an anti-herpesvirus compound from *Geum japonicum* and *Syzygium aromaticum*. *Journal of Pharmacology and Experimental Therapeutics*, 284(2), 728-735.
- Mair, C. E., Liu, R., Atanasov, A. G., Schmidtke, M., Dirsch, V. M., & Rollinger, J. M. (2016). Antiviral and anti-proliferative *in vitro* activities of piperamides from black pepper. *Planta Medica*, 82(S 01), P807.
- Motilva, V., De La Lastra, C. A., & Martin, M. J. (1994). Ulcer-protecting effects of naringenin on gastric lesions induced by ethanol in rats: Role of endogenous prostaglandins. *Journal of Pharmacy and Pharmacology*, 46(2), 91-94.
- Pradhan, D., Suri, K. A., Pradhan, D. K., & Biswasroy, P. (2013). Golden heart of the nature: Piper betle L. *Journal of Pharmacognosy and Phytochemistry*, 1(6).
- Reagor, L., Gusman, J., McCoy, L., Carino, E., & Heggors, J. P. (2002). The effectiveness of processed grapefruit-seed extract as an antibacterial agent: I. An *in vitro* agar assay. *The Journal of Alternative & Complementary Medicine*, 8(3), 325-332.
- Schoeman, D., & Fielding, B. C. (2019). Coronavirus envelope protein: Current knowledge. *Virology Journal*, 16(1), 1-22.
- Shamim Molla, M., Azad, A. K., Al Hasib, M. A., Hossain, M. M., Ahammed, M. S., Rana, S., & Islam, M. T. (2019). A review on antiviral effects of *Nigella sativa* L. *Pharmacology Online Newsletter*, 2, 47-53.

- Singh, N., Rao, A. S., Nandal, A., Kumar, S., Yadav, S. S., Ganaie, S. A., & Narasimhan, B. (2021). Phytochemical and pharmacological review of *Cinnamomum verum* J. Presl: A versatile spice used in food and nutrition. *Food Chemistry*, 338, 127773.
- So, F. V., Guthrie, N., Chambers, A. F., Moussa, M., & Carroll, K. K. (1996). Inhibition of human breast cancer cell proliferation and delay of mammary tumorigenesis by flavonoids and citrus juices. *Nutrition and Cancer*, 26, 167-181.
- Srivastava, A. K., Chaurasia, J. P., Khan, R., Dhand, C., & Verma, S. (2020). Role of medicinal plants of traditional use in recuperating devastating COVID-19 situation. *Medicinal & Aromatic Plants (Los Angeles)*, 9(359), 2167-0412.
- Surana, S. J., Gokhale, S. B., Rajmane, R. A., & Jadhav, R. B. (2006). Non-saccharides natural intense sweeteners—An overview of current status. *Natural Product Radiance*, 5(4), 270-278.
- Upadhyay, R. K. (2016). Nutraceutical, pharmaceutical, and therapeutic uses of *Allium cepa*: A review. *International Journal of Green Pharmacy*, 10(1).
- Zayachkivska, O. S., Konturek, S. J., Drozdowicz, D., Konturek, P. C., Brzozowski, T., & Ghegotsky, M. R. (2005). Gastroprotective effects of flavonoids in plant extracts. *Journal of Physiology and Pharmacology Supplement*, 56(1), 219-231.
- Zhang, D. H., Wu, K. L., Zhang, X., Deng, S. Q., & Peng, B. (2020). In silico screening of Chinese herbal medicines with the potential to directly inhibit 2019 novel coronavirus. *Journal of Integrative Medicine*, 18(2), 152-158.