

Assessing the Role of Medicinal Plants in Combating Respiratory Diseases: A Questionnaire Survey in Kohat, Pakistan

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Abstract

Background: The impact of respiratory disorders on healthcare systems is still a major problem for global health. Despite the fact that modern medicine has made great strides in treating these ailments, complementary and alternative ways of managing respiratory health are gaining popularity.

Objective: The main objective of this study was to assess the efficiency of medicinal plants in combating respiratory diseases in Kohat, Pakistan.

Methodology: A questionnaire-based survey was conducted at DHQ Teaching Hospital Kohat from April 2022 to March 2023. The study included 82 patients diagnosed with respiratory disorders, who provided informed consent to participate. Descriptive statistics, such as frequencies and percentages, were utilized to characterize the participant's demographic characteristics and consumption habits for medicinal plants.

Results: Among the 82 patients, a greater number of participants (n=57; 69.51%) reported utilizing medicinal

herbs to treat respiratory conditions. Liquorice (n=13; 23%) was the most often utilized medicinal plant, followed by Puthkanda (n=11; 19%) and Ginger (n=9 ; 16%). The leaves (n=19; 34%), fruits (n=15; 26%), and stem (n=12; 21%) were the most often used plant components, while decoction (n=14; 25%) and extract (n=13; 23%) were the favored preparation techniques. More than one-third of patients (n=46; 80.70%) suggested using medicinal plants to treat respiratory conditions.

Conclusion: The survey reveals significant utilization of medicinal plants for managing respiratory diseases in Kohat, Pakistan, emphasizing their potential as complementary approaches to conventional treatments. Integrating traditional knowledge into modern healthcare practices could lead to improved respiratory health outcomes and overall well-being.

Keywords: medicinal plants, respiratory disease, traditional medicine, herbal medicine, Pakistan

Introduction

Respiratory diseases remain a critical global health concern, affecting millions and imposing a significant strain on healthcare systems. The prevalence of respiratory conditions, such as acute infections, chronic obstructive pulmonary disease (COPD), asthma, and related disorders, remains alarmingly high, resulting in substantial morbidity and mortality. Despite remarkable advancements in modern medicine for treating respiratory illnesses, there is an increasing interest in

investigating complementary and alternative methods for managing respiratory health [1-3].

For a long time, medicinal plants have been an essential part of traditional healthcare systems all around the world. Herbal remedies have been used to treat various illnesses, including respiratory disorders, for centuries. Their effectiveness has been passed down through generations, making them a respected and enduring healing method. Medicinal plants provide a natural source of bioactive compounds with potential therapeutic

properties that can ease respiratory symptoms and enhance lung function. These herbal remedies have attracted attention as a supplementary approach to conventional treatments for respiratory conditions, offering the possibility of improved symptom relief, fewer side effects, and higher patient satisfaction [4-7].

In Pakistan, a country blessed with abundant biodiversity, traditional medicine remains deeply rooted in the culture. The use of medicinal plants for managing respiratory health remains widespread, with many remedies employed by communities throughout the nation. Gaining an understanding of the perceptions and practices surrounding these herbal treatments in Pakistan can offer valuable insights into their potential effectiveness in combating respiratory diseases [8-10].

The main objective of this study was to assess the efficiency of medicinal plants in combating respiratory diseases in Kohat, Pakistan. Through gathering data from a diverse group of participants, we aim to gain a comprehensive view of how medicinal plants are used, their benefits, limitations, and accessibility in managing respiratory conditions. The results of this research will provide valuable insights into the current practices related to herbal remedies for respiratory health, offering a better understanding of their potential as complementary or alternative approaches to conventional treatments.

Materials and Methods

A questionnaire based survey was conducted to investigate the utilization of medicinal plants in treating respiratory disorders. The study was conducted from April 2022 to March 2023 at the DHQ Teaching Hospital Kohat. Before beginning the research, the Ethical Council of IRB of KUST granted the study's ethical clearance.

Data Collection

The study included 82 patients who fulfilled the inclusion criteria, and they actively participated by completing the questionnaire. Before conducting face-to-face interviews, the objectives of the research were explained to the participants, and their informed consent was obtained.

Questionnaire Design and Questionnaire Content

A total of 18 questions made up the questionnaire, which was created especially for this study. Participants had the possibility of providing extra replies in addition to the multiple-choice format that was used for the majority of the questions. The questionnaire covered a variety of

major topics, including sociodemographic information, medical information and specific information about the use of medicinal plants.

Inclusion Criteria

1. Participants had to be 18 years of age or older.
2. Participants must have been diagnosed with a respiratory disorder by a healthcare professional.
3. Individuals who voluntarily expressed their interest and provided informed consent to be part of the study.

Exclusion Criteria

1. Individuals below 18 years of age were excluded from the study.
2. Participants who did not have a confirmed respiratory disorder diagnosis were excluded.
3. Individuals who were unable to provide informed consent due to cognitive impairment or other reasons.

Statistical Analysis

Microsoft Office Excel and the Statistical Package for the Social Sciences (SPSS) version 26.0 software were used to record and evaluate the data that were gathered. Descriptive statistics, including frequencies and percentages, were used to summarize the demographic characteristics and patterns of medicinal plant usage among the participants. Statistical significance was defined as a p value less than 0.05.

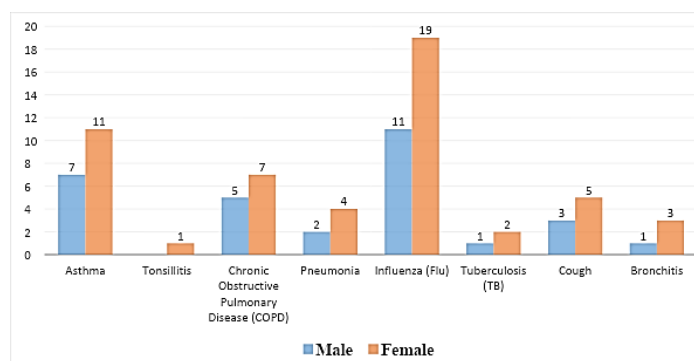
Results

The research included 82 patients, of which 52 (63.42%) were female and 30 (36.52%) were male (table 1). According to the gender breakdown, both males and females acknowledged to using plants: 63.33% of men (n=19) and 73.07% of females (n=38). Regarding age, the 46–54 age group (n=17; 29.83%) reported the greatest plant usage, while the 18–27 age group (n=5; 8.78%) reported the lowest. When it came to marital status, those who were married utilized plants the most (n=32; 56.14%), followed by participants with a university degree (n=19; 33.33%). Plant use was most prevalent among individuals with high incomes (n=28; 49.12%), whereas it was least prevalent among those with low incomes (n=8; 14.04%). Compared to urban participants (n=41; 71.93%), fewer plants were utilized overall by those living in rural areas (n=16; 28.07%). The use of plants in respiratory disorders was significantly associated with gender (p=0.01) and location (p=0.002).

Table 1: Exploring plant use patterns: a demographic analysis of study participants

Variables		Plant use			P values
		Yes	No	Total	
		n (%)	n (%)	n (%)	
Gender	Male	19 (63.33%)	11 (36.67%)	30 (36.58)	0.01
	Female	38 (73.07%)	14 (26.93%)	52 (63.42)	
Age	18-27	5 (8.78%)	9 (36.0%)	14 (17.07%)	0.068
	28-36	10 (17.54%)	4 (16.0%)	14 (17.07%)	
	37-45	14 (24.56%)	6 (24.0%)	20 (24.39%)	
	46-54	17 (29.83%)	2 (8.0%)	19 (23.18%)	
	Above 55	11 (19.29%)	4 (16.0%)	15 (18.29%)	
Marital Status	Single	15 (26.32%)	7 (28.0%)	22 (26.83%)	0.073
	Married	32 (56.14%)	12 (48.0%)	44 (53.66%)	
	Other	10 (17.54%)	6 (24.0%)	16 (19.51%)	
Education status	Illiterate	4 (7.01%)	1 (4.0%)	5 (6.09%)	0.089
	Primary school	7 (12.29%)	3 (12.0%)	10 (12.19%)	
	Middle school	12 (21.05%)	7 (28.0%)	19 (23.17%)	
	High school	15 (26.32%)	5 (20.0%)	20 (24.39%)	
	University	19 (33.33%)	9 (36.0%)	28 (34.14%)	
Income	Low	8 (14.04%)	4 (16.0%)	12 (14.63%)	0.097
	Medium	21 (36.84%)	9 (36.0%)	30 (36.59%)	
	High	28 (49.12%)	12 (48.0%)	40 (48.78%)	
Inhabitation	Rural	16 (28.07%)	7 (28.0%)	23 (28.05%)	0.002
	Urban	41 (71.93%)	18 (72.0%)	59 (71.95%)	

According to medical data, it demonstrates that females account for 63.41% (n=52) of the cases, while males represent 36.59% (n=30). The most common respiratory disease in both sexes was asthma, which affects 21.15% (n=11) of females and 23.33% (n=7) of males. Surprisingly, influenza (Flu) accounts for 36.58% of all cases (n=30), making it the most prevalent respiratory condition overall (figure 1).

**Figure 1:** Gender disparities in respiratory diseases: a comprehensive analysis of prevalence among females and males

Patients suffering from respiratory diseases reported utilizing a diverse selection of 12 medicinal plant types to address various conditions (table 2). Among 57 patients who sought relief from respiratory conditions using medicinal plants, Liquorice emerged as the most popular option, with 13 patients choosing its advantages. Puthkanda came in second with 11 patients, while ginger came in third with 9 patients. Peppermint usage was also notable, with 7 patients finding it helpful for their respiratory disease (figure 2). Decoction (n=14; 25%) and extract (n=13; 23%) were determined to be the two most preferred methods of preparation (figure 3). In addition, the plant's leaves, which accounted for (n=19; 34%), fruits, (n=15; 26%), and stem, (n=12; 21%), were the parts that were utilized the most frequently (Figure 4).

Table 2: Medicinal Plants Used by Patients for Treating Various Respiratory Diseases

Medicinal Plants	Family Name	Common Name	Plant Part Used	Preparation Method	Therapeutic Effects
<i>Mentha Piperita</i>	Lamiaceae	Peppermint	Leaves, Stem	Paste, Infusion, Extract, Juice	Cough, Influenza
<i>Viola Odorata</i>	Violaceae	Banafsha	Stem, Root	Infusion, Extract And Decoction	Asthma, Influenza
<i>Justicia Adhatoda</i>	Acanthaceae	Malabar Nut	Leaves	Extract, Paste, Ash, Powder, Decoction	Asthma, Cough, Tuberculosis
<i>Acacia Arabica</i>	Mimosaceae	Kiker	Fruit, Leaves	Decoction, Extract, Powder	Bronchitis, Tonsillitis
<i>Achyranthes Aspera</i>	Amaranthaceae	Puthkanda	Root	Decoction, Powder, Extract, Paste, Ash	Asthma, Bronchitis, Cough, Pneumonia
<i>Cordia Obliqua</i>	Boraginaceae	Lasora	Fruit, Leaves	Powder, Extract	Cough, Tuberculosis
<i>Glycyrrhiza Glabra</i>	Fabaceae	Liquorice	Roots	Decoction, Extract, Paste	Asthma, Cough, Pneumonia
<i>Ficus Religiosa</i>	Papilionaceae	Peepal	Fruit, Leaves	Extract, Paste, Ash	Asthma, Tuberculosis
<i>Phyla Nodiflora</i>	Verbenaceae	Cape Weed	Root, Stem, Leaves	Infusion	Asthma, Influenza
<i>Curcuma Longa</i>	Zingiberaceae	Turmeric	Underground Stem	Extract, Decoction, Infusion	Tuberculosis
<i>Zingiber Officinale</i>	Zingiberaceae	Ginger	Stem	Juice, infusion, extract and paste	Cough, influenza, chronic obstructive pulmonary disease
<i>Phoenix Dactylifera</i>	Arecaceae	Date palm	Fruit	Decoction, extract, powder	Bronchitis

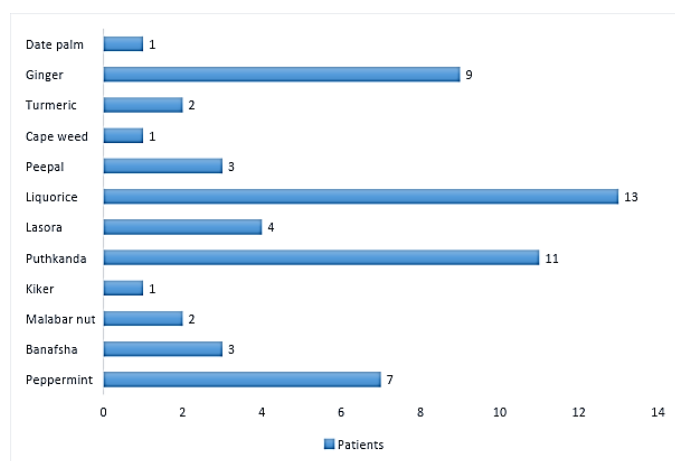


Figure 2: Patient Preferences for Medicinal Plants in Managing Respiratory Conditions

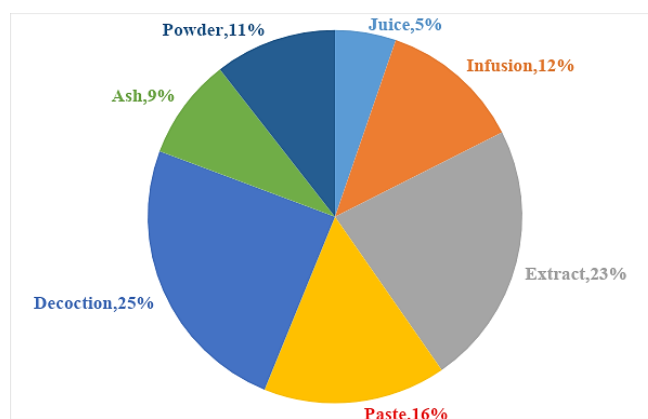


Figure 3: Preparation methods of medicinal plants for managing respiratory disorders

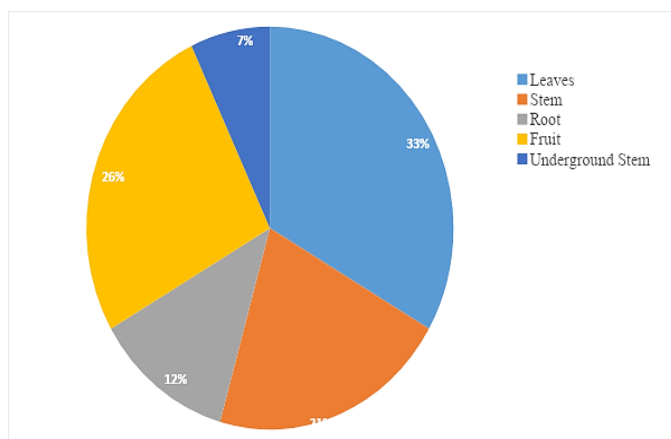


Figure 4: Plant Parts Utilized for Treating Respiratory Diseases

The information on variety of factors that affect patients' preferences for plants was displayed in table 3. Patients predominantly use plants for helping in treatment (n=21; 36.84%) and to feel good (n=17; 29.82%). The preferred sale channels are friends and relatives (n=19; 33.33%) and herbalists (n=15; 26.32%). Most patients believe in the beneficial effects of plants (n=43; 75.44%), while a smaller percentage considers them harmful (n=9; 15.79%) or neutral (n=5; 8.77%). The majority of patients are receptive to plant use recommendations (n=46; 80.70%), but a significant minority prefers not to receive such suggestions (n=11; 19.30%).

Table 3: Exploring Patient Perspectives and Utilization of Plants for Health Purpose

Characteristics	Number of Patients	Percentage
Reasons for plant use		
To feel good	17	29.82
To help treatment	21	36.84
To treat disease	13	22.81
To reduce side effects	6	10.53
Sale Channel Preferences		
TV	4	7.02
Pharmacist	7	12.28
Friends and relatives	19	33.33
Social Media	12	21.05
Herbalist	15	26.32
Benefit status of plants		
Beneficial	43	75.44
Harmful	9	15.79
Neutral	5	8.77
Recommendation of plant use		
Yes	46	80.70
No	11	19.30

Discussion

The present study aimed to comprehensively explore the role of medicinal plants in managing respiratory diseases through a comprehensive questionnaire survey conducted in Kohat, Pakistan. The burden of respiratory

diseases on the world's healthcare systems is a major problem for global health. Despite significant advances in modern medicine, there is a growing interest in exploring complementary and alternative methods for respiratory health management, with medicinal plants being integral components of traditional healthcare systems for centuries. This research provides valuable insights into the utilization and benefits of medicinal plants in managing respiratory conditions. The results underscore the potential of herbal remedies as complementary or alternative approaches to conventional treatments for respiratory ailments, making this research essential in understanding the current practices surrounding herbal treatments for respiratory health in Pakistan, a country with rich biodiversity and deeply rooted traditional medicine practices.

Over half of the individuals with respiratory disorders examined for this study (n=57; 69.51%) admitted to utilizing therapeutic herbs. Notably, women used plants at a greater rate than males did (n=38; 73.07% vs. n=19; 63.33%). Additionally, those who lived in cities were more likely to utilize medicinal herbs (n=41; 71.93%). These results are consistent with international research [11–13], which repeatedly demonstrate that women are leading in the use of complementary treatments, including herbal medicines, for the treatment of medical disorders.

The study identified 12 medicinal plants used by patients for managing respiratory disorders, with liquorice (23%), Puthkanda (19%), and Ginger (16%) emerging as the most favored choices. These results support earlier research and are in line with traditional knowledge [14–17], highlighting the popularity of liquorice, Puthkanda, and ginger in traditional medicine for managing respiratory ailments. Liquorice is renowned for its potent anti-inflammatory and antioxidant properties, making it a favored option for conditions like coughs, bronchitis, and asthma. Puthkanda is valued for its expectorant and bronchodilatory properties, effectively alleviating respiratory disorders such as chronic bronchitis and chest congestion. Ginger exhibits impressive antimicrobial and anti-inflammatory characteristics, making it a beneficial herbal remedy for respiratory issues like asthma and bronchitis, with its bronchodilatory effects helping in airway relaxation. These findings further reinforce the potential of these medicinal plants as valuable herbal remedies in the management of respiratory conditions. Additionally, the study found that the most preferred preparation methods were decoction (25%) and extract (23%), while the leaves (34%), fruits (26%), and stem (21%) were the most frequently utilized parts of the plants. Our study's preparation techniques and plant components were comparable to those employed in other investigations [18, 19].

Apart from investigating the usage of medicinal plants, the study also explored patient perspectives and their adoption of plants for health-related reasons. The results were consistent with earlier studies [20–22], revealing that patients mainly used plants to aid in treatment (36.84%) and to improve overall well-being (29.82%). A

large majority of patients (75.44%) firmly believed in the positive effects of plants, demonstrating a lasting trust in the healing power of herbal remedies. Remarkably, most patients were open to receiving recommendations for plant usage (80.70%), indicating a receptiveness to incorporating traditional healing practices into their healthcare routines.

Conclusion

The questionnaire survey conducted in Kohat, Pakistan, reveals a significant utilization of medicinal plants for combating respiratory diseases. The popularity of specific herbal remedies like liquorice, Puthkanda, and Ginger, combined with the patients' strong belief in their effectiveness, underscores the enduring relevance of traditional medicine in managing respiratory health. These findings offer valuable insights into the potential benefits of herbal remedies as complementary or alternative approaches to conventional treatments. Integrating traditional knowledge into modern healthcare practices could lead to improved respiratory health outcomes and contribute to the overall well-being of individuals affected by respiratory conditions. Further research and collaboration between traditional and modern medicine fields are crucial for unlocking the full therapeutic potential of medicinal plants and promoting comprehensive respiratory care.

References

- da Silva AL, Cruz FF, Rocco PR, Morales MM. New perspectives in nanotherapeutics for chronic respiratory diseases. *Biophysical reviews*. 2017 Oct;9:793-803. DOI: [10.1007/s12551-017-0319-x](https://doi.org/10.1007/s12551-017-0319-x)
- Bishwajit G, Tang S, Yaya S, Feng Z. Burden of asthma, dyspnea, and chronic cough in South Asia. *International journal of chronic obstructive pulmonary disease*. 2017 Apr 6:1093-9. DOI: [10.2147/COPD.S133148](https://doi.org/10.2147/COPD.S133148)
- Yin SY, Wei WC, Jian FY, Yang NS. Therapeutic applications of herbal medicines for cancer patients. *Evidence-Based Complementary and Alternative Medicine*. 2013 Oct;2013. DOI: [10.1155/2013/302426](https://doi.org/10.1155/2013/302426)
- Jamshidi-Kia F, Lorigooini Z, Amini-Khoei H. Medicinal plants: Past history and future perspective. *Journal of herbmed pharmacology*. 2017 Dec 29;7(1):1-7. doi: [10.15171/jhp.2018.01](https://doi.org/10.15171/jhp.2018.01).
- Usman MR, Jain BV, Patil KG, Sonawane YP. Concomitant Use of Local Herbal Cornucopia in Providing Relief from Respiratory Disorders. *Journal of Survey in Fisheries Sciences*. 2023 Mar 13;10(2S):1054-61. DOI: <https://doi.org/10.17762/sfs.v10i2S.794>.
- Khazdair MR, Ghafari S, Sadeghi M. Possible therapeutic effects of *Nigella sativa* and its thymoquinone on COVID-19. *Pharmaceutical biology*. 2021 Jan 1;59(1):694-701. DOI: [10.1080/13880209.2021.1931353](https://doi.org/10.1080/13880209.2021.1931353).
- Zhang J, Hu K, Di L, Wang P, Liu Z, Zhang J, Yue P, Song W, Zhang J, Chen T, Wang Z. Traditional herbal medicine and nanomedicine: Converging disciplines to improve therapeutic efficacy and human health. *Advanced Drug Delivery Reviews*. 2021 Nov 1;178:113964. doi: [10.1016/j.addr.2021.113964](https://doi.org/10.1016/j.addr.2021.113964).
- Rehman F, Hussain T, Abdullah M, Ashraf I, Ch KM, Rafay M, Bibi I. Ethnobotanical Survey: Common Medicinal Plants Used By People Of Cholistan Desert. *The Professional Medical Journal*. 2015 Oct 10;22(10):1367-72. DOI: <https://doi.org/10.29309/TPMJ/2015.22.10.1047>.
- Lawal IO, Olufade II, Rafiu BO, Aremu AO. Ethnobotanical survey of plants used for treating cough associated with respiratory conditions in Ede South local government area of Osun State, Nigeria. *Plants*. 2020 May 20;9(5):647. DOI: [10.3390/plants9050647](https://doi.org/10.3390/plants9050647).
- Younis W, Asif H, Sharif A, Riaz H, Bukhari IA, Assiri AM. Traditional medicinal plants used for respiratory disorders in Pakistan: a review of the ethno-medicinal and pharmacological evidence. *Chinese medicine*. 2018 Dec;13(1):1-29. DOI: [10.1186/s13020-018-0204-y](https://doi.org/10.1186/s13020-018-0204-y).
- Jeitler M, Erehman A, Koppold DA, Ortiz M, Jerzynski L, Stöckigt B, Rotter G, Blakeslee S, Brinkhaus B, Michalsen A, Seifert G. Self-care and lifestyle interventions of complementary and integrative medicine during the COVID-19 pandemic—A cross-sectional study. *Frontiers in medicine*. 2023 Jan 9;9:1033181. DOI: [10.3389/fmed.2022.1033181](https://doi.org/10.3389/fmed.2022.1033181).
- ERARSLAN ZB, Sinan AY, KÜLTÜR Ş. A questionnaire-based study on medicinal plant use in respiratory diseases. *Journal of Faculty of Pharmacy of Ankara University*. 2020 Sep 9;44(3):437-51. Doi: [10.33483/jfpau.754110](https://doi.org/10.33483/jfpau.754110)
- Rana D, Bhatt A, Lal B, Parkash O, Kumar A, Uniyal SK. Use of medicinal plants for treating different ailments by the indigenous people of Churah subdivision of district Chamba, Himachal Pradesh, India. *Environment, Development and Sustainability*. 2021 Feb;23:1162-241. DOI: [10.1007/s10668-020-00617-0](https://doi.org/10.1007/s10668-020-00617-0).
- Zahoor M, Yousaf Z, Yasin H, Shinwari ZK, Haroon M, Saleh N, Younas A, Aftab A, Shamsheer B, Qamar NR, Rashid M. Ethnobotanicals and commercial trends of herbal markets in Punjab, Pakistan. *Journal of Herbal*

- Medicine. 2021 Apr 1;26:100425. DOI:[10.1186/s13002-017-0151-1](https://doi.org/10.1186/s13002-017-0151-1).
15. Mehta PP, Ghoshal D, Pawar AP, Kadam SS, Dhapte-Pawar VS. Recent advances in inhalable liposomes for treatment of pulmonary diseases: concept to clinical stance. *Journal of drug delivery science and technology*. 2020 Apr 1;56:101509. DOI:[10.1016/j.jddst.2020.101509](https://doi.org/10.1016/j.jddst.2020.101509).
 16. Timalisina D, Pokhrel KP, Bhusal D. Pharmacologic activities of plant-derived natural products on respiratory diseases and inflammations. *BioMed Research International*. 2021 Oct 4;2021:1-23. DOI: [10.1155/2021/1636816](https://doi.org/10.1155/2021/1636816).
 17. Rathinavel T, Palanisamy M, Palanisamy S, Subramanian A, Thangaswamy S. Phytochemical 6-Gingerol–A promising Drug of choice for COVID-19. *Int J Adv Sci Eng*. 2020 May 29;6(4):1482-9. <https://doi.org/10.29294/IJASE.6.4.2020.1482-1489>.
 18. Afzal S, Ahmad HI, Jabbar A, Tolba MM, AbouZid S, Irm N, Zulfiqar F, Iqbal MZ, Ahmad S, Aslam Z. Use of medicinal plants for respiratory diseases in Bahawalpur, Pakistan. *BioMed Research International*. 2021 Apr 5;2021. DOI: [10.1155/2021/5578914](https://doi.org/10.1155/2021/5578914).
 19. Okoli RI, Aigbe O, Ohaju-Obodo JO, Mensah JK. Medicinal herbs used for managing some common ailments among Esan people of Edo State, Nigeria. *Pakistan Journal of Nutrition*. 2007;6(5):490-6. DOI: [10.3923/pjn.2007.490.496](https://doi.org/10.3923/pjn.2007.490.496).
 20. Gazzaneo LR, De Lucena RF, de Albuquerque UP. Knowledge and use of medicinal plants by local specialists in an region of Atlantic Forest in the state of Pernambuco (Northeastern Brazil). *Journal of ethnobiology and ethnomedicine*. 2005 Dec;1:1-8. doi: [10.1186/1746-4269-1-9](https://doi.org/10.1186/1746-4269-1-9).
 21. Giday M, Asfaw Z, Woldu Z. Medicinal plants of the Meinit ethnic group of Ethiopia: an ethnobotanical study. *Journal of ethnopharmacology*. 2009 Jul 30;124(3):513-21. DOI: [10.1016/j.jep.2009.05.009](https://doi.org/10.1016/j.jep.2009.05.009).
 22. Asadbeigi M, Mohammadi T, Rafieian-Kopaei M, Saki K, Bahmani M, Delfan M. Traditional effects of medicinal plants in the treatment of respiratory diseases and disorders: an ethnobotanical study in the Urmia. *Asian Pacific journal of tropical medicine*. 2014 Sep 1;7:S364-8. DOI: [10.1016/S1995-7645\(14\)60259-5](https://doi.org/10.1016/S1995-7645(14)60259-5).