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Ayurveda After Age of Covid-19 Exploring the Impact and Empowering Informed Decisions Through Health Literacy

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Abstract

This paper explores the role of Ayurveda in the post- COVID era, focusing on its potential impact on healthcare systems and the empowerment of informed decision-making through health literacy. Ayurveda, an ancient holistic healing system originating in India over 5,000 years ago, offers a unique approach to health promotion and disease management based on personalized treatments, herbal medicines, lifestyle modifications, and preventive care. The COVID-19 pandemic has underscored the importance of exploring complementary treatments, such as Ayurveda, which provides immune-boosting techniques, post-COVID symptom management, mental health support, and integrative healthcare options. By integrating Ayurveda into mainstream healthcare systems, policymakers and healthcare authorities can address contemporary health challenges more effectively while promoting greater health literacy among individuals. This paper discusses the historical background, principles, and therapeutic modalities of Ayurveda, along with its potential role in boosting immunity and managing post- COVID symptoms. It also examines the challenges and opportunities of integrating Ayurveda into post-pandemic healthcare, including policy recommendations, education reforms, and industrial initiatives. Overall, the integration of Ayurveda into modern healthcare systems holds promise for improving healthcare delivery, enhancing patient outcomes, and fostering greater health literacy in the post- COVID era.

Keywords: *Ayurveda, Ayurvedic Herbs, Holistic Health, Immune-Boosting Herbs, Immunomodulation, Immune Health Interventions, Immune System.*

Introduction

Background and Significance of Ayurveda in Healthcare

Ayurveda, often referred to as the "Science of Life," stands as one of the oldest holistic healing systems globally, originating in India over 5,000 years ago. Its roots delve deep into ancient Vedic texts, including Rigveda and Atharvaveda, where references to medicinal plants and healing practices can be found. Over the millennia, Ayurveda evolved into a sophisticated medical system, encompassing diverse disciplines such as internal medicine, surgery, pediatrics, psychiatry, and geriatrics. At the core of Ayurveda lies the concept of balance and harmony between the body, mind, and spirit. According to Ayurvedic philosophy, health is attained through a dynamic equilibrium of the three doshas (bioenergetic forces) – Vata (air and space), Pitta (fire and water), and Kapha (earth and water) – within the individual. Imbalances in doshas are believed to lead to illness, prompting Ayurvedic interventions aimed at restoring balance through personalized treatments tailored to each individual's unique constitution (Prakriti). Ayurveda takes a holistic approach to health, addressing the underlying causes of illness and promoting overall well-being, unlike conventional medicine that often focuses on treating symptoms or specific diseases.

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Ayurvedic practitioners assess various aspects of an individual's life, including diet, lifestyle, mental and emotional states, and environmental influences, to develop personalized treatment plans aimed at restoring balance and preventing diseases. Ayurveda has diverse therapeutic modalities ranging from herbal medicines and dietary recommendations to lifestyle modifications, detoxification therapies (Panchakarma), yoga, meditation, and massage (Abhyanga). These therapies are often combined to address the root causes of diseases and to enhance the body's natural healing mechanisms. In recent years, Ayurveda has gained popularity beyond its traditional homeland, with an increasing number of people seeking a holistic approach to health and wellbeing. Ayurvedic clinics, wellness centers, and educational institutions have proliferated globally, offering Ayurvedic treatments, training programs, and research opportunities. The integration of Ayurveda into mainstream health care systems in some countries reflects the growing recognition of its potential contribution to preventive and integrative medicine. Despite its long history and widespread use, Ayurveda faces various challenges, including standardization of practices, quality control of herbal medicines, regulatory issues, and skepticism from conventional medical establishments. However, there are also opportunities for Ayurveda to address contemporary health challenges, such as chronic diseases, mental health disorders, and lifestyle-related conditions, through a holistic and personalized approach to health promotion and disease management. Ayurveda represents a rich and ancient medical tradition, with profound insights into the nature of health and disease. Its holistic philosophy, personalized approach, and diverse therapeutic modalities continue to inspire individuals and healthcare practitioners worldwide, offering new perspectives on health and healing in the modern age [1].

Introduction to Covid-19 and Its Impact on Healthcare Systems

The global effects of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)-caused coronavirus disease (COVID-19) pandemic have been significant. It has caused millions of illnesses and almost five million deaths globally by late October 2021. Although the COVID-19 epidemic has had a direct or indirect impact on every industry, many nations' already overcrowded health systems have worsened as a result of the crisis. Relentless transmission of the virus across various environments significantly affects the provision of healthcare services, especially during the initial phases. This poses challenges for managing medical supplies, optimizing facility usage, and overseeing the allocation of healthcare personnel. Data indicate that the COVID-19 pandemic has profoundly disturbed the delivery of healthcare services, particularly in countries with limited resources [2]. In addition to the direct consequences of the COVID-19 pandemic, additional factors that contributed to the disruption included indirect strain on health systems and the overstretching of others. The COVID-19 pandemic has highlighted the weaknesses of existing healthcare systems [3]. The COVID-19 pandemic has impacted services for treating and preventing infectious and non-communicable diseases. Medical facilities have delayed the development of many necessary facilities [4]. Patients' fear and worry throughout the pandemic prevented them from attending acute care appointments and follow-up visits. Owing to the interruption of crucial healthcare services caused by the COVID-19 pandemic, there is a substantial risk of indirect illness and death from other diseases that could have been avoided and treated, in addition to the immediate health impact of the pandemic itself. The most frequent reasons given for critical gaps or service reductions during COVID-19 were as follows: moving medical staff to support COVID-19 services, postponing

planned treatments, decreasing public transportation, losing money to pay for services, restricting utilization, and high rates of morbidity and mortality among medical staff. Many nations have stated that the primary causes of service interruptions are a shortage of medications, diagnostic tools, and other technologies [5].

Similarly, Ethiopia's health system faced significant challenges after the first COVID-19 case was announced in March 2020.The increasing number of COVID-19 cases necessitated the reorganization of healthcare personnel and adaptation of facilities. Conversely, individuals with various ailments hesitate to visit the medical facilities. A comparison between service utilization during the COVID-19 period and the pre-COVID-19 era revealed significant disparities in healthcare delivery methods. Notably, there has been a marked decline in the number of patients seeking routine medical care. The global experience with the COVID-19 crisis underscores the critical need to establish robust and sustainable healthcare systems. This necessitates substantial investments in the development and training of healthcare personnel, as well as ensuring adequate provision of equipment, particularly personal protective gear, and measures for occupational safety. Creating a conducive work environment is therefore essential. Fostering social dialogue is imperative for an effective crisis response and for shaping a health-ready future. The sixth issue of the Ethiopian Journal of Health Sciences, which is currently available, includes two case reports, twenty-five original papers, and an editorial covering a range of subjects. This issue's seven original pieces discuss the effects of the Corona virus disease of 2019 on families, the community, and medical professionals.

Rationale for Exploring Ayurveda in the Post-Covid Era

The global COVID-19 pandemic has highlighted the importance of researching complementary and alternative treatment methods, including Ayurveda, to address current health concerns. The following reasons support the investigation of Ayurveda's relevance in the post-COVID era:

1. Immune modulation: Ayurveda provides a comprehensive method for boosting immunity, which is an important defense mechanism against viral disorders, such as COVID-19. Ayurvedic concepts focus on maintaining the body, mind, and spirit in balance to boost immunity through dietary adjustments, lifestyle changes, herbal remedies, and exercises such as yoga and meditation.
2. Management of post-COVID symptoms: Many people getting well from COVID-19 still have symptoms that return to normal, such as exhaustion, breathing problems, memory problems, and mental health issues. Ayurveda offers a comprehensive framework for treating the underlying causes of imbalance and fostering overall well-being through individualized therapies aimed at regulating these post-COVID symptoms [6].
3. Mental health support The COVID-19 pandemic has had a significant psychological impact, resulting in stress, anxiety, sadness, and trauma. Herbal medicine, mindfulness exercises, stress-reduction methods, and lifestyle adjustments are just a few of Ayurveda’s holistic approaches to mental health care. Therefore, they can be used in conjunction with traditional mental health therapies.
4. Preventive healthcare: Ayurveda places a strong emphasis on preventative healthcare practices that try to keep people healthy and stop illness before it starts. To lessen the effects of pandemics and other health emergencies, preventive medicine and

holistic wellness practices have become increasingly important in the post-COVID era.

5. Integrative healthcare: The effectiveness and accessibility of healthcare services can be improved by incorporating Ayurveda into conventional healthcare systems, especially for the treatment of complicated chronic illnesses that may emerge in the wake of the COVID-19 pandemic. Patients may benefit from a more thorough and individualized treatment approach when mainstream medical professionals and Ayurvedic practitioners work together.
6. Ayurveda has been used for hundreds of years and is a vital component of India's cultural legacy. Investigating Ayurveda in the post-COVID era offers a chance to uphold and advance this antiquated medical practice while modifying it to meet modern medical requirements and scientific guidelines [7].

Knowledge of Ayurveda's potential roles in immunological regulation, COVID-19 symptom management, psychological counselling, integrative medicine, preventative care, and cultural heritage preservation spurs research into practice in the wake of the pandemic. The COVID-19 pandemic and its aftermath have presented healthcare systems with numerous health concerns that can be better addressed using Ayurvedic ideas and practices.

Ayurveda: An Overview

Historical Background and Principles of Ayurveda

Ayurveda's history dates back thousands of years, as does the quest for health, which predates humankind's struggles to survive and adapt to the natural environment. It has developed alongside human civilization and has become a complete healthcare system. According to Indian philosophy, physical well-being is necessary for materialistic, spiritual, and social advancement. Through meditation, Brahma—the Hindu legendary God of Creation, who is thought to have created the universe—evolved the science of Ayurveda and passed it on to Prajapati Daksha. The earliest Indian literature, dating back to 5000–1000 BCE, is the Vedas, which includes allusions to plants and natural resources for a variety of medicinal purposes. These include the Rig Veda, the Sam Veda, the Yajur Veda, and the Atharva Veda. Two ancient texts, Ramayana and Mahabharata, describe several medical miracles that employ botanical and surgical techniques. However, during the “Samhita” period, circa 1000 BCE, Ayurveda emerged as a complete medicinal system 1. Sushruta Samhita and Charaka were composed during each era. The two Samhitas founding fathers, Sage Bharadwaja and Sage Devadas Dhanwantari, have established two distinct schools of thought. Punarvasu Atreya, the founder of the Atreya School, or the School of Physicians learned Ayurveda from Sage Bharadwaja [8]. The establishment of the Dhanwantari School, also known as the School of Surgeons, is attributed to the revered monarch Devadas Dhanwantari, which is believed to embody the physician-God Dhanwantari. Among the notable figures associated with this school were Agnivesh, Bhela, Jatukarna, Parasara, Harita, and Ksharpani—six disciples of the sage Atreya—who emerged as prominent proponents of the school of physicians. Each penned extensive work on Ayurvedic medical practice, which is now known by his name. The most well-known pupil of Punarvasu Atreya, Agnivesha, penned Agnivesha-Samhita prior to the sixth century BCE. Charaka, king Kanishka's trusty physician, is reported to have acquired this text in the first century CE. However, he was unable to finish it, so he abandoned it halfway through “Chikitsasthana” ’s chapter. A scholar from Kashmir, Dridhabala, completed Charaka's treatise, the “Charaka Samhita,” later in the eighth century CE. These 17 chapters, titled “Siddhisthana” and “Kalpasthana,” are

currently regarded as ancient and authoritative Ayurveda texts. Prominent members of the surgical school were Dhanwantari, the Varanasi king's disciple, as well as Susruta, Bhoja, Gopura, Karavirya, Aupadhenava, and Aurabhra [1]. The primary goal of Ayurveda is outlined in Figure 1.

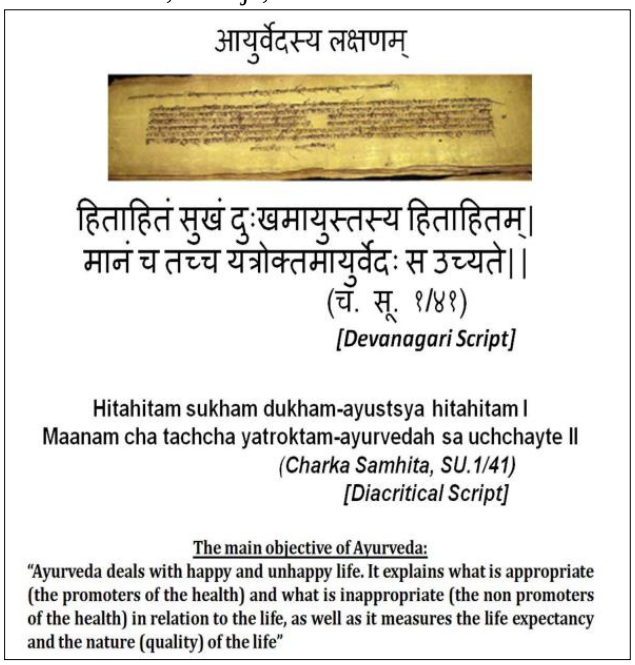

Figure 1. Main Goal of Ayurveda [8]

Rakshita, Vaitaran, and others have all contributed extensive treatises on the practices of midwifery and surgery, some of which continue to be frequently referenced in other studies. This composition is comparable to that of Sushruta Samhita and Charaka Samhita before the sixth-century CE. While Sushruta's work deals mainly with surgical matters and provides precise information about ancient India's surgical instruments, Agnivesha Samhita is essentially a general medical treatise. Later, an unknown writer added the Uttara-tantra [9]. The major Disciples in Ayurveda are shown in Figure 2.

In modern times, Sushruta Samhita is the name given to the entire text, including the supplement. The Astanga Sangraha and Astanga Hridaya, written by Vrdha Vagbhata and Vagbhata during the sixth and seventh centuries CE, encapsulate essential principles from both the Charaka and Sushruta Samhita [10]

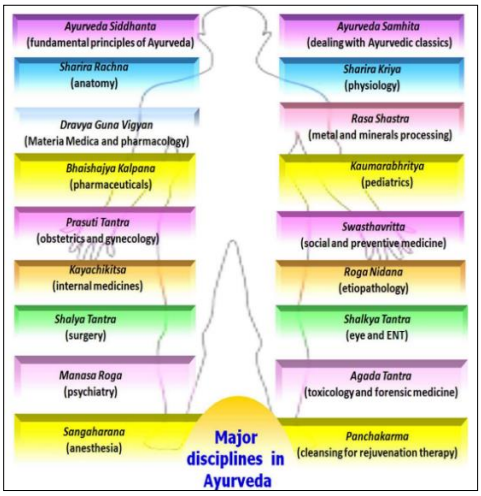

Figure 2. Major Disciplines in Ayurveda [8]

Therefore, the three aforementioned great texts are collectively referred to as the "Brihattrayi," and they served as the basis for other classics known as the "Laghutrayi," Laghutrayi such as Madhava Nidana, Sarangadhara Samhita, and Bhavaprakasha. Madhavakara wrote the Madhava Nidana, which addresses disease diagnosis. Sarangadhara Samhita listed Ayurvedic pharmaceuticals with an emphasis on formulations and dose forms. Bhava Misra's book, Bhavaprakash, focuses on diets and medicinal plants. Takshashila University's Jivaka, a renowned surgeon who once treated Gautam Buddha, studied Ayurveda during the Buddhist era. Medical students from all over the world traveled to the ancient University of Takshashila in the year 200 BCE to study Ayurveda. Students studying medicine at the University of Nalanda came from China and Japan between 200 CE and 700 CE. It is assumed that several medicinal systems, such as traditional Chinese and Tibetan remedies, were nourished by Ayurveda, who arrived at them through Buddhism. The Greeks and Romans interacted with one another through maritime trade. At 800 CE, Nagarjuna introduced the use of metals and minerals for medicinal purposes in a practice known as Rasasashtra. Some of Rasasashtra's major treatises are Rasaratnasamuchaya, Rasarnava, and Rasa Hridaya Tantra, which elaborate on how to produce metallic formulations and detoxify metals using a variety of natural ingredients [11]. Ayurveda's history is shown in Figure 3.

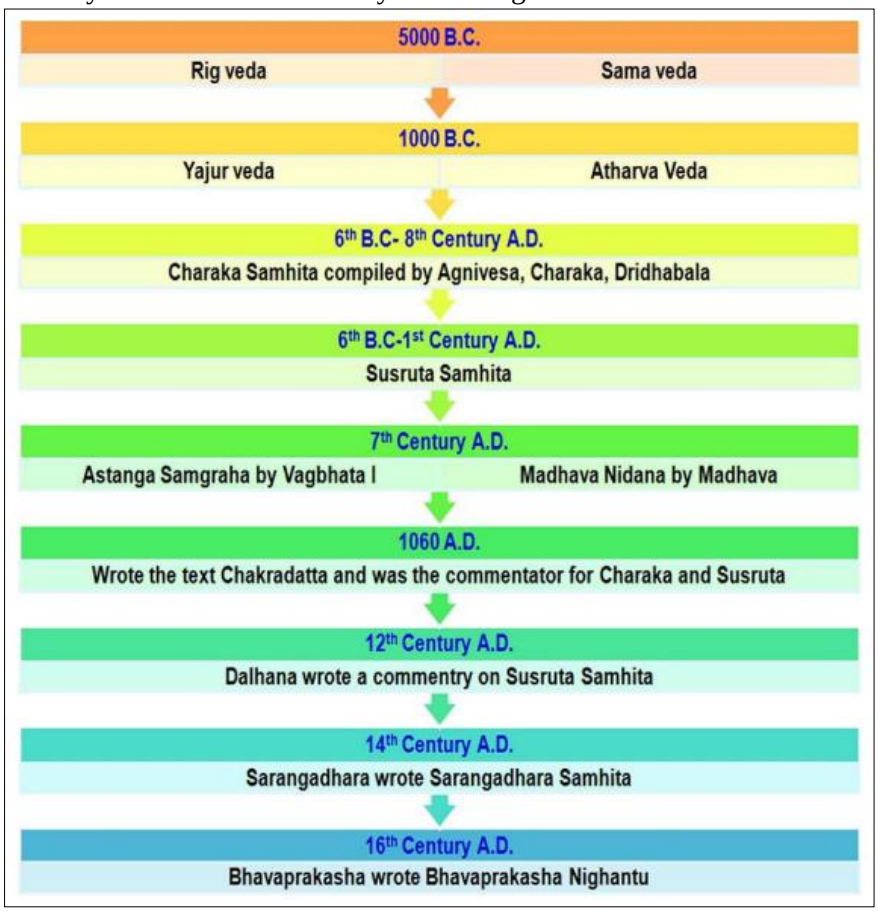

Figure 3. Historical Background of Ayurveda [8]

Integration of Ayurveda in to Modern Healthcare Systems

Simply because something is old does not necessarily mean that it is valuable or of a high quality. For example, even valuable items such as gold require occasional maintenance to maintain their value. India's medical systems, science, and technology are highly advanced.

However, the fact that these ideas and methods are old does not mean they should be dismissed. Rather, their age should not be a reason to discard them. To benefit from the wisdom that underlies the science and technology found in ancient texts, we must objectively analyze them in light of our current understanding of the concepts and procedures of the natural sciences. By doing so, we will be able to answer the questions "What," "Why," and "How." It is worth noting that over the past few decades, numerous studies have been conducted, supported by traditional health care systems, to identify their "active compounds" and use them to generate unique treatments tailored to certain targets. While there have been some remarkable successes, the "reductionist" strategy generally has serious limitations, as evidenced by the "side effects" associated with the majority of so-called "target-specific" medications. In this case, it is better to use the "holistic" and "systems" approach that is central to Ayurveda and carefully examine the different Rasayanas, Bhasmas, and Asavas that are discussed in ancient texts to determine how they work and how well they treat different health problems.

Quality control has emerged as a significant issue with the recent spike in the popularity of Ayurveda, affecting not only the numerous Rasayanas and other Ayurvedic formulations but also other Ayurvedic processes and practices, including Panchakarma and other massages. Except for a few simpler formulations, most Ayurvedic formulations are complicated mixtures of several botanical and/or mineral components, making it impractical to control their quality using physicochemical characteristics [12]. Therefore, it is necessary to identify the appropriate biological quality control parameters using model organisms. However, there is a need to restrain the industry's and practitioners' inclination to label any purportedly "herbal" preparation as "Ayurvedic." It is necessary to address the reciprocal mistrust that currently exists between traditional and modern health care providers. Practitioners of Ayurveda and other traditional medical systems need to come out of their shells and receive training and exposure to modern biological principles, particularly those related to genetics, genomics, cell and molecular biology, developmental biology, and physiology. Modern science and medicine practitioners must acknowledge the system organization of living organisms and the holistic concept ingrained in Ayurveda. Only by combining these efforts would it be possible to distinguish between the truths and myths that are ingrained in all ancient customs and bodies of knowledge [13] Any society's goals of "health for all" would be greatly advanced by combining modern diagnostic techniques with the holistic tenets of Ayurvedic and other traditional healthcare systems. Finding and comprehending the similarities between many languages and beliefs is crucial. the foundations for ayurgenomics-based precision and integrative medicine are presented in Figure 4.

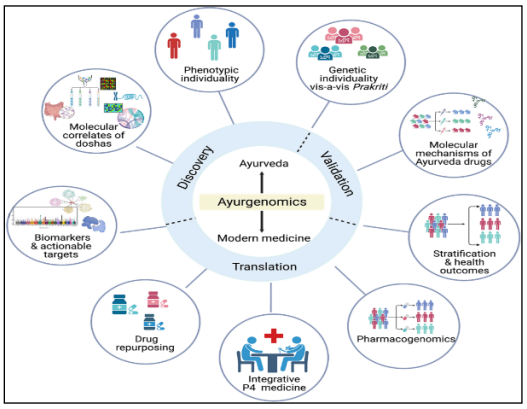

Figure 4. Frameworks for Precision and Integrative Medicine Based on Ayurgenomics [13]

Ayurvedic Practices and Immune Health

Role of Ayurvedic Herbs and Formulations in Boosting Immunity

Various natural ingredients, including medicinal plants and herbs such as garlic (Allium sativum), giloy (Tinospora cordifolia), and tulsi (Ocimum basilicum), as well as spices such as clove, cinnamon, ginger, black pepper, and turmeric, are recognized as immunity boosters, as shown in Figure 5. These substances not only possess antiviral properties but also contribute to strengthening the immune system. Recent studies have emphasized the antiviral attributes of commonly used spices and herbs, such as curcumin, cinnamon, ginger, clove, black pepper, garlic, neem, giloy, and basil, particularly during the COVID-19 pandemic. Furthermore, compounds such as zinc, quercetin, vitamin A, B1, B2, B6, C, and E found in neem leaves have been shown to enhance immune function [14].

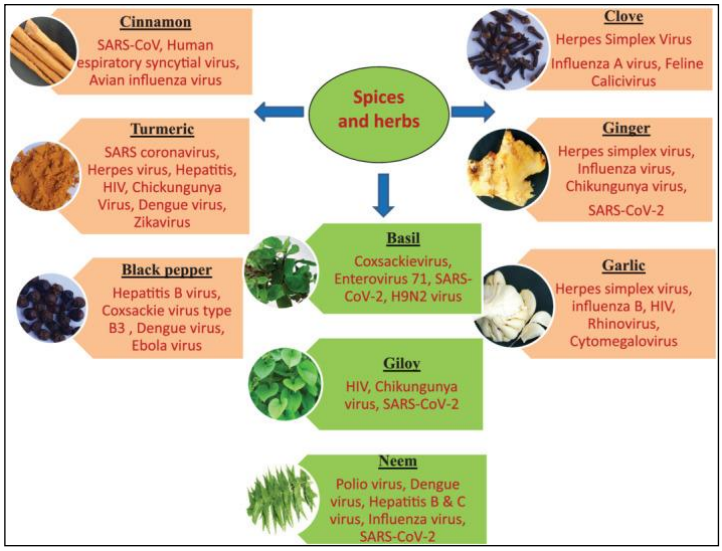

Figure 5. Common Plants and Spices Having Antiviral Characteristics [14]

Curcuma Longa L. (Turmeric)

Turmeric (Curcuma longa L.), a member of the ginger family Zingiberaceae, is native to India and Southeast Asia, is a member of the ginger family (Zingiberaceae). The main bioactive components found in the rhizomes of this plant are polyphenols, steroids, sesquiterpenes, and curcuminoids [15]. Asian nations have traditionally used curcumin, a naturally occurring polyphenol extracted from turmeric (Curcuma longa), as traditional medicine to treat a wide range of illnesses. Numerous studies have demonstrated that curcumin has certain pharmacological characteristics, including anti-inflammatory, anti-angiogenic, and anti-neoplastic effects, without causing harm. According to the Food and Drug Administration (FDA), it is "generally recognized as safe." Clinical trials have demonstrated that a daily dose of curcumin (up to 12 g) is safe for human consumption and does not induce adverse effects. No toxicity was observed when curcumin was administered at dose of 2,500–8,000 mg daily for three months. Curcumin is a potent antiviral agent that inhibits viral multiplication [16].

Several viruses, such as those that cause hepatitis, SARS coronavirus, influenza, HIV, herpes simplex, dengue, chikungunya, and other infections, have been shown to be resistant to the antiviral potential of curcumin. The ability of curcumin to control many molecular targets that help cells do many

things, such as controlling transcription and initiating cellular signaling pathways, is another indication that it can fight viruses. Curcumin has emerged as a leading antiviral medication owing to its ability to target multiple cellular pathways, thereby inhibiting the growth and replication of viruses. Molecular docking techniques have revealed that curcumin binds to and obstructs target receptors that are crucially involved in viral infections. These include PD-ACE2, spike glycoprotein-RBD, and SARS-CoV-2 protease [17].

Zingiber Officinale (Ginger)

Ginger is a medicinal plant that grows naturally in several countries. Zingiber officinale, or ginger, is a member of the Zingiberaceae family of plants and includes the well-known plants turmeric, cardamom, and galangal. This plant is native to Southeast Asia and grows throughout the region, particularly in India. In Ayurveda, ginger (Zingiber officinale) is referred to as Sunthi, and ancient texts, such as Charaka, Sushruta, Vagbhatta, and Chakra-dutta, describe the herb. In the traditional Unani medical system, Zanjabeel, also known as zicgerofficinale, is a well-known herbal remedy [18].

Ginger is a rich source of bioactive substances with therapeutic effects, including steroids, alkaloids, and phenolic compounds. Paradol, zingerone, and shogoals are analogs of zingiberol, the main aromatic component of the rhizome. Ginger contains many sub-chemicals, including 4-gingerol, 6-gingerol, 8-gingerol, 10-gingerols, 6-shogaols, and 14-shogaols, in addition to the primary bioactive compounds. According to previous reports, they possess antipyretic, analgesic, anti-arthritic, antiemetic, and anti-inflammatory properties.

Several studies have underscored the potent antiviral activity of ginger and its bioactive constituents against various viruses, including the chikungunya virus, herpes simplex virus, human respiratory syncytial virus, and SARS-CoV-2 [19]. In one study, lyophilized juice extracted from Zingiber officinale was evaluated for its antiviral efficacy against the hepatitis C virus across different doses ranging from 5 to 200 μg/mL. Analysis of viral RNA segment amplification indicated that 100 μg/mL effectively suppressed viral replication. A molecular docking study was performed to examine the anti-SARS-CoV-2 potential of several bioactive compounds, such as zingerone, shogaol, geraniol, gingerenone A, and zingiberene. These compounds interact with the major protease (Mpro). It was discovered that the bioactive components in ginger inhibit MPro or prevent spike (S) proteins from attaching to the ACE2 receptor [20]. The S protein attaches to the angiotensin-converting enzyme 2 (ACE2) receptor in the host cell, creating an environment that is suitable for viral replication. This explains the entry of SARS-CoV-2 into the host during the infection. The main Protease (MPro) processes the poly-proteins pp1a and pp1ab during viral replication [21].

Cinnamomum Cassia (Cinnamon)

One species of aromatic tree in the Lauraceae family is Cinnamomum cassia. For a long time, traditional Chinese, Indian, Persian, and Unani medicines have extensively used cinnamon. Cinnamon has been a popular spice in many nations for thousands of years. The bark of young branches of this plant contains cinnamon, which is used as a daily condiment worldwide. It has a great economic value and can be used for medicinal purposes. It is used to treat several illnesses, including headache, fever, leukorrhea, amenorrhea, diarrhea, and flatulence. Additionally, it has been noted that the daily use of cinnamon helps prevent throat infections [22].

Cinnamon bark contains 21 chemical components, including eugenol (3.19%) and cinnamaldehyde (60.41%), both of which are known for their antimicrobial properties. Numerous studies have highlighted the diverse

therapeutic properties of cinnamon, including its antibacterial, antiviral, antifungal, antioxidant, antihypertensive, antidiabetic, anticancer, gastroprotective, and immunomodulatory effects. One study revealed that, while a low dose of cinnamon (10 mg/kg) primarily elevated serum immunoglobulin levels, a higher dose (100 mg/kg) significantly increased the phagocytic index, serum immunoglobulin levels, and antibody titer. Consequently, a higher dose enhanced both humoral and cell-mediated immunity, whereas a lower dose predominantly affected humoral immunity. In one study, the effects of cinnamon hydroalcoholic extract on herpes simplex virus-1 (HSV-1) were investigated. These findings demonstrated that the hydroalcoholic extract effectively reduced the viral titer of HSV-1 by impeding viral attachment to cells [23].

Syzygium Aromaticum (Clove)

Clove, a plant belonging to the Myrtaceae family known for its antimicrobial properties against oral bacteria, is widely used as an antiseptic to prevent infectious diseases. In addition to their medicinal uses, cloves are employed in the food industry to increase shelf life because of their antibacterial properties. The FDA has approved clove oil, oleoresins, clove buds, and eugenol for use as dietary supplements [24]. According to the WHO, humans can consume up to 2.5 milligrams of clove per kilogram of body weight per day. Flavonoids, hydroxycinnamic acids, hydroxybenzoic acids, and hydroxyphenylpropens are some of the primary phenolic compounds found in cloves.

Eugenol is the primary bioactive ingredient of cloves. Eugenol has extensive antibacterial properties against fungi, bacteria, and acid-fact-bacteria (grade 1-negative). The well-known antiemetic (relieves nausea and vomiting) and carminative qualities of cloves have been widely recognized. Eugeniin, a compound extracted from the herbal extracts of S. aromaticum and Geum japonicum, exhibited anti-herpes simplex virus properties at a dose of 5 μg/mL. In addition, eugenol inhibits viral replication, thereby reducing the risk of infection. Eugeniin, on the other hand, inhibits the production of viral DNA by blocking HSV-1 DNA polymerase [25].

Piper Nigrum (Black Pepper)

Piper belongs to the Piperaceae family and is renowned for its strong aroma, earning it the title of “king of spices.” Many tropical countries, including Brazil, Indonesia, and India, have grown black peppers. Piper nigrum is used in perfumes, medicine, and preservatives because of its bioactive components that have considerable biological effects. Ayurvedic, Siddha, Unani, and Tibetan medicines all extensively use piperine, a potent black pepper alkaloid. Piperine (1-peperoyl piperidine) is a primary pungent alkaloid. It is well-known to have a variety of pharmacological properties, including antihypertensive, anti-Alzheimer's, antidepressant, antiplatelet, anti-inflammatory, antioxidant, antipyretic, antitumor, analgesic, and antimicrobial [24, 26].

Piper nigrumin chloroform and methanolic extracts were assessed for antiviral efficacy against human parainfluenza virus and the enteric virus vesicular stomatitis virus in human cell lines. They discovered that a higher number of alkaloids in the chloroform extract of Piper nigrum resulted in increased antiviral activity. A molecular docking study found that piperine was better than the commercial antiviral ribavirin in blocking the VP35 interferon inhibitory domain of the Ebola virus and methyltransferase of the dengue virus. In a docking-based investigation, bioactive components of black pepper, namely piperdardiine and piperanine, were found to be very active against COVID-19 and can be employed to treat the virus [25, 27].

Ocimum Basilicum L. (Basil)

Ocimum basilicum L. (OB), commonly known as sweet basil, is a popular medicinal herb belonging to the Labiatae family. Essential oils of this plant have been widely used in food, cosmetics, and oral health products for many years. Several studies have confirmed the antibacterial properties of basil, making it a natural choice for use as a spice. It has been documented that the essential oils of OB exhibit efficaciousness against a diverse array of bacteria, fungi, and parasites.

Viral infections in the eyes, lungs, and liver are among the conditions in which various parts of the OB are treated. It has been observed that Ocimum basilicum contains a number of intriguing chemicals, including sesquiterpenoids (caryophyllene and farnesol), triterpenoid (ursolic acid), flavonoid (apigenin), and monoterpenoids (carvone, cineole, fenchone, geraniol, myrcene, and thujone). Several studies have shown that water and methanol extracts of basil leaf and seed oil boost the immune system's ability to fight various infections. This is achieved by increasing the number of T-helper and natural killer cells, lymphocytes, neutrophils, phagocytic activity, antibody titers, and other factors [28]. It has been observed that ursolic acid inhibits tumor growth and viral infections of the human immunodeficiency virus (HIV) and herpes simplex virus (HSV-1). Additionally, OB extracts and specific purified components have demonstrated a wide range of anti-DNA and anti-RNA viral properties. In a molecular docking investigation, vicenin, sorientin 4'-O-glucoside 2' - O-phydroxy-benzoate-, and ursolic acid, three phytochemical compounds of Tulsi, inhibited the main protease of SARS-CoV-2 [29].

Allium Sativum L. (Garlic)

The Liliaceae family, which includes the garlic plant, Allium sativum L., is native to Asia, although it is widely grown in China, North Africa (Egypt), Europe, and Mexico. It has been used as a drug for thousands of years. This plant is a bulb that can grow to 25–70 cm in height, and its blossoms are used to flavor and spice cuisine. Garlic has a high nutritional content, enhances food flavor, and relieves dyspepsia. Numerous low-toxicity pharmacological actions of garlic include anthelmintic, anti-inflammatory, antioxidant, and antifungal properties [15]. Alliinase, an enzyme found in garlic, converts alliin into allicin, also known as diallyl-dithiosulfinate. Allicin is an antiviral and an antifungal agent. The chemicals in garlic that killed the viruses were ajoene, allicin, allyl methyl thiosulfanate, and methyl allyl thiosulfanate. Studies of the antiviral action of garlic extract against influenza virus A/H1N1 in cell culture have revealed that the extract prevents the virus from penetrating and multiplying in culture. Garlic extract had an inhibitory effect on infectious bronchitis virus (IBV-a coronavirus) in chicken embryos [30].

Azadirachta Indica (Neem)

Azadirachta indica, the botanical name for neem trees, is a rapidly growing evergreen herb that is a member of the Meliaceae family. Neem, a traditional medicinal plant with Indian provenance, has long been used in various parts of Asia and Africa to treat a variety of acute and chronic ailments. Traditional medicine utilizes all components of the neem tree, including the seeds, roots, leaves, blossoms, and bark, as a do-it-yourself treatment for a range of human diseases. They possess spermicidal, insecticidal, larvicidal, antimalarial, antibacterial, and antiviral properties. Numerous terpenoids have been identified in the bark of this herb, including limonoids, β-sistosterol, 6-desacetylnimbinene, nimbione, margocin, quercetin, nimbin, nimbidin, and nimbolide [31]. Due to its capacity to scavenge free radicals, a substance extracted from neem leaves known as "hyperoside" has demonstrated promise as a universal medication against influenza strains. The

hyperoside components of the neem leaf extract, LGH, Naproxen, BMS-885838, and BMS-883559 chemical medicines, and conserved influenza virus nucleoprotein residues produced the highest outcomes [32]. The neem is a remarkable plant that has been dubbed the "tree of the 21st century" by the UN.

Owing to the proven and potent antiviral properties of neem, scientists have initiated investigations to explore its potential for the development of treatments against SARS-CoV-2.Naturally occurring bioactive compounds such as methyl eugenol, oleanolic acid, and ursolic acid, sourced from Tulsi and neem, have exhibited inhibitory effects on SARS-CoV-2.These compounds target key viral components, including spike glycoprotein, RNA polymerase, and proteases, thereby impeding viral attachment and replication. Research has identified approximately 20 bioactive chemicals isolated from neem leaf extracts that exhibit strong binding affinity to the COVID-19 major protease protein crucial for virus replication. Additionally, in silico screening of ligands from Nimba and Amrita (Azadirachta indica and Tinospora cordifolia) collectively known as Nimbamritam, revealed promising interactions with SARS-CoV-2 residues, inhibiting Mpro, or spike protease, indicative of potential anti-SARS-CoV-2 activity [33].

Tinospora Cordifolia (Giloy)

A member of the Menispermaceae family, Tinospora cordifolia, sometimes known as "giloy," is mostly found in Asian countries, such as China, India, Sri Lanka, and Myanmar. It is a native Indian medicinal plant known as Guduchi. Ayurvedic formulas are used to treat a variety of illnesses. Owing to its therapeutic value, T. cordifolia has been used extensively for commercial purposes. It is used as a potent medication to treat a wide range of illnesses including jaundice, urogenital disorders, skin conditions, diabetes, anemia, inflammation, and allergic conditions. Each of the various parts of T. cordifolia —leaves, stems, roots, flowers, and seeds —has the pharmacological properties listed above. Additionally, this plant is utilized in Ayurvedic "Rasayanas" to strengthen defenses against illnesses and boost immunity. The MTT test was used to evaluate the antiviral potential of the crude extract obtained from the dry stem of Tinospora cordifolia against herpes simplex virus [34]. Molecular dynamics techniques were utilized to investigate five phytoconstituents of T. cordifolia: berberine, beta-sitosterol, coline, tetrahydropalmatine, and octacosanol. Their findings revealed that berberine effectively inhibited the activity of the 3CLpro protein, thereby impeding viral replication [35]. Additionally, molecular docking studies showed that tinocordiside, a phytochemical found in T. cordifolia, inhibited the primary protease of SARS-CoV-2. Notably, among the four major SARS-CoV-2 target surface glycoproteins—receptor-binding domain, RNA-dependent RNA polymerase, and main proteases —berberine, isocolumbin, magnoflorine, and tinocordiside–compounds isolated from T. cordifolia exhibited significant binding efficacy 36].

Challenges and Opportunities in Integrating Ayurveda in the Post-Covid Healthcare

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)-caused coronavirus disease 2019 (COVID-19), the most significant global health crisis since the 1918 influenza pandemic, has had a catastrophic impact on global demographics and killed over 3.77 million people worldwide. COVID-19 has devastated many nations since it was proclaimed to be a global pandemic, overwhelming numerous healthcare systems in the process. Although significant advancements in clinical research have improved our understanding of SARS-CoV-2 and the treatment of COVID-19, there is growing concern about how to stop the virus from

spreading further. SARS-CoV-2 still seriously harms people worldwide, and many countries are currently experiencing second or third waves of outbreaks that are primarily caused by mutant variants of the virus. It takes time for someone who has contracted COVID-19 to return to their regular schedule. Patients with COVID-19 typically require two–three weeks for full recovery. Adhering to a general health regimen that includes a balanced diet, exercise, stress-relieving techniques, and yoga is frequently helpful for early healing. More than four weeks after infection, and occasionally even after initial symptom recovery, some SARS-CoV-2-infected individuals have new, recurring, or persistent symptoms and clinical findings. Patients with mild or asymptomatic acute infections can develop post-COVID problems. The medical and research sectors are still looking into clinical findings and post-acute symptoms. Health issues can affect physical and mental wellbeing. Following an acute COVID-19 episode, patients may experience a range of symptoms, the most common being lethargy, low-grade fever, and cough, all of which are subject to recurrence and resolution. Additional symptoms observed include dyspnea, headaches, dysphagia, dyspnea, rashes, gastrointestinal distress, metabolic disturbances (such as poorly controlled diabetes), thromboembolic disorders, depression, and other mental health issues [37].

Currently, there is little evidence of COVID-19's aftereffects; however, further research is needed and is being aggressively conducted. All post-COVID-19 patients must receive follow-up care and be in good health, which requires a holistic approach. Post-acute COVID-19 appears to be a multi-system illness. Considering the patient as a whole, a clinical treatment is necessary. The following factors may contribute to prolonged recovery: deconditioning, immune reactions, such as posttraumatic stress disorder, relapse or reinfection, and inflammatory and other immune reactions. It can be difficult to distinguish between the symptoms caused by various factors and those resulting from post-COVID issues. In addition to the social isolation brought on by pandemic mitigation efforts, patients suffering from the acute and post-acute impacts of COVID-19 often experience symptoms of depression, anxiety, or mood swings. Additionally, some patients with post-COVID symptoms might not have tested positive for SARS-CoV-2 due to declining antibody levels, false-negative antibody testing during follow-up, or a lack of testing or erroneous testing during the acute period. The natural history of the SARS-CoV-2 infection is currently being studied. Scholars have investigated the frequency, mode of action, length, and intensity of symptoms following acute infection with SARS-CoV-2, along with the risk variables linked to illnesses that accompany COVID-19.Young people, including those who are physically fit before SARS-CoV-2 infection, have also experienced symptoms that persist for several months following acute sickness, whereas elderly patients and those with underlying medical issues may be at a higher risk of severe disease. A comprehensive and coordinated therapeutic strategy for COVID-19 aftercare is currently being developed by multidisciplinary teams assembled in post-acute COVID care clinics at various medical sites. Survivor support groups build social connections, offer assistance, and distribute resources to individuals who have survived COVID-19 and to other affected parties.

The entire spectrum of COVID-19, from its acute phase to longer-term impacts and problems, is still being actively investigated by the Centers for Disease Control and Prevention. To improve healthcare practices, clinical judgment, and the public health response to this virus, a deeper understanding of the natural history of SARS-CoV-2 infection and associated post-COVID sequelae will be established with the aid of this effort. Thus far,

children have largely avoided major illnesses and unfavorable outcomes. According to the available ICMR survey data, children between the ages of 10 and 17 years were seropositive (25.3%), which was comparable to that of adults prior to the start of the vaccine effort. It is surprising that there are fewer people under the age of 20 with confirmed COVID-19 cases than anticipated. This implies that while most children do not experience any symptoms, they are as vulnerable to infection as adults. Most symptomatic patients have only minor illnesses. The percentage of children among new cases increases gradually, as shown in nations where a sizable number of adults have received COVID-19 vaccination (in the US, the proportion increased from 14% to 24% in the second week of May and changed to 19.8% in the third week). Several experts predict that a third wave will disproportionately affect children. Therefore, it is imperative to prepare for any potential unexpected spike in COVID-19 cases in children. PHCs and HWCs, or primary healthcare centers, should be strengthened in addition to the current children's facilities, especially the intensive care unit (ICU) and high-dependency unit (HDU). The Government of India's Ministry of Health and Family Welfare has published guidelines for the Operationalization of COVID Care Services for children and adolescents. In light of this, the Indian Ministry of AYUSH has published the Home Care Guidelines for Children and AYUSH Practitioners' Advisory on Prophylactics in Children during the COVID-19 pandemic.

In Ayurveda, the concept of immunity is emphasized under Vyadhikshamatva, where Ojas and Bala play crucial roles. Oja is seen as a person's biological strength or Bala. According to Ayurveda, immune illnesses can be roughly categorized as Oja visramsa, Oja vyapat, or Oja kshaya. Oja is responsible for immunity against infections and resistance to the deterioration of the body. When Oja is in appropriate amounts, it preserves health; when it is insufficient (Oja kshaya), it causes disorders related to immunity in the body. Being in a vulnerable group means that, whether the third wave occurs or not, it becomes imperative to be ready to handle the diagnostic and therapeutic issues specific to the pediatric population before it occurs. Therefore, age-appropriate guidelines are needed to boost immunity in children, in addition to diet-centered and medication-complemented strategies in adults. Prototypes of these features can be found in traditional podiatric treatises, both mainstream (Kāūyapa Samhitā and Hārīta Samhitā) and vernacular (Ārogyakalpadruma). The theoretical basis and practical applications of food modification can be found in Kāśyapa Samhitā's Bhojyopakramanīya adhyāya and Yūṣanirdeśīya adhyāya. Pragmatic immunomodulatory techniques, such as Prakarsa formulations, are included in Ārogyakalpadruma. The Ministry of the AYUSH, Government of India recently released home quarantine recommendations for children. These rules are practical and efficient and incorporate both traditional and modern knowledge. Furthermore, if applied in accordance with regional and seasonal variances, oil massage, nasal medication, oil pulling, and herbal paste patches in the vertex (tailam) will guarantee not only disease prevention but also healthy growth and development of children, which is essential for the future of society. Development of anti-COVID-19 treatments. A graphical overview of phytomedicines, herbal remedies, bioactive substances, functional foods, and nutraceuticals is presented in Figure 6 [38].

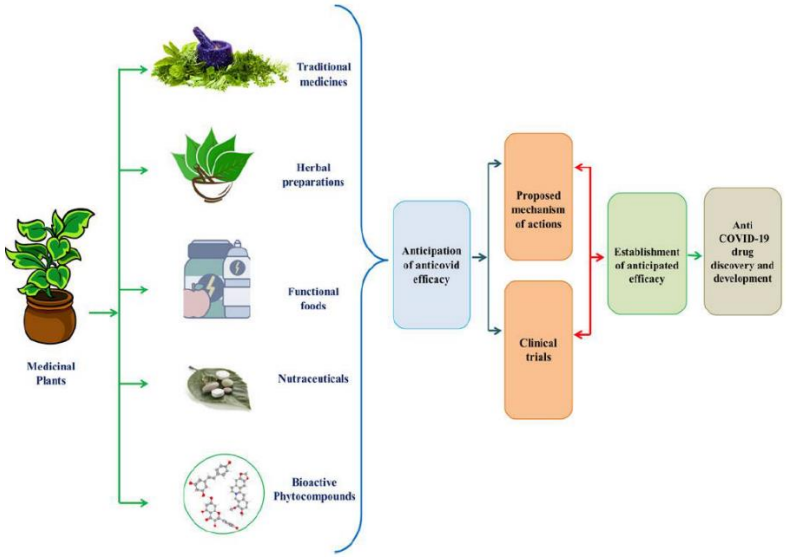

Figure 6. Phytomedicines, Herbal Remedies, Bioactive Substances, Functional Foods, and Nutraceuticals: A Graphical Overview for the Creation of Anti-COVID-19 Treatments [38]

Health Literacy and Informed Decision Making

A priority request for evidence and data was made by 170 member states of the World Health Organization (WHO) to enlighten policymakers, regulatory bodies, healthcare stakeholders, and the public about the safe, economical, and equitable use of traditional medicine. To maximize the contribution of traditional medicine to global health and sustainable development, the World Health Organization (WHO) has recently established the Global Center for Traditional Medicine in India. It focuses on innovation and technology; sustainability and equity; evidence and learning; and data and analytics. By 2030, the United Nations Sustainable Development Goals (SDG) of the United Nations will include 17 goals and 169 indicators. A distinctive holistic approach, in line with the SDG agenda, stresses environmental issues, societal health, and well-being through multidimensional performance indicators to address the growing need for value-based healthcare. Ayurveda is anticipated to substantially contribute to SDG 3 (Good Health and Well-Being), owing to its well-established practice and research in India. Numerous Ayurvedic research papers on COVID-19 during the most recent pandemic. Therefore, research on the development of an Ayurvedic clinical profile for COVID-19 patients has intensified. This is based on discussions with contemporary medical professionals who treat COVID-19 patients, as well as traditional Ayurvedic literature. Additionally, it witnessed the creation of workable plans in traditional medicine to handle crises during the pandemic. The transition from “pathy-based” to “people-centered holistic healthcare” demonstrates the necessity of a single healthcare system [39]. Potential phytochemicals from in silico investigations, such as Withaniasomnifera, have been found to have inhibitory effects on the SARS-CoV-2 virus in COVID-19.[20] According to certain studies, telemedicine has been used to facilitate Ayurvedic consultations during the COVID-19 lockdown. These studies highlight the platforms and communication channels used for patient evaluation, diagnosis, and prescription [40].

Originating in ancient India, Ayurveda is a complete system of natural healing with over 2000 years of evolutionary history. As opposed to “Veda,” which means “knowledge” or “science,” the Sanskrit word “Ayus” means “life process” or “life span.” Ayurveda, often translated as the “Science of Life,” places a

strong focus on preserving health and wellbeing as well as averting illness. Ayurveda is a knowledge system from which techniques for approving medication and treatment originate. To exclude chance, the clinical outcomes were thoroughly examined. To make the treatment plans, strict justification (yukti) was used based on cross-sectional (samanyatodrsta), prospective (sesavat), and retrospective (purvavat) observational methods. The cause and effect can be determined by comparing the therapy (paksa) to positive (sapaksa) and negative (vipaksa) controls. With its lengthy and continuous evolutionary history, Ayurveda produced an astonishing array of textbooks and teachers, making it the world's largest body of medical literature. Ayurveda's earliest manuscripts are at least a millennium older than the common period [10].

Research techniques derived from western science and medicine have been applied to Ayurveda, and ethnopharmacology is currently one of the most popular methodologies for studying Ayurveda. Serious ethnopharmacological research on Ayurvedic medicinal herbs began when the antihypertensive qualities of Rauwolfia serpentina were discovered. This resulted in the identification of the plant alkaloid reserpine, which has been shown to have antihypertensive properties. As Ayurvedic formulations and herbs are already used by humans and their clinical efficacy and safety are well established, there is great potential for breakthroughs in drug development. However, Ayurvedic formulas contain a variety of substances, and their intricate mechanisms of action depend on the interactions and antagonistic effects of a wide range of chemical components. Therefore, Ayurveda may not be a good fit for contemporary drug research techniques that separate the active compounds from herbs and herbal formulations. On the other hand, laboratory studies using in vitro, ex vivo, in silico, and in vivo models that examine the complexity of Ayurvedic formulations can help us understand how they work and make conventional formulations more effective and easier to deliver. This clinical-to-lab strategy, also known as reverse pharmacology, is pertinent to the scientific assessment of ethnopharmacological methods in traditional medical systems. Methods such as network pharmacology are more appropriate for dealing with the intricacy of Ayurvedic compositions. Researchers have found that the Ayurvedic mixture Triphala, which is made up of Terminalia chebula Retz, Phyllanthus emblica L., and Terminalia bellirica (Gaertn) Roxb, could be useful for studying how networks of drugs work. Traditional Ayurvedic medicine is constantly customized, and depending on the Ayurvedic diagnosis, multimodal treatments given to several patients with the same illness may change greatly. Consequently, it is difficult to perform clinical trials utilizing a randomized controlled design [9]. The need for scientific proof of safety and effectiveness is growing along with global interest in Ayurveda and other traditional therapies. Encouraging people to learn about the tenets, applications, and advantages of Ayurvedic treatment is part of promoting health literacy in the field. The following are some methods for increasing Ayurvedic health literacy.

1. Education Programs: To raise public awareness and comprehension of Ayurvedic concepts, including the three doshas (Pitta, Kapha), dietary recommendations, lifestyle choices, and herbal medicines, offer educational programs, workshops, and seminars [38].
2. Online Resources: Create and manage reputable informational pages, articles, videos, and other resources on websites, blogs, and social media channels devoted to Ayurveda, enabling people to study the principles and practices of the practice during their own leisure time.
3. Publications: To reach a wider audience, publish books, essays, pamphlets, and other materials on Ayurveda, which include a

range of topics such as fundamental concepts, real-world applications, case studies, and success stories.

4. Community Workshops: To engage people and solve their health concerns, arrange interactive sessions, demonstrations, and hands-on experiences at community workshops and health fairs centered around Ayurvedic principles and practices.
5. Collaborations: Work together with community organizations, wellness centers, holistic practitioners, and healthcare professionals to incorporate Ayurvedic concepts into current healthcare initiatives. This will expand the program's reach and encourage multidisciplinary collaborations.
6. Cultural Events: Take part in festivals, fairs, and other events to promote Ayurvedic practices, provide consultations, and hand out educational materials to promote awareness and appreciation of Ayurveda in a cultural context.
7. Continuing Education: To help healthcare workers, yoga instructors, and wellness coaches apply Ayurvedic principles to their work, improve their knowledge and abilities, and offer continuing education programs and certifications.
8. Online Courses: Provide flexible and accessible learning opportunities to learners globally by creating online courses and e-learning modules on Ayurveda for those who wish to enhance their comprehension and application of Ayurvedic concepts.
9. Public Health Campaigns: Start public health campaigns that highlight prevention, holistic well-being, and self-care techniques while endorsing Ayurvedic approaches to particular health issues or concerns.
10. Patient Education: Provide patients with the tools they need to use Ayurvedic principles and practices to make educated decisions about their health and well-being in healthcare settings such as clinics, hospitals, and wellness centers.

Through the application of these tactics, people can raise their level of Ayurvedic health literacy, enabling them to incorporate Ayurvedic principles into their daily lives for increased vitality and well-being [39].

Future Directions and Recommendations

Policy Recommendations for Integrating Ayurveda into Mainstream Healthcare Systems

Indian government officials created the Department of Indian Systems of Medicine and Homeopathy (ISM&H) within the Ministry of Health and Family Welfare in March 1995 to provide targeted attention to the advancement of the Ayurveda and other Indian medical systems. In November 2003, it changed its name to the Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homeopathy (AYUSH). Allopathic medicine is not the only recognized medical system; each letter in the word AYUSH represents an official medical system. Following the 2014 election of a new government, the Department of AYUSH was formally upgraded to become the Ministry of AYUSH, completed with an independent minister and mandate to bridge the gaps in healthcare delivery and outreach currently present in all areas of Indian medicine. The Ministry is in charge of developing policies, organizing, and carrying out plans and initiatives to improve the scope, caliber, and results of the AYUSH industry. Recently, Sowa Rigpa, a traditional medical system used by inhabitants of the Himalayan region, was acknowledged and included in the AYUSH family. The Ministry of AYUSH has many goals, some of which are as follows: (1) Improving the quality of education in teaching and training institutions; (2) Increasing the capacity of research and development organizations and ensuring that time-bound priority research programs are carried out; (3)

Putting plans into action for the promotion, conservation, cultivation, and sustainable development of medicinal plants used in AYUSH systems; (4) Standardizing and Quality Control of Drugs in accordance with Global Trends; (5) Mainstreaming and Integrating AYUSH services within the national health delivery network; and (6) Raising awareness of AYUSH through information, education, and communication.)[40].

Promotion of Ayurveda in Education and Practice

Education Policy

The Central Council of Indian Medicine (CCIM), a statutory body established under the terms of the Indian Medicine Central Council (IMCC) Act of 1970, oversees the Ayurvedic educational system and professional practice. To maintain consistent educational standards throughout the nation, the Central Government has enacted strict regulations governing the establishment of new colleges, the expansion of admission capacity in all fields of study or training, and the introduction of new or advanced programs in Ayurvedic colleges. Ayurvedic colleges number 265, of which 117 provide postgraduate programs in both public and private sectors. The World Health Organization (WHO) acknowledges Ayurveda because it embraced traditional medicine to accomplish the goal of "health for all" and because of its potential to help people receive primary healthcare. Ayurveda performed better than several other medicinal systems in terms of illness prevention and treatment. The present state of Ayurveda's workforce and institutional makeup in India is as follows: (i) 438,721 registered medical practitioners; (ii) 15,193 dispensaries; (iii) 753 hospitals; (iv) 35,182 beds; and (v) 219 teaching institutes. Ayurvedic physicians with degrees or comparable credentials are recognized as licensed medical practitioners under the Indian Medicine Central Council Act of the 1970s. The prerequisites for registration and the ability to practice Ayurvedic medicine clinically include Master's degrees in 22 different specializations from MD/MS programs and Bachelor of Ayurvedic Medicine and Surgery (BAMS) programs, as well as comparable training [40].

Industrial Initiatives

Formulation development and upholding quality requirements Authorized books listed in a schedule of the Drugs and Cosmetics Act, 1940 contain formulae or natural raw materials of plant, animal, mineral, or marine origin from which legally manufactured Ayurvedic medicines can be made with permission. Consequently, several formulations have been produced and used as Ayurvedic medications. The National Ayurvedic Formulary published 265 standardized formulations from classical texts in four volumes. This is to convince people that standardizing Ayurvedic medicines will lead to better quality control. The Ayurvedic Pharmacopoeia has published a total of thirteen volumes, split into two parts. These parts contained 645 monographs of quality standards for single drugs and 252 monographs of quality standards for formulations containing more than one ingredient. The pharmacopeial standards for Ayurvedic medicines are based on 12 assessment criteria: identity, purity, and strength. These include confirmed identification, chemical ingredients, allowable levels of heavy metals, pesticide residues, aflatoxins, and microbiological loads. Similarly, an Essential Drug List comprising over 250 medicines has been published to guarantee the availability of high-quality Ayurvedic medicines to health facilities nationwide. The states then assist in obtaining these medicines for the free public distribution of patients via dispensaries and other medical facilities. The framework for Ayurvedic drug quality control was developed by the Ayush Ministry, as shown in Fig. 7.

Figure 7. The Ministry of Ayush's Framework for Ayurvedic Drug Quality Control [40]

The Ayurvedic Pharmacopoeia Committee of Multidisciplinary Experts is responsible for developing and updating the standards for Ayurvedic medications, while the Pharmacopoeia Commission of Indian Medicine and Homoeopathy oversees this process. Using advanced machinery and analytical techniques, several scientific laboratories, including the Pharmacopoeial Laboratory for Indian Medicine (PLIM), which is an appellate laboratory under the terms of the Drugs and Cosmetics Act of 1945, are working to standardize the SOPs of Ayurvedic drugs. Even if the current pharmacopoeia setup has made significant progress, a unified pharmacopoeial infrastructure is meant to improve outcomes and coordination. Pharmacopoeial standards development is suggested to be enhanced for this reason by research carried out by government-accredited laboratories or other establishments. This endeavor will support the current pharmaceutical standards for single- and multi-ingredient medications made from plants, minerals, metals, and animals [8]. Standard Operating Procedures (SOP) pertaining to the manufacturing processes of formulations are utilized in the development of various quality standards. For example, chromatography atlases and pharmacognosy atlases are appended to quality standards to facilitate testing procedures and identify marker compounds or phytochemical standard materials for ASU&H drugs [8]. The framework for Ayurvedic medication quality monitoring combines parameters, such as DNA barcoding and fingerprinting of medicinal plant ingredients. Under the guidelines of the Pharmaceuticals and Cosmetics Act of 1940 and its regulations, the Ministry of AYUSH's Drug Control Cell is responsible for the regulation and quality control of Ayurvedic pharmaceuticals. To ensure that Ayurvedic and other traditional medicines meet the legal requirements for quality control, the Drug Control Cell collaborates with state licensing authorities, drug controllers, and drug testing laboratories. The process of amending regulatory regulations is ongoing and is conducted in response to perceived demands and new developments in the field of natural medicine quality control. Several efforts have been made to monitor the adherence of manufacturing companies to GMPs, recommended shelf lives, and proof of the efficacy and safety of pharmaceuticals. To establish a vertical organization for AYUSH drugs under the Central Drug Standards Control Organization, which is led by the Drugs Controller General, the government approved

the creation of extra senior-level regulatory roles. States receive financial assistance to improve their functional and infrastructural capacities for the manufacturing, examination, and regulation of Ayurvedic and other traditional medicines.

Conclusion

The COVID-19 pandemic has highlighted the importance of exploring complementary healthcare systems such as Ayurveda in the post-pandemic era. With its holistic approach to health promotion, personalized treatments, and emphasis on immunity, Ayurveda offers valuable insights and potential solutions to contemporary health challenges. The integration of Ayurveda into mainstream healthcare systems presents opportunities to enhance healthcare delivery, improve patient outcomes, and foster greater health literacy among individuals. Through policy initiatives, educational reforms, and industrial initiatives, governments and healthcare authorities can promote the integration of Ayurveda into modern healthcare systems, thereby empowering individuals to make informed decisions regarding their health and well-being. By leveraging the strengths of both traditional and modern medicine, we can create a more resilient and inclusive healthcare system that addresses the diverse health needs of populations worldwide.

Conflict of Interest

The authors (s) have no conflicts of interest regarding the research, authorship, or publication of this article.

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