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Fighting against Severe Acute Respiratory Syndrome: A Systematic Review on Plant Foods and Natural Products as Complementary Herbal Medicines

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ABSTRACT

The corona pandemic 2019 (CoViD-19) has encouraged social movement for the physical distancing and awareness for the use of natural products of medicinal plants for home remedies. Scientists are working to unravel the genetic makeup of corona virus i.e., the causative agent of CoViD-19 in order to find treatments for the infection. Until now, even medicine and vaccine have been formulated in order to help cure the disease. The primary objective of this article is to identify and analyse the published articles in the areas of complementary herbal plant application for antiviral and anti-inflammatory properties, ways to enhanced immunity, and to cure infectious symptoms. One of the paramount options including the use of herb-based medicinal derivatives have been proposed to cure infections with the positive outcome. Most of the established traditional medicinal systems like Traditional Chinese medicine and Ayurveda have recommended a list of several potent herbal and essential oils that ease the symptoms of infections by their regular massaging on the scalp. These results can serve as a yard stick for the efficacious utilisation of food plants as home remedy and for the development of clinical study on disease prevention from natural resources in a global context.

Keywords: Chemometric, CoViD-19, flu-like symptoms, medicinal plants, MERS

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INTRODUCTION

Viral respiratory infection can be classified by causative agents, for instance, common cold was caused by either influenza viruses (Type A, and B) or coronaviruses (Al-Tawfiq et al. 2013; Falsey et al. 2002). β-coronaviruses are also the major causes of the Severe Acute Respiratory Syndrome (SARS-CoV) and Middle East Respiratory Syndrome Corona virus (MERS-CoV), the epidemic outbreaks in 2003 and 2012, respectively (Chang et al. 2020; Desforges et al. 2020; Evelyne et al. 2020). The rhino-influenza and coronaviruses cause acute respiratory multi-organ dysfunction with lung inflammatory lesions and structural damage, and acute respiratory distress syndrome (ARDS) which lead to pulmonary failure and result in patient fatality (Adnan et al. 2020; Chen et al. 2020). World Health Organization (WHO) recommended regular washing of hands, masking of nose and mouth while sneezing and coughing, thorough cooking of food and maintain social distancing from individuals who are symptomatic for respiratory infections. The new strain of corona virus came to existence in December 2019 which was later spread out globally with increasing number of deaths and hospitalizations in no time. The viruses were officially renamed SARS-CoV-2 by the International Committee on Taxonomy of Viruses (ICTV), which later known as coronavirus disease 2019 (or CoViD-19) (Lupia et al. 2019). The symptoms of infection started appearing after an incubation period of ~ 6 days. The most common symptoms at onset of CoViD-19 illness are fever, cough, and fatigue. Meanwhile, patients could also develop sinus infection, sputum production, headache, hemoptysis, dyspnoea, and lymphopenia (Ren et al. 2020; Wang et al. 2020) (Figure 1). To date (as of November 2020), increasing numbers of cases and deaths from CoViD-19 are still being reported globally with consistent increase in numbers (WHO 2020).

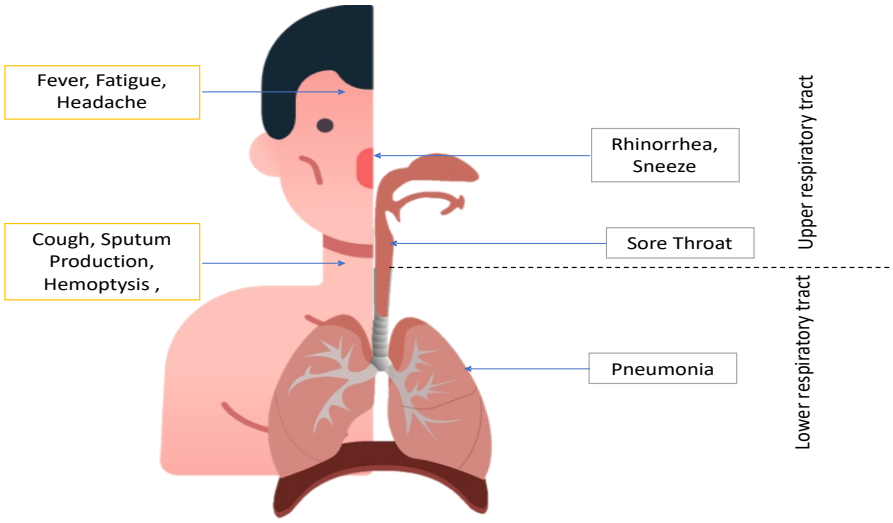

Figure 1. Common disorders caused by Covid-2019 to upper and lower respiratory tracts.

Control measures have been implemented for CoViD-19 including the community gathering closures (Moberly 2020) isolation of confirmed and suspected cases, and identification of contacts, which is a crucial part of these control efforts (Hellewell et al. 2020; Niu and Xu 2020). With the continuing inflation, the public has been advised by various health authorities to crucially reduce the movement and stay at home as a basic means to avoid human-to-human transmission (Chen et al. 2020; Mahase 2020). It has been predicted that without these efforts, the number of infected cases could ramp-up in which it may put tremendous pressure to national public heath to prepare additional resources for medical care and treatments (Hellewell et al. 2020). At the initial stage, exorbitant efforts have been made to prevent the onset of symptoms or treat this novel coronaviruses by boosting immunity via adding herbal components in the diets along with balanced nutrition (Mahase 2020; Han et al. 2020; Luo et al. 2020; Zhang and Liu 2020; Kupferschmidt and Cohen 2020). Here comes the role of medicinal plants and purified natural products which are the vital resources of antiviral properties, strengthening the immune system that can minimise flu-like symptoms and complications. One of the compounds with the potential of curing the disease is hydroxychloroquine, a synthetic form of quinine that is derived from the bark of the Cinchona tree. This drug has been found to be effective in reducing the exacerbations of pneumonia and limiting the replication of virus (Cortegiani 2020). According to the National Administration of Traditional Chinese Medicine (NATCM), 90% of the response rate was achieved by application of the herbal formula named Qing Fei Pai Du Tang in 214 clinical cases suffering from pneumonia due to CoViD-19 (Hong-Zhi et al. 2020). The infusion of ephedra andlicorice root has been reported by the Traditional Chinese Medicine (TCM) hospital which was observed to be effective in relieving the symptoms of hundreds of patients suffering from CoViD-19. Moreover, these natural resources are readily available within the local community and are acceptable to treat preliminary illness prior to conventional medicine (Welz et al. 2018). The intake of these natural reserves could reduce the stress in the metabolic pathway of the body and thereby, delay the onset density of the disease amongst patients and provide them adequate resistance required during this pandemic.

With this critical necessity, one intuitive yet important aspect is to narrow the vast literature on the natural remedies for Severe Acute Respiratory Syndrome as they serve as the general landscape in the development of natural product with the medicinal functions in different global cultures and postulate the cornerstones of further research and development for the treatments. In the current study, we aimed to identify and analyse the research reports on complementary herbal plant applications for the treatments of related symptoms of SARS-Cov. Moreover, we use chemometric analysis to comprehend the relationship between the defined treatments and the secondary metabolites of the herbal remedies. Ultimately, this study could be used as the reference tool for self-caring as to conform to the public movement for physical distancing during CoViD-19 pandemic.

METHODOLOGY

Exploration Strategy

The relevant literatures, covering published articles from 2010-2020, were collected via using different electronic databases viz. PubMed and Web of science. The hunting terms for articles associated with intervention of medicinal plants were divided into two groups: Medicinal plant intervention (plant OR herb OR ethnobotany OR antivirus OR immune) and acute respiratory symptoms (inflammatory OR dyspnoea OR sneeze OR cough OR sputum OR haemoptysis OR fatigue OR fever OR headache). Subsequently, the resulting reported literature was formatted and imported into a mutual reference software library (such as Endnote^{x9},Clarivate Analytics, USA) for all of the searched databases. All the duplicates were customarily removed by the program.

METHODOLOGY FOR SELECTION OF STUDIES

Full research articles or review articles of *invitro* and *in vivo* studies were selected for inclusion. The complete criteria for inclusion and exclusion are mentioned in **Table 1**.

Data retrieving and quality evaluation.

An outline spreadsheet was used to extract the data from the articles. Detailed information about the journal, year

of publication, type of study, plant names and family, treatments, type of functional properties and plant parts used, active ingredients and general notes about toxicity and precaution were collected from the abstracts and methodology of articles. All studies were independently screened based on their titles and abstracts of independent individuals (authors of vivid expertise, postgraduates and undergraduate students enrolled in Herb and Spice course (359460), at the Faculty of Agriculture, Chiang Mai University (name credited in the acknowledgement). Additional clarification using terms from the listed final data was obtained from the Library of the Faculty. According to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PRISMA), the collected data were consulted with 27-point checklist (Liberati et al. 2009).

Statistical analysis

In the general exclusion step, the relationship among the medicinal plant species, interventions and culture was displayed using Venn plot. These plots were created with BioVinci software (BioTuring Inc., San Diego, CA, USA). Factor analysis between medicinal plants (active ingredients) and cures was conducted using Principal Component Analysis (PCA) (XLstat trail version, USA). The data were also previewed as bubble maps. The bubble size indicated the binary counting of papers after the inclusion.

RESULTS

Data retrieving

The search resulted perched down to the total of 458 articles. The criteria of selection screened the articles for inclusion down to 392 papers which were majorly review articles. The foremost criteria were to exclude about half of the reports and the eligible articles that carried out chemometric visualisations (n=176). Lastly, the application of principal component relationships of plant family and infectious respiratory syndromes helped the final inclusion step (Figure 2).

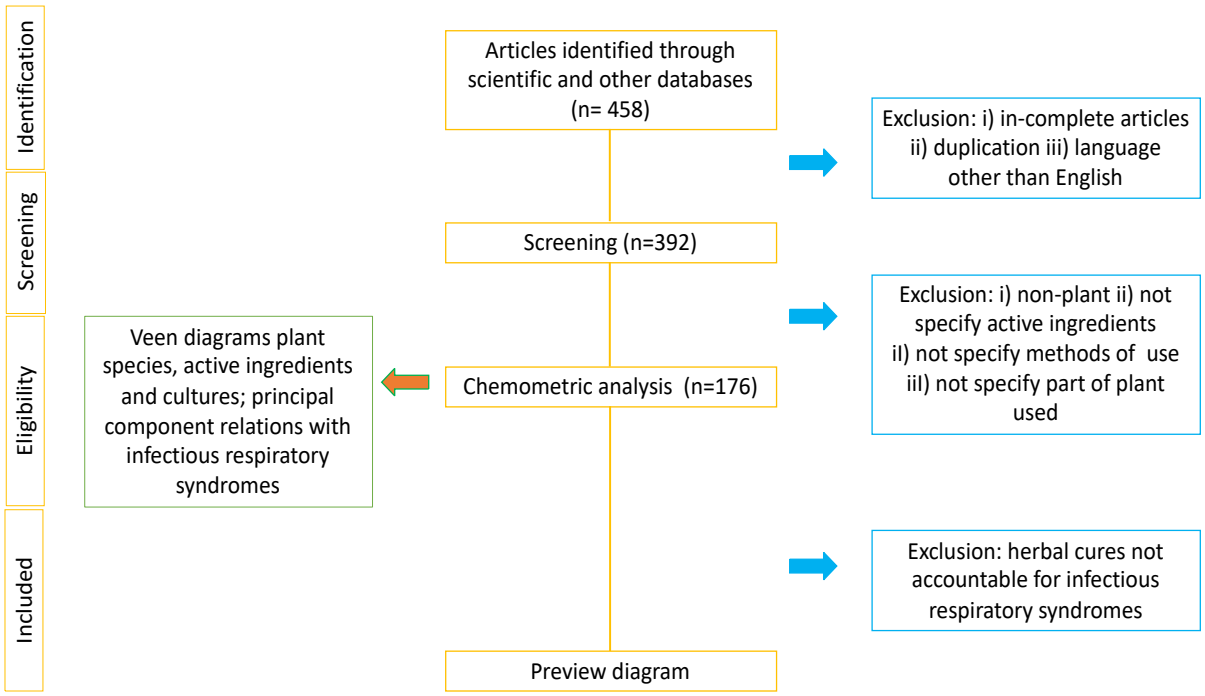

Figure 2. Flow diagram for data inclusion in this study as complied with PRISMA 2009 flow diagram for systematic review.

Venn diagram

Venn diagram was shown in Figure 3. The majority of the evaluated plants were used for inflammatory treatments, followed by immune boosting and other antivirus and post infection symptoms (Figure. 3A). There are no exemplary plant species that could evidently cure all the infectious respiration syndromes. In addition, eight plant species were positively mentioned to cure all symptoms except dyspnoea. Nine plant species were found with probable prospective for carrying the properties of antivirus, anti-inflammatory and human immune booster (Figure. 3B). Six plant species were cited which reduced post-infectious symptoms including sneezing, cough, sputum, haemoptysis, fatigue, fever, and headache, respectively. The details of plant species are mentioned in the supplementary file. Figure. 3D illustrates the use of complementary herbal medicines in the scenario of global context. It is apparent that each culture of plants which were utilized to cure infectious respiratory syndromes are common withinfour families (viz. Anacardiaceae, Apiaceae, Lamiaceae and Phyllanthaceae). East Asian culture i.e., traditional Chinese medicine shared common plant knowledge with Southern Asia and both of them had influenced the plant usage in South east Asia. It is also worth to observe that the commonly utilized plant families are most likely to be known in African, Europe, and South East Asia cultures.

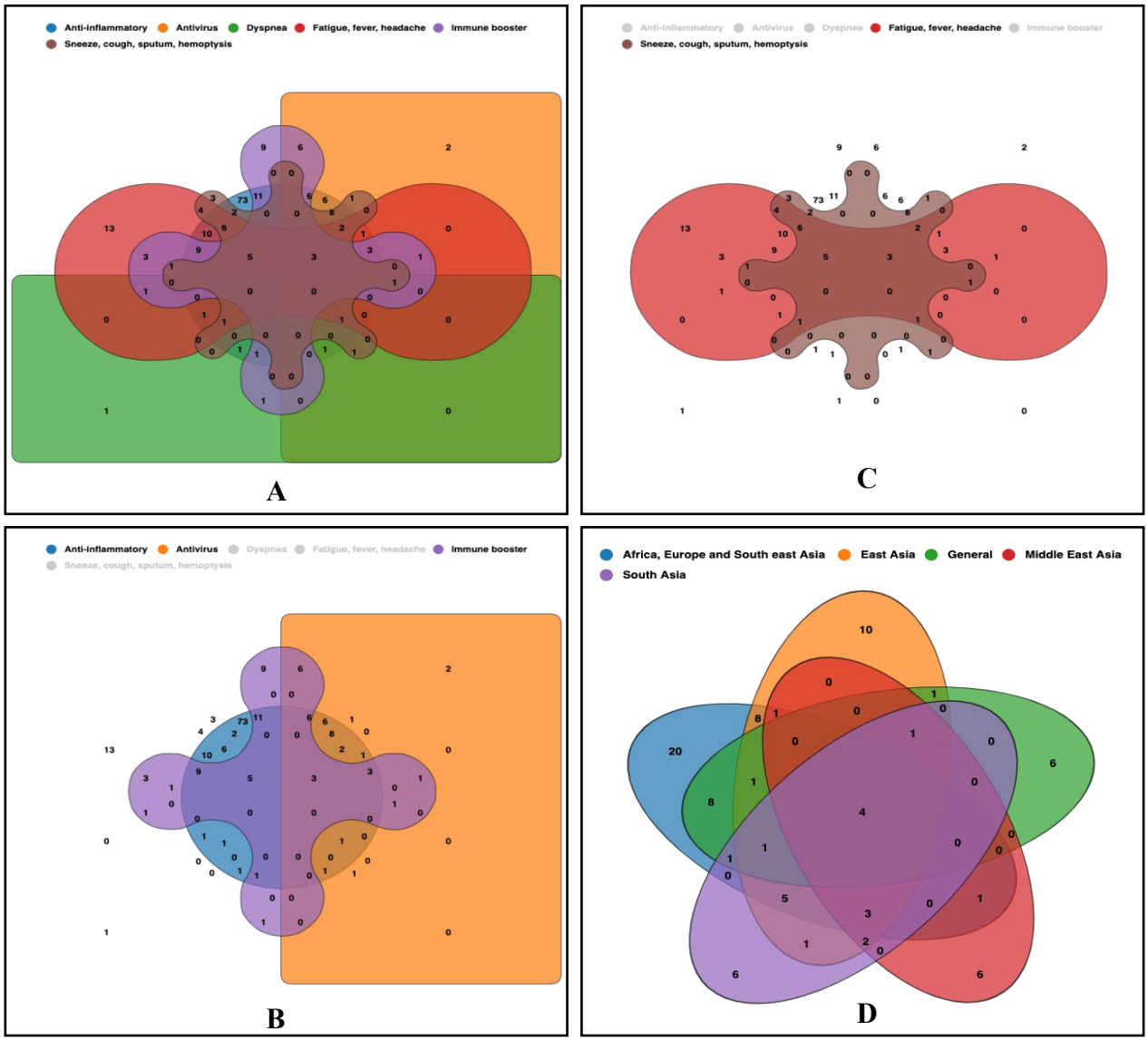

Figure 3. Venn diagrams of plant species used, and treatments related infectious respiratory syndromes (A–C) and uses of plant families as complementary herbal medicines in different cultures (D).

Chemometric

PCA was applied to determine the impact of bioactive compounds for the treatment of various respiratory syndromes from the vivid plant species. The factor loadings of the first three principal components, depicted Eigen value of 1.002 and cumulative percentage of 64.11%, wherein, PC1 and PC2 accounted 25.21 and 22.21% variance (**Table 2** and Figure 4). The PCA loading factors revealed that 25.21% of variance in PC1 depicted symptoms (such as sneezing, cough, sputum or haemoptysis, fatigue, fever and headache) showed positive correlation with flavonoids, carotenoids, diterpenes, sesquiterpenes, alkaloids and steroids, respectively.

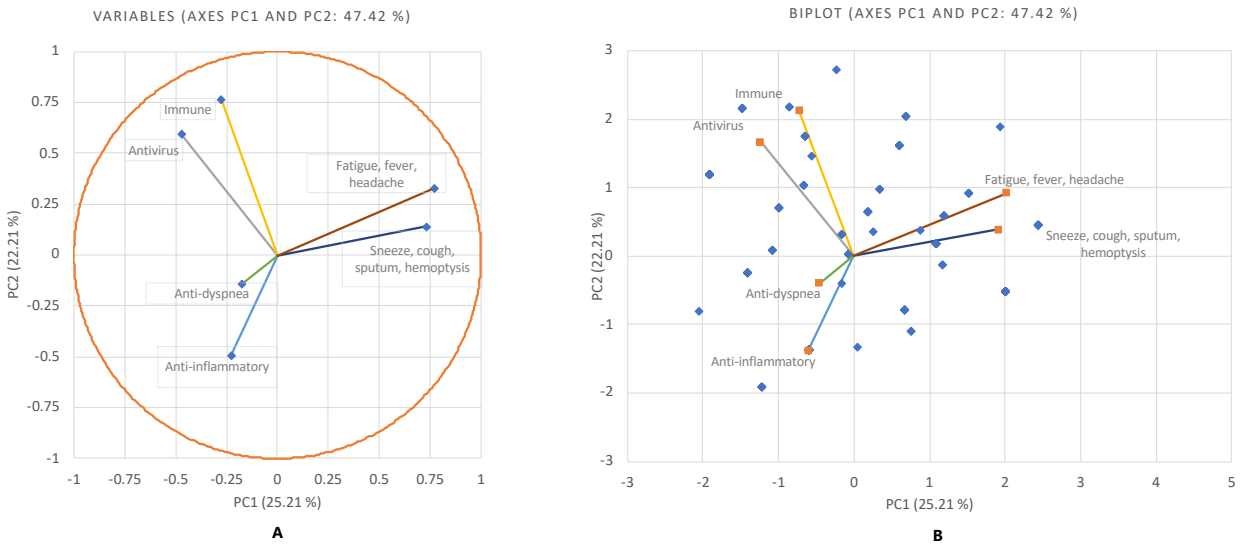

Figure 4. Principal component analysis of cures for infectious respiratory syndrome (A) and biplot scattering analysis of plant families used across global culture context.

These bioactive compounds that loaded heavily in PC1 were found to be majorly attributed by the plant species of Podocarpaceae, Lamiaceae, Rubiaceae, Nymphaeaceae, Berberidaceae, Elaeagnaceae, Solanaceae, Moraceae, and Lauraceae, respectively. The PC2 with variance of 22.21% were found to be dominated by the plant species of Caricaceae, Asteraceae, Myrtaceae, Moringaceae, Berberidaceae, Zingiberaceae, and Sapindaceae (**Table 2**). The compounds that indicated show cased conduciveness for treatment of diseases listed in PC2 and were mainly accredited to monoterpenes, diterpenes, monoterpenes, amino acids, alkaloids, rumicin, chrysarobin, steroids, glutathione peroxidase 7 (GPX7), and saponins, respectively.

The preview diagram in both Figures 5 and 6 displayed the overall frequency of plant families and bioactive ingredients which were highly commensurate to infectious disease of respiratory syndrome.

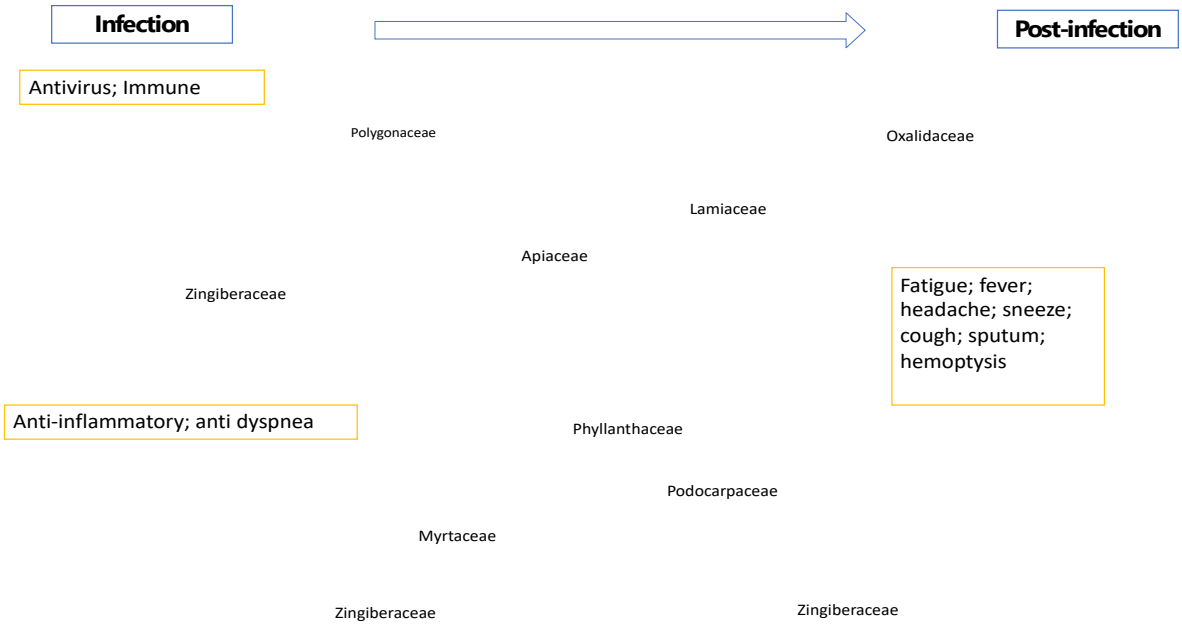

Figure 5. Preview diagram (bubble) of plant families and cures for infectious respiratory syndromes.

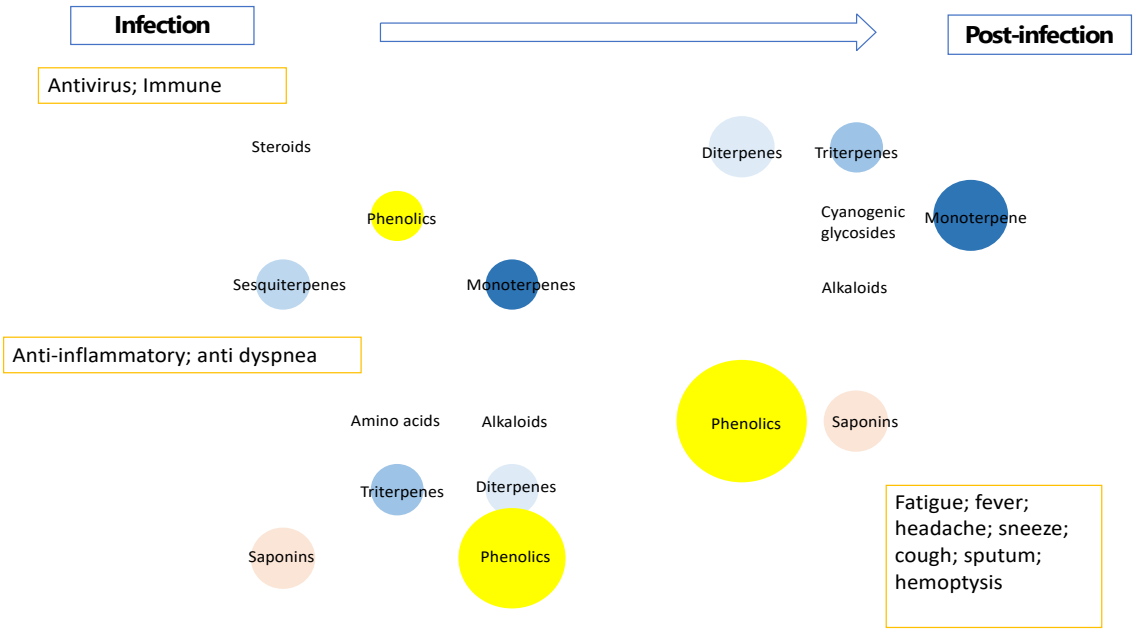

Figure 6. Preview diagram of the active ingredient classes and cures for infectious respiratory syndromes.

DISCUSSION

Plant species for treatments of infectious respiratory syndromes

In comparison with influenza, the critical study which was conducted with patients infected with rhinovirus/coronavirus had shown the symptoms of persistent lung disease, along with the presence of nasal congestion and cough. It is well understood that viral infection contributes to the pathogenesis of mucosal inflammation which later exacerbates the chronic disease process (Lee and Lane 2011). Furthermore, acute inflammation of the nasal mucosa is usually accompanied by the lower degree of fever, malaise, headache and relative cough as well (Masood, et al. 2007). This is known as a defensive reflex of upper respiratory infection which is generally transient, whereas the persistent cough is associated with a whole range of conditions such as asthma, rhinosinusitis, and gastro-oesophageal reflux (Chung and Chang 2002). Concurrently, this simulates the infections of lower respiratory tract in terms of acute bronchitis, acute exacerbations of chronic bronchitis, asthma exacerbations, and pneumonia. However, some patients could also develop sputum along with the presence of fatigue, myalgias and fever (Stolza et al. 2006). The synthetic antibiotics are facing the continuous limitation of side effects on health and their continuous usage leading to development of bacterial resistance. Thus, there is an increasing demand for the development of antimicrobial agents which must be active against microorganisms without any negative effects. Therefore, the pharmaceutical companies are accelerating the development of antimicrobial drugs from the natural sources possessing harmless properties to the host. The essential oils derived from medicinal plants are found to be the most significant sources of natural antimicrobial agents which are still prescribed by the traditional medicinal practitioners against infectious diseases (Saric 1989). By assembling the systematic review, we were able to extract and highlight the significantly inevitable plant families that can be utilised as a potent cure for the infectious respiratory syndromes (show cased in **Table 3**).

Cultures and modes of application

Traditional medical practitioners under Ayurveda commonly utilise leaves, stems, flowers and roots for the preparation of ethno-medicinal recipes. The most common plants which are used for the prevention of respiratory diseases in Indian subcontinent include the members of Asteraceae family, followed by Solanaceae, Moraceae, Poaceae, Fabaceae, Amaranthaceae, Lamiaceae, Rosaceae, Violaceae, Ranunculaceae, Asclepiadaceae, Euphorbiaceae, Apiaceae, Polygonaceae, Malvaceae, Acanthacea, Brassicaceae, Boraginaceae, Liliaceae, Capparaceae, Labiatae, Mimosaceae, Papilionaceae and Myrtiaceae, respectively (Abdillahi et al. 2010). The detailed description of these plants is listed in **Table 4**.

The main respiratory infections treated by the dosage of these plant products include tuberculosis, cough, fever, cold, sore throat, chest complaints, influenza, blocked and runny nose, asthma, bronchitis, pneumonia, lung infection and sinusitis. The pharmacological properties that enabled their uses for the treatment of respiratory problems include anti-inflammatory, anti-histaminic, immunomodulatory, muscle relaxant, anti-allergic, bronchodilator and antioxidant activities (Abdillahi et al. 2011). Some of the traditional medicinal plants like *Achyranthes aspera, Adhatodavasica*, *Glycyrrhiza glabra, Viola odorata* and *Onosma bracteatum* were employed for the treatment of respiratory problems which are currently utilised for the preparation of popular herbal medicines. A large number of plant-derived natural compounds have been investigated for evaluating their effect on cellular mechanisms and also for the treatment of inflammatory pulmonary syndromes (Karou et al. 2007).

Traditional Chinese medicine (TCM), that relies on natural products, plays an essential role in healthcare system and disease control in most Asian countries (Cushnie et al. 2014). The anti-inflammatory effects of flavonoids of different plants have been found to be beneficial in asthma treatment. Sakuranetin, a flavonoid from *Baccharis retusa*, has been evidenced to reduce the

number of inflammatory cells in the lung, especially eosinophils, and effectively inhibit the metabolism NF-κB in lung (Slader et al. 2006). Kuwanon G, a flavonoid extracted from root bark of *Morus alba* L., was found to cause reduction in the levels of IgE in ovalbumin-induced allergic asthma in mice (Ogbaji) et al. 2018). Song et al. (2015) revealed that Picroside C, a compound isolated from *Pseudolysimachion rotundum* protects the neutrophil influx and further, has the capacity for the inhibition of the NF-κB pathway that counteracts the lung inflammation.

The practice of treating ailments by herbal medicine is well established and documented in Asia. Among the different types of recipes used for the utilisation of medicinal plants, the most common mode for manufacturing of phyto-medicines include decoction, juice, paste, powder, oil, tea, pills, and infusion (Song et al. 2015; Qiu et al. 2016). Thus, a large amount of the medicinal plants that are recognised globally for controlling diseases are exported from this continent, particularly from China and India.

Active ingredients

The overall ethnobotanical, ethnopharmacological, and phytochemical studies of these medical plants revealed their significant role in treatment of diseases and their uses in medicines, pharmacy and cosmetics. A significant portion of the folkloric reputes associated with these plants had been investigated experimentally by acting as antimicrobial, anticarcinogenic, antidiarrheal, antiulcer, anti-inflammatory, antioxidant and antidiabetic. The use of medicinal plants in traditional healthcare systems has been in practices since many centuries and numerous cultures throughout the world are still depending on these plants for their primary healthcare. Owing to the recent advances in plant sciences, there has been a burgeoning use of these plants and their products for the treatment of various ailments. Due to the existing belief of natural products, about 70–80% of the world population, still rely on medicinal plants for their primary healthcare system (Adnan et al. 2014). The bioactive phytochemicals presented in these plants are being investigated globally for their broad-spectrum medicinal properties, thus the medicinal plants are receiving more considerations nowadays, particularly in the field of medicine and pharmacology. The therapeutic activity of medicinal plants is mainly attributed to their antimicrobial properties and the usage of these plants have been found to be effective in decreasing the prospects of antibiotic resistance in food borne pathogenic microorganisms (Taur and Patil 2011). Medicinal plants are being used for isolation of pure active compounds or Phyto-complex, which is a combination of active ingredients and other substances like enzymes, resins, essential oils, tannins to facilitate their actions. **Table 5** summarises the active ingredients that play the significant mode of action toward curing infectious respiratory syndromes.

CONCLUSION

The traditional medicinal plants having potential for the treatment of respiratory problems are now being exceedingly utilised in the preparation of popular herbal medicines. Owing to recent advances in plant sciences, there has been a tremendous rise in the utilization of these plants and their products for the treatment of variegated ailments. The most efficacious drugs used globally for treatment of respiratory and associated problems are disposed from the traditional medicinal plants. The latest trend in development of drugs employing medicinal plants encourages researchers and various organisations to investigate and validate the utilisation of traditional medicinal plants. The application of medicinal plants in traditional medical practices such as Ayurveda, Unani and traditional Chinese medicines has been established as an organised as supportive pillar of medicines since prehistoric times.

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Data availability statement

The data that support the findings of this study are available from the corresponding author, SRS, upon reasonable request.

REFERENCES

1. Abdillahi HS, Finnie JF, Van Staden J. 2011. Anti-inflammatory, antioxidant, anti-tyrosinase and phenolic contents of four Podocarpus species used in traditional medicine in South Africa. J Ethnopharmacol. 136(3):496–503.
2. Abdillahi HS, Stafford GI, Finnie JF, Van Staden J. 2010. Ethnobotany, phytochemistry and pharmacology of *Podocarpus sensu* latissimo (sl). South Afri J Bot. 76(1):1–24.
3. Adnan Shereen M, Khan S, Kazmi A, Bashir N, Siddique R. 2020. COVID-19 infection: origin, transmission, and characteristics of human coronaviruses. J Adv Res. 24:91–98.
4. Adnan M, Ullah I, Tariq A, Murad W, Azizullah A, Khan AL, Ali N. 2014. Ethnomedicine use in the war affected region of northwest Pakistan. J Ethnobiol Ethnomed. 10(1):16.
5. Ahmed HM. 2019. Ethnomedicinal, phytochemical and pharmacological investigations of *Perilla frutescens* (L.) Britt. Molecules. 24(1):102.
6. Al-Tawfiq JA, Assiri A, Memish ZA. 2013. Middle East respiratory syndrome novel corona (MERS-CoV) infection Epidemiology and outcome update. Saudi Med. J. 34:991–994.
7. Arumugam G, Swamy MK, Sinniah UR. 2016. *Plectranthus amboinicus* (Lour.) Spreng: botanical, phytochemical, pharmacological and nutritional significance. Molecules. 21(4):369.
8. Ben Khedher MR, Hammami M, Arch JRS, Hislop DC, Eze D, Wargent ET, Kepczynska MA, Zaibi MS. 2018. Preventive effects of *Salvia officinalis* leaf extract on insulin resistance and inflammation in a model of high fat diet-induced obesity in mice that responds to rosiglitazone. PeerJ. 6:4166.
9. Beristain-Bauza SD, Hernandez-Carranza P, Cid-Perez TS, Avila-Sosa R, Ruiz-Lopez II, Ochoa-Velasco CE. 2019. Antimicrobial activity of ginger (*Zingiber Officinale*) and its application in food products. Food Rev. Int. 35(5):407–426.

10. Chang L, Yan Y, Wang L. 2020. Coronavirus Disease 2019: Coronaviruses and blood safety. Transfus Med Rev. 34(2):75–80.
11. Chen P, Mao L, Nassi CS, George P, Harmer P, Ainsworth BE, Li F. 2020. Coronavirus disease (COVID-19): The need to maintain regular physical activity while taking precautions. J Sport Health Sci. 9(2):103–104.
12. Chen J, Hu C, Chen L, Tang L, Zhu Y, Xu X, Chen L, Gao H, Lu X, Yu L, et al. 2020. Clinical study of mesenchymal stem cell treatment for acute respiratory distress syndrome induced by epidemic influenza A (H7N9) infection: A Hint for COVID-19 Treatment. Engineering. 6(10):1153–1161.
13. Chung KF, Chang AB. 2002. Therapy for cough: active agents. Pulmonary PharmTherap. 15(3):335–338.
14. Cortegiani A, Giulia I, Mariachiara I, Antonino G, Sharon E. 2020. A systematic review on the efficacy and safety of chloroquine for the treatment of COVID-19. J Crit Care. 57:279–283.
15. Cushnie TPT, Cushnie B, Lamb AJ. 2014. Alkaloids: an overview of their antibacterial, antibiotic-enhancing and antivirulence activities. Int J Antimic Agents. 44(5):377–386.
16. Desforges M, Le Coupanec A, Dubeau P, Bourgouin A, Lajoie L, Dube M, Talbot PJ. human coronaviruses and other respiratory viruses: underestimated opportunistic pathogens of the central nervous system?. Viruses, 2020, 12(1): 14
17. Di Lorenzo C, Dell'agli M, Badea M, Dima L, Colombo E, Sangiovanni E, Restani P, Bosisio E. 2013. plant food supplements with anti-inflammatory properties: a systematic review (II). Cri Rev Food Sci Nutr. 53(5):507–516.
18. Dogan K, Tornuk F. 2019. Improvement of bioavailability of bioactive compounds of medicinal herbs by drying and fermentation with *Lactobacillus plantarum*. Func Food Health Dis. 9(12):735–748.
19. Duelund L, Amiot A, Fillon A, Mouritsen OG. 2012. Influence of the active compounds of Perilla frutescensleaves on lipid membranes. J Nat Prod. 75(2):160–166.
20. Evelyne B, Chen G, Teresa FM. 2020. Understanding COVID-19 new diagnostic guidelines - a message of reassurance from an internal medicine doctor in Shanghai. Swiss Medical Weekly. 150.
21. Falsey AR, Walsh EE, Hayden FG. 2002. Rhinovirus and coronavirus infection-associated hospitalizations among older adults. J Infect Dis. 185:1338–1341.
22. Foudah AI, Alam P, Alam A, Salkini MA, Alqarni MH, Yusufoglu HS. 2019. Development of High-performance Thin-layer Chromatography (HPTLC) Validated Method for simultaneous quantification of eucalyptol and alpha-pinene in Lamiaceae plants. J Pharm Res Int. 31(6):1–11.
23. Han WZ, Quan B, Guo Y, Zhang J, Lu Y, Feng G, Wu QW, Fang F, Cheng L, Jiao NL, Li XN, Chen Q. 2020. The course of clinical diagnosis and treatment of a case infected with coronavirus disease 2019. J Med Virol. 92(5): 461–463.
24. Hellewell J, Abbott S, Gimma A, Bosse NI, Jarvis CI, Russell TW, Munday JD, Kucharski AJ, Edmunds WJ, Sun F, et al. 2020. Feasibility of controlling COVID-19 outbreaks by isolation of cases and contacts. The Lancet Glob Health. 8:488–496.
25. Hong-Zhi DU, HOU, Xiao-Ying, MIAO Yu-Huan, HUANG Bi-Sheng, LIU Da-Hui. 2020. Traditional Chinese Medicine: an effective treatment for 2019 novel coronavirus pneumonia (NCP). Chin J Nat Med. 18(3):206–2010.
26. Ilieva Y, Kaloyanov K, Yosifov D, Robev B, Zhelezova I, Genova M, Mihova A, Balatzenko G, Zaharieva MM, Berger MR, Konstantinov SM. 2014. Antineoplastic potential of curcumin (cooperative study in Bulgaria and Germany). Phytochem Rev. 13(2):459–469.
27. Karou D, Nadembega WMC, Ouattara L, Ilboudo DP, Canini A, Nikiéma JB, Simpore J, Colizzi V, Traore AS. 2007. African ethnopharmacology and new drug discovery. Med Arom Plant Sci Biot. 1(1): 61–69.
28. Kupferschmidt K, Cohen J. 2020. Race to find COVID-19 treatments accelerates. Sci. 367:1412–1413.
29. Lee S, Lane AP. 2011. Chronic rhinosinusitis as a multifactorial inflammatory disorder. Curr Infect Dis Rep. 13(2):159–168.
30. Lee WH, Loo CY, Bebawy M, Luk F, Mason RS, Rohanizadeh R. 2013. curcumin and its derivatives: their application in neuropharmacology and neuroscience in the 21st century. Curr Neuropharm. 11(4):338–378.
31. Li HL, Ge YH, Luo ZM, Zhou YL, Zhang XG, Zhang JQ, Fu Q. 2017. Evaluation of the chemical composition, antioxidant and anti-inflammatory activities of distillate and residue fractions of sweet basil essential oil. J Food Sci Tech Mys. 54:1882–1890.
32. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, Ioannidis JPA, Clarke M, Devereaux PJ, Kleijnen J, Moher D. 2009. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. J Clin Epidemiol. 62:1–34.
33. Luo H, Tang QL, Shang YX, Liang SB, Yang M, Robinson N, Liu JP. 2020. Can Chinese Medicine Be Used for Prevention of Corona Virus Disease 2019 (COVID-19)? A review of historical classics, research evidence and current prevention programs. Chin J Integr Med. 26(4):243–250.
34. Lupia T, Scabini S, Mornese Pinna S, Di Perri G, De Rosa FG, Corcione S. 2019. novel coronavirus (2019-nCoV) outbreak: A new challenge. J Glob Antimicrob Resist. 21:22–27.
35. Mahase E. 2020. Covid-19: 90% of cases will hit NHS over nine week period, chief medical officer warns. Bmj-Brit Med J. 368.
36. Mahomoodally F, Mesaik A, Choudhary MI, Subratty AH, Gurib-Fakim A. 2012. In vitro modulation of oxidative burst via release of reactive oxygen species from immune cells by extracts of selected tropical medicinal herbs and food plants. Asian Pac J Trop Med. 5(6):440–447.
37. Marchese A, Orhan IE, Daglia M, Barbieri R, Di Lorenzo A, Nabavi SF, Gortzi O, Izadi M, Nabavi SM. 2016. Antibacterial and antifungal activities of thymol: A brief review of the literature. Food Chem. 210:402–414.
38. Masood A, Moumoulidis I, Panesar J. 2007. Acute rhinosinusitis in adults: an update on current management. Postgrad Med J. 83(980) 402–408.

39. Moberly T. 2020. Covid-19: school closures and bans on mass gatherings will need to be considered, says England's CMO. Bmj-British Med J. 368.
40. Nisar MF, He JW, Ahmed A, Yang YX, Li MX, Wan CP. 2018. Chemical Components and Biological Activities of the Genus Phyllanthus: A Review of the Recent Literature. Molecules. 23:2567.
41. Niu Y, Xu F. 2020. Deciphering the power of isolation in controlling COVID-19 outbreaks. Lancet Glob Health. 8(4):452–453.
42. Ogbaji PO, Li J, Xue X, Shahrajabian MH, Egrinya EA. 2018. Impact of bio-fertilizer or nutrient solution on spinach (*Spinacea oleracea*) growth and yield in some province soils of P.R. China. Cecet Agr Moldova. 51(2):43–52.
43. Qiu J, Chi G, Wu Q, Ren Y, Chen C, Feng H. 2016. Pretreatment with the compound asperuloside decreases acute lung injury via inhibiting MAPK and NF-κBsignaling in a murine model. Int Immunopharmacol. 31:109–115.
44. Ren LL, Wang YM, Wu ZQ, Xiang ZC, Guo L, Xu T, Jiang YZ, Xiong Y, Li Y-J, Li X-W, et al. 2020. Identification of a novel coronavirus causing severe pneumonia in human: a descriptive study. Chin Med J. 133(9):1015–1024.
45. Sabaragamuwa R, Perera CO, Fedrizzi B. 2018. *Centella asiatica* (Gotu kola) as a neuroprotectant and its potential role in healthy ageing. Trends Food SciTechnol. 79:88–97.
46. Saghir SAM, Sadikun A, Khaw KY, Murugaiyah V. 2013. Star fruit (*Averrhoa carambola* L.): From traditional uses to pharmacological activities. Boletin Latinoameri Y Del Caribe De Plantas Med Y Arom. 12(3):209–219.
47. Sarić, M., 1989. The medicinal plants of the Federal Republic of Serbia. *SAAS: Belgrade*.
48. Shahrajabian MH, Sun WL, Cheng Q. 2019. Clinical aspects and health benefits of ginger (*Zingiber officinale*) in both traditional Chinese medicine and modern industry. Acta Agric Scandinavica Section B-Soil Plant Sci. 69(6):546–556.
49. Shaikh S, Shriram V, Srivastav A, Barve P, Kumar VA. 2018. A critical review on Nepal Dock (*Rumex nepalensis*): A tropical herb with immense medicinal importance. Asian Pac J Trop Med. 11(7):405–414.
50. Shishodia S. 2013. Molecular mechanisms of curcumin action: Gene expression. Biofactors. 39(1):37–55.
51. Singh JS. 2002. The biodiversity crisis A multifaceted review. Curr Sci. 82(6):638–647.
52. Sisay M, Gashaw T. 2017. Ethnobotanical, ethnopharmacological, and phytochemical studies of Myrtus communisLinn: a popular herb in unani system of medicine. J Evid Based Com Altern Med. 22(4):1035–1043.
53. Slader CA, Reddel HK, Jenkins CR, Armour CL, Bosnic-Anticevich SZ. 2006. Complementary and alternative medicine use in asthma: who is using what?. Respirol. 11(4):373–387.
54. Song HH, Shin IS, Woo SY, Piscroside C. 2015. a novel iridoid glycoside isolated from *Pseudolysimachion rotundum* var. subinegrum suppresses airway inflammation induced by cigarette smoke. J Ethnopharmacol. 170:20–27.
55. Stolza D, Christ-Craind M, Gencaya MM, Bingisserb R, Huberc PR, Müllerd B, Tamma M. 2006. Diagnostic value of signs, symptoms and laboratory values in lower respiratory tract infection. Coronary Artery Dis. 136(27-28):434-40.
56. Subramoniam A. 2016. Food from plants with antiarthritic properties. Annals Phytomed; Int J. 5(1):4–23.
57. Sueth-Santiago V, Mendes-Silva GP, Decote-Ricardo D, de Lima MEF. 2015. Curcumin, the golden powder from turmeric: insights into chemical and biological activities. Quimica Nova. 38(4):538–552.
58. Sun WL, Shahrajabian MH, Cheng Q. 2019. Anise (*Pimpinella anisum* L.), a dominant spice and traditional medicinal herb for both food and medicinal purposes. Cogent Biol. 5:1673688.
59. Taur DJ, Patil RY. 2011. Some medicinal plants with antiasthmatic potential: a current status. Asian Pac J Trop Biomed. 1(5):413–418.
60. Trujillo J, Chirino YI, Molina-Jijon E, Anderica-Romero AC, Tapia E, Pedraza-Chaverri J. 2013. Renoprotective effect of the antioxidant curcumin: Recent findings Redox Biol. 1(1):448–456.
61. Vitali LA, Beghelli D, Nya PCB, Bistoni O, Cappellacci L, Damiano S, Lupidi G, Maggi F, Orsomando G, Papa F, Petrelli D, Petrelli R, Quassinti L, Sorci L, Zadeh MM, Bramucci M. 2016. Diverse biological effects of the essential oil from Iranian Trachyspermum ammi. Arabian J Chem. 9(6):775–786.
62. Wang W, Tang J, Wei F. 2020. Updated understanding of the outbreak of 2019 novel coronavirus (2019-nCoV) in Wuhan, China. J Med Virol. 92(4):441–447.
63. Welz AN.; Emberger-Klein A, Menrad K. 2018. Why people use herbal medicine: insights from a focus-group study in Germany. BMC Complement Altern Med.18:92.
64. WHO. 2020. Coronavirus disease (COVID-2019) situation reports. In. Geneva, Switzerland: World Health Organisation.
65. Yang BR, Liu PZ. 2014. Composition and biological activities of hydrolyzable tannins of fruits of Phyllanthus emblica. J Agric Food Chem. 62:529–541.
66. Zhang L, Liu YH. 2020. Potential interventions for novel coronavirus in China: A systematic review. J Med Virol. 92:479–490.

Table 1. The criteria of inclusion and exclusion for selection of reported studies

	Inclusion criteria	Exclusion criteria
Language restrictions	Providing at least English abstract	Languages other than English
Publication date restrictions	From 2010 up to 2020 (March)	Article published before 2010 and as form 25th, March 2020
Type of articles	Full research and review articles providing completed abstract and key words	In completed articles i.e., lacking abstract and keywords
Type of study (design)	Ethnobotany studies, *in vitro* and *in vivo* studies using animal or human model (no restriction for dosage, timing or frequency)	No evidence mentioned of human used. Not specify active ingredient(s) or natural product(s)
Complementary herbal cures	Use of herbal or natural products owning the functional properties to cure symptoms of infectious r*espiratory syndromes.* Herb plant-derived preparations included in any of these types (fresh/ dried forms, extract, essential oil emanating from aerial parts, leaves, seeds or fruits and others including root and flower.	The studies of no specific plant names either in the forms of common or scientific names Uses of natural products of marine, microbial and animal origins. Not specify plant part utilised. Not specify method of utilisation
Plant intervention for r*espiratory syndromes*	Research articles conducted on use of plant or plant derivatives for treatment of infectious r*espiratory syndromes*	

Table 2. Principal component analysis and loading of the first three principal components.

Total variance explained			
PC	Eigen values	Variability (%)	Cumulative (%)
1	1.512	25.207	25.207
2	1.333	22.210	47.416
3	1.002	16.696	64.112
Observation	F1	F2	F3
Podocarpaceae	2.421	0.454	0.256
Lamiaceae	2.001	-0.509	-0.386
Anacardiaceae	-0.596	-1.354	-0.385
Apiaceae	-0.596	-1.354	-0.385
Asteraceae	-0.596	-1.354	-0.385
Oleaceae	-0.596	-1.354	-0.385
Piperaceae	-0.596	-1.354	-0.385
Moraceae	-0.596	-1.354	-0.385
Rosaceae	-0.596	-1.354	-0.385
Caricaceae	0.590	1.620	0.829
Phyllanthaceae	2.001	-0.509	-0.386
Myrtaceae	-1.915	1.195	-0.624

Zingiberaceae	-0.656	1.766	-0.229
Bromeliaceae	2.421	0.454	0.256
Solanaceae	0.170	0.657	0.186
Rutaceae	0.170	0.657	0.186
Brassicaceae	-0.656	1.766	-0.229
Nelumbonaceae	-1.089	0.086	-0.209
Ranunculaceae	0.878	0.387	3.726
Geraniaceae	-0.577	1.469	-1.020
Orchidaceae	1.508	0.931	-0.210
Capparaceae	2.001	-0.509	-0.386
Leguminosae	-0.596	-1.354	-0.385
Campanulaceae	-1.915	1.195	-0.624
Cannabaceae	-0.596	-1.354	-0.385
Amaranthaceae	-0.596	-1.354	-0.385
Labiatae	-0.596	-1.354	-0.385
Rubiaceae	2.001	-0.509	-0.386
Araliaceae	0.170	0.657	0.186
Nymphaeaceae	1.508	0.931	-0.210
Malvaceae	0.170	0.657	0.186
Annonaceae	0.249	0.360	-0.605
Berberidaceae	1.508	0.931	-0.210
Urticaceae	-1.915	1.195	-0.624
Moringaceae	-0.596	-1.354	-0.385
Taccaceae	0.663	-0.783	0.010
Fabaceae	-0.596	-1.354	-0.385
Apocynaceae	-0.596	-1.354	-0.385
Berberidaceae	0.336	0.991	-0.554
Sapindaceae	0.590	1.620	0.829
Asparagaceae	1.162	-0.118	-0.139

Table 3. Applications of high frequency-based plant families and their functional properties and cures

Cures for infectious respiratory syndromes	Plant families	Plant species	Uses detail	References
Antivirus and immune booster	Apiaceae	*Pimpinella anisum* L.	Treatment for catarrh, an excessive secretion of epithelial cells due to respiratory tract infections generally also inducing prostaglandin-mediated bronchoconstriction; this secretion, cleared by pneumocyte cilia, consists mainly of flaked away epithelial cells, microorganisms and mononuclear cells.	Sun *et al.* (2019)
		Centella asiatica	Used to treat a variety of ailments including leprosy, eczema, psoriasis, respiratory infections, ulcers, colds, hepatitis, epilepsy, fatigue, fevers, asthma and syphilis.	Sabaragamuwa *et al.* (2018)
		Trachyspermum ammi	It helps relieve congestion and improves the vital capacity of the lungs on regular consumption. It improves breathing problem in asthmatic patients and helps improve overall lung function.	Sun *et al.* (2019)

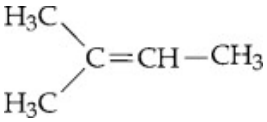
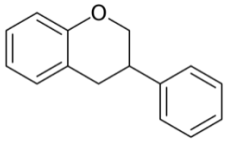
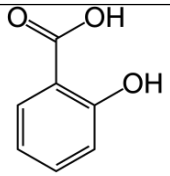
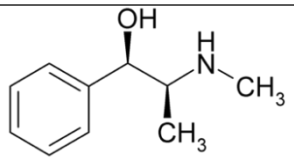
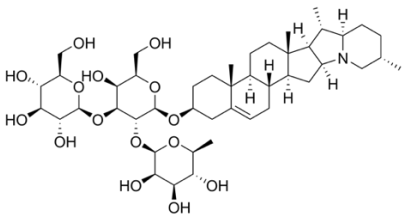
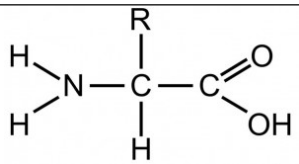
	Zingiberaceae	*Curcuma longa*	Curcumin, the active compound in *Curcuma longa* is used to manage any infection related to respiratory tract. Due to its anti-inflammatory properties, the herb is known to cure the inflammation of the lungs. This property also helps in the treatment of bacterial and viral infections like cough, common cold and flu. The herb is helpful in getting the relief from chest congestion as well.	Sabaragamuwa *et al.* (2018); Vitali *et al.* (2016); Trujillo *et al.* (2013)
		Zingiber officinale	*Zingiber officinale* has antiviral activity against human respiratory syncytial virus-induced plaque formation on airway epithelium. The extracts from the rhizome exhibited antibacterial activity against respiratory tract pathogens. In the TCM, ginger is used to warm the body and treat cold extremities, improves a weak and tardy pulse. Gingerol and shogaol in particular, is known for their strong antioxidant and anti-inflammatory properties	Ilieva *et al.* (2014); Di Lorenzo *et al.* (2013)
	Polygonaceae	*Rumex nepalensis* Spreng	*R. nepalensis* exhibited inhibitory action against RNA polymerase of hepatitis C virus. The herb is also considered as a medicine for cough and headache, as a laxative, antidote and depurative.	Shahrajabian *et al.* (2019)
Anti-inflammatory and anti-dyspnea	Zingiberaceae	*Curcuma longa*	Due to its anti-inflammatory properties, the herb is known to cure the inflammation of the lungs. This property also helps in the treatment of bacterial and viral infections like cough, common cold and flu.	Sueth-Santiago *et al.* (2015); Subramoniam (2016); Shishodia (2013); *Lee et al.* (2013)
	Myrtaceae	*Myrtus communis* L	Volatile oil of *M. communis* and its decoction decreased the aver age time of pain relief and decreased the size of ul cers in patients with minor RAS.	Beristain-Bauza et al. (2019)
Post-infectious symptoms	Lamiaceae	*Monarda* spp.	Possess pharmacological properties including *reduction of* mucus in organs, including the lungs. It reduces respiratory complications include infections, inflammation and respiratory failure.	Shaikh *et al.* (2018)
		Ocimum spp.	It has the ability to inhibit the replication of most of the microbes and used in enhancement of defensive factors such as mucin secretion, cellular mucus and longevity of mucosal cells.	Sisay and Gashaw (2017); Marchese *et al.* (2016)
		Origanum spp.	Oregano has important essential oils and acids that make it effective for respiratory issues. The rosmarinic acid found in oregano has powerful antihistamine effects and is adecongestant, along with strong antibacterial properties. This can not only eliminate mucus but also kill bacteria causing the infection, quickly speeding up recovery.	Shaikh, *et al.* (2018); Mahomoodally *et al.* (2012)
		Perilla frutescens	Perilla contains chemicals that might decrease swelling and affect other chemicals that cause respiratory problems and asthma.	Li *et al.* (2017); Dogan and Tornuk (2019)
		Plectranthus amboinicus	This herb is useful for the treatment of sore throat, congestion, sinusitis as it contains the compounds that act as powerful expectorants	Duelund *et al.* (2012)

			which eliminate phlegm and mucus from the respiratory tracts.	
		Salvia officinalis L.	Salvia essential oils have been used in the treatment of a wide range of diseases like those of the nervous system, heart and blood circulation, respiratory system, digestive system, and metabolic and endocrine diseases. It is also applied directly to the mouth or throat for cold sores, gum disease (gingivitis), sore mouth, throat, or tongue, swollen, painful nasal passages and swollen tonsils.	Ahmed (2019); Arumugam *et al.* (2016)
	Oxalidaceae	*Averrhoa carambola* L.	Star fruit exhibits anti-microbial, anti-bacterial and anti-fungal properties. Used for the treatment of cough, cold, bronchitis, and symptomatic relief of colds and infection of the upper respiratory tract.	Foudah *et al.* (2019)
	Phyllanthaceae	*Phyllanthus spp.*	The active ingredients from *Phyllanthus* plants are known to have immunomodulation, anti-viral and antibacterial, diuretic, anti-hyperglycaemia and hepatoprotection properties. Phyllanthus has antimicrobial effect and may help reduce inflammation. It can be used for the treatment of respiratory com- plaints, mainly as an expectorant in cough associated with cold.	Ben Khedher *et al.* (2018); Saghir *et al.* (2013)
	Podocarpaceae	*Podocarpus*	Used for the treatment of respiratory infections (e.g. cold, influenza, bronchitis). The therapeutic application of *Podocarpus* oil includes the respiratory disorders (bronchial catarrh, supportive treatment of pertussis).	Yang and Liu (2014); Nisar *et al.* (2018)

Table 4. Description of the commonly used medicinal plants in Ayurveda.

Local name	Plant Families	Plant species	Parts used	Uses
Kolroi, Tosh, Talispatra	Pinaceae	*Abies spectabilis*	Leaves, Needles	Leaves in the form of decoctions or infusions are used to cure bronchitis, phthisis and pulmonary infections. Also function as antispasmodic, appetizer, digestive and diuretic.
Ratti, Gunja, Chuntli	Leguminosa	*Abrus precatorius* Linn	Roots, Seeds	Used in nervous disorders and cattle poisoning
Khair, Khadir, Catechu	Leguminosa	*Acacia catechu* Wild	Heart wood, Extract (sapwood)	Used in sore- mouth, chest pain, colic pain, cancer and bronchial asthma
Kikar, Babul	Leguminosa	*Acacia nilotica* Delite.	Heart wood, gum, pod, bark	Used to cure sore throat, asthma, diabetes, skin diseases, urinary and vaginal discharge
Birinjasif, Millfoil, Yarrow	Asteraceae	*Achillea millefolium* Linn.	Leaves and flower head	Used in infusion form as diuretic, stimulant and haemostatic. Flower head is also used as carminative, tonic and aromatic stimulant.
Puthkunda, Chirchita, Apamarga	Amaranthacea	*Achyranthes aspera* Linn.	Whole plant	Seeds are used as hydrophobia in case of snake bites, in opthalmia and cutaneous diseases. The plant infusion is also used as a remedy in dropsy.
Mohro, Mouro, Safed Bish	Ranunculaceae	*Aconitum deinorrhizum* Stapf.	Roots and tubers	It is used externally as a massage in neuralgia, paralysis and muscular rheumatism.
Atvisha, Atish, Patish	*Ranunculaceae*	*Aconitum heterophyllum* Wall.	Roots, tubers and leaves	used as a diuretic and applied externally as a massage in neuralgia, paralysis and muscular rheumatism
Kashmal	Berberidaceae	*Berberis lycium*	Roots and barks	used in leprosy
Bhang	Cannabaceae	*Cannabis sativa*	Leaves	used as Narcotics, Sedative, anti-inflammatory
Haldi	Zingiberaceae	*Curcuma longa*	Tubers	Used in wound healing and in inflammation, paste of fresh rhizome mixed with warm water is given to heal up internal wounds.

Table 5. Active ingredients and their functionality to cure infectious respiratory syndromes.

Active ingredients classes	Chemical structures	Mode of actions	References
Terpenes		The terpenoids presented in essential oils are able to modulate significantly immune response of phagocytes and monocytes. Besides, terpenes have the ability to counter neuro-inflammationby inhibiting nuclear factor kappa-light-chain-enhancer of activated B cells.	Taur, and Patil, (2011)
Flavonoids		Flavonoids such as apigenin-6-C-β-l-fucopyranoside and apigenin-6-C-(2′′-O-α-l-rhamnopyranosyl)-β-l-fucopyranoside possess anti-inflammatory activity with positive inhibitory potential againstedema formation and myeloperoxidase activity.	Foudah *et al.* (2019)
Phenolics		Phenolics can interfere with the oxidative cycle thus inhibiting or slowing the degradation of bio polymers. In *Podicarpus*spp., totarol is effective as a topical anti-inflammatory agent and is commercially need at present.	Yang, and Liu, (2014); Nisar *et al.*(2018)
Alkaloids		Alkaloids showed positive inhibitory effect with inflammatory cytokines and inflammatory mediator.	Li *et al.* (2017); Dogan,and Tornuk, (2019)
Saponins		Saponins have been shown to exhibit antivirus properties that is the major causes of fever.	Ben Khedher*et al.*(2018); Saghir *et al.*(2013)
Amino acids		The ordered amino acids are then linked by enzymatic action to form a protein and regulate the expression of anti-inflammatory cytokines.	Singh (2002)