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# Integrating Contemporary Perspectives With Evidence-Based Phytopharmaceuticals For Enhanced Well-Being In Upper Respiratory Tract Infections

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## Abstract

Respiratory tract infections represent a significant contributor to both morbidity and mortality rates within the human population, with a particular emphasis on their impact within developing nations such as India. The prevalence of upper respiratory tract infections, such as nasopharyngitis, pharyngitis, tonsillitis, and otitis media, accounted for 87.5% of all recorded instances of infection. The remaining 12.5% of cases were attributed to lower respiratory tract infections, specifically pneumonia and bronchiolitis. Viruses are responsible for the vast majority of acute upper respiratory tract infections. The etiology of the common cold is primarily viral, with antimicrobial medicines typically unnecessary for treatment, unless there are complications such as acute otitis media with effusion, tonsillitis, sinusitis, or lower respiratory tract infection. In recent years, respiratory tract infections caused by viruses have significantly affected communities worldwide, with influenza viruses being particularly impactful. This impact has been exacerbated by the lack of accessible and efficacious treatment options or vaccines. Ayurveda is a form of alternative medicine that prioritizes the promotion of optimal health and uses natural herbs and formulations for the diagnosis and treatment the fundamental principle revolves around prioritizing health promotion, disease prevention, early diagnosis, and personalized treatment. The rapid changes in the antigenic structures of respiratory viruses present challenges in the development of efficacious vaccines, particularly for RNA viruses. Several herbal medicines have been identified as helpful in various studies. These include Maoto, licorice roots, antiwei, North American ginseng, berries, Echinacea, plants extracting carnosic acid, pomegranate, guava tea, and Bai Shao. Scientific data exists pertaining to the efficacy of therapies in the treatment of colds, such as oral zinc, which has been shown to potentially diminish the duration and intensity of cold symptoms. Nevertheless, consistent consumption of vitamin C supplements merely yields a marginal decrease in both the duration and intensity of common colds. The efficacy of probiotics in mitigating the frequency and incidence of acute upper respiratory tract infections, as well as minimizing the need for antibiotic treatment, has been demonstrated in comparison to a placebo. Furthermore, it has been suggested that alkaline diets or beverages may possess antiviral capabilities, as evidenced by *in vitro* experiments that have shown the ability of an alkaline environment to deactivate respiratory viruses. Various forms of traditional medicine have been found to be effective in treating tract infections. This review focuses on a selection of traditional remedies basically “Kadha” (Decoction) specifically chosen for the treatment of respiratory tract infections.

**Keywords:** Nasopharyngitis, Pharyngitis, Tonsillitis, Influenza, Antiviral, Kadha (Decoction).

## 1. Introduction

Acute respiratory infection is a major issue in both newborns and adults, with most of these infections affecting the upper respiratory tract. Bacterial pathogens primarily cause lower respiratory tract infections, while viral pathogens predominantly cause upper respiratory tract infections. The viral causative agent was already identified in 16.6% of cases, with the following viruses isolated: influenza A and B (45.65%), parainfluenza 1 and 3 (26.08%), adenovirus (19.56%), and respiratory syncytial virus (6.52%) **[1]**. The

primary upper respiratory tract infections include common colds, sinusitis, pharyngitis, epiglottitis, and laryngotracheitis. Epiglottitis and laryngotracheitis are atypical conditions that are typically severe and are often attributed to *Haemophilus influenzae* type b. *Streptococcus pyogenes* is a common cause of bacterial pharyngitis **[2]**. The clinical manifestations exhibit significant heterogeneity, devoid of any discernible association with particular viral pathogens **[3]**. Most of the symptoms are moderate and include rhinorrhea, sneezing, nasal congestion and blockage, postnasal drip, and cough. Other accompanying symptoms such as mild fever, throat pain, watery eye discharge, gastrointestinal discomfort, and overall feeling of illness may also be observed **[4,5]**. Common viruses responsible for causing upper respiratory tract infections (URIs) include rhinovirus, coronavirus, adenovirus, respiratory syncytial virus (RSV), influenza, and parainfluenza virus **[3,6,7]**. The transmission methods of viruses vary widely. RSV is primarily spread through direct contact with infected children and contaminated surfaces, whereas influenza typically spreads through inhaling airborne droplets. The precise transmission route of rhinovirus remains uncertain and is still being studied. **[6]**. The occurrence of respiratory viral infections in the tropics follows a distinct seasonal pattern and is highly susceptible to changes. In temperate regions, influenza epidemics are more prevalent in aquatic environments. Influenza A is the causative agent of epidemics as a result of significant antigenic variations, while influenza B is responsible for milder outbreaks **[8]**. The rapid changes in the antigenic structures of respiratory viruses present challenges in developing efficacious vaccines, especially for RNA viruses. There is a demand for alternative natural treatments, and various herbal remedies have been utilized for the prevention and management of viral respiratory diseases. Scientific data supports the efficacy of many alternative therapies for colds, such as oral zinc, which might potentially decrease the duration and intensity of a cold. Regularly consuming vitamin C supplements has a minimal effect on reducing the duration and intensity of colds. Probiotics were found to be superior to placebos in diminishing the frequency of acute upper respiratory tract infections, the incidence rate of acute upper respiratory tract infections, and the utilization of antibiotics. Moreover, alkaline diets or beverages may include antiviral characteristics, as evidenced by *in vitro* experiments that have shown the ability of an alkaline environment to deactivate respiratory viruses.

This highlights the fact that the majority of respiratory infections in adults and newborns are caused by viruses, which do not require antibiotics for treatment. It is crucial to use medicines judiciously, especially in cases of upper respiratory tract infections.

The concept of wisely using alternative conventional treatments and Ayurvedic medicines for upper respiratory tract infections, as mentioned below, is based on recent assessments.

## 2. Upper Respiratory Tract Infections

Upper respiratory tract infections, caused by viruses, are commonly associated with the common cold, sinusitis, pharyngitis, epiglottitis, and laryngotracheitis. Organisms enter the respiratory tract by inhaling droplets and infiltrating the mucosa. Epithelial damage may occur, accompanied by redness, swelling, bleeding, and occasionally fluid release. The common cold is a viral infection mostly caused by the rhinovirus, however other viruses such as parainfluenza, respiratory syncytial, coronavirus, adenovirus, echovirus, coxsackievirus, and parainfluenza virus can also be responsible **[9]**. Rhinovirus is responsible for around 60% of infections **[1,10]**. The causative agents differ depending on the age of the host and the time of year. Manifestations encompass rhinorrhea, nasal congestion, and pharyngeal discomfort. Typically, this condition is accompanied by elevated body temperature, general discomfort, sneezing, and nasal secretions that may turn into pus-like discharge. The symptoms are nonspecific and do not exhibit any distinctive characteristics of a particular substance. The typical length of symptoms is approximately 7 days **[1]**. The common cold typically has a positive prognosis, leading to complete recuperation. Nevertheless, there may be situations where challenges emerge. The conditions include acute otitis media with effusion, tonsillitis, sinusitis, and lower respiratory tract infection **[9]**. Antibiotics should not be administered solely for the signs and symptoms of a cold unless the particular diagnostic criteria for diagnosing severe consequences are satisfied **[11]**. Research has demonstrated that administering antibiotics as a preventive measure for bacterial problems associated with the common cold is ineffective. A meta-analysis of five randomized controlled clinical studies examining the effectiveness of antibiotic treatment for colds in preventing lower respiratory infections concluded that such treatment does not provide any protective benefit. Additionally, it did not shorten the duration of the upper respiratory illness **[12]**.

Identifying the indications and manifestations of the typical progression of a common cold will aid in avoiding excessive prescription of antibiotics. Lack of acquaintance with them can result in misdiagnosis of secondary bacterial illness and improper use of medications. The common cold often presents with mucopurulent nasal discharge, which is thick, opaque, and can sometimes seem greenish or yellowish **[9]**. Antimicrobial therapy is unnecessary for this discharge unless it continues for a duration of 10-14 days **[11]**. In summary, it is not advisable to use antibiotics for the common cold. Mucopurulent nasal discharge is a typical symptom of the common cold and generally does not require antibiotics unless it lasts for more than 10-14 days **[1]**.

Sinusitis is the medical term for the inflammation of the mucosal lining in one or more of the paranasal sinuses **[13]**. The phenomenon can be ascribed to either infectious or non-infectious (allergic) causes. Maxillary sinusitis is a frequent occurrence in youngsters. Sinusitis is

categorized based on the duration of symptoms into three groups: acute (lasting up to 3 weeks), sub-acute (lasting between 3 and 10 weeks), and chronic (lasting more than 10 weeks). After two weeks, 79% of patients saw complete resolution of these anomalies, even though none of them received any antibiotics **[14]**. Antibiotics are the main course of treatment for sinusitis once the diagnostic criteria have been satisfied. Amoxicillin, administered at a dosage of 40 mg per kilogram per day, is effective in treating acute uncomplicated sinusitis in the majority of children **[15]**. Approximately 35% of non-typable *H. influenzae* and 85% of *M. catarrhalis* strains exhibit the production of beta-lactamases, rendering them resistant to amoxicillin **[16]**. Hence, in the absence of a response within a 48-hour timeframe, it is advisable to contemplate the use of a beta-lactamase-stable antibiotic such as amoxicillin-clavulanate or cetactor. These medications warrant consideration. These medications should be prioritized as the initial treatment option if sinusitis occurs repeatedly, does not show improvement, or is a severe illness accompanied by high fever and face edema. The therapy should be administered for a minimum duration of 10 days **[17]**. The diagnosis of sinusitis is primarily based on clinical assessment, and investigations are rarely necessary. Radiographic studies are only recommended in cases of recurrent sinusitis or when the diagnosis is uncertain **[18]**. The radiograph displays the presence of air-fluid level, opacification, or mucosal thickness **[13]**. CT scan or MRI can be performed to conduct a more comprehensive analysis and reveal the same observations. An X-ray should only be performed, when necessary, since these symptoms can also be present in viral rhinosinusitis. This study examines the CT scans of 31 adults between the first 48-96 hours of simple viral respiratory infections. It was shown that 90% of the participants had an abnormality in their maxillary sinus cavity. After two weeks, these abnormalities were successfully resolved in 79% of cases, even though none of the individuals received any medications **[14]**.

Pharyngitis involves the inflammation of the mucous membranes and underlying structures in the throat. This clinical diagnosis includes tonsillitis, tonsillopharyngitis, and nasopharyngitis. Pharyngitis can be classified into two categories: one with symptoms related to the nose (nasopharyngitis) and one without any nasal involvement (pharyngitis or tonsillopharyngitis). Nasopharyngitis is typically caused by a viral infection, although pharyngitis without nasal symptoms can be caused by a variety of infectious agents, such as bacteria, viruses, fungi, and other pathogens. Adenoviruses are the predominant etiological agents of nasopharyngitis, alongside other viral pathogens such as influenza, parainfluenza, and enteroviruses. The causative agents of pharyngitis include *Streptococcus pyogenes*, *Haemophilus influenzae*, *Corynebacterium diphtheriae*, and *Neisseria meningitidis* **[14]**. Diagnosing Group A streptococcal pharyngitis should be based on laboratory tests combined with clinical and epidemiological evidence. Antibiotics should be prescribed for pharyngitis patients only if a Group A streptococcal or another bacterial infection is confirmed. Penicillin is the recommended treatment for Group A streptococcal pharyngitis.

Acute epiglottitis is a condition characterized by inflammation, typically induced by infection, that specifically impacts the epiglottis and nearby structures. Some authors refer to this ailment as a "supraglottis" due to this specific reason **[19]**. Unlike children, the use of indirect laryngoscopy to see the epiglottis is deemed safe in adults **[20]**. The epiglottis and adjacent structures will exhibit edema and display signs of inflammation. Aggressive treatment is necessary for patients diagnosed with epiglottitis who have tachycardia, elevated white blood cell count, and a history of quickly worsening painful throat and respiratory obstruction **[21]**. Tachycardia which is disproportionately high compared to other symptoms is regarded as an early sign of possible airway obstruction and low oxygen levels **[22]**. Immediate administration of antibiotics is crucial. The preferred medicine is a cephalosporin of the second or third generation, which is effective against *Hemophilus influenzae* which is resistant to ampicillin **[23]**. Prior to this, a suggested course of action involved the use of both ampicillin and chloramphenicol in combination **[24]**. The prevalence of ampicillin-resistant Haemophilus influenzae varies among different institutions and can reach up to 36% **[25]**. Multiple authors recommend the utilization of steroids, however, there is a lack of controlled research that substantiates any advantageous outcomes from this treatment **[23,26]**. The application of epinephrine in three instances of severe epiglottitis **[27]**. Epiglottitis, once seen as a severe illness mostly affecting children, is now observed with greater frequency in adults. Swift identification of the ailment will assist in decreasing the death rate caused by this curable illness.

Parainfluenza type I and II viruses are the main culprits behind croup or laryngotracheitis, although they can also lead to typical cold symptoms, bronchiolitis, or in rare cases, aseptic meningitis **[27]**. Parainfluenza virus type I infections reach their highest point every other autumn, but type II infections have more frequent peaks and often involve conjunctivitis along with other signs of upper respiratory tract infection. Parainfluenza is transmitted via direct touch, secretions, droplets, and inanimate objects that can carry the virus (fomites). People infected with the virus can spread it starting a week before symptoms appear and continue shedding the virus for 1 to 3 weeks after symptoms begin. The incubation period for the parainfluenza virus varies from 2 to 6 days. Treatment includes administering dexamethasone orally or intramuscularly at a dosage of 0.6 mg/kg. **(Figure 1)** illustrates the viruses responsible for upper respiratory tract infections, along with the affected human anatomy, symptoms, and common types of these infections.

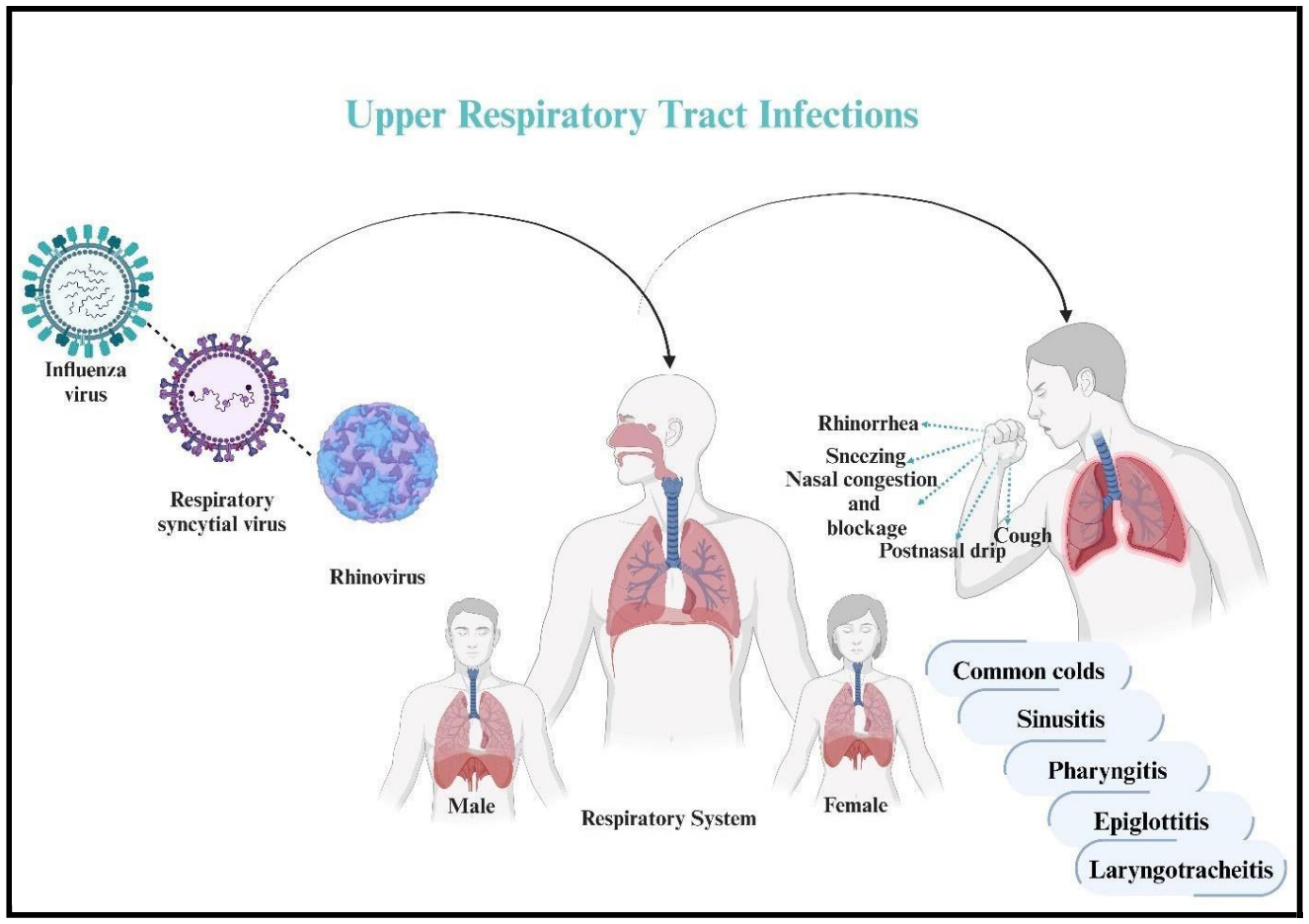


**Figure 1:** Diagrammatic Overview of Upper Respiratory Tract Infections

Figure 1 illustrates the viruses responsible for upper respiratory tract infections, along with the affected human anatomy, symptoms, and common types of these infections. The key elements include three viruses: the influenza virus, represented by a teal-colored sphere; the respiratory syncytial virus, depicted as a purple sphere; and the rhinovirus, shown as a blue sphere. The respiratory system is highlighted using two anatomical figures, one male and one female, showing the nasal passages, throat, and lungs. Additionally, there is an illustration of a person coughing, which represents the symptoms associated with upper respiratory tract infections. The symptoms depicted are runny nose (rhinorrhea), sneezing, nasal congestion and blockage, postnasal drip, and cough. The infections outlined are common colds, sinusitis, pharyngitis, epiglottitis, and laryngotracheitis. This figure connects these elements to explain how the viruses cause upper respiratory tract infections, leading to various symptoms and specific types of illnesses. Created with BioRender.com, accessed on 05 February 2025.

## 3. Phytopharmaceuticals In Upper Respiratory Tract Infections

Ayurveda is a style of alternative medicine that focuses on enhancing overall well-being and employing natural herbs and formulations for the diagnosis and treatment of patients. The central focus is on emphasizing health promotion, preventing diseases, early detection, and tailoring treatment to the individual **[28]**. The modifications of antibiotics and the frequent shifts in therapeutic strategies are impeding the lifestyle and treatment approach for upper respiratory tract infections. In this review paper, our focus is on the Ayurvedic contemporary perspective for improving the well-being of individuals with upper respiratory tract infections. Ancient civilizations utilized traditional herbal remedies to prevent or treat colds, influenza, and other upper respiratory tract infections (URTIs). Several recent papers have already addressed the effectiveness of various herbal medicines in treating upper respiratory tract infections. These remedies include Maoto, licorice roots, antiwei, North American ginseng, berries, echinacea, plants extracted carnosic acid, pomegranate, guava tea, and bai shao **[29]**. The management and therapy of influenza mostly rely on chemical or biological substances that are extracted from plants. The agents encompass a diverse range of polyphenols, flavonoids, saponins, glucosides, and alkaloids **[30]**. Herbal medications encompass several forms of treatment, including Phytotherapies, Ayurvedic Medicine, and home remedies such as herbal tea and kadha **[31]**. To address these prevalent health problems, individuals can utilize natural herbs and spices that have been employed for ages in traditional Indian Medicine **[31, 32]**. Commonly utilized Ayurvedic remedies for upper respiratory tract infections include tulsi, ginger, turmeric, cardamom, and black pepper. These herbs possess antiviral and anti-inflammatory characteristics that can mitigate the intensity of flu symptoms, such as cough and sore throat **[33]**. Ayurvedic medicines also help to boost the immune system, which is essential in fighting off infections. In addition to that, with the modernization of Ayurveda, there is a new concept of PPPM has arisen, which gives us a new definition of Ayurveda from the Western aspect, i.e., predictive, prevention, and personalized medicine. Significant parallels exist between traditional systems such as Ayurveda and the modern approach of predictive, preventive, and personalized medicine (PPPM) **[34]**. The Horizon 2020 program of the European Union recognizes PPPM as the central element of its strategy **[36]**. In India, the Government of India is spearheading the efforts for the Department of AYUSH, which falls under the Union Ministry of Health and Family Welfare. Therefore, it is imperative that we prioritize our attention on herbal medicines.

Nevertheless, there is a general scarcity of randomized controlled trial (RCT) data about their effects **[35]**. **(Figure 2)** shows a variety of natural ingredients often used to treat upper respiratory tract infections.

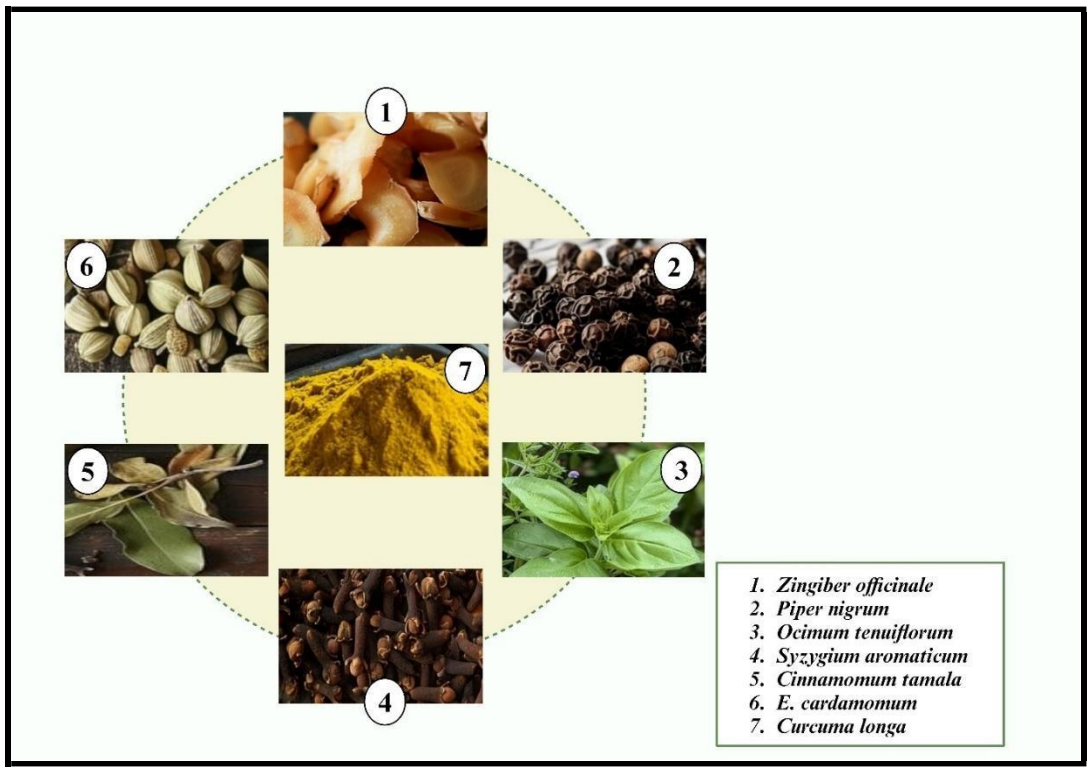


**Figure 2:** Some Ayurvedic components to treat upper respiratory tract infection

Figure 2 shows a variety of natural ingredients often used to treat upper respiratory tract infections. These ingredients include ginger (*Zingiber officinale*), black pepper (*Piper nigrum*), holy basil (*Ocimum tenuiflorum*), clove (*Syzygium aromaticum*), Indian bay leaf (*Cinnamomum tamala*), cardamom (*E. cardamomum*), and turmeric (*Curcuma longa*). These components are typically combined to make "Kadha," a traditional home remedy well-known for easing the symptoms of upper respiratory tract infections. Created with BioRender.com, accessed on 08 February 2025

This study aimed to investigate the nutritional and health advantages, as well as the antibacterial, anti-inflammatory, and antioxidant properties, of various herbs and spices such as Cardamom (*E. cardamomum*), Ginger (*Zingiber officinale*), Holy Basil (*Ocimum tenuiflorum*), Black Pepper (*Piper nigrum*), Clove (*Syzygium aromaticum*), Indian Bay Leaf (*Cinnamomum tamala*), Dalchini (*Cinnamomum zeylanicum)*, Ajwain (*Trachyspermum ammi*), Pudhina (*Mentha piperita*), Haldi (*Curcuma longa*), Jeera (*Cuminum cyminum*). These ingredients were combined to create a Kadha (Decoction).

The Charak Samhita describes the Panchvidh Kashyapam, which outlines five distinct methods for consuming herbs and medicinal plants **[36]**. These include i. Swaras (juicing), ii. Kwath (decoction), iii. Kalka (a paste from), iv. Hima (a mixture of herbs), v. Phant (an herb-infused concoction). For oral consumption of pharmacologically active substances from herbs and species, the preparation of Kadha (Decoction) is one of the most preferred methods **[38]**. Kadha, a concoction made from dehydrated or low-moisture components such as spices and herbs, is regarded as one of the earliest medicinal remedies developed by the pharmaceutical practices of humanity. Kadha, a well-known remedy with a long history of use, is gaining renewed attention due to a recent recommendation by The Indian Ministry of AYUSH, Government of India. The ministry has suggested the use of Kadha to enhance immunity and alleviate inflammation during the COVID-19 crisis (The Ministry of AYUSH, 2020). **(Table 1)** discusses the Commercial Availability of Kadha (Decoction) Products: Company Names and Constituent Ingredients.

**Table 1:** Commercial Availability of Kadha (Decoction) Products: Company Names and Constituent Ingredients

| **Name of the product** | **Available Company** | **Components** | **Uses (focusing on Upper Respiratory Tract Infections)** |
|---|---|---|---|
| Ayush Kadha | Ayush Pharma (https://ayushpharma.org/en/apis/) | Tulsi, Ginger, Black Pepper | Supports respiratory health, helps in easing cough and congestion |
| Herbal Kadha | Herbal Wellness (https://www.herbalwellness.com/) | Ashwagandha, Turmeric, Cinnamon | Boosts immunity, reduces inflammation in the respiratory tract |
| RespiraCure | Natural Remedies (https://www.naturalremedy.com/) | Tulsi, Licorice, Cardamom | Soothes throat aids in respiratory wellness |
| Immunoguard Kadha | BioHerbs Ltd. (https://bioherbs.co/) | Giloy, Amla, Neem | Strengthens immune response, supports recovery from respiratory infections |

| | | | |
|---|---|---|---|
| Dabur Kadha | Dabur (https://www.dabur.com/) | Tulsi, Ginger, Black Pepper, Cinnamon, Clove | Helps in relieving symptoms of upper respiratory tract infections |
| Patanjali Ayurvedic Kadha | Patanjali (https://www.patanjaliayurved.net/) | Tulsi, Dalchini, Suthi, Krishna Marich, Pipali, Tejpatra | Supports respiratory health and immunity |
| Himalaya Wellness Tulasi Respiratory Wellness | Himalaya (https://www.himalayawellness.com/) | Tulsi, Shunti | Promotes respiratory wellness and supports immunity. |

*These ingredients are crucial components in each Kadha product, offering unique benefits, especially in the treatment of upper respiratory tract infections. Representative list only

**Description*:*** This table provides an overview of several Kadha (decoction) products available from different companies. Each product combines natural ingredients known for their therapeutic benefits in supporting respiratory health and boosting the immune system. The table emphasizes how these Kadha products are used, particularly their effectiveness in addressing upper respiratory tract infections by alleviating cough and congestion and promoting overall respiratory well-being.

## 4. Studies On Anti-Microbial, Anti-Inflammatory & Immuno-Modulatory Activities Of Ingredients Of "Kadha" (Decoction)

This review examines recent studies on natural traditional herbs, spices, and herbal bioactive metabolites, with a specific focus on Kadha (Decoction). The aim is to explore their potential in preventing and treating upper respiratory tract infections. **(Figure 3)** illustrates the many approaches to address respiratory diseases, highlighting the challenges in vaccine development and the significance of alternate therapies. In this study, we examined various components of Kadha for their potential immunomodulatory effects and analyzed how these findings contribute to the broader understanding of upper respiratory tract infections. We already discussed the which are ingredients of Kadha. **(Table 2)** discusses the Components, Scientific Names, Therapeutic Effects, and Medicinal Properties of Kadha (Decoction).

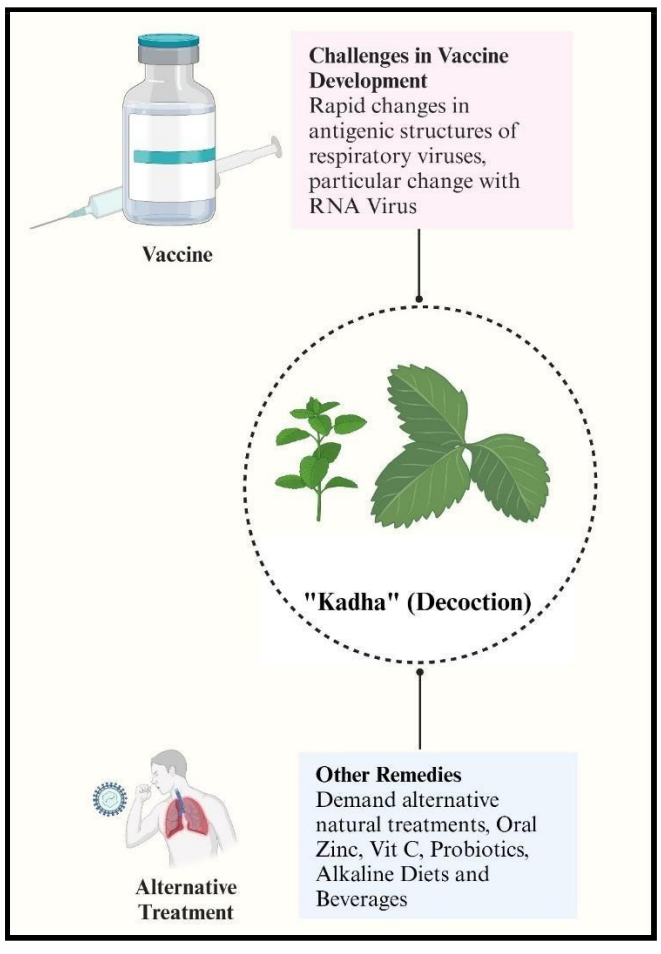


**Figure 3:** Diagrammatic overview of why "Kadha" (Decoction) is the focused approach to treat upper respiratory tract infection

Figure 3 illustrates the many approaches to address respiratory diseases, highlighting the challenges in vaccine development and the significance of alternate therapies. The image depicts a vaccine container and syringe, accompanied that addresses the difficulties encountered in developing vaccines. These obstacles mostly arise from the fast alterations in the antigenic structures of respiratory viruses, particularly RNA viruses. The artwork moreover showcases a depiction of herbal leaves, emphasizing "Kadha" (Decoction) as a customary treatment for respiratory diseases. Furthermore, it portrays an individual coughing, symbolizing the indications of respiratory illnesses. The "Other Remedies" section includes alternative treatments such as natural remedies, oral zinc, vitamin C, probiotics, and alkaline diets and beverages. These features collectively

emphasize a holistic strategy for addressing respiratory infections by integrating traditional immunizations with natural alternative therapies. The figure created with BioRender.com, accessed on 11 March 2025.

**Table 2:** Components, Scientific Names, Therapeutic Effects, and Medicinal Properties of Kadha (Decoction)

| Name of Components of Kadha (Decoction) | Scientific Name | Therapeutic Effects and Medicinal Properties | Studies | References | Population | Experimental details |
|---|---|---|---|---|---|---|
| Cardamom | *E. Cardamomum* | Diuretic, effective against coughs, colds, heart disease, aids digestion, respiratory issues, TB, asthma, cardiovascular illnesses, dental infections, antioxidant properties | Boosts *in vitro* cell-mediated lymphocyte proliferation; increases Th-2 cytokines including IL-4 and IL-10; antioxidant properties that protect immune cells from oxidative damage | **[37,45–47]** | *In vitro* | Enzyme-linked immunosorbent assay for detecting T helper (Th)1 cytokine, Th2 cytokine |
| Ginger | *Zingiber officinale* | Improves digestion, nausea, stomach issues, motion sickness, rheumatic diseases, respiratory disorders, antimicrobial, anti-inflammatory, antioxidant, antiviral, and immunomodulatory properties | A study found ginger extract has antifungal activity against Candida albicans. A 2000 study found that mice administered ginger extract had higher erythrocyte agglutinin antibody titers and plaque-forming cell counts, indicating better humoral immunity. | **[50,53, 60]** | *In vivo* | Biofilm assay, Cell cytotoxicity evaluation |
| Tulshi | *Ocimum tenuiflorum* Or, *Ocimum Sanctum* | Antibacterial, antitubercular, antimicrobial, antiviral, anti-inflammatory, analgesic, anti-arthritic properties; protects against genetic, immunological, and cellular damage | Exhibits antibacterial activity, reduces edema inflammation; protects against various toxins; increases antibody levels and cellular immune response in albino rats | **[64,66, 71,75]** | *In vivo* study | Erythrocyte agglutination tests and E-rosette formation study |
| Black Pepper | *Piper nigrum* | Antioxidant, antiviral, anti-inflammatory, antipyretic properties; treats vertigo, rheumatic disorders, diarrhea, cholera, heart disease, liver problems, respiratory disorders | Inhibits cytochrome 450 in rats; shows antiviral activity against vesicular stomatitis virus and human parainfluenza virus; effective against COVID-19 | **[82,83, 85,86]** | *In silico* Approach<br>*In vitro* study | Molecular docking and simulation **[83]**<br>MTT assay and LDH measurement **[85]** |
| Clove | *Syzygium aromaticum* | Antioxidant, antibacterial, antifungal, analgesic, antispasmodic properties; effective for toothaches, joint pain | Increases white blood cell counts and enhances humoral and cellular immune responses in immunosuppressed mice | **[91,93, 97]** | *In vivo* study | white blood cell (WBC) count, ELISA **[97]** |
| Indian Bay Leaf | *Cinnamomum tamala* | Therapeutic effects against cancer, inflammation, heart disease, and neurological issues; antioxidant, anti-inflammatory, antidiabetic, antibacterial, and anticancer properties | Contains trans-cinnamaldehyde; exhibits antidepressant effects; shows improvement in behavioral despair and tail suspension tests | **[98, 99, 101, 102]** | CIA mice model *in vivo* study | DPPH assay, western blot, NOS production of isolated lymphocytes was evaluated using Greiss's method, histology **[101]** |
| Dalchini | *Cinnamomum zeylanicum* | Treats sore throat, influenza, cold, headache; improves digestion and reduces inflammation | Reduces lipoxygenase enzyme activity; decreases pro-inflammatory cytokines in collagen-induced arthritis mice | **[103,104]** | In-vitro study | UPLC/MS analyses, cell culture and treatments **[104]** |
| Ajwain | *Trachyspermu m ammi* | Antioxidant, anti-inflammatory, immunomodulatory activities; treats asthma, stomach pain, cramps, heartburn, vomiting, bloating, diarrhea, respiratory issues | Reduces hepatic free radical stress toxicity; acts as an ameliorant against oxidative stress | **[107–109]** | *In vivo* study in *Mastomys coucha* model. | Extraction by flash chromatography, purification by HPLC, In-vitro screening by 1) Worm mobility assay, 2) MTT-formazan colorimetric assay for viability of worms |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | In vivo screening **[109]** |
| Pudhina | *Mentha piperita* | Treats gastrointestinal issues, upper respiratory tract infections, skin problems, coughs, bronchitis, nausea, vomiting, muscle pain, menstrual cramps | Prevents RSV infection; strengthens natural defenses; boosts growth and immunity | **[111–113]** | *In vitro* study Studies on human and animal model | Respiratory burst activity was measured by chemiluminescent assay (CL), ELISA, Biochemical analysis, Statistical analysis by SPSS ver. 18 **[113]** |
| Haldi | *Curcuma longa* | Anti-inflammatory, antioxidant effects; treats bronchial asthma, whooping cough, various types of coughs, and dyspnea; provides immediate relief in catarrh and coryza | Balances Th17 and Treg cells; reduces IL-6, IL-8, and TNF-alpha | **[122,128,129]** | *In vitro* study *In vivo* in mice model | Histopathological study, Immunomodulation **[128]** |
| Jeera | *Cuminum cyminum* | Antibacterial, analgesic, antiradical, and antipyretic properties; used for inflammation, stomach pain, fever, and infections; recommended for cough and bronchopulmonary illness | Increases T-cell activation and Th1 cytokine production; exhibits analgesic, anti-inflammatory, and immunological effects | **[128–130]** | *In Vitro* study *In vivo* in mice model | Histopathological study, Immunomodulation **[128]** |

*TB-Tuberculosis, In vitro- Refers to studies or processes performed outside a living organism, typically in a controlled laboratory environment, such as in test tubes or Petri dishes, Th-1- Type 1 T helper cells, IL-4- Interleukin 4, IL-10- Interleukin 10, RSV-infection- Respiratory syncytial virus infection, Th-17- Type 17 T helper cells, IL-6- Interleukin 6, IL-8- Interleukin 8, TNF-alpha- Tumor necrosis factor-alpha.

***Description:*** The table provides a comprehensive summary of the constituents of Kadha (decoction), encompassing its scientific nomenclature, therapeutic impacts, and medicinal characteristics. Each individual element is acknowledged for its therapeutic attributes, specifically in enhancing respiratory well-being and bolstering the immune system. The table additionally contains citations to scientific research that substantiate the health advantages and therapeutic characteristics of each constituent, emphasizing their effectiveness in addressing upper respiratory tract infections, as well as other health concerns.

## (*E. Cardamomum*) Cardamom:

Cardamom, scientifically known as *E. cardamomum*, is a dehydrated spice frequently employed to augment flavors. It belongs to two genera, namely Elettaria and Amomum. Green cardamom is commonly referred to as Elaichi in Marathi, Hindi, and Urdu in South Asia. All of its spices serve as culinary spices and aid in digestion and stimulating hunger in those with Anorexia nervosa. It is widely recognized in Ayurveda for its therapeutic properties, the efficacy of diuretic medications, and its effectiveness against coughs, colds, and heart disorders. Historically, it has been utilized for the management of kidney and bladder issues, as well as for its gastroprotective properties. Cardamom has a rich historical usage in India for various ailments such as gastrointestinal disorders, respiratory obstruction, TB, asthma, cardiovascular diseases, eyelid irritation, and dental infections. Cardamom infusion is employed as an oral rinse to alleviate sore throats and gum infections. Cardamom seeds are renowned for their aphrodisiac qualities **[37]**. The phytochemicals present in *E. Cardamomum* oil, such as Protocatechualdehyde, Protocatechuic acid, Alpha-terpinyl acetate, 1,8-cineole, Linalool, Linalyl acetate, Limonene, 4-terpineol, and Geraniol, are responsible for its anti-inflammatory and anti-bacterial activities **[38]**. Cardamom has been the subject of research due to its potential antibacterial effects, in addition to its culinary use. Multiple studies have shown that cardamom essential oil and extracts effectively hinder the growth of certain food-borne diseases and fungi **[39]**. A study conducted an evaluation of the antibacterial effectiveness of various plant essential oils, including cardamom, against a variety of bacterial strains. Cardamom essential oil has demonstrated significant antibacterial effectiveness against many bacterial species, including *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, and *Vibrio cholerae*. Moreover, the oil has demonstrated robust antioxidant properties in many Indian spices, such as cardamom, against diverse strains of bacteria and fungi. It has been observed that cardamom exhibits noteworthy antibacterial activity. Multiple research investigations indicate that cardamom has the potential to enhance the immune system, lower elevated blood pressure, alleviate chronic inflammation, treat digestive disorders, and enhance respiratory function **[40,41]**. The presence of antioxidant components in cardamom, including epicatechin, vanillin, p-coumaric acid, trans-ferulic acid, and ellagic acid, allows it to effectively scavenge free radicals and reduce oxidative stress. As a

result, cardamom can prevent inflammation, which is mostly caused by oxidative stress **[42]**. Multiple studies have shown that cardamom has the capacity to hinder the production of pro-inflammatory cytokines, including tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6), in models based on cell lines **[43]**. *E. cardamomum* has been discovered to exhibit strong antioxidant and anti-inflammatory effects in relation to several diseases and situations. For instance, a study published in the Iranian Journal of Basic Medical Sciences demonstrated that the extract of *E. cardamomum* decreased indicators of inflammation, such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), in individuals diagnosed with metabolic syndrome **[43,44]**. This makes *E. cardamomum* a potential natural alternative for inflammatory diseases due to its tendency to lower inflammation and oxidative stress by inhibiting pro-inflammatory indicators **[43]**. The immune system is essential for defending the body against a range of pathogens, including bacteria, viruses, and fungi, and for promoting overall health and well-being. Multiple conducted investigations on *E. cardamomum* have demonstrated its immunomodulatory properties. Immunomodulatory refers to the capacity to regulate or adjust the functioning of the immune system.

Eugenol, a bioactive constituent of cardamom, has been documented to markedly augment *in vitro* cell-mediated lymphocyte proliferation. For instance, a 2010 study published in the Journal of Medicinal Food conducted an *in vitro* experiment using primary splenocytes. The study demonstrated that extracts from *E. cardamom* increased the production of Th-2 cytokines, such as IL-4 and IL-10, which are responsible for the type-1 hypersensitive reaction. It is believed that the water-based extracts of cardamom have the ability to trigger type-1 hypersensitivity, which refers to allergic reactions **[45]**.

A separate study, published in the International Journal of "Annals of Phytomedicine" in 2020, discovered that the extract from *E. cardamom* enhances the activity of type II helper T cells and exhibits an immunomodulatory effect by stimulating the production of pro-inflammatory cytokines such as IL-6 and TNF-α **[46]**. Furthermore, scientific study has demonstrated that *E. cardamomum* possesses antioxidant qualities, which aid in the neutralization of detrimental free radicals within the body and safeguard immune cells against oxidative harm. An imbalance between free radicals and antioxidants can result in oxidative stress, which can negatively impact immune function and contribute to a range of health issues. It may aid in bolstering immune system functionality **[47]**.

## (*Zingiber Officinale*) Ginger:

Ginger, scientifically known as *Zingiber officinale*, is referred to by several names in different languages and cultures. In Gujarati, it is called "Aadu," in Kannada "Shunti," in Telugu "Allam," in Arabic "Zanjabil," in Tamil and Malayalam "Inji," and in Hindi and Urdu "Adrak." Ginger rhizomes are primarily utilized in Indian Traditional Ayurvedic Medicine and Conventional Chinese Medicine to treat various gastrointestinal disorders, particularly nausea and vomiting associated with motion sickness and pregnancy, as well as stomach issues, respiratory disorders, and rheumatic disorders. Ginger is widely consumed and used in home remedies for conditions such as acid reflux, toothache, and stomach discomfort. Additionally, it serves as an astringent, leading to the constriction of mucous membranes or exposed tissues. It is sometimes used internally to regulate the release of serum or mucus. Ginger contains several phytochemicals, including 6-gingerol, 6-shogaol, 6-paradol, Zingiberene, Bisabolene, 1-dehydrogingerdione, 6-gingerdione, 10-gingerdione, 4-gingerdiol, 6-gingerdiol, 10-gingerdiol, citral, and Eucalyptol, which possess potent antimicrobial activities **[48,49]**. Ginger is also rich in the anti-influenza cytokine TNF-α **[50]**. Multiple research projects have been undertaken to investigate the efficacy of ginger as an antibacterial agent, and the findings have consistently demonstrated its antimicrobial capability. The antibacterial activity of *Z. officinale* has garnered significant attention in recent years. Ginger has been found to possess strong antibacterial properties against many microbes, such as bacteria, viruses, and fungi, as demonstrated by numerous scientific investigations. Ginger exhibits antibacterial capabilities as a result of its bioactive components, including gingerols, shogalos, and paradols, which possess strong antimicrobial characteristics. These substances have been documented to disrupt the cell membranes of microbes, hinder their growth, and impede their capacity to create biofilms, which are the protective layers that enable bacteria to survive and flourish in various settings **[51]**. For instance, a study published in the International Journal of Preventive Medicine discovered that ginger extract has shown strong inhibitory effects against many food-borne pathogens, including *Escherichia coli*, *Salmonella*, and *Staphylococcus aureus* **[52]**. A recent study, published in the Journal of Systematic Reviews in Pharmacy, revealed that Ginger extract exhibits noteworthy antifungal properties against Candida albicans, a prevalent fungal pathogen accountable for oral and vaginal candidiasis **[53]**. Moreover, ginger has demonstrated encouraging antiviral properties against viruses such as influenza virus and human norovirus **[54]**. *Z. officinale* exhibits highly promising antibacterial properties, making it a valuable asset in the domains of medicine and food safety. Due to its natural origin and minimal toxicity, it is much sought after as a replacement for synthetic antimicrobial agents. These compounds can pose dangers such as resistance development and side effects. Further research is required to comprehensively comprehend the mechanism by which ginger acts and enhance the utilization of ginger as an antibacterial agent. Nevertheless, the current scientific evidence substantiates the potential of *Z. officinalis* as a valuable reservoir of antibacterial properties, establishing a strong basis for further investigation and utilization across diverse domains **[55,56]**. Numerous studies conducted on experimental models and in clinical trials have

demonstrated that ginger has anti-inflammatory properties. An example is a research study published in the Journal of Food Science and Biotechnology, which showed that ginger extract effectively decreased inflammation in a mouse model of dextran sulfate sodium-induced colitis. This was achieved by suppressing the production of pro-inflammatory cytokines and diminishing oxidative stress **[57]**. The ginger extract also decreases inflammation in rheumatoid arthritis by suppressing the synthesis of inflammatory markers such as interleukin-1β (IL-1β) and tumor necrosis factor-alpha (TNF-α) **[58]**. Furthermore, a prior investigation demonstrated that the use of ginger oil (at a dosage of 33 mg/kg) by rats over a period of 26 days resulted in a notable decrease in both paw and joint swelling linked to severe chronic adjuvant arthritis **[61]**. Scientific data indicates that ginger and its many components have anti-inflammatory properties, both in laboratory settings (*in vitro*) and in living organisms (*in vivo*). Nevertheless, the available data regarding the efficacy of ginger as an anti-inflammatory agent in humans *in vivo* remain contradictory and insufficient. Ginger has been discovered to possess immunomodulatory properties, bolstering the body's immunological response to combat infections. It also amplifies the function of immune cells, including macrophages and killer cells, which are crucial in the battle against microbial diseases **[59]**. Ginger is rich in bioactive chemicals such as gingerols, shogaols, and paradols, which have been proven to have anti-inflammatory and antioxidant effects. Moreover, the *Z officinale* possesses immunomodulatory characteristics that are advantageous in the treatment of cough, common cold, and influenza. The Immuno-modulatory activity of Zingiber officinale was studied in a few studies. For instance, a 2000 study published in the "Journal of Ethnopharmacology" suggests that mice who were given a ginger extract containing 50% ethanol (25mg/kg) for seven days experienced an increase in erythrocyte agglutinin antibody titers and plaque-forming cell counts. This indicates an enhancement in their humoral immunity **[60]**.

Ginger was observed to reduce the production of IL-2 and IL-10 in an *in-vitro* investigation, resulting in the inhibition of lymphocyte proliferation. Nevertheless, a liquid extract of ginger in water was discovered to substantially enhance the synthesis of IL-1β, IL-6, and TNF-α in activated macrophages detected in the peritoneum of mice. Additionally, it also promoted the growth of splenocytes and the production of cytokines. In addition, a 12-week diet consisting of ginger rhizome resulted in elevated levels of various blood parameters including hematocrit, hemoglobin, erythrocyte, MCH, MCHC, WBC values, and neutrophil percentage. Moreover, the use of ginger essential oil was discovered to enhance both humoral and cell-mediated immune responses in mice with compromised immunity **[61,62]**. Collectively, these investigations indicate that ginger may possess an immunomodulatory impact by promoting cytokine synthesis, enhancing NK cell functionality, and augmenting antibody and chemokine generation. Further research is required to have a comprehensive understanding of the mechanism behind ginger's immunomodulatory effects.

## (*Ocimum Tenuiflorum/Ocimum Sanctum*) Tulsi:

Holy Basil, scientifically known as *Ocimum tenuiflorum* and also referred to as *Ocimum Sanctum*, is a fragrant herb that belongs to the Lamiaceae family. In India, it is alternatively referred to as Tulsi. Since ancient times, it has been utilized as a remedy for respiratory ailments and the common cold. Basil leaves have widespread application in the culinary business, and perfume industry, as well as the creation of dental and oral products. Tulsi mostly contains the chemical compounds Linalool, Ursolic acid, β caryophyllene, Eugenol, Carvacrol, Oleanolic acid, and Rosmarinus acid. The leaves of the *Ocimum tenuiflorum* plant include phytochemicals such as saponins, alkaloids, flavonoids, cardiac glycosides, steroids, phenols, and tannins. The methanolic extract exhibits antibacterial activity against both gram-positive and gram-negative bacteria **[63]**. The acetone extract exhibited extensive antibacterial activity against bacteria, however, the methanol extract had somewhat diminished antibacterial activity compared to the acetone extract **[64]**. Several virtual testing distributions have been conducted on phytochemicals, such as Tulsi, to evaluate their effectiveness against various viral proteins. A computational study was carried out to analyze the phytochemicals found in Tulsi. Ethanol was used to extract these phytochemicals, which were then tested as inhibitors of the main protease. The objective was to investigate the possibility of covalent ligand contact with the catalytic residue Cys145. The results demonstrate that the flavonoids and polyphenolic compounds found in Tulsi have the ability to chemically attach to the catalytic site Cys145 of the main protease, effectively blocking the viral proteins in a permanent manner **[65]**. Experimental studies have shown that Tulsi possesses the capacity to safeguard against the genetic, immunological, and cellular damage caused by medicines, industrial pollutants, and pesticides. The damages encompass hepatic, renal, and cerebral impairment. Due to its capacity to provide protection against specific noxious substances **[66]**. Tulsi provides protection against the harmful effects of pesticides such as rogor, lindane, endosulfan, and chlorpyrifos, as well as industrial pollutants like butylparaben, carbon tetrachloride, copper sulfate, and ethanol. Furthermore, it has demonstrated a defensive effect against many pharmaceutical interventions, such as acetaminophen, meloxicam, paracetamol, haloperidol, and anti-tubercular drugs **[66]**. *Ocimum tenuiflorum*, also known as Tulsi or Holy Basil, is a medicinal herb that has been utilized in traditional medicine for numerous centuries owing to its myriad health benefits. Tulsi exhibits a notable characteristic of antibacterial action, which has been thoroughly examined in recent years. Tulsi extracts have been found to possess antimicrobial properties, as indicated by multiple investigations. This article provides a summary of many experiments that have examined the

antibacterial properties of Tulsi extracts against bacteria, fungi, and viruses.

The study on Tulsi extracts showed significant antibacterial effectiveness against gram-positive bacteria, such as *Staphylococcus aureus* and *Bacillus subtilis*, as well as gram-negative bacteria, including *Escherichia coli* and *Pseudomonas aeruginosa*. The active constituents attributed to this activity are purported to be camphor, eucalyptol, and eugenol, among other chemicals. Tulsi extracts have demonstrated antifungal effectiveness, along with antibacterial activity, against many fungal infections **[67,68]**. Tulsi extracts, which contain β-caryophyllene and caryophyllene oxide, have been found to prevent the growth of the fungus-like organism Candida albicans **[67]**. Moreover, Tulsi extracts that contain bioactive components such as Ursolic acid, eugenol acid, and Rosmarinus acid have demonstrated antiviral effects against a range of viruses by impeding the reproduction of Herpes Simplex Virus (HSV), Influenza Virus, H9N2, NDV, BHV, and Human Immunodeficiency Virus (HIV) **[69]**. The study examining the crude extract of Tulsi leaves in the presence of polyphenols from *A. arabica* has demonstrated a favorable antiviral impact against the H9N2 virus, which is accountable for Human Influenza **[70]**. The findings suggest that Tulsi extracts possess strong antibacterial capabilities that effectively against bacteria, fungi, and viruses. Tulsi extracts combat infections through the mechanisms of enzyme inhibition, cell membrane rupture, and modification of the host immune response. Nevertheless, additional investigation is required to comprehensively comprehend the fundamental mechanisms, ideal dosage, and potential adverse effects of Tulsi extracts. In 2014, the International Journal of Current Microbiology and Applied Sciences released a study that examined the anti-inflammatory effects of *Ocimum sanctum* extract on Carrageenam-induced rat paw edema. The findings demonstrated that the Tulsi phytochemical extract effectively suppressed the cyclooxygenase and lipoxygenase pathways of arachidonic acid metabolism, leading to notable anti-inflammatory effects against edema **[71]**. Furthermore, a separate publication in the PLoS One journal assessed the major constituent ursolic acid (UA) found in Tulsi and determined that it is a highly promising chemical with anti-inflammatory, analgesic, and possible anti-arthritic characteristics **[72]**. Additionally, research has investigated the anti-inflammatory characteristics of Tulsi. The research was published in the Journal of Ethnopharmacology in 2014 and examined the essential cellular and metabolic process accountable for the anti-inflammatory effects of alcoholic and aqueous extracts of dried Tulsi leaves. The study discovered that the extract reduced the expression of pro-inflammatory genes in THP-1 cells that were induced by Lipopolysaccharide (LPS). This was achieved by preventing the movement of NF-κB, a crucial regulator of inflammation, into the cell nucleus. Additionally, the extract hindered the transformation of monocytes into macrophages that were induced by phorbol 12-myristate 13-acetate (PMA) **[66,73]**. The occurrence of bioactive compounds, such as phenolics, flavonoids, terpenoids, and fatty acids, in *the Ocimum sanctum* indicates their ability to counteract inflammatory pathways **[74]**. Furthermore, the majority of scientific evidence suggests that *Ocimum sanctum* and its different constituents possess anti-inflammatory properties. Nevertheless, the available data on the efficacy of holy basil as a powerful anti-inflammatory drug in humans *in vivo* remains contradictory and insufficient, necessitating more investigation. Analyzed the immunoregulatory characteristics of *Ocimum sanctum* leaves in albino rats by measuring the levels of agglutinating antibodies and E-rosette production in response to challenges with *Salmonella typhosa* and sheep erythrocytes antigens. The study observed an enhanced immune response, both in terms of increased antibody levels in the widal and sheep erythrocyte agglutination tests and the production of erythrocyte rosettes and lymphocytosis, indicating a cellular immune response **[75]**. A study was done to examine the immunomodulatory impact of *Ocimum sanctum* and *Valairasa chendhuram* on *Oreochromis mossambicus* fish that were exposed to toxicity induced by copper acetate. It was discovered that both *O. sanctum* and *Valairasa chendhuram* were successful in improving the fish's immune response and repairing their hematological parameters **[76]**. The study examined the lymphocyte proliferation of *O. basilicum*, *P. Americana*, *P. virginica*, and *Rosa spp*. It was discovered that both methanol and aqueous extracts of *O. basilicum* demonstrated 80% and 83% lymphocyte proliferation, respectively **[77]**. Furthermore, these findings indicate that holy basil may possess immunomodulatory properties by promoting the synthesis of cytokines, enhancing the functionality of macrophages, NK cells, and T-cells, and augmenting the generation of antibodies. Further investigation is required to comprehensively comprehend the mechanisms underlying the immunomodulatory effects of holy basil.

## (*Piper Nigrum*) Black Pepper:

Black Pepper, scientifically known as *Piper nigrum*, is commonly referred to as the "King of species". It is a highly popular spice that not only adds its unique flavor to dishes but also enhances the taste of other ingredients. Extensive research has been conducted on the biological characteristics and bioactive phyto compounds of black pepper **[78,79]**. Black pepper is a member of the Piperaceae family, which is one of the oldest groups of flowering plants found in tropical locations. This family consists of 13 genera **[80]**. The antimicrobial action was seen against a diverse array of pathogens by inhibiting biofilm formation, bacterial efflux pumps, and bacterial swarming and swimming motilities **[78,81]**. Black pepper is also used as a home remedy as a treating choice for upper respiratory tract infections. Black pepper possesses antiviral, anti-inflammatory, and antioxidant characteristics **[82]**. Black pepper has demonstrated antipyretic effects. Additional therapeutic characteristics of this substance encompass the treatment of vertigo, rheumatic conditions, diarrhea,

and cholera. Black pepper is utilized for treating a variety of ailments including constipation, earache, gangrene, heart illness, hernia, hoarseness, indigestion, insect bites, insomnia, joint pain, liver difficulties, lung disease, oral abscesses, sunburn, tooth decay, toothaches **[83]**. A study conducted on rats determined that piperine, a bioactive molecule found in black pepper, effectively inhibits cytochrome 450, which is responsible for metabolizing warfarin. As a result, the presence of piperine reduces the concentration of warfarin in the bloodstream **[84]**. Black pepper plays a crucial role in enhancing the immune system, particularly in the context of preparing "Kadha". The antiviral efficacy of black pepper chloroform and methanolic extract against vesicular stomatitis virus and human parainfluenza virus was evaluated on human cell lines. The antiviral activity of black pepper is more pronounced in the chloroform extract, primarily because it has a higher concentration of alkaloids **[85]**. A study utilizing docking techniques revealed that bioactive chemicals found in black pepper, including piperdardiine and piperazine, exhibit significant activity against COVID-19. These compounds hold the potential for further development as treatments for the disease **[86]**. Black pepper offers relief from sinusitis and nasal congestion, which are prevalent signs and symptoms of upper respiratory tract infections. The antiviral activities of quercetin, a flavonoid found in black pepper, consistently enhance the body's immune system **[87]**. Additional research is necessary to fully understand the processes that contribute to the immunomodulatory effects of black pepper.

## (*Syzygium Aromaticum*) Clove:

Clove (*Syzygium aromaticum*) has particularly garnered attention for its strong antioxidant and antimicrobial activities, distinguishing it from other species **[88]**. Cloves are a notable botanical origin of phenolic compounds, such as flavonoids, hydroxybenzoic acids, hydroxycinnamic acids, and hydroxyphenyl propens. Clove contains eugenol as its primary bioactive component **[89]**. The clove contains additional phenolic acids such as caffeic, ferulic, elagic, and salicylic acids. Clove also contains flavonoids, including kaempferol, quercetin, and its glycosylated derivatives, albeit in smaller amounts. Clove exhibited a greater concentration of polyphenols and antioxidant substances. The predominant phenolic chemicals identified were phenolic acids (namely gallic acid), flavonol glucosides, phenolic volatile oils (namely eugenol and acetyl eugenol), and tannins. The significant potential of clove as a radical scavenger and as a commercially viable source of polyphenols was emphasized **[90]**. Clove has demonstrated antibacterial efficacy against many bacterial and fungal species. The antimicrobial efficacy of black pepper, geranium, nutmeg, oregano, thyme, and cloves was assessed against 25 strains of both gram-positive and gram-negative bacteria. Thyme, oregano, and clove oils exhibited the widest spectrum of effectiveness **[91]**. The antifungal properties of eugenol and carvacrol were evaluated in a model of vaginal candidiasis. The samples were compared to the control group using microbial and histological methods. Eugenol and carvacrol show potential as effective antifungal agents for treating and preventing vaginal candidiasis **[91]**. The use of clove as a pain reliever has been documented since the 13th century, specifically for toothaches, and joint discomfort, and as an antispasmodic. The primary chemical responsible for this effect is eugenol. The observed process has been attributed to the activation of calcium and chloride channels in ganglionic cells **[92]**. The analgesic effect of clove is attributed to its role as a capsaicin agonist **[93]**.

Cloves are utilized in traditional medicine as respiratory aids. Specifically, this spice is a key component in teas consumed in tropical Asia to promote coughing. Additionally, inhaling the fragrance emitted from hot clove tea is a prevalent method of utilizing cloves to alleviate respiratory ailments such as coughs, colds, asthma, bronchitis, and sinusitis. In Asia, it is usual to masticate cloves as a remedy for throat discomfort and pharyngeal irritation. It is said that consuming cloves after they have been heated will alleviate intense coughing **[94]**. Clove oil functions as an expectorant to address respiratory ailments such as colds, bronchitis, cough, asthma, and upper respiratory problems **[95]**. When combined with honey, it aids in the treatment of persistent coughs and is particularly beneficial for alleviating respiratory distress **[96]**. Clove is believed in traditional medicine to possess the ability to enhance the human immune system and enhance resistance to diseases **[94]**. Clove oil demonstrated positive effects on the overall count of white blood cells and boosted the immune response known as delayed-type hypersensitivity in animal models during experimental tests. A significant recovery of both humoral and cellular immune responses was reported in mice that were immunosuppressed with cyclophosphamide and treated with clove essential oil. The restoration of immunological responses was dependent on the dosage of the oil. The immunostimulatory action was linked to enhancements in both cell-mediated and humor-mediated immune response mechanisms, as determined by the use of clove essential oil **[97]**.

## (*Cinnamomum Tamala*) Indian Bay Leaf:

The Indian Bay Leaf (*Cinnamomum tamala*), belonging to the Lauraceae family, is a plant native to India that is generally referred to as Tejpata or Bay Leaf. This plant is a significant indigenous medicinal plant that is distributed across different regions of India. This plant primarily utilizes its aromatic leaves, which serve as a significant source of bioactive chemicals with extensive therapeutic, culinary, and medical applications. *Cinnamomum* is employed as a conventional remedy for mitigating pain and inflammation in those afflicted with arthritic rheumatism. Plants possess cinnamaldehyde, cinnamic acid, cinnamate, and various other constituents that exhibit potent medicinal properties against cancer, inflammatory conditions, heart protection, and neurological problems **[98]**. Polyphenols show

favorable antioxidant, anti-inflammatory, antidiabetic, antibacterial, and anticancer properties **[99]**. The bark of the *Cinnamomum* tree contains significant procyanidin chemicals, including cinnamtannin B1, cinnamtannin D1 (CTD-1), parameritannin A1, procyanidin B2, and procyanidin C1. These substances exhibited immunosuppressive properties and modulated immunological function in laboratory animals **[100]**. The ethyl and methyl alcohol extracts of *C. verum* include trans-cinnamaldehyde and other related chemicals. Starting on the second day of treatment, several substances have shown notable ameliorative effects ($p<0.05$) **[101]**. Extracts from *Cinnamomum tamala* demonstrated comparable antidepressant effects to imipramine when administered at a dosage of 400 mg/kg. These factors lead to behavioral despair, acquired helplessness, and tail suspension. The plant demonstrates significant anxiolytic properties and offers therapeutic benefits for treating psychological disorders **[102]**.

## (*Cinnamomum Zeylanicum*) Dalchini:

Dalchini, scientifically referred to as *Cinnamomum zeylanicum*, is a highly utilized aromatic herb that offers a multitude of therapeutic advantages. Cinnamon is the dried inner brown bark of a cinnamon tree. It alleviates symptoms related to a sore throat, influenza, common cold, and headache. Dalchini is used to improve gastrointestinal health and has anti-inflammatory qualities. Cinnamon is used as a treatment for COVID-19. Ayush-Kwath is an Ayurvedic herbal mixture used to boost the immune system and fight illnesses **[103]**. The methanolic and ethanolic extracts of *C. zeylanicum* exhibit anti-inflammatory effects by efficiently inhibiting the activity of the lipoxygenase (LOX) enzyme in mice. The mice were intentionally generated with collagen-induced arthritis experimentally. Both extracts were found to reduce the production of pro-inflammatory cytokines in the mouse **[103]**. Different research evaluated the anti-inflammatory effectiveness of ethanolic extracts from *C. zeylanicum* and *C. longa* in polymorphonuclear cells subjected to lipopolysaccharide (LPS)-induced interleukin-6 (IL-6) and tumor necrosis factor (TNF-α). In vitro studies have shown that cinnamic acid exhibits anti-inflammatory effects by reducing the levels of IL-6 and TNF- α in cells. **[104]** Cinnamomum bark contains benzaldehyde, cinnamaldehyde, and cumin aldehyde, which exhibit immune-stimulatory effects by increasing blood immunoglobulin levels, antibody titer, and reducing neutrophil count. Cinnamomum raises levels of immunoglobulins in the bloodstream. It enhances both cell-mediated and humoral immunity. Cinnamaldehyde can strongly regulate monocyte/macrophage-mediated immunological responses by inhibiting PI3K, PDK 1, and NF-Kb activation of signaling components **[105]**.

## (*Trachyspermum Ammi*) Ajwain:

Ajwain, scientifically named *Trachyspermum ammi*, is an erect annual herb with a furrowed stem. It originated from India and the eastern region of Persia. Ajwain's most advantageous aspect is its little fruit, similar to caraway, highly prized in Indian cooking for its flavor in many recipes, baked goods, and snacks. Ayurvedic remedies use this plant for its stimulant, carminative, antispasmodic, and tonic qualities **[106]**. It is a common home remedy used for various health ailments such as stomach pain, cramps, heartburn, vomiting, bloating, gas, loose stool, diarrhea, breathing difficulties, and postprandial abdominal discomfort. Ajwain is a plant that belongs to the Apiaceae family. It commonly thrives throughout India, particularly in Rajasthan and Gujarat, because of its historical usage **[107]**. An *in vivo* study assessed the antioxidant and ameliorative effects of ajwain extract on hexachlorocyclohexane-induced oxidative stress and damage. The study found that consuming ajwain extract in the diet can decrease the toxicity caused by hepatic free radical stress **[108]**. Ajwain was also assessed for demonstrating anti-inflammatory properties. Both the complete alcoholic extract and total aqueous extract exhibit considerable anti-inflammatory activity in living organisms **[109]**. Ajwain's immunomodulation property is mainly due to thymol and carvacrol. Ajwain seeds can regulate T-cell responses, especially in reducing inflammation in the lung airways of asthmatic individuals. Carvacrol balance alters the immune response by reducing the expression of certain cytokines (TNF-α, IL-17, IL-4, IL-1β, and TGF-β) and boosting the expression of others (IFN-γ and FOXP3), shifting it from Th2 to Th1 type. Ajwain oil is utilized in treating respiratory conditions by exerting its effects through immunomodulation. Thymol enhances the proliferation of peripheral blood mononuclear cells (PBMC) or lymphocytes, enhancing the memory/activated CD8 alpha+ T cell subsets that play important functions in innate immune responses and antibody production **[110]**.

## (*Mentha Piperita*) Pudhina:

Pudhina species, known as *Mentha piperita*, are utilized globally for their flavoring and therapeutic attributes. It is usually referred to as Peppermint and belongs to the Lamiaceae family, also known as Brandy mint, Candy mint, Lamb mint, and Balm mint, among others. It is a widely used medicinal herb in various traditional medical practices. In Ayurveda, this component is crucial in many compound compositions for treating gastrointestinal issues, upper respiratory tract infections, and skin ailments. Peppermint oil is used as an inhalant to alleviate respiratory congestion. Peppermint tea is utilized for treating coughs, bronchitis, inflammation of the oral mucosa, and throat. Traditionally, it has been utilized to address many digestive issues such as colic in newborns, flatulence, diarrhea, indigestion, nausea, vomiting, morning sickness, and anorexia, and as a spasmolytic to alleviate gas and cramps. The oil is utilized for toothache, rheumatism, muscle discomfort, and alleviating menstrual cramps **[111,112]**. Pudhina may boost the body's natural defense system, aiding in fighting RSV infection by impeding virus entry

without worsening the condition. The immunomodulatory activity of *M. piperita* is seen by intraperitoneal delivery of peppermint oil, 1-menthol, and 1,8-cineole to allergic guinea pigs. Peppermint extracts in the diet improve growth performance and boost immune system function by enhancing blood parameters **[113]**.

The anti-inflammatory characteristics of peppermint essential oil and extract were evaluated. Common screening procedures such as the carrageenan-induced hind paw oedema model, croton oil-induced ear oedema, and in vitro nitric oxide (NO) generation were used. Excessive phagocyte activation in inflammatory illnesses leads to the formation of damaging reactive oxygen species such as hydroxyl, superoxide anion, and non-free radical species (H2O2), which can damage tissues and trigger an inflammatory response by generating mediators and chemotactic factors. It inhibits the production of TNF-alpha, IL-6, NO, and PGE2. The anti-inflammatory properties may be advantageous in combating respiratory infections. Methanol inhibited the synthesis of inflammatory mediators such as leukotrienes, prostaglandins, and interleukins **[114]**. Mint extract exhibits antiviral properties against influenza A, herpes simplex virus, vaccinia virus, and human immunodeficiency virus-1 (HIV-1). It inhibits the synthesis of NO, TNF-alpha, IL-6, and PGE 2 in macrophages, indicating a connected mechanism in viral infections. RSV infections can trigger the release of TNF-alpha, leading to worsened sickness and substantial weight loss **[115]**.

## (*Curcuma Longa*) Haldi:

Haldi, scientifically known as *Curcuma longa*, is a perennial herb that is erect, leafy, and part of the Zingiberaceae family. It can grow up to 1m high with a short stem, oblong pointed leaves, and funnel-shaped yellow flowers. It is found in tropical and subtropical locations worldwide, commonly grown in Asian countries, particularly in India and China. 'Haldi' is a traditional Indian spice with rhizomes that are rectangular, ovate, pyriform, and often short-branched **[115–117]**. A recent study indicates that turmeric has newfound significance due to its possible anti-inflammatory and anticancer properties **[118]**. Curcumin, a yellow powder produced from rhizomes, is used for medicinal purposes. Turmeric is a renowned treatment in ancient Indian traditional medicine and cosmetics, functioning as a versatile herbal therapy for practitioners of Ayurveda, Siddha, Unani, and Chinese medicine **[119]**.

Ground turmeric is consumed with hot milk to treat cough and respiratory issues **[120]**. Turmeric has anti-inflammatory and anti-purulent properties. Therefore, it is beneficial for respiratory system disorders. A clinical experiment demonstrated that the volatile oil of turmeric when taken orally, was highly effective in treating bronchial asthma **[121]**. Turmeric powder, when taken orally, effectively alleviated asthma and cough symptoms **[128]**. Recent rhizomes were found to be efficient in treating whooping cough, various types of coughs, and dyspnea **[122]**. Breathing in burning turmeric fumes can induce a significant outflow of mucus and provide immediate relief in cases of catarrh and coryza **[123]**. The dried and ground root is administered for bronchitis **[124]**. COPD is a lung condition resulting from bronchial blockage that is not completely resolved by bronchodilator medications. The condition is marked by elevated levels of macrophages, neutrophils, and T lymphocytes in the lungs. In COPD, numerous inflammatory mediators are elevated, including pro-inflammatory cytokines such as IL-6 and TNF-alpha. It results in persistent inflammation and gradual deterioration of the lungs. Turmeric is utilized in COPD treatment and aids in promoting autophagy while inhibiting many illnesses associated with endoplasmic reticulum stress by activating NAD-dependent deacetylase sirtuin-1 (SIRT1). Turmeric has shown anti-inflammatory and antioxidant properties. It has been utilized to manage different respiratory illnesses, such as COPD. Turmeric plays a preventive role in COPD by regulating the balance between T-helper 17 cells (Th17) and Regulatory T cells (Tregs). It also reduces the levels of IL-6, IL-8, and TNF-alpha **[125]**. High levels of pro-inflammatory cytokines in hematopoiesis impair immunity and reduce immune cell differentiation in COVID-19 patients.

Curcumin, a bioactive compound found in turmeric, can improve the process of immune cell development in the blood and acts as an immunomodulator. Curcumin regulates the immune response by inhibiting the proliferation of lymphocytes and the production of cytokines by targeting the activation of the NF-κB transcription factor **[126]**. The cytokines responsible for the cytokine storm are IL-1, IL-2, IL-6, IL-10, transforming growth factor (TGF)-β, interferons (IFN), and TNF-α. IL-6 and TNF-α expressions are primarily correlated with COVID-19-induced acute respiratory distress syndrome and organ damage. Curcumin reduces lung inflammation caused by influenza by blocking NF-κB signaling. Furthermore, an escalation in pulmonary inflammation and related damage was linked to the activation of NF-κB in the airway epithelium. Curcumin's inhibitory effect on IFN-α and other inflammatory cytokines is associated with the suppression of NF-κB. Curcumin's inhibitory effect on inflammatory cytokines helps improve pulmonary fibrosis **[127]**.

## (*Cuminum Cyminum*) Jeera:

Jeera (*Cuminum cyminum*) is a widely used seed species globally. Cumin is an annual herbaceous medicinal plant that is part of the Apiaceae family. Jeera possesses qualities that alleviate Kapha and Vata, stimulate appetite, aid digestion, act as an antimicrobial, have analgesic effects, and have antipyretic properties. It is recommended for use in cases of inflammation, stomach pain, fever, and infections caused by microorganisms. They are utilized in bronchopulmonary diseases to alleviate cough and as an analgesic medication. Cumin seed's immunomodulatory effects were assessed in immunosuppressed mice, where it enhanced T-cell activity and Th1

cytokine production in healthy animals. It has analgesic, anti-inflammatory, and immunological properties **[128]**.

Cumin oil has been widely utilized in the treatment of bronchopulmonary diseases, cough, and as an analgesic **[129]**. The significant antioxidant activity of cumin oils is attributed to phytoconstituents such as alcohol, linalool, carvacrol, anethole, estragole, flavonoids, monoterpene, and polyphenolic substances. Cumin's antiradical capabilities are suggested to be the main mechanism behind its various pharmacological effects, such as its antiviral actions **[130]**. Research on cumin administration has shown immunomodulatory effects via influencing T cells. An evident rise in T-cell (CD4 and CD8) count and a Th1 dominant immunological response in a dosage-dependent fashion were noted. T cells decreased, corticosterone levels increased, and adrenal glands enlarged in immune-suppressed mice subjected to restraint. An increase in thymus and spleen weight indicates that cumin is an effective immunomodulator that enhances immunity in immune-compromised individuals.

## 5. Limitations Of The Study

The research investigates the efficacy of traditional remedies, specifically Ayurvedic preparations such as "Kadha," in the treatment of respiratory tract infections (RTIs). Although the investigation offers important perspectives on the potential benefits of herbal therapies for RTIs, it is essential to acknowledge various limitations that may affect the assessment of these remedies' overall effectiveness.

### Insufficient Large-Scale Clinical Trials:

Although numerous studies on traditional remedies have shown encouraging outcomes, most of the research is either anecdotal or derived from small-scale trials **[132]**. There is a significant lack of large, randomized controlled trials (RCTs) that definitively establish the effectiveness of Ayurvedic treatments for respiratory tract infections (RTIs) **[131]**. In the absence of robust clinical evidence from extensive studies, the findings from current research may be questionable or restricted in their applicability.

### Standardization Challenges In Herbal Medicine:

Another significant issue is the challenge of maintaining consistency and standardization in the application of herbal remedies **[133]**. The potency and active constituents of plant-based formulations can vary widely, influenced by factors such as the type of plant, agricultural practices, and methods of preparation **[134]**. This variability poses difficulties in ensuring that patients receive identical dosages or therapeutic benefits from each remedy, which can lead to inconsistent treatment outcomes.

### Cultural And Regional Bias:

The prevalence of Ayurvedic treatments is primarily found in regions where this medical tradition is deeply embedded in the culture and history **[135]**. As a result, the conclusions drawn from the study may not be relevant to all populations. In areas where Ayurvedic practices are less common, the acceptance and significance of these treatments may be limited, which could affect the generalizability of the study's results.

## 6. Significance Of The Study

This investigation is highly relevant to global health, particularly regarding RTIs and their therapeutic approaches. The examination of traditional treatments, such as Ayurvedic practices, suggests a viable alternative or complementary strategy for the management of RTIs. The study's significance is highlighted in several essential domains.

### Emphasizing A Different Strategy For RTI Management:

Respiratory tract infections rank among the top causes of illness and death globally, especially in developing countries **[136]**. Traditional medical treatments, such as antibiotics and antiviral drugs, often fall short in addressing viral infections and can lead to adverse effects or the development of drug resistance **[137]**. This study investigates Ayurveda remedies as alternative methods for treating RTIs, potentially decreasing dependence on pharmaceutical interventions, particularly in areas with restricted access to contemporary healthcare services.

### Reinforcing The Role Of Traditional Medicine:

The study draws attention to the potential benefits of integrating traditional medicine, particularly Ayurveda, into established healthcare systems. Ayurveda's emphasis on personalized, natural, and holistic treatment methods corresponds with the growing global trend towards alternative medicine **[138]**. This integration could result in a more balanced and unified approach to healthcare, especially in resource-limited regions where traditional medicine is a fundamental aspect of the healthcare landscape.

### Potential For Prevention And Early Intervention:

The emphasis on prevention and early intervention within Ayurveda presents a valuable opportunity for enhancing public health outcomes through its focus on disease prevention, early diagnosis, and customized treatment **[139]**. By employing herbal remedies and making lifestyle changes to avert or diminish the severity of respiratory tract infections (RTIs), we can significantly ease the global healthcare burden. This preventive framework is consistent with the World Health Organization's aims of advancing sustainable health and well-being.

## 7. Conclusion

The oldest medical system, Ayurveda, offers a profound understanding of life's science, comprising philosophy, science, and medicine, all condensed into its most basic forms. Derived from the Sanskrit term that means "The Science of Life," Ayurveda is an age-old body of knowledge that offers insights into general health and natural healing methods. The present study investigates the potential applications of Ayurveda for treating upper respiratory tract infections, with a particular emphasis on at-home remedies such as "Kadha." This traditional blend, consisting of many organic ingredients known for their immunomodulatory and anti-inflammatory properties, shows how successful Ayurveda is at treating common ailments. The several natural species utilized in Kadha have been identified by our investigation; each was chosen for its unique qualities and impacts based on research and literature. While the existing body of knowledge provides insightful information, it is important to acknowledge that further study is required to validate and improve these conclusions. While there is a wealth of historical instances and anecdotal data supporting the benefits of Ayurveda, rigorous scientific research is necessary to demonstrate its effectiveness in treating upper respiratory tract infections and other health conditions. Further studies should concentrate on elucidating the precise mechanisms of action, optimizing dosing regimens, and assessing long-term outcomes in order to further our understanding and use of Ayurvedic principles in modern healthcare environments. Because Ayurveda is becoming more and more popular around the world, it is imperative that regulatory frameworks be established to ensure the efficacy, safety, and uniformity of Ayurvedic treatments. Assisting in the collaboration of researchers, regulatory bodies, and traditional healers preserves the integrity of Ayurveda and makes its integration into mainstream healthcare systems easier. Additional research is required to assess the effectiveness of Ayurveda's thorough and extensively studied approach to health and wellness in managing upper respiratory tract infections. Through further research, collaboration, and the application of regulatory monitoring, we may completely apply Ayurveda to address contemporary healthcare issues and improve everyone's general well-being.

## Abbreviations

1. CT scan: Computed Tomography scan
2. MRI: Magnetic Resonance Imaging
3. PPPM: Predictive, Preventive, and Personalized Medicine
4. RCT: Randomized Controlled Trial
5. COPD: Chronic Obstructive Pulmonary Disease
6. Macrophages, NK cells, and T-cells: Macrophages, Natural Killer cells, and T-lymphocytes
7. TNF alpha: Tumor Necrosis Factor-alpha
8. TB: Tuberculosis
9. *In vitro*: Refers to studies or processes performed outside a living organism, typically in a controlled laboratory environment, such as in test tubes or Petri dishes
10. Th-1: Type 1 T helper cells
11. IL-4: Interleukin 4
12. IL-10: Interleukin 10
13. RSV-infection: Respiratory Syncytial Virus infection
14. Th-17: Type 17 T helper cells
15. IL-6: Interleukin 6
16. IL-8: Interleukin 8
17. TNF-alpha: Tumor Necrosis Factor-alpha

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