

CAPITAL UNIVERSITY OF SCIENCE AND
TECHNOLOGY, ISLAMABAD



**Ethnobotanical and
Ethnopharmacological Survey of
Village Foja Dhara, Jhang
District, Punjab, Pakistan**

by

Hijab Fatima

A thesis submitted in partial fulfillment for the
degree of Master of Philosophy

in the

Faculty of Pharmacy

Department of Pharmacognosy

2026

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Acknowledgement

First and foremost, I am grateful to Allah, the Most Gracious and the Most Merciful, for blessing me with strength, courage, and wisdom to complete this academic journey. I would like to express my sincere appreciation to Dr. Muhammad Saalim, my research supervisor, for his guidance, continuous motivation, and constructive feedback throughout the course of this study. His dedication to academic excellence and mentorship influenced the quality of my research in the best positive way.

I am also sincerely thankful to all the faculty members of the Department of Pharmacy, Capital University of Science and Technology, for providing an excellent academic environment and motivating me throughout this MPhil journey. I wish to express my profound gratitude to my beloved parents for their unconditional love, endless prayers, and trust in my abilities. Their constant support has been the greatest source of strength throughout my academic journey.

My heartfelt thanks are extended to the people of Village Foja Dhara, District Jhang, especially all the informants and traditional knowledge holders who generously shared their valuable ethnobotanical knowledge and willingly participated in this study. Their cooperation, hospitality, and trust made this research possible. I am equally grateful to my dearest friends for their continuous encouragement and moral support during the completion of this work.

Finally, I extend my sincere appreciation to everyone who, directly or indirectly, contributed to the successful completion of this research. May Allah reward all of them abundantly for their kindness.

(Hijab Fatima)

Abstract

Traditional medicine continues to be an important part of primary health care in many rural Pakistani communities. However, the indigenous ethnobotanical knowledge associated with these plants is rapidly disappearing due to urbanization, modernization and the oral transmission of knowledge. Despite the rich flora diversity of the Punjab province, quantitative ethnobotanical documentation of the semi-arid plain of Jhang district is still limited. This study was therefore carried out to systematically document the medicinal plants used by the residents of the village Foja Dhara in the district Jhang, Punjab, Pakistan, and to assess their cultural significance using standard quantitative ethnobotanical indices.

A descriptive, cross-sectional ethnobotanical and ethnopharmacological survey was carried out from January to April 2025. Data was collected from 97 knowledgeable informants selected by means of a multi-stage sampling approach which included a purposive and systematic random sampling. Information on medicinal plant species, common names, parts of the plant, preparation methods, therapeutic uses and routes of administration was obtained by means of a validated semi-structured questionnaire. Plant samples were collected, taxonomically validated and quantitatively analysed by reference to the Relative Frequency of citation (RFC), Use value (UV), Fidelity level (FL) and Informant Consensus Factor (ICF).

The survey documented 49 medicinal plant species belonging to 32 botanical families, which represents 325 reports on the medicinal products used to treat 17 categories of diseases. The most widely distributed families were the Fabaceae, Asteraceae and Moraceae. Leave was the most commonly used plant component, followed by fruit and seeds. The predominant method of preparation of the medicinal product was paste, while oral administration was the main route of administration. The most frequently treated disease category was dermatological, followed by gastrointestinal, respiratory, metabolic and febrile. Based on high RFC and UV values, quantitative analysis identified *Ficus benghalensis* and *Calotropis procera* as the most culturally relevant medicinal plants. Several plant

species also demonstrated high Fidelity Levels for specific diseases, reflecting a strong therapeutic preference among the informants. High Informant Consensus Factor values observed for selected ailment categories like dermatological diseases indicated substantial agreement among respondents regarding the use of particular medicinal plants.

This study is the first comprehensive quantitative ethnobotanical documentation of the village of Foja Dhara and one of the few such surveys carried out in the Jhang district. The findings preserve valuable indigenous medicinal knowledge at risk of being lost and identify culturally important species that may be promising candidates for future phytochemical, pharmacological, toxicological and clinical research.

Keywords: Ethnobotany; Medicinal plants; Traditional knowledge; Quantitative ethnobotany; Relative Frequency of Citation; Use Value; Fidelity Level; Informant Consensus Factor; District Jhang; Pakistan.

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Abbreviations

ConSEFS	Consensus Statement on Ethnopharmacological Field Studies
FC	Frequency of Citation
FL	Fidelity Level
FL (%)	Fidelity Level Percentage
ICF	Informant Consensus Factor
N	Total Number of Informants
Np	Number of Informants Reporting a Plant for a Particular Ailment
Nt	Number of Plant Taxa Used
Nur	Number of Use Reports
RFC	Relative Frequency of Citation
TCIM	TCIM Traditional, Complementary and Integrative medicine
UV	Use Value
Ui	Number of Use Reports Reported by Each Informant

Chapter 1

Introduction

1.1 Background of the Study

Medicinal plants have been used for medicinal purposes since the earliest records of human civilization. Archaeological and historical evidence suggests that plant-based medicines were used in ancient civilizations such as Mesopotamia, Egypt, China, and the Indian subcontinent long before modern pharmaceutical science [1]. Despite the remarkable progress made in synthetic drugs, medicinal plants continue to play a central role in health care worldwide, especially in developing countries where they are affordable, accessible, and culturally accepted [2]. The World Health Organization identifies traditional medicine as an important component of primary healthcare, and a huge proportion of populations in Asia and Africa continue to rely on plant-based remedies for their routine health needs (WHO, 2019). Additionally, many important modern drugs have been discovered directly or indirectly from plants, including aspirin from willow (*Salix* spp.), quinine from *Cinchona* spp., digoxin from foxglove (*Digitalis purpurea*), and artemisinin from sweet wormwood (*Artemisia annua*) [3]. Ethnobotany is the study of human-plant relationships. In particular, it focuses on how communities perceive, manage, and use plant resources for medicinal purposes, food, rituals, and other cultural uses [4].

It bridges between the biological and social sciences and contributes to biodiversity conservation, anthropology, and pharmacology [5].

Ethnopharmacology is a closely related discipline that assesses traditional medicinal products and investigates their pharmacological activity, efficacy, mechanism of action, and safety using modern scientific approaches [6].

Pakistan is a major player in world's ethnobotanical landscape due to its diverse geography, from the Himalayas and Hindu Kush mountains to the Salt Range, fertile alluvial plains, arid deserts, and coastal ecosystems. The country is home to over 6,000 species, of which approximately 400 to 600 are used in traditional medicine [7].

Traditional health care systems, including Unani medicine and local folk remedies continue to be the a primary source of health care for many rural communities with limited access to health services [8].

Punjab is the the most populous province of Pakistan. It has a rich ethnomedicinal legacy. Studies in various regions have shown the use of herbal plant remedies for gastrointestinal disorders, respiratory diseases, skin infections, musculoskeletal pain, and inflammatory disorders[9].

District Jhang is situated between the Chenab and Jhelum rivers. It is predominantly rural and many residents continue to rely on locally available medicinal plants for the treatment of common ailments.

Village Foja Dhara is a typical rural community where traditional medical knowledge is still actively practised but it is not yet scientifically documented. The study was carried out to document the medicinal plants used by inhabitants of Foja Dhara village and to use quantitative ethnobotanical indices to assess their cultural significance to preserve indigenous knowledge, and to promote biodiversity and sustainable development [10].

The findings should preserve valuable native knowledge and provide a scientific basis for future ethnopharmacological research.

1.2 Functional Definitions

1.2.1 Ethnobotany

Ethnobotany is a scientific study of the dynamic relationship between human and plants, focusing on how communities perceive, manage, and use plant resources in various cultural settings [11].

1.2.2 Ethnopharmacology

Ethnopharmacology is an interdisciplinary field that studies and scientifically evaluates the pharmacological activity, efficacy, mechanisms of action, and safety of traditional medicinal products using modern experimental approaches [12].

1.2.3 Medicinal Plants

Medicinal plants are plant species that contain biologically active constituents with therapeutic potential and are used either directly in traditional remedies or as raw materials for the development of pharmaceutical products [13].

1.2.4 Traditional Knowledge

Traditional knowledge refers to the accumulated knowledge, practices, and beliefs developed and passed down through generations by indigenous and local communities regarding the sustainable use of natural resources, particularly medicinal plants [14].

1.2.5 Relative Frequency of Citation

Relative Frequency of Citation (RFC) is a quantitative ethnobotanical index that indicates the local importance of a plant species and is calculated by dividing the number of informants who cited the species by the total number of informants participating in the survey [7].

1.2.6 Use Value

Use Value (UV) is a quantitative ethnobotanical index used to determine the relative importance of a medicinal plant species based on the number of use reports provided by informants, reflecting the diversity and extent of its medicinal applications [15].

1.2.7 Fidelity Level

Fidelity Level (FL) is a quantitative ethnobotanical index that represents the percentage of informants who consistently report the use of a particular plant species for the treatment of a specific disease, indicating its perceived therapeutic effectiveness [16].

1.2.8 Informant Consensus Factor

Informant Consensus Factor (ICF) is a quantitative ethnobotanical index that measures the level of agreement among informants regarding the use of medicinal plants for treating specific disease categories. Higher ICF values indicate greater consensus and may suggest plants with important therapeutic potential [17].

1.3 Statement of the Problem

A key problem addressed by this study is the lack of systematic scientific documentation of the medicinal plant knowledge of the rural community in Village Foja Dhara, District Jhang. Although the community possesses a rich tradition of medicinal plant use, this knowledge is transmitted orally across generations, making it highly vulnerable to loss due to urbanization, migration, and declining interest among younger generations. If not documented systematically, this knowledge could be lost permanently, along with valuable information that could contribute to the discovery and testing of new drugs [18].

1.4 Research Gap

Although ethnobotanical surveys have now been carried out in most of Pakistan's major regions, including Khyber Pakhtunkhwa, Gilgit-Baltistan, Azad Jammu and Kashmir, Sindh and a number of districts of Punjab, the semi-arid areas of the central Punjab continue to be relatively neglected. The district of Jhang, situated in the doab between the Chenab and Jhelum rivers, has not been subject to comprehensive quantitative ethnobotanical studies and there is no documented history of Foja Dhara village or its immediate vicinity. The most geographically close documented survey is in Toba Tek Singh, but the different ecological conditions, caste composition and disease burden of the Jhang plain means that its flora and related knowledge cannot be expected to be the same as that of neighboring districts. This study is conducted to fill that gap [19].

1.5 Research Aim and Objectives

To perform quantitative analysis and document ethnobotanical data collected from the inhabitants of Village Foja Dhara, District Jhang, Punjab, Pakistan.

- i. To identify and document the medicinal plants used by the local community.
- ii. To document the vernacular names, plant parts used, methods of preparation, and therapeutic uses of the recorded medicinal plants.
- iii. To calculate the Relative Frequency of Citation (RFC), Use Value (UV), Fidelity Level (FL), and Informant Consensus Factor (ICF) for the documented plant species.
- iv. To compare the documented findings with previously published ethnobotanical studies from Pakistan and other regions to identify similarities and differences in medicinal plant use.
- v. To identify plant species with high cultural significance and pharmacological potential.

1.6 Significance of the Study

Filling the gap identified above is important for a number of reasons. By producing the first quantitative ethnobotanical record for Jhang district, the study adds to the existing national and regional literature and expands the ethnobotanical coverage to a part of the Punjab that has been neglected hitherto. The quantitative indices used here translate the knowledge of the community into comparable values, which allows the most culturally relevant and highly consensus species to be selected as evidence-based points to serve as baseline for phytochemical and pharmacological investigations, rather than selected arbitrarily.

1.7 Scope of the Study

This research focuses on the residents of Village Foja Dhara, District Jhang, Punjab, Pakistan. It includes ethnobotanical field surveys, plant collection and identification, and quantitative analysis using RFC, UV, FL, and ICF indices. Laboratory-based phytochemical, toxicological, and pharmacological evaluations are beyond the scope of this study.

Having established the problem, the research gap, and the aim of the study, it is compulsory to situate this work within the existing body of knowledge.

The following chapter therefore reviews the relevant ethnobotanical and ethnopharmacological literature and examines how comparable surveys have been designed and analysed in Pakistan and elsewhere, and clarifies why the methodological approach adopted in this study is appropriate for addressing the identified gap.

Chapter 2

Literature Review

2.1 Ethnobotany and Ethnopharmacology: Scope and Importance

2.1.1 Scope of Ethnobotany

The discipline covers medicinal uses, wild food plants, veterinary applications, and traditional ecological knowledge more broadly [20]. Medicinal ethnobotany receives the most attention because of its direct connection to healthcare and its obvious relevance to pharmaceutical research [21]. But the field also contributes to conservation planning by identifying plants that are culturally important and potentially at risk from over-harvesting [22].

2.1.2 Importance of Ethnobotany

Ethnobotany is very important for several reasons. It preserves traditional knowledge before it disappears [20]. It gives researchers a principled basis for selecting plants to investigate pharmacologically.

It identifies species which are needed to be saved so that conservation attention can be directed appropriately. And it can support sustainable livelihoods for communities whose knowledge has economic as well as scientific value [22].

2.1.3 Ethnobotany vs Ethnopharmacology

Although ethnobotany and ethnopharmacology share a common foundation in traditional knowledge systems, they differ in their scope and objectives. Ethnobotany is primarily concerned with documenting the relationships between people and plants. It focuses on recording indigenous knowledge and understanding how communities interact with plant resources within their cultural and ecological contexts [10].

However, Ethnopharmacology is a multidisciplinary scientific field that investigates the biological and pharmacological effects of traditional medicinal substances derived from plants, animals, fungi, and minerals.

It seeks to validate traditional therapeutic claims through phytochemical, pharmacological, toxicological, and clinical studies, thereby providing scientific evidence for the efficacy and safety of plant based remedies [23].

While ethnobotanical studies generate valuable information on medicinal plant use, ethnopharmacology transforms this knowledge into evidence-based research that can contribute to drug discovery and the integration of traditional medicine into modern healthcare systems [24].

Table 2.1 presents the comparison between Ethnobotany and Ethnopharmacology.

TABLE 2.1: Comparison between Ethnobotany and Ethnopharmacology

Aspect	Ethnobotany	Ethnopharmacology
Focus	Traditional uses of plants	Scientific evaluation of traditional medicines
Objective	Documentation of indigenous plant knowledge	Validate medicinal effectiveness and safety

Table 2.1 continued from previous page

Aspect	Ethnobotany	Ethnopharmacology
Methods	Interviews, surveys, field observations	Laboratory work and pharmacological studies
Data Collected	Plant uses, preparation methods, local names	Bioactive compounds and biological activities

2.2 Ethnopharmacology and Its Significance

Ethnopharmacology takes the medicinal knowledge that ethnobotany documents and tests it investigating the efficacy, mechanisms, and safety of substances used in traditional healing [21].

It does not treat traditional use as proof of effectiveness, but as a well-filtered hypothesis. Artemisinin, paclitaxel, digoxin all began as traditional remedies and ended up as major pharmaceuticals [3].

Contemporary reviews note that the field remains highly productive for addressing problems including antimicrobial resistance and chronic inflammatory and metabolic diseases [25].

The bioactive compounds typically involves flavonoids, alkaloids, terpenoids, tannins, phenolic acids produce antioxidant, anti-inflammatory, antimicrobial, and antidiabetic effects through mechanisms that continue to be actively studied [3].

Beyond discovery, ethnopharmacological work also supports the development of standardized herbal medicines and helps identify potential toxicities or interactions between plant-derived and conventional drugs [26]. The following figure describes a general relationship between Ethnobotany and Ethnopharmacology:

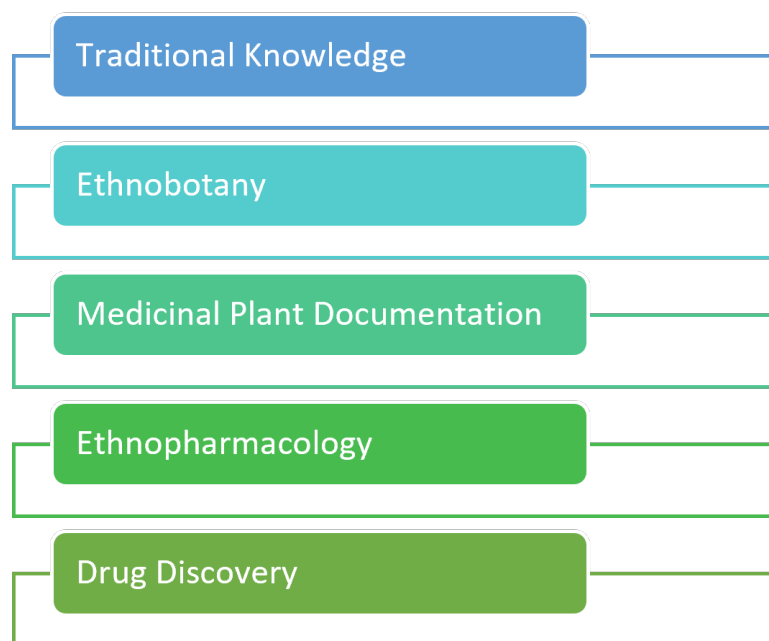


FIGURE 2.1: Relationship between ethnobotany and ethnopharmacology, illustrating how traditional knowledge documented through ethnobotanical research serves as the foundation for ethnopharmacological investigations, scientific validation, and the discovery of bioactive compounds for potential therapeutic applications.

2.3 Historical Development of Ethnobotanical and Ethnopharmacological Research

Plant-based medicine originates from written record. Major traditional medical system including Ayurveda, Traditional Chinese Medicine and Unani has built up extensive knowledge of medicinal plants over centuries and much of that knowledge remains in active use today [27].

As a formal scientific discipline, ethnobotany took shape during the twentieth century and has become increasingly rigorous and quantitative since then [20]. The development of tools such as Relative Frequency of Citation (RFC) , Use Value (UV), Fidelity Level (FL%) and Informant Consensus Factor (ICF) have meant that the field can move beyond purely descriptive accounts and make systematic, evidence-based assessments of plant significance .More recently, the scientific standard has been further raised by digital databases, geo-spatial analysis and meta-analysis [21]. Ethnopharmacological research is rooted in healing systems of

ancient civilizations, including China, India, Egypt and Greece, where medicinal plants and natural remedies have been used in a systematic way to cure disease and maintain health [18]. Traditional knowledge, gathered over generations, has provided the baseline for the therapeutic use of plants and has subsequently become a valuable source of scientific research [28].

During the nineteenth and twentieth centuries, advances in natural product chemistry enabled the isolation and characterization of bioactive compounds from medicinal plants, leading to the development of important drugs such as morphine, quinine, and atropine from traditionally used plant remedies [25]. These discoveries described the potential of indigenous medicinal knowledge to contribute to modern pharmacotherapy.

Ethnopharmacology emerged as a distinct scientific discipline in the late 1960s and gained further recognition with the establishment of the Journal of Ethnopharmacology in 1979, promoting interdisciplinary research that integrates ethnobotany, pharmacognosy, phytochemistry, pharmacology, and anthropology [29]. Since then, the field has emerged from simple documentation of traditional remedies to the scientific validation of their efficacy, safety, mechanisms of action [28].

2.4 Importance of Medicinal Plants in Primary Healthcare

Traditional plant medicines are often the first line of treatment for rural populations around the world. Medicinal plants are widely used because of their affordability, accessibility, and cultural acceptance. They are employed to manage a broad range of conditions, including gastrointestinal disorders, respiratory infections, skin diseases, musculoskeletal disorders, diabetes, and liver diseases. Many species contain several active substances that can combine to produce a wide range of pharmacological effects [25].

The global herbal medicinal products market has grown, driven by the growing interest of consumers in natural health products. This growth reinforces the need for proper scientific validation, quality control and safety assessment, in which ethnopharmacology and ethnobotany will contribute to the best of their ability [24].

2.5 Ethnobotanical and Ethnopharmacological Surveys

Ethnobotanical surveys are structured efforts to document how a society knows and uses plants [1]. The standard data collected include the vernacular names used, the plant components used, the way they are administered and the diseases or conditions they treat [20].

Collected information is used to identify treatments with potential pharmacological activity for further scientific evaluation and development of medicinal products [30].

2.5.1 Ethnobotanical Survey Protocol

Ethnobotanical surveys are generally conducted following standardized methodologies described by Martin [31]. These protocols include obtaining prior informed consent, selecting knowledgeable informants, and documenting indigenous knowledge through semi-structured interviews, questionnaires, focus group discussions, participant observation, and guided field walks. During field investigations, plant specimens are collected and authenticated through herbarium-based taxonomic identification or various digital applications.

The protocol emphasizes ethical research practices, accurate botanical documentation, and community engagement to ensure the reliability and reproducibility of ethnobotanical data [29].

Ethical obligations are an important part of the process. Prior informed consent must be obtained from participants, and communities retain rights over their traditional knowledge [32].

2.5.2 Ethnopharmacological Survey Protocol

Ethnopharmacological investigations are generally conducted in accordance with the recommendations of the Consensus Statement on Ethnopharmacological Field Studies (ConSEFS). This protocol emphasises the formulation of clear research objectives, obtaining ethical approval, a comprehensive documentation of medicinal plant use and the collection of validated samples. Data collection typically includes information on local disease concepts, plant parts used, preparation methods, dosing regimens, route of administration, therapeutic indications and reported adverse reactions [33].

The information collected is analysed using both qualitative and quantitative approaches and finally compared with existing phytochemical and pharmacological evidence for the assessment of the therapeutic relevance of traditional medicinal products. The ConSEFS guidelines also emphasise transparency, reproducibility and strict reporting standards to increase the scientific quality and translational value of ethnopharmacological research [30].

2.5.3 Importance of Ethnobotanical Surveys in Relation to WHO Priorities

The systematic documentation of traditional medicinal knowledge is relevant to the World Health Organization (WHO) priorities for strengthening the evidence base of traditional, complementary and integrative medicine (TCIM). The WHO Global Traditional Medicine Strategy emphasizes strengthening research and evidence, ensuring safety and quality, supporting appropriate integration of traditional medicine into health systems, and respecting traditional knowledge, cultural values, sustainability and biodiversity (World Health Organization, 2025) [34].

Ethnobotanical surveys can contribute to these priorities by systematically documenting locally used medicinal plants, their traditional indications, plant parts, preparation methods and routes of administration. Such documentation provides baseline information that can support subsequent phytochemical, pharmacological and safety investigations and can help identify areas where further scientific evidence is required.

Therefore, ethnobotanical surveys can serve as an initial evidence-generating step by preserving information on traditional plant use and identifying culturally important practices and plant resources for further investigation. However, documentation of traditional use should not be interpreted as confirmation of therapeutic efficacy or safety but provides a baseline for future research [35].

2.6 Quantitative Ethnobotanical Indices

Quantitative indices transform the qualitative information gathered in ethnobotanical surveys into numerical data that can be compared across species, communities, and studies [15]. By doing so, they possible identification of culturally significant plants and assess how much agreement exists among informants, and prioritize species for further scientific investigation [19]. Their use has become standard practice in contemporary ethnobotanical research precisely because they increase transparency and comparability [20].

The four indices most commonly employed are Relative Frequency of Citation (RFC), Use Value (UV), Fidelity Level (FL), and Informant Consensus Factor (ICF), each capturing a different dimension of ethnomedicinal significance [36].

2.6.1 Relative Frequency of Citation

RFC measures how widely recognized a plant is specifically, what proportion of the informants interviewed mentioned it. It is calculated as:

$$RFC = \frac{FC}{N} \quad (2.1)$$

where FC is the number of informants citing the species and N is the total number of informants [15]. Values run from 0 to 1; a value approaching 1 means nearly everyone in the community knows and uses the plant, which is a strong indicator of cultural importance. Plants with high RFC values tend to be both widely available and used for multiple conditions, making them obvious candidates for pharmacological validation [24].

2.6.2 Use Value

Use Value captures the versatility of a plant that how many different uses informants reports with it. The formula is

$$UV = \frac{\sum U_i}{N} \quad (2.2)$$

where U is the total number of use reports and N the total number of informants [36]. A high UV indicates that a plant figures prominently across multiple therapeutic contexts, suggesting it may contain diverse bioactive constituents [3]. A low UV may mean the plant has a narrow but specialized role [15]. UV is especially useful for identifying the multipurpose species most deeply integrated into local healthcare [31].

2.6.3 Fidelity Level

Fidelity Level asks a more specific question: of all the informants who use a given plant medicinally, what proportion use it for the same disease [30]. It is expressed as

$$FL(\%) = \left(\frac{Np}{N} \right) \times 100 \quad (2.3)$$

where N_p is the number citing a plant for a particular condition and N is all informants citing that plant for any purpose. An FL of 100% indicates complete consensus on a single therapeutic application a powerful signal of genuine ethnomedicinal relevance. Lower FL values indicate either that the plant is used for diverse conditions or that informants simply do not agree on its primary application [37].

2.6.4 Informant Consensus Factor

Informant Consensus Factor (ICF) is calculated at the disease category level. It measures the degree of agreement among informants regarding the medicinal plants used to treat a particular category of diseases. The formula is:

$$ICF = \frac{(N_{ur} - N_t)}{(N_{ur} - 1)} \quad (2.4)$$

where N_{ur} is the total number of use reports in a disease category and N_t the number of plant taxa used. Values close to 1 indicate that many people are reaching for the same small set of plants [12].

2.6.5 Importance and Limitations Quantitative Indices in Ethnobotanical Research

These four indices offer a layered picture of medicinal plant importance: RFC tells us which plants are broadly recognized, UV which are therapeutically versatile, FL which are used with high specificity for particular ailments, and ICF where there is strong community-wide agreement at the disease-category level [37].

Because high citation rates and strong consensus both increase the possibility of finding genuine bioactivity [38]. These indices are valuable tools for prioritizing species when resources for laboratory investigation are limited. However, the indices also have limitations. Their values may be influenced by sample size,

informant knowledge, plant availability, cultural preferences, disease prevalence, and the way use reports are defined and recorded [39].

2.7 Global Ethnobotanical Studies

Ethnobotanical surveys conducted across different regions of the world consistently demonstrate that traditional medicinal plant knowledge remains deeply integrated into local healthcare systems and often exhibits similar utilization patterns despite cultural and ecological differences [28].

Decoction is commonly reported as the predominant method of remedy preparation due to its simplicity and effectiveness in extracting bioactive constituents. Furthermore, gastrointestinal disorders, respiratory ailments, dermatological conditions, and musculoskeletal complaints represent some of the most frequently treated disease categories using medicinal plants worldwide [40]. These ethnobotanical investigations not only preserve traditional knowledge but have also contributed to the discovery of novel bioactive compounds and provide comparative datasets that help distinguish culturally shared practices from region-specific medicinal plant uses [22].

2.7.1 Ethnobotanical Studies in Africa

Africa combines extraordinary biological diversity with strong traditions of plant-based medicine, and in many parts of the continent traditional healers remain the primary healthcare providers particularly in areas where clinical services are inaccessible. Surveys conducted across the continent document extensive use of plants for infectious diseases, digestive complaints, reproductive conditions, and inflammatory ailments [41].

Ethiopia has been the focus of numerous ethnobotanical studies. A survey in the Zegie Peninsula, documented 111 medicinal plant species used for more than 50 ailments. It reported that leaves are the most-used part and oral administration is

the most common route. These findings are replicated in other Ethiopian studies and indicate strong internal consistency in local medical traditions [42].

In Morocco, aromatic species including *Rosmarinus officinalis*, *Thymus vulgaris*, and *Artemisia herba-alba* are widely used for gastrointestinal and metabolic conditions several of which have since been confirmed to have antioxidant and antidiabetic properties in laboratory studies [43]. South African ethnobotany has focused particularly on species used against infectious diseases and HIV-related conditions, with plants such as *Sutherlandia frutescens* and *Hypoxis hemerocallidea* attracting scientific interest for their immunomodulatory and antioxidant activities [41]. Across these studies, African ethnobotanical research highlights how effectively traditional knowledge can guide pharmacological investigation and contribute to conservation and local economic development [44].

2.7.2 Ethnobotanical Studies in Latin America

Latin America has the world's richest medicinal plant diversity and some of its deepest indigenous knowledge traditions, particularly in the Amazon Basin [36]. Studies from Peru, Brazil, Colombia, and Ecuador have documented hundreds of medicinal species used against a broad spectrum of conditions including infectious disease, snakebite, inflammation, and digestive disorders [18].

Peru holds a particular place in the history of quantitative ethnobotany. Work in the Tambopata region by Phillips and Gentry was influential in demonstrating the value of statistical approaches for identifying culturally important plants [36]. Many of the species they and others documented have since been found to possess antimicrobial, antiparasitic, and anti-inflammatory properties [18].

2.7.3 Ethnobotanical Studies in Europe

Even in a region as industrialized as Europe, traditional plant medicine remains a living practice especially in Mediterranean countries with unbroken cultural

traditions. Surveys in Spain, Italy, Greece, and the Balkans document extensive use of plants for digestive, respiratory, and dermatological conditions [45, 46].

Spain has been a center of methodological innovation, with northern Spanish studies making important contributions to the development of cultural importance indices and demonstrating their value for interpreting ethnobotanical data [15].

Well-studied European medicinal species including *Matricaria chamomilla*, *Salvia officinalis*, *Thymus vulgaris* and *Melissa officinalis* have pharmacological evidence supporting their traditional antimicrobial, anti-inflammatory, and anxiolytic uses, and have contributed to the broader project of developing evidence-based herbal medicine [47].

2.7.4 Ethnobotanical Studies in Asia

Asia is home to some of the world's oldest and most well-established traditional medical systems, including Ayurveda, Traditional Chinese Medicine, Unani, Siddha, and Tibetan medicine. It collectively draws on thousands of plant species and continues to influence the healthcare of billions of people.

Indian ethnobotanical research has documented extensive medicinal plant use among tribal and rural communities, with frequently cited species including *Azadirachta indica*, *Ocimum tenuiflorum*, *Tinospora cordifolia*, and *Withania somnifera*, all of which have solid pharmacological evidence backing their traditional uses [48].

In China, the most famous example of traditional knowledge directly leading to modern medicine is the isolation of *Artemisia annuus* Tu Youyou, which was awarded the Nobel Prize in 2015 [49].

Studies in Iran, Turkey, Nepal and Bhutan have further deepened the regional picture, documenting plant-based uses in everything from urban markets to remote mountain communities [50, 51].

2.7.5 Ethnobotanical Studies in China

China has one of the oldest and most extensively documented traditions of medicinal plant use in the world, with ethnobotanical knowledge deeply rooted in Traditional Chinese Medicine and the healthcare practices of numerous ethnic communities. Ethnobotanical studies among the Gelao, Bulang, Yi, and other indigenous groups have documented a remarkable diversity of medicinal plants used to treat gastrointestinal disorders, respiratory diseases, skin disorders, and inflammatory conditions. Recent studies indicate that traditional medicine continues to play a vital role in primary healthcare, particularly in rural and mountainous regions where access to modern healthcare facilities is limited [52].

Ethnobotanical research in China has not only contributed to the preservation of indigenous knowledge systems but has also facilitated the identification of medicinal plants and bioactive compounds with potential pharmacological value. Furthermore, the systematic documentation of traditional plant use has strengthened conservation efforts and promoted the sustainable utilization of medicinal plant resources in the country's biodiversity-rich regions [53, 54].

2.7.6 Ethnobotanical Studies in the Arab World

The Arab world is characterized by diverse ecosystems, including deserts, mountains, coastal regions, and Mediterranean landscapes, which have fostered a rich tradition of medicinal plant knowledge. Ethnobotanical studies conducted in Saudi Arabia, Morocco, Jordan, Egypt, Tunisia, and other Arab countries have documented the widespread use of medicinal plants for the treatment of digestive disorders, respiratory diseases, diabetes, skin infections, and musculoskeletal disorders [55].

Traditional herbal medicine continues to play an important role in community healthcare, particularly among rural and nomadic populations. Several studies have reported that leaves are the most commonly used plant part, while decoction and infusion are the predominant methods of preparing herbal remedies [56].

Ethnobotanical research in the Arab world has also emphasized the importance of preserving traditional knowledge, which is increasingly threatened by urbanization, socioeconomic changes, and growing reliance on modern medicine.

These studies have also identified numerous medicinal plants with promising therapeutic potential, providing valuable leads for future phytochemical and pharmacological investigations [57].

2.8 Ethnobotanical Studies in Pakistan

With around thousands of species of flowering plants and geography ranging from high-altitude alpine zones to arid coastal plains, Pakistan is a floristically diverse country with a correspondingly rich tradition of plant-based medicine [58].

Unani medicine, herbal home remedies, and community folk practices together form a healthcare system that many rural Pakistanis turn to first, treating a wide spectrum of conditions from gastrointestinal problems to skin infections to diabetes [19].

Ethnobotanical surveys have been conducted across most major regions of Pakistan, including Khyber Pakhtunkhwa, Gilgit-Baltistan, Azad Jammu and Kashmir, Sindh, and Punjab. These studies consistently report that leaves are the most commonly used plant part, decoction is the predominant method of preparation, and oral administration is the most frequently employed route of administration [59].

Certain species recur across these geographically diverse studies, including *Withania somnifera*, *Azadirachta indica*, *Moringa oleifera*, *Fagonia cretica*, *Mentha longifolia*, and *Foeniculum vulgare* species that have also been pharmacologically validated for antioxidant, anti-inflammatory, antimicrobial, and antidiabetic activities [9].

Collectively, this body of research has preserved substantial traditional knowledge and generated numerous leads for pharmaceutical development [58].

2.9 Ethnobotanical Studies in Punjab, Pakistan

Punjab's status as Pakistan's most populous province is matched by the diversity of its medicinal plant traditions. Fertile plains, riverine areas, semi-arid zones, and agricultural land together support diverse medicinal and aromatic flora, and rural communities throughout the province continue to rely on this diversity for treating digestive, respiratory, dermatological, musculoskeletal, and metabolic conditions [9].

Ethnobotanical research in Punjab has grown substantially over the past decade. Across these studies, certain patterns are consistent: leaves are the most used plant part, decoctions are prepared most frequently, and oral administration is the dominant route [60].

2.9.1 Chenab Riverine Area, Punjab

One of the most thorough ethnobotanical surveys in Punjab was a study of the Chenab River basin. Researchers documented 129 medicinal plant species in 112 genera and 59 families, with the most prominent being the Poaceae and Asteraceae. Leaves and decoction came top of the list again.

High levels of use have been observed for *Withania somnifera*, *Ficus religiosa* and *Calotropis procera*, which indicate both their cultural importance and their therapeutic versatility. The authors recommended pharmacological follow-up of the most frequently reported species and identified them as priorities for future research [9].

2.9.2 Southern Punjab

Southern Punjab, the districts around Bahawalpur, Multan, and Dera Ghazi Khan presents a slightly different ecological picture from the riverine north that is hot, semi-arid, and home to plants adapted to those conditions [61]. *Capparis decidua*,

Salvadora persica, *Citrullus colocynthis*, and *Calotropis procera* feature prominently in these surveys, used for digestive complaints, skin disease, inflammation, and diabetes [62].

2.9.3 Common Trends in Punjab Studies

Across the full body of Punjab ethnobotanical research, several patterns emerge with striking regularity:

- i. Leaves are the most commonly used plant part.
- ii. Decoction is the predominant method of preparation.
- iii. Oral administration is the most frequently used route of administration.
- iv. Gastrointestinal and respiratory disorders are the most commonly treated disease categories.
- v. Elderly informants and traditional healers are the primary custodians of medicinal plant knowledge.

2.10 Common Ethnobotanically Important Plant Species Reported in Pakistan

Certain species show up repeatedly in ethnobotanical literature from across Pakistan, marking them as both culturally significant and scientifically interesting. Many have been formally investigated and shown to possess bioactivities consistent with their traditional uses [24].

2.10.1 *Withania somnifera* - Ashwagandha

Widely used as a tonic, adaptogen, and anti-inflammatory agent for weakness, arthritis, and stress, *Withania somnifera* owes much of its activity to withanolide compounds that exhibit neuroprotective, antioxidant, anti-inflammatory, and immunomodulatory effects [63].

2.10.2 *Moringa oleifera* - Suhanjna

A staple of Pakistani folk medicine for nutritional supplementation and management of diabetes, inflammation, anemia, and infections. The leaves are exceptionally rich in polyphenols, vitamins, minerals, and glucosinolates, which account for its antioxidant, anti-inflammatory, and antidiabetic properties [64].

2.10.3 *Azadirachta indica* - Neem

Used for skin diseases, infections, fever, and diabetes. Neem's limonoid compounds including azadirachtin and nimbin among others are responsible for its well-documented antimicrobial, anti-inflammatory, and antiparasitic activities [65].

2.10.4 *Fagonia indica* - Dhamasa

It is prominent in the arid zones of Pakistan, traditionally used for fever, inflammation, skin disorders, and conditions associated with cancer. Laboratory work has confirmed antioxidant, cytotoxic, and anti-inflammatory effects [66].

2.10.5 *Mentha longifolia* - Podina

Mentha longifolia (wild mint) is widely used in traditional medicine for the treatment of indigestion, abdominal pain, nausea, and respiratory complaints. Pharmacological studies have shown that its essential oil possesses significant antimicrobial

and spasmolytic activities, which support its traditional use in gastrointestinal and respiratory disorders [67].

2.10.6 *Foeniculum vulgare* - Saunf

Widely used as a carminative, digestive aid, and remedy for cough and menstrual discomfort. Its principal active constituent, anethole, contributes antioxidant, anti-inflammatory, and antispasmodic effects [68].

2.10.7 *Curcuma longa* - Haldi

Its traditional uses span inflammation, wound healing, liver disorders, and joint pain. Curcumin, its main polyphenol, is one of the most extensively studied natural anti-inflammatory and antioxidant compounds [69].

2.10.8 *Zingiber officinale* - Adrak

It is used for nausea, digestive disturbance, colds, and inflammatory conditions. Gingerols and shogaols are the primary bioactive constituents responsible for its anti-inflammatory, antioxidant, and antiemetic effects [70]. Table 2.2 presents major medicinal plants frequently reported in ethnobotanical studies of Pakistan and their pharmacological significance.

2.11 Plant Parts Commonly Used in Traditional Medicine

The proportion of plant material being used is important, as bioactive compounds are not evenly distributed in plant tissue. In almost all ethnobotanical studies, leaves are at the top of the list, which makes sense as they are abundant in secondary metabolites, including flavonoids, tannins, alkaloids and terpenoids [60].

TABLE 2.2: Major medicinal plants frequently reported in ethnobotanical studies of Pakistan and their pharmacological significance.

Scientific Name	Common Name	Plant Part Commonly Used	Traditional Uses	Major Bioactive Constituents	Reported Pharmacological Activities
<i>Withania somnifera</i>	Ashwagandha	Roots	Weakness, arthritis, stress, nervous disorders	Withanolides, sitoindosides, alkaloids	Adaptogenic, antioxidant, anti-inflammatory, neuroprotective, immunomodulatory
<i>Moringa oleifera</i>	Moringa	Leaves	Nutritional supplementation, diabetes, anemia, infections, inflammation	Polyphenols, flavonoids, glucosinolates, vitamins and minerals	Antioxidant, anti-inflammatory, antidiabetic, antimicrobial
<i>Azadirachta indica</i>	Neem	Leaves, bark, seeds	Skin diseases, fever, infections, diabetes	Azadirachtin, nimbin, nimbolide, limonoids	Antimicrobial, anti-inflammatory, antiparasitic, antidiabetic
<i>Fagonia cretica</i>	Dhamasa	Aerial parts	Fever, inflammation, skin disorders, cancer-related ailments	Flavonoids, saponins, alkaloids, phenolic compounds	Antioxidant, anti-inflammatory, cytotoxic, hepatoprotective
<i>Mentha longifolia</i>	Wild Mint	Leaves	Indigestion, abdominal pain, nausea, respiratory complaints	Menthol, menthone, pulegone, essential oils	Antimicrobial, spasmolytic, antioxidant, digestive stimulant

Table 2.2 continued from previous page

Scientific Name	Common Name	Plant Part Commonly Used	Traditional Uses	Major Bioactive Constituents	Reported Pharmaceutical Activities
<i>Foeniculum vulgare</i>	Fennel	Fruits (Seeds)	Digestive disorders, cough, menstrual discomfort	Anethole, fenchone, estragole, flavonoids	Antioxidant, anti-inflammatory, antispasmodic, carminative
<i>Curcuma longa</i>	Turmeric	Rhizomes	Inflammation, wound healing, liver disorders, joint pain	Curcumin, demethoxycurcumin, bisdemethoxycurcumin	Antioxidant, anti-inflammatory, hepatoprotective, wound healing

The leaves are also harvested less damaging than the roots or bark, which makes leaf-based remedies more sustainable in the long term [22]. Other parts commonly used are roots, bark, seeds, fruit, flowers, leaves and whole plants. Roots and bark often produce high concentrations of phytochemicals, but intensive collection pressure may be detrimental to the survival of plants. The most commonly used plant material in Pakistan covers a wide range of plant parts, varying in their species, for example leaves of *Moringa oleifera*, fruit of *Foeniculum vulgare*, rhizomes of *Curcuma longa*, roots of *Withania somnifera* and aerial parts of *Fagonia cretica* [63, 69].

2.12 Methods of Preparation and Routes of Administration

How the plant is prepared is as important as which part is used, as different methods extract different compounds and different routes of administration determine

how they are delivered to the body [71]. The route also depends on the physical characteristics of the plant, the nature of the treated condition and the resources available [72].

2.12.1 Decoction

Boiling plant material in water is the most consistently reported preparation method across ethnobotanical studies globally [60]. Decoction is well-suited to tough materials roots, bark, seeds, stems because extended heat and water extraction pulls out polyphenols, tannins, glycosides, and alkaloids effectively [1].

It is simple, cheap, and perceived as potent, which likely accounts for its popularity. In Pakistan, it is commonly used with *Foeniculum vulgare*, *Mentha longifolia*, *Withania somnifera*, and *Fagonia cretica*, among many others [63, 67, 68].

2.12.2 Infusion

Essentially the herbal tea method steeping plant material in hot water for a short time rather than boiling. Infusion is preferable for delicate materials like leaves and flowers whose volatile or heat-sensitive compounds would be destroyed by prolonged heating. Aromatic species including *Mentha longifolia*, *Matricaria chamomilla*, and *Ocimum tenuiflorum* are typically prepared this way [67].

2.12.3 Powders

Dried plant material ground into powder can be taken directly, mixed with water, milk, or honey, or encapsulated. In South Asia, powdered *Curcuma longa* rhizome and *Withania somnifera* root are among the most common examples [63, 69].

2.12.4 Juices and Extracts

Fresh juice is extracted by crushing plant material and pressing out the liquid. It is a method that retains compounds that would be altered by heat. Leaf juice

from *Moringa oleifera* and Aloe vera is frequently used in folk medicine, applied both orally and topically [64, 73].

2.12.5 Pastes and Poultices

Grinding fresh plant material with water or oil produces pastes that can be applied directly to the skin for conditions like wounds, burns, skin infections, and joint pain [74].

2.12.6 Syrups and Honey-Based Preparations

Combining plant extracts with honey or sugar improves palatability and adds soothing effects. These preparations are most commonly used for cough, sore throat, and other respiratory conditions [75].

2.12.7 Routes of Administration

2.12.7.1 Oral Administration

The dominant route worldwide. Decoctions, infusions, powders, and syrups are ingested for systemic conditions including gastrointestinal disorders, fever, diabetes, and respiratory illness [8].

2.12.7.2 Topical Administration

Used for skin diseases, wounds, burns, and musculoskeletal pain, with ointments, poultices, and plant juices applied directly to affected areas [74].

2.12.7.3 Inhalation

Steam, smoke, or vapors from aromatic plants are inhaled to treat respiratory disorders and nasal congestion. Essential oil-rich species like mint and eucalyptus are particularly associated with this route [76].

2.12.7.4 Gargling and Mouth Rinsing

Herbal decoctions used as mouthwashes or gargles for oral ulcers, gingivitis, sore throat, and dental infections [77]. Table 2.3 explains Common routes of administration of traditional herbal remedies and representative examples.

TABLE 2.3: Common routes of administration of traditional herbal remedies and representative examples.

Route of Administration	Description	Common Dosage Forms	Representative Plant Examples	Traditional Uses
Oral Administration	Most widely used for systemic treatment of diseases.	Decoctions, infusions, powders, syrups, juices	<i>Withania somnifera</i> , <i>Foeniculum vulgare</i> , <i>Zingiber officinale</i> , <i>Moringa oleifera</i>	Gastrointestinal disorders, fever, diabetes, respiratory illnesses, stress, weakness
Topical Administration	Direct application to affected body parts.	Pastes, poultices, ointments, oils, fresh plant juice	<i>Curcuma longa</i> , <i>Azadirachta indica</i> , <i>Fagonia cretica</i>	Wounds, burns, skin infections, inflammation, musculoskeletal pain
Inhalation	Inhalation of vapors, steam, smoke, or volatile oils.	Steam inhalation, aromatic vapors, smoke	<i>Mentha longifolia</i> , <i>Eucalyptus globulus</i>	Cough, cold, nasal congestion, sinusitis, respiratory disorders
Gargling and Mouth Rinsing	Herbal preparations used for oral and throat conditions.	Mouthwashes, gargles, decoctions	<i>Azadirachta indica</i> , <i>Foeniculum vulgare</i>	Oral ulcers, gingivitis, sore throat, dental infections, oral hygiene
Other Routes	Less frequently reported routes used in traditional medicine.	Nasal drops, eye drops, herbal baths, rectal preparations	Various aromatic and medicinal plant species	Sinus congestion, headaches, eye disorders, rheumatic pain, skin diseases

2.13 Disease Categories Commonly Treated with Medicinal Plants

Disease categories provide a useful organizing framework for ethnobotanical data, enabling quantitative analysis and cross-study comparison. In Pakistan and globally, gastrointestinal disorders, respiratory diseases, dermatological conditions, musculoskeletal complaints, metabolic disorders, and genitourinary problems are consistently the most frequently treated categories [74, 76].

2.13.1 Gastrointestinal Disorders

Diarrhea, dysentery, abdominal pain, constipation, and indigestion are among the most commonly treated conditions across virtually every ethnobotanical study. *Foeniculum vulgare*, *Mentha longifolia*, and *Zingiber officinale* are frequently cited for their carminative, antispasmodic, and antimicrobial properties [68, 70].

2.13.2 Respiratory Disorders

Cough, cold, asthma, bronchitis, and sore throat are treated with plant remedies. *Ocimum tenuiflorum*, *Mentha longifolia*, and *Glycyrrhiza glabra* are among the commonly reported species [76].

2.13.3 Dermatological Conditions

Wounds, burns, eczema, acne, and fungal infections are treated with plants such as *Aloe vera*, *Azadirachta indica*, and *Curcuma longa*, all of which have demonstrated relevant antimicrobial and anti-inflammatory [65, 73].

2.13.4 Musculoskeletal Disorders

Traditional remedies for arthritis, back pain, joint pain, and muscle inflammation often depend on plants with anti-inflammatory properties including *Withania somnifera*, *Curcuma longa*, and *Zingiber officinale*. These are recurrent examples with solid pharmacological support [69, 70, 78].

2.13.5 Endocrine and Metabolic Disorders

Medicinal plants for diabetes, obesity, and hyperlipidemia are widely reported. *Moringa oleifera*, *Azadirachta indica*, and *Momordica charantia* are among the most commonly cited antidiabetic species in Pakistani ethnobotany [14, 64].

2.13.6 Genitourinary Disorders

Urinary tract infections, kidney stones, and menstrual irregularities are commonly treated in traditional medicine using plants with diuretic, anti-inflammatory, and antimicrobial properties. These pharmacological activities help promote urine flow, reduce inflammation, and reduce symptoms associated with urinary and reproductive tract disorders [79].

2.13.7 Fever and Infectious Diseases

Plant remedies for fever, malaria-like symptoms, and general infections often draw on species rich in phenolics and terpenoids, many of which have confirmed antimicrobial and antipyretic activities [80].

2.13.8 Nervous System Disorders

Anxiety, insomnia, stress, and cognitive complaints are addressed with plants including *Withania somnifera*, which is among the best-studied medicinal species for neuroprotection and stress reduction [63].

Taken together, the literature reviewed in this chapter shows that while quantitative ethnobotanical surveys are conducted in much of Pakistan and the world at large, the semi-arid plains of central Punjab, and particular Jhang district, remain almost completely underexplored. This gap, together with the standardised indices (RFC, UV, FL and ICF) which have proved their effectiveness in comparable environments, is directly relevant to the design of this study. The following chapter describes the field of study, sampling strategy, data collection instruments and analytical methods adopted to fill this gap.

Chapter 3

Materials and Methods

3.1 Study Area

3.1.1 Geographic Location

This ethnobotanical study was conducted in Village Foja Dhara, located in Tehsil Shorkot, District Jhang, Punjab, Pakistan. District Jhang is situated in central Punjab between latitudes $30^{\circ}37'$ – $31^{\circ}59'$ N and longitudes $71^{\circ}37'$ – $73^{\circ}13'$ E. It is bordered by Chiniot and Sargodha districts to the north, Faisalabad and Toba Tek Singh districts to the east, Khanewal district to the south, and Bhakkar and Khushab districts to the southwest [81]. The study area lies within the fertile alluvial plains of Punjab, primarily shaped by the Chenab and Jhelum river systems, and supports extensive agricultural activities. The terrain is predominantly flat and well suited for crop cultivation, with agriculture and livestock farming serving as the main livelihoods of the local population. Owing to its rural setting, the residents of Village Foja Dhara possess rich traditional knowledge of medicinal plants, which continues to play an important role in primary healthcare practices [82].

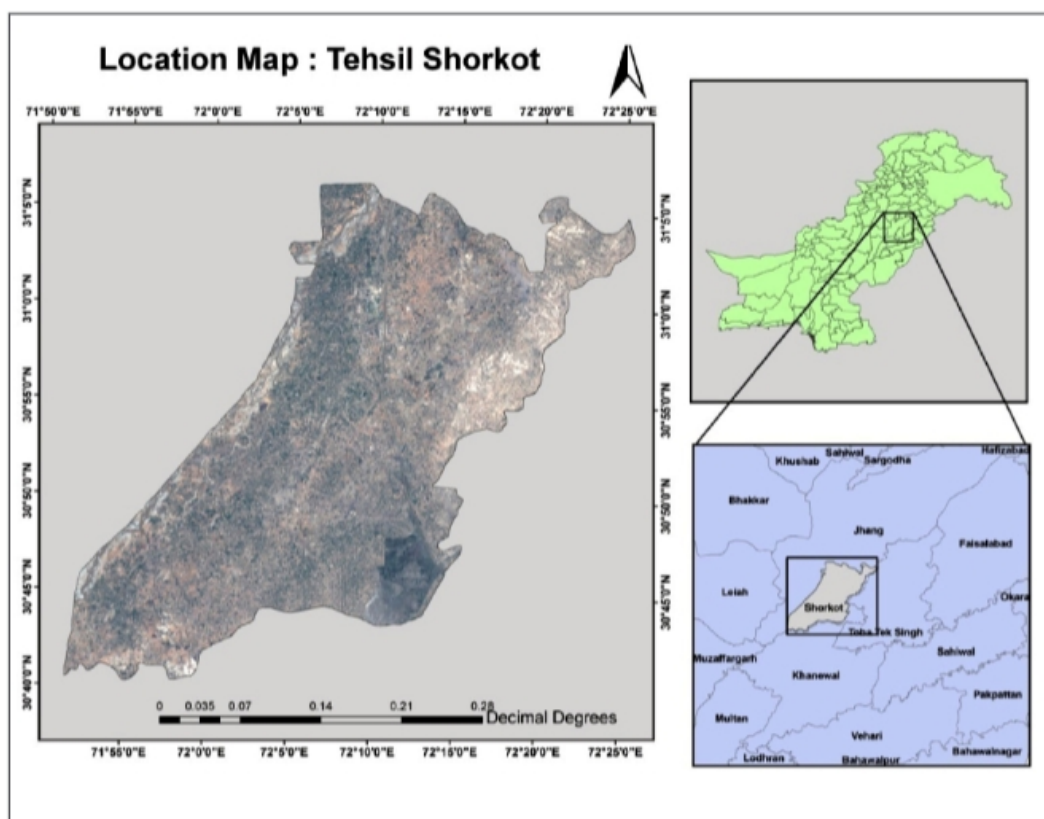


FIGURE 3.1: Geographical location of the study area showing Village Foja Dhara in Tehsil Shorkot, District Jhang, Punjab, Pakistan, where the ethnobotanical and ethnopharmacological survey was conducted to document indigenous medicinal plant knowledge. Source: Adapted from Ahmed *et al.*, 2014 [81].

3.1.2 Climate and Environmental Conditions

The area has a semi-arid to subtropical climate with exceptionally hot summers and relatively mild winters. The summer period runs from April to September and temperatures can reach up to 45 degrees Celsius, while winter temperatures usually range between 5 and 20 degrees Celsius. The area receives most of its annual precipitation during the July-September monsoon season.

The rainfall patterns affect agricultural productivity and the distribution of vegetation in the region. Irrigation channels and groundwater sources provide additional support to crop growth and development [82]. The climate of Foja Dhara supports the emergence of a large number of herbaceous, shrubby and tree species. Seasonal variations also affect the availability and harvesting dates of medicinal herbs used by local populations.

3.1.3 Vegetation and Floral Diversity

The vegetation of the Foja Dhara village is made up of cultivated crops, medicinal herbs, bushes, climbers, grasses and trees. Agricultural fields, roadsides, canal banks, pastures, swamps and domestic gardens are important habitats for medicinal plants. Several families of plants are present in study area including the families Fabaceae, Asteraceae, Lamiaceae, Poaceae, Solanaceae, Euphorbiaceae, Malvaceae, Moraceae, Brassicaceae and Rutaceae. These plants are traditionally used to treat gastrointestinal problems, respiratory diseases, skin diseases, fever, diabetes, musculo-skeletal disorders and various other diseases. The high diversity of flora found in this area reflects the close interaction between the local population and the surrounding environment, which has resulted in the conservation of valuable ethnological knowledge [83].

3.1.4 Socioeconomic Characteristics of the Local Population

The population of Village Foja Dhara is primarily engaged in agriculture and livestock farming. Agriculture is the main source of income, while other professions include teaching, work in the field, driving, small business, government employment and domestic management. The social structure of the village is strongly rooted in family and community ties, with traditional knowledge transmitted orally across generations. Elderly community members, traditional healers, and experienced farmers possess extensive knowledge of medicinal plants and their therapeutic uses [84].

3.1.5 Selection of Study Area

The village of Foja Dhara was selected as a study area because of its rich ethnobotanical heritage and the continued reliance of the local population on traditional

healing methods. Preliminary visits indicated the presence of extensive indigenous knowledge of medicinal plants, particularly among older members of the community, which was further supported by the available literature. The documentation of this traditional knowledge was therefore considered necessary to preserve valuable cultural information before it was gradually eroded by modernization, urbanisation and changing lifestyles. The study findings may contribute to future pharmacological research.



FIGURE 3.2: Photographic view of Village Foja Dhara, District Jhang, Punjab, Pakistan, depicting the rural landscape and natural environment where medicinal plants are traditionally collected and utilized by the local community.

3.2 Study Design

A descriptive cross-sectional ethnobotanical survey was conducted in Village Foja Dhara, District Jhang, Punjab, Pakistan, from January to April 2025. The study was designed to systematically document the indigenous knowledge of medicinal plants used by the local community and to evaluate their quantitative ethnobotanical significance.

A cross-sectional design was considered the most appropriate for this study as it allows data to be collected from a representative population at a single time point and allows evaluation of existing conventional knowledge without changing community practice. This approach is generally recommended in ethnobotanical

research, where the goal is to capture the predominant uses of plants and the cultural knowledge [31].

The survey followed internationally recognised ethnobotanical methods as described in Alexiades (1996) ensuring methodological rigour, reproducibility and ethical consistency.

These frameworks emphasise the systematic collection of data through structured and semi-structured interviews, observer visits to participants and guided field visits, which are essential to reduce bias and ensure accurate documentation of traditional knowledge systems.

Moreover, these standardized methods facilitate comparisons with ethnobotanical studies conducted in other regions of Pakistan and around the world [85].

3.3 Study Population and Sample Size

3.3.1 Study Population

The study population comprised permanent residents of Village Foja Dhara, District Jhang, Punjab, Pakistan, who possessed knowledge of medicinal plants and traditional healthcare practices.

In order to ensure a comprehensive documentation of indigenous ethnobotanical knowledge, the informants were selected from different professional and social groups. These included traditional healers, older members of the community, farmers, housewives, teachers, drivers, students and other knowledgeable people known in the community for their medicinal plant knowledge.

Inclusion of participants from different demographic backgrounds has proven useful in collecting different perspectives on the use of medicinal plants and traditional medical practices, as recommended by ethnobotanical research methods [85].

3.3.2 Sample Size

The size of the sample was determined by a formula proposed by Yamane for finite-population samples [86]. According to information from the local Union Council and community records, the estimated number of adult residents with knowledge at Foja Dhara village was around 550 persons. The sample size was calculated using the following formula:

$$n = \frac{N}{1 + N(e)^2} \quad (3.1)$$

Where:

- n = required sample size
- N = total population
- e = level of precision (sampling error)

Using a population size of 550 and a precision level of 10% (0.10):

$$n = 84.6 \quad (3.2)$$

The minimum required sample size was therefore around 85 respondents. In order to increase the reliability and representativeness of the findings of the study, a total of 97 informants were finally interviewed during the survey.

3.4 Inclusion and Exclusion Criteria

3.4.1 Inclusion Criteria

Participants were included if they:

- i. Were permanent residents of Village Foja Dhara.
- ii. Were aged 18 years or above.
- iii. Possessed knowledge regarding medicinal plants.
- iv. Voluntarily agreed to participate in the study.

3.4.2 Exclusion Criteria

Participants were excluded if they:

- i. Were below 18 years of age.
- ii. Were temporary residents or visitors.
- iii. Possessed no medicinal plant related knowledge.
- iv. Were unable to communicate effectively during interviews.

3.5 Sampling Technique

A multistage sampling approach was adopted to ensure both comprehensive population representation and inclusion of knowledgeable informants. In the first stage, purposive sampling was used to identify key informants, including traditional healers and elderly community members recognized for their extensive ethnobotanical knowledge. This technique is widely used in ethnobotanical research, as indigenous knowledge of a medicinal product is often concentrated in specific community members [31]. In the second phase, systematic random sampling was used to select households from the study area to ensure that the population was representative. After establishing the sampling interval, each k th household was included on the basis of a random basis. This procedure minimised selection bias and facilitated the integration of participants from different ages, sexes, educational backgrounds and professions.

3.6 Ethical Considerations

Before data collection, oral informed consent was obtained from all participants. The purpose of the study was clearly explained, and participants were informed that their participation was entirely voluntary. The confidentiality and anonymity of respondents was preserved throughout the entire research process [30]. Traditional knowledge was recorded for academic purposes only and participants retained the right to withdraw at any time without consequence from the study in accordance with Ethnobiology Ethics as presented by the International Society of Ethnobiology [87].

3.7 Data Collection Tools

Data were collected using a semi-structured ethnobotanical questionnaire developed in accordance with internationally recognised guidelines for ethnobotanical and ethnopharmacological research [85]. The semi-structured format allowed systematic collection of data while allowing sufficient flexibility to document the detailed traditional knowledge and ethnobotanical practices reported by the participants [30].

The questionnaire consisted of four major sections:

Section 1: Informed Consent

Section 2: Demographic Information

- i. Informant identification code
- ii. Age
- iii. Gender
- iv. Occupation
- v. Caste/ethnic group

- vi. Residence

Section 3: General Ethnobotanical Knowledge

It consisted of general multiple choice questions regarding ethnomedicinal practices.

Section 4: Ethnobotanical and Ethnopharmacological Information

- i. Local plant name
- ii. Botanical name
- iii. Plant family
- iv. Plant part(s) used
- v. Human or veterinary use
- vi. Preparation method
- vii. Route of administration
- viii. Dose and frequency of use
- ix. Duration of treatment
- x. Disease category
- xi. Specific ailment treated
- xii. Wild or cultivated status
- xiii. Availability status
- xiv. Reported side effects and precautions

The questionnaire was filled by personal interview in Urdu and Punjabi to facilitate effective communication and to ensure accurate documentation of the indigenous knowledge. The questionnaire structure has been designed to capture detailed information on the use of plants, preparation methods, therapeutic uses and related

traditional medical practices, as recommended by ethnobotanical and ethnopharmacological research [31]. A full semi-structured ethnobotanical questionnaire used to collect the data is attached as Appendix A.

3.7.1 Pilot Study for Questionnaire Validation

A pilot study was conducted in Islamabad, Pakistan before the formal data collection. It included of 10 participants who had knowledge of herbal medicines and traditional medical practices. The objective of the pilot study was to assess the clarity, accuracy, relevance and adequacy of the questionnaire and to identify any interview errors that may have been made in the course of the interview. Participants were asked to provide feedback on the clarity, wording, sequence, and content of the questionnaire. The pilot study enabled researchers to evaluate the practicality of the data collection tool, to estimate the average interview time and to ensure that the questionnaire adequately captured the required ethnobotanical and ethnopharmacological data. Based on the feedback received, minor changes have been made to clarify some of the questions prior to the use of the questionnaire in the main study. Data from pilot study was used solely for refining the questionnaire and was not added in the final analysis of the study. In order to increase the validity, reliability and efficiency of the research tools used in ethnobotanical research, it is recommended to perform a pilot study before the main survey [88].

3.8 Data Collection Procedure

Field surveys were conducted through repeated visits to Village Foja Dhara.

The data collection process involved the following steps:

- i. Identification of knowledgeable informants through community recommendations.

- ii. Face-to-face interviews were conducted using a semi-structured questionnaire.
- iii. Recording of local plant names and traditional medicinal uses.
- iv. Documentation of the plant parts used, methods of preparation, dosage forms, and routes of administration.
- v. Photographic documentation of available medicinal plants whenever possible.

All information was recorded in questionnaires and subsequently transferred to Microsoft Excel for analysis.

3.9 Collection and Identification of Plant Specimens

Plant specimens reported by informants were collected from agricultural fields, home gardens, roadsides, and surrounding natural habitats.

The collected specimens were:

- i. Carefully uprooted or sampled.
- ii. Dried under suitable conditions.
- iii. Labeled with collection numbers.
- iv. Preserved for taxonomic identification.

Identification was carried out using standard botanical literature, *Flora of Pakistan*, and available taxonomic resources. Scientific names were verified using authenticated botanical databases [30]. Plant Identification was authenticated at Quaid-i-Azam University Plant Science Department by **Amir Sohail, Visiting**

Lecturer and Herbarium Assistant at the Herbarium of Quaid-i-Azam University, Islamabad (ISL) under supervision of **Professor Dr. Mushtaq Ahmad (Director of Botanical Garden)**.

3.10 Data Management

All collected information was entered into Microsoft Excel spreadsheets. The collected data were checked for completeness, consistency, and duplication before analysis.

The final dataset consisted of:

- i. Informant demographic data
- ii. Plant-use reports
- iii. Medicinal plants master list
- iv. Ethnobotanical indices Calculations
- v. Traditional remedies.

3.11 Quantitative Ethnobotanical Analysis

Quantitative ethnobotanical indices were used to assess the cultural significance and medicinal importance of the plant species documented during the survey.

3.11.1 Relative Frequency of Citation

Relative Frequency of Citation (RFC) was calculated to determine the local importance of each medicinal plant species among the respondents.

Formula:

$$RFC = \frac{FC}{N} \quad (3.3)$$

Where:

- FC = Number of informants citing a species
- N = Total number of informants participating in the survey

RFC values range from 0 to 1, with higher values indicating greater recognition and use of a species within the community.

3.11.2 Use Value (UV)

Use Value (UV) was calculated to assess the relative importance of each medicinal plant based on the number of use reports provided by the informants.

Formula:

$$UV = \frac{\sum U_i}{N} \quad (3.4)$$

Where:

- U_i = Number of use reports cited by each informant for a species
- N = Total number of informants

Higher UV values indicate greater ethnomedicinal importance and a wider range of reported uses.

3.11.3 Informant Consensus Factor

Informant Consensus Factor (ICF) was calculated to measure the level of agreement among informants regarding the use of medicinal plants for specific disease categories.

Formula:

$$ICF = \frac{(Nur - Nt)}{(Nur - 1)} \quad (3.5)$$

Where:

- Nur = Number of use reports within a disease category
- Nt = Number of plant taxa used for that disease category

ICF values range from 0 to 1, with higher values indicating greater consensus among informants.

3.11.4 Fidelity Level

Fidelity Level (FL%) was calculated to determine the preference for a particular plant species in the treatment of a specific ailment.

Formula:

$$FL(\%) = \left(\frac{Np}{N} \right) \times 100 \quad (3.6)$$

Where:

- Np = Number of informants citing a species for a specific ailment
- N = Total number of informants reporting the use of that species

Higher FL values indicate greater specificity of use and stronger perceived therapeutic effectiveness.

3.12 Statistical Analysis

All quantitative analyses were descriptive and were performed with Microsoft Excel 2019. Descriptive statistics were chosen because the study objectives were to document and characterise existing patterns of medicinal use of medicinal products rather than to test hypotheses or to infer relationships between variables in a larger population. For categorical variables such as sex, age group, occupation, caste, plant component used, preparation method, route of administration and category of disease, absolute frequencies and percentages have been calculated and summarised in tables and graphs. Continuing demographic data (age) have been summarised by mean. The cultural significance of the documented plant species was quantified using four standard ethnobotanical indices: Relative Frequency of Citation (RFC), Use Value (UV), Fidelity Level (FL), and Informant Consensus Factor (ICF), calculated using the formulas described in Section 3.11. The following analyses were conducted:

- i. Frequency distributions
- ii. Plant parts used across ailments
- iii. Preparation methods
- iv. Route of administration
- v. Demographic summaries
- vi. Ethnobotanical index calculations

Results were presented in the form of:

- i. Tables
- ii. Bar charts
- iii. Pie charts
- iv. Ethnobotanical index graphs.

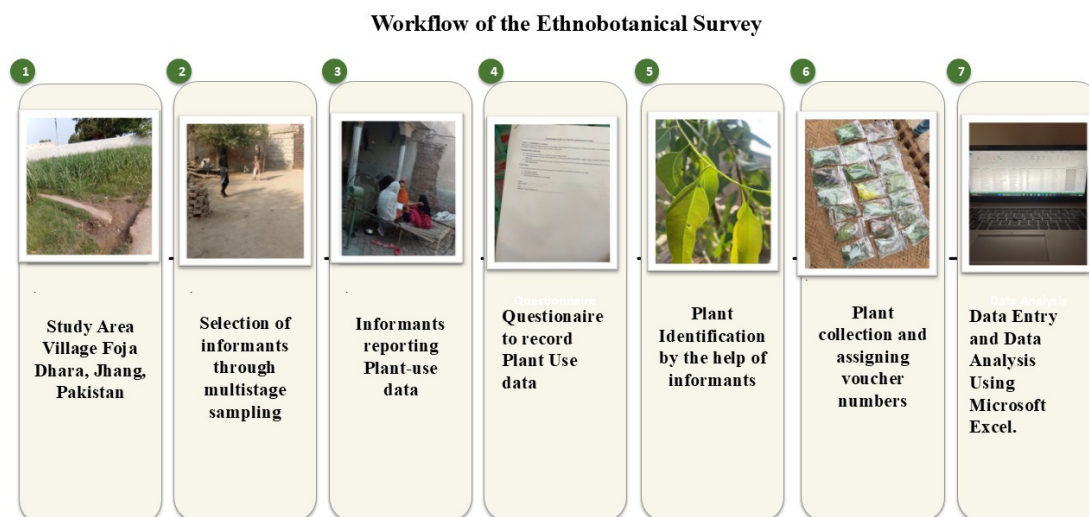


FIGURE 3.3: Flowchart illustrating the overall methodology adopted for the ethnobotanical survey, including study design, participant selection, field data collection, plant identification and quantitative ethnobotanical analysis.

The findings of these analyses are presented in the following chapter. The chapter begins with the socio-demographic characteristics of the informants, followed by the documented medicinal plant species, their families, plant parts used, methods of preparation, and routes of administration. It then presents the quantitative ethnobotanical indices (RFC, UV, FL, and ICF) described above. Each set of results is presented first and then interpreted in the light of comparable ethnobotanical studies in the field.

Chapter 4

Results and Discussions

4.1 Sociodemographic Profile of Informants

A total of 97 informants from Village Foja Dhara, District Jhang, Punjab, Pakistan participated in the ethnobotanical and ethnopharmacological survey. The total informants were recorded as 50 males (51.5%) and 47 females (48.5%), that reflects a balanced gender distribution. This balance was intentionally created during data collection to ensure that both male and female members of the community participated in the survey to present their medicinal knowledge, since gender has been widely recognized as an important determinant of ethnobotanical knowledge in South Asian communities [8, 9]. The age range of informants was 18 to 85 years, with a mean age of 42.1 years. The largest age cohort was the 36–45-year group, which accounted for 28 (28.9%) of the total informants, followed by the 18–25 and 26–35 groups, each comprising 18 informants (18.6%). Older age groups (56–65 and 66 and above) together represented 20 informants (20.6%). The participation of elderly informants is specifically important because older community members usually have deeper and more specialized medicinal plant knowledge accumulated over decades of practice [7]. Similar age distributions have been reported in comparable studies from Punjab, including the work in the

Chenab Riverine area [9]. It also found that middle-aged and elderly informants had deeper ethnobotanical knowledge due to their longer experience.

In occupation consideration, housewives constituted the largest group because they are actively involved in preparation of plant based medicinal remedies and preservation of ethnomedicinal knowledge (37; 38.1%), followed by farmers (25; 25.8%) and students (11; 11.3%). The high representation of housewives is consistent with the documented role of women in managing domestic healthcare in rural Pakistani communities where medicinal plant use for treating common ailments is primarily a domestic activity. Farmers are the people who interact directly with agricultural and wild plant environments on a daily basis. They also contributed substantially to the recorded knowledge base, particularly regarding wild plant species. Healers ($n = 5$; 5.2%), though numerically small but they provided some of the most detailed and compound medicinal knowledge, including multi-ingredient recipes. With respect to caste, the Siyal caste dominated the informant pool (86; 88.7%), that reflects the demographic composition of Village Foja Dhara. The sociodemographic characteristics of the informants are summed up in Table 4.1.

TABLE 4.1: Sociodemographic characteristics of informants ($n = 97$), Village Foja Dhara, District Jhang, Punjab, Pakistan

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	50	51.5
	Female	47	48.5
Age Group (years)	18–25	18	18.6
	26–35	18	18.6
	36–45	28	28.9
	46–55	13	13.4
	56–65	10	10.3
	66 and above	10	10.3
Occupation	Housewife	37	38.1
	Farmer	25	25.8
	Student	11	11.3
	Retired	5	5.2
	Healer	5	5.2
	Milk man	4	4.1

Table 4.1 continued from previous page

Demographic Variable	Category	Frequency (n)	Percentage (%)
Caste	Shopkeeper	4	4.1
	Teacher	3	3.1
	Driver	3	3.1
	Siyal	86	88.7
	Mochi	6	6.2
	Kukara	3	3.1
	Kodhan	1	1.0
	Syed	1	1.0

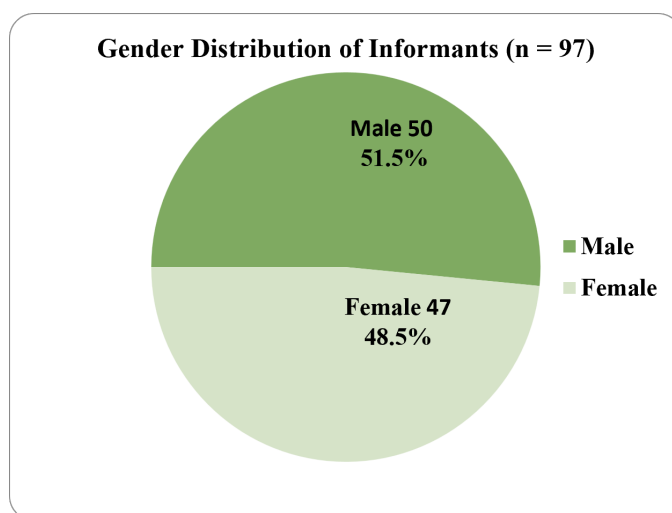


FIGURE 4.1: Distribution of informants according to gender, illustrating the proportion of male and female participants who contributed indigenous knowledge regarding the medicinal uses of plants in Village Foja Dhara.

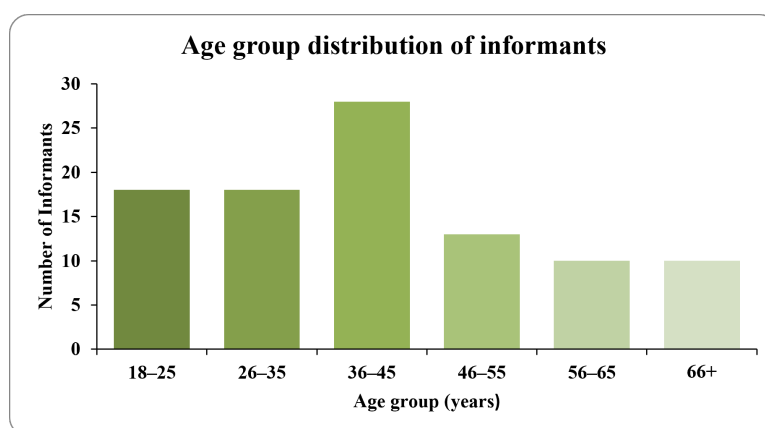


FIGURE 4.2: Age-wise distribution of study participants, demonstrating the representation of different age groups involved in the ethnobotanical survey and highlighting the contribution of experienced community members to traditional medicinal knowledge.

The occupational composition of the informant pool, illustrated in Figure 4.3, further reflects the rural agrarian character of Village Foja Dhara. The dominance of housewives and farmers, who together accounted for 63.9% of all informants, shows that medicinal plant knowledge in this community is concentrated among those who interact directly with the domestic and agricultural plant species.

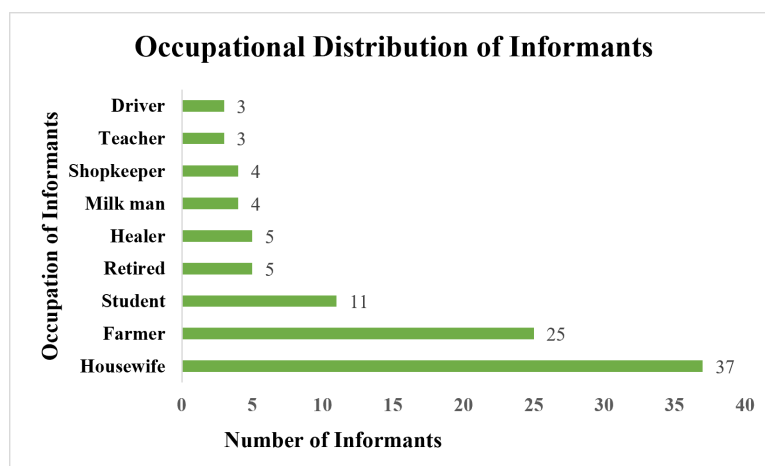


FIGURE 4.3: Occupational distribution of informants participating in the survey, showing the major professional groups contributing to indigenous ethnomedicinal knowledge within the study community.

The demographic characteristics of the informants provide an important background to the understanding of the origin and distribution of native medicinal product knowledge in the field. Building on this background, the following section presents the variety of medicinal plants documented in the survey and highlights their contribution to the traditional health practice of the village of Foja Dhara.

4.2 Documented Medicinal Plant Species

A total of 49 medicinal plant species belonging to 32 plant families were recorded from Village Foja Dhara on the basis of 325 use reports obtained from 97 informants. All documented plant species were reported as currently in use that confirms the active practice of traditional medicine in this community. The 49 species represent a significant contribution to the documented ethnobotanical knowledge of District Jhang, for which no prior scientific record was available.

The relatively large number of documented medicinal plant species indicates that traditional herbal medicine continues to play an important role in primary health-care in the study area. This diversity is probably because of diverse habitats around the village, including agricultural fields, canal bank and residential gardens as well as the local community's continued reliance on readily available plant resources. The documented species includes both wild and cultivated plants. The full botanical inventory with local names, scientific names, families, plant parts used, and preparation methods is summarised in Table 4.2.

TABLE 4.2: Recorded Medicinal Plant Species with General Disease Categories and Specific Ailments

Sr. No.	Local Name	Botanical Name	General Disease Category	Specific Ailment(s)
1	Dadhri Booti	<i>Euphorbia helis-copia</i>	Dermatological	Ring worm
2	Pathar Booti	<i>Bryophyllum pinnatum</i>	Nephrological; Hepatic; Urinary	Kidney Stones; Jaundice; UTI
3	Thoom	<i>Allium sativum</i>	Cardiovascular; Dermatological; Musculoskeletal; Olfactory; Dental; Gastrointestinal	Hypertension; Paronychia; Wounds; Joint pain; Ear pain; Toothache; Intestinal worms
4	Kandyari	<i>Prosopis cineraria</i>	Dental; Oral	Toothache; Mouth blisters
5	Bhakhra booti	<i>Tribulus terrestris</i>	Nephrological; Musculoskeletal	Kidney Stones; Joint pain; UTI
6	Peelkan	<i>Salvadora persica</i>	Hepatic; Respiratory; Gastrointestinal; Dermatological; Oral	Jaundice; Asthma; Indigestion; Wounds; Gum Infection
7	Papra booti	<i>Fumaria indica</i>	Febrile; Hepatic	Fever; Jaundice
8	Naag dhawan	<i>Euphorbia tithymaloides</i>	Dermatological	Abscesses; Boils
9	Kaasni booti	<i>Cichorium intybus</i>	Febrile; Dermatological; Hepatic; Nephrological	Fever; Acne ; Jaundice; Liver problems; UTI
10	Dhamasa booti	<i>Fagonia cretica</i>	Neoplastic; Hepatic; Metabolic	Cancer; Jaundice

Table 4.2 – Continued from previous page

Sr. No.	Local Name	Botanical Name	General Disease Category	Specific Ailment(s)
11	Kor Tumba	<i>Citrullus colocynthis</i>	Metabolic; Musculoskeletal; Dermatological	Diabetes; Joint pain; Skin Fungus; Eczema; Abscesses
12	Bohar	<i>Ficus benghalensis</i>	Respiratory; Metabolic; Dermatological; Dental	Cough; Flu; Diabetes; Asthma; Dry cough; Wounds; Toothache
13	Bukan booti	<i>Phyllanthus nodiflora</i>	Dermatological	Wounds; Abscesses
14	Jaman	<i>Syzygium cumini</i>	Metabolic; Gastrointestinal; Hepatic	Diabetes; Diarrhea; Jaundice
15	Suhanjna	<i>Moringa oleifera</i>	Metabolic; Cardiovascular	Diabetes; Hypertension
16	Keekar	<i>Acacia nilotica</i>	Gastrointestinal; Musculoskeletal; Oral; Hepatic; Dental	Stomach Ulcer; Joint pain; Toothache; Jaundice; Liver problems
17	Aloevera	<i>Aloe barbadensis</i>	Gastrointestinal; Dermatological	Indigestion; Constipation; Itching; Wounds; Hairfall
18	Neem	<i>Azadirachta indica</i>	Dermatological	Skin Fungus; Abscesses; Wounds; Foot fungus; Lice and ticks
19	Pabri	<i>Origanum majorana</i>	Gastrointestinal; Cardiovascular	Indigestion; Heartburn; Hypertension; Bloating
20	Baathu	<i>Chenopodium album</i>	Gastrointestinal	Constipation; Indigestion; Bloating
21	Safaيدا	<i>Eucalyptus tereticornis</i>	Respiratory; Dermatological; Febrile	Cough; Wounds; Flu; Rhinitis; Fever; Asthma; Skin Burn
22	Chibar	<i>Cucumis melo</i>	Dermatological; Metabolic; Gastrointestinal	Paronychia; Itching; Diabetes; Intestinal worms
23	Akra	<i>Calotropis procera</i>	Dermatological; Musculoskeletal	Skin Fungus; Warts; Scabies; Abscesses; Joint pain; Wounds; Eczema

Table 4.2 – Continued from previous page

Sr. No.	Local Name	Botanical Name	General Disease Category	Specific Ailment(s)
24	Ganna (sugar-cane)	<i>Saccharum officinarum</i>	Gastrointestinal	Indigestion
25	Bakain	<i>Melia azedarach</i>	Gastrointestinal; Dermatological	Piles; Eczema; Itching; Wounds; Acne ; Boils; Intestinal worms
26	Shahtoot	<i>Morus alba</i>	Respiratory	Cough; Dry cough
27	Adrak	<i>Zingiber officinale</i>	Respiratory	Cough
28	Beri	<i>Ziziphus mauritiana</i>	Dermatological; Gynaecological	Blisters; Wounds; Milk production; Eczema
29	Gurhel ka phool	<i>Hibiscus rosa</i>	Dermatological; Psychological; Gastrointestinal; Gynaecological	Dandruff; Depression; Bloating; Post partum depression
30	Podina	<i>Mentha spicata</i>	Gastrointestinal	Vomiting; Indigestion; Bloating
31	Paneer dodi	<i>Withania coagulans</i>	Dermatological; Metabolic	Acne ; Diabetes
32	Khajoor	<i>Phoenix dactylifera</i>	Dermatological	Boils
33	Wasal	<i>Allium cepa</i>	Dermatological	Hairfall
34	Haldi	<i>Curcuma longa</i>	Dermatological; Musculoskeletal	Wounds; Wound pain
35	Band gobi	<i>Brassica oleracea</i>	Musculoskeletal	Joint pain
36	Sookay Dhany	<i>Coriandrum sativum</i>	Oral	Mouth blisters
37	Phulai	<i>Senegalia modesta</i>	Dental; Dermatological; Gastrointestinal	Toothache; Wounds; Gastric Irritation
38	Kulfa	<i>Portulaca oleracea</i>	Febrile; Hepatic; Urinary	Fever; Jaundice; Urinary burning
39	Arand	<i>Ricinus communis</i>	Musculoskeletal	Joint pain
40	Saunf	<i>Foeniculum vulgare</i>	Gastrointestinal	Bloating

Table 4.2 – Continued from previous page

Sr. No.	Local Name	Botanical Name	General Disease Category	Specific Ailment(s)
41	Methi	<i>Trigonella foenum</i>	Gynaecological	Menstrual cramps
42	Gulab ka phool	<i>Rosa rubiginosa</i>	Ophthalmological	Eye Infection
43	Chaye ki patti	<i>Camellia sinensis</i>	Gastrointestinal	Diarrhea
44	Amarbail	<i>Cuscuta reflexa</i>	Dermatological	Itching
45	Putkanda	<i>Achyranthes aspera</i>	Gastrointestinal	Bloating
46	Itsit booti	<i>Trianthema portulacastrum</i>	Gastrointestinal	Constipation
47	Kainch mainch	<i>Solanum nigrum</i>	Ophthalmological	Eye Infection
48	Bhangra	<i>Eclipta prostrata</i>	Dermatological	Snake bite
49	Joe	<i>Avena Sativa</i>	Metabolic	Diabetes

While the overall diversity of medicinal plants shows the richness of local ethnobotanical knowledge, a study of their taxonomic distribution provides a more detailed view of the botanical groups that are most involved in traditional medicinal use. The following section therefore describes the distribution of documented species between the various family plants.

4.3 Family Representation and Plant Diversity

The 49 documented species were distributed across 32 plant families, indicating considerable taxonomic diversity within the local medicinal flora (Table 4.3). Fabaceae was the most species-rich family, contributing four species (*Prosopis cineraria*, *Acacia nilotica*, *Senegalia modesta*, and *Trigonella foenum*), representing 8.0% of the total. Euphorbiaceae contributed three species (*Euphorbia helioscopia*, *Euphorbia tithymaloides*, and *Ricinus communis*; 6.0%), and Apiaceae

(*Coriandrum sativum*, *Foeniculum vulgare*, and one other; 6.0%). Several families, including Cucurbitaceae, Alliaceae, Zygophyllaceae, Moraceae, Myrtaceae, Meliaceae, Amaranthaceae, Zingiberaceae, Solanaceae, and Asteraceae, were each represented by two species (4.0%), whereas the remaining 18 families were represented by a single species each.

The predominance of Fabaceae in the documented flora remains consistent with numerous ethnobotanical studies from Punjab and neighboring regions, where leguminous plants consistently rank among the most commonly utilized medicinal plant species owing to their prominence in the local landscape, their well-established pharmacological profiles, and their multipurpose utility [60]. The representation of Euphorbiaceae, which is known globally for its diverse secondary metabolite chemistry including terpenoids, flavonoids, and tannins with broad antimicrobial and anti-inflammatory activities, further elaborates the pharmacological potential of the Foja Dhara medicinal flora [25]. The predominance of the main plant families like Fabaceae is probably due to their wide ecological distribution and their adaptation to the semi-arid climate of the central Punjab. These families also include a number of species rich in bioactive secondary metabolites, which make them valuable in traditional medicinal products and increase their use in local communities. Following table 4.3 shows the distribution of medicinal species across families and their percentage.

TABLE 4.3: Distribution of documented medicinal species across plant families

Plant Family	Number of Species	Percentage (%)
Fabaceae	4	8.0
Euphorbiaceae	3	6.0
Apiaceae	3	6.0
Cucurbitaceae	2	4.0
Alliaceae	2	4.0
Zygophyllaceae	2	4.0
Moraceae	2	4.0
Myrtaceae	2	4.0
Meliaceae	2	4.0

Table 4.3 continued from previous page

Plant Family	Number of Species	Percentage (%)
Amaranthaceae	2	4.0
Poaceae	2	4.0
Zingiberaceae	2	4.0
Solanaceae	2	4.0
Rosaceae	2	4.0
Asteraceae	2	4.0
Papaveraceae	1	2.0
Crassulaceae	1	2.0
Salvadoraceae	1	2.0
Apocynaceae	1	2.0
Lamiaceae	1	2.0
Moringaceae	1	2.0
Asphodelaceae	1	2.0
Rhamnaceae	1	2.0
Malvaceae	1	2.0
Verbenaceae	1	2.0
Brassicaceae	1	2.0
Portulacaceae	1	2.0
Arecaceae	1	2.0
Convolvulaceae	1	2.0
Theaceae	1	2.0
Aizoaceae	1	2.0

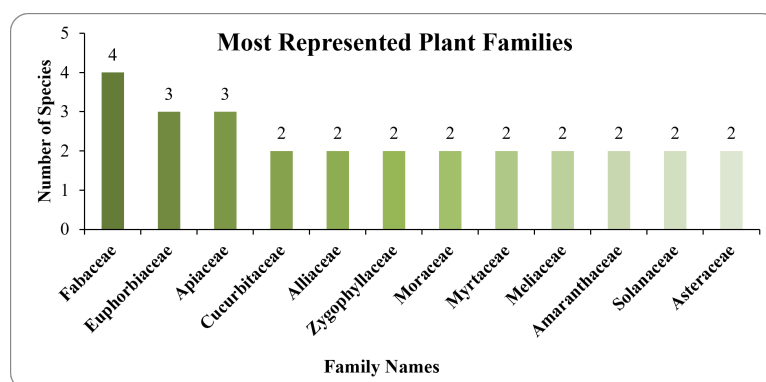


FIGURE 4.4: Distribution of documented medicinal plant species among botanical families, illustrating the relative contribution of each family to the ethnomedicinal flora recorded from Village Foja Dhara.

In addition to their taxonomic classification, medicinal plants also vary in their form of growth, which affects their abundance, availability and use in local communities.

The following section therefore examines the distribution of documented species in terms of their growth as wild or cultivated plants.

4.4 Wild versus Cultivated Status of Documented Species

Out of total 325 recorded use reports, 167 (51.4%) involved cultivated plant species and 158 (48.6%) involved wild species that reflects a near-equal dependence on both wild and cultivated plants in this community.

At the species level, approximately half of the 49 documented plants were collected from natural environments including agricultural field margins, roadsides, riverbanks, and surrounding wildland areas, while the remaining species were collected from home yards and cultivated fields.

This balance is important to be noticed that explains the dominant agricultural character of the Foja Dhara landscape and is consistent with findings from the broader Punjab region where wild plants are the important components of the traditional pharmacopoeia despite the cultivation of medicinal plants [89].

The dependence on wild plants carries conservation implications. Several wild species documented in this ethnobotanical study, including *Fagonia cretica* (Dhamasa Booti), *Prosopis cineraria* (Kandyari), and *Tribulus terrestris* (Bhakhra Booti), are subject to unsustainable harvesting pressure across the semi-arid landscapes of Punjab [60].

The documentation of these species and their therapeutic uses provides data that could act as a support for community level conservation of culturally important species.

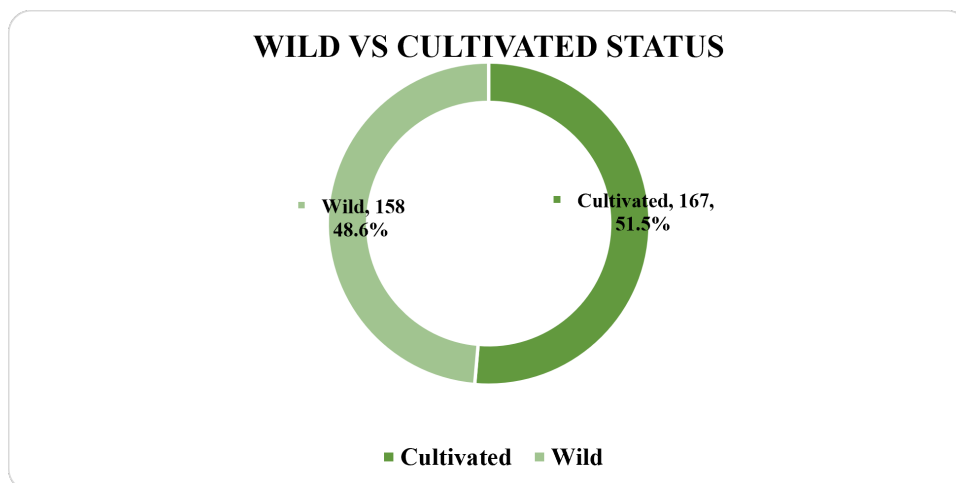


FIGURE 4.5: Comparison of wild and cultivated medicinal plant species documented during the survey, demonstrating the primary sources from which traditional herbal remedies are obtained by the local population.

4.5 Human versus Animal Medicinal Use

The majority of use reports (311; 95.7%) documented human medicinal uses of plants. However, 14 use reports (4.3%) concerned veterinary application that shows importance of livestock in this agricultural community's economic prespective.

The animal-specific uses included treatment of gastrointestinal conditions in livestock using *Aloe vera* and *Saccharum officinarum*, wound care using *Azadirachta indica* and *Salvadora persica*, and milk production enhancement using *Ziziphus mauritiana*.

The documentation of veterinary uses was not the primary focus of this study but it is still valuable with respect to future ethnopharmacological investigation as some compounds effective in humans may have parallel applications in veterinary medicine.

Although medicinal plants vary in their form of growth and their animal or human use the therapeutic value of each species depends to a large extent on specific parts of the plant used in plant based medicinal remedies. Consequently, the following section examines the frequency and type of plant parts used locally.

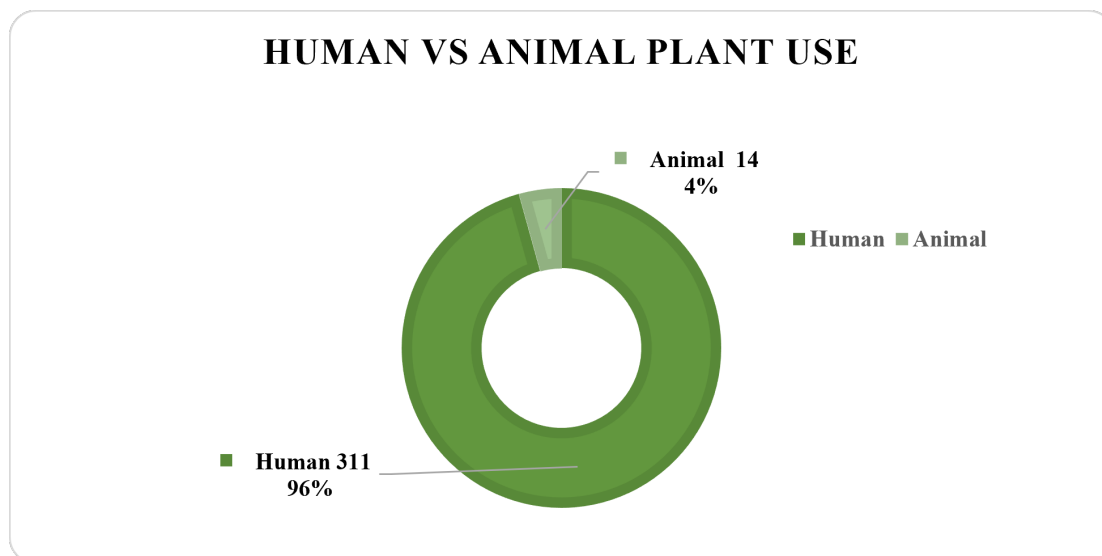


FIGURE 4.6: Proportion of medicinal plants used for human and veterinary healthcare, highlighting the predominance of species employed in traditional human medicine while also indicating their role in veterinary practices.

4.6 Plant Parts Utilized

The plant parts utilized by informants in Village Foja Dhara and their frequencies are summarized in Table 4.4. Leaves are reported as dominant plant part being used, accounting for 168 use reports (51.7% of the total). This was followed distantly by fruit (35; 10.8%), root (29; 8.9%), latex (24; 7.4%), seeds (18; 5.5%), flowers (16; 4.9%), cloves/bulbs (12; 3.7%), rhizome (8; 2.5%), bark (5; 1.5%), and gel (3; 0.9%).

The dominance of leaves in medicinal plant use is a universally consistent pattern reported in ethnobotanical literature globally and within Pakistan [90]. Leaves are the preferred plant part because they are the primary sites of photosynthesis and secondary metabolite biosynthesis, leading to the accumulation of high concentrations of bioactive compounds such as flavonoids, terpenoids, and phenolic acids [91].

Leaves are the most accessible and renewable part of the plant and can generally be harvested without causing permanent damage, making their use consistent with traditional ecological knowledge that promotes sustainable resource utilization [92].

The use of latex, documented for *Euphorbia heliscopia* (Dadhri Booti), *Euphorbia tithymaloides* (Naag Dhawan), *Calotropis procera* (Akra), *Ficus benghalensis* (Bohar), and *Aloe barbadensis* (Aloevera), is notable. Latex-based preparations require careful handling due to the potential for skin and mucosal irritation, and several informants also mentioned the precaution to avoid ingestion when using *Euphorbia* and *Calotropis* latex preparations.

This precautionary knowledge reflects wisdom of community regarding the dual nature of these plants as both therapeutic agents and potential hazards. Table 4.4 shows Plant parts being used and their frequency of use in Village Foja Dhara.

TABLE 4.4: Plant parts utilized and their frequency of use in Village Foja Dhara

Plant Part	Frequency (n)	Percentage (%)
Leaves	168	51.7
Fruit	35	10.8
Root	29	8.9
Latex	24	7.4
Seeds	18	5.5
Flowers	16	4.9
Clove (garlic)	12	3.7
Rhizome	8	2.5
Bark	5	1.5
Gel	3	0.9
Twigs	1	0.3
Other (whole fruit/leaf)	7	2.2
Total	325	100.0

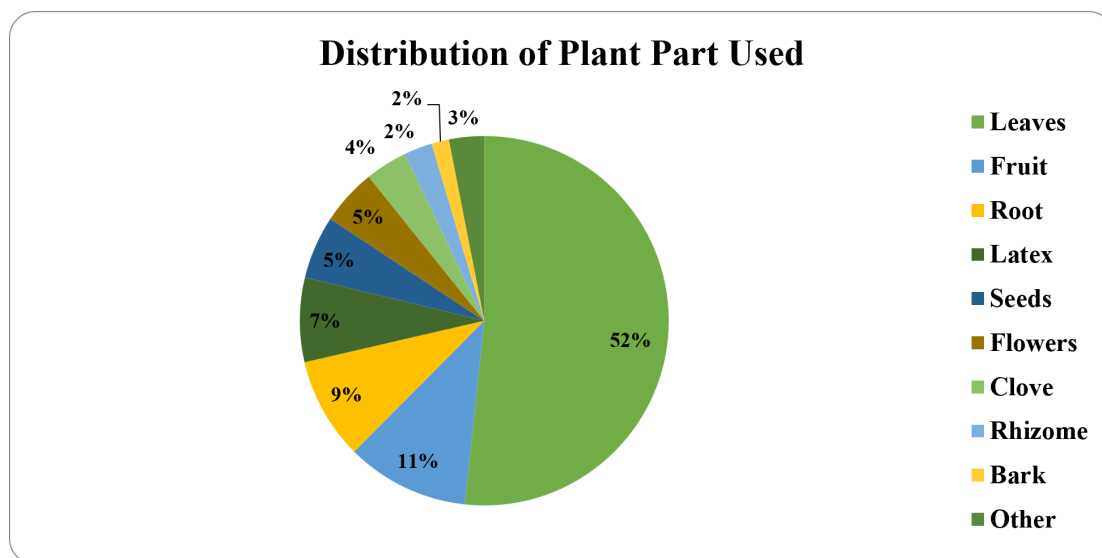


FIGURE 4.7: Frequency distribution of plant parts utilized in traditional herbal preparations, illustrating the relative preference for leaves, fruits, roots, bark, seeds, and other plant parts among the documented medicinal species.

The choice of herbal ingredients is closely linked to the methods used in traditional herbal medicine, as different methods of preparation affect the extraction and administration of the bioactive substances. The methods of preparation used by the respondents are therefore set out in the following section.

4.7 Methods of Preparation

Five principal methods of remedy preparation were documented, with paste being the most frequently employed, accounting for 139 use reports (42.8%), followed by decoction (75; 23.1%), powder (72; 22.2%), inhalation (23; 7.1%), whole fruit or vegetable application (13; 4.0%), and oil extraction (2; 0.6%) (Table 4.5). The high frequency of paste preparations presents the dominance of topically applied remedies in this community that are particularly used for dermatological conditions, which constituted the largest ailment category. Paste preparations typically involve crushing fresh or dried plant material sometimes with the addition of carrier oils such as mustard oil, olive oil, or coconut oil, and application of the mixture directly to affected skin areas.

Decoction is second common method that involves boiling plant material in water for a defined period to extract bioactive constituents, and is particularly linked with the treatment of gastrointestinal, febrile, hepatic, and respiratory conditions. This method is consistent with the global ethnobotanical literature, in which decoction is widely recognized as one of the most effective and universal traditional extraction methods [93].

In contrast to earlier studies conducted in Pakistan, where decoction was often reported as the dominant preparation method, the present study found paste to be more prevalent that presents the high prevalence of dermatological conditions in the study area.

Inhalation was exclusively reported for respiratory ailments, primarily using the aromatic leaves and bark of *Eucalyptus tereticornis* (Safaida) and the roots and latex of *Ficus benghalensis* (Bohar). Informants described placing aromatic plant material in hot water and inhaling the steam, a practice that closely resembles modern steam inhalation therapies used in conventional medicine for the relief of nasal and bronchial congestion. The biological basis for this practice lies in the volatile terpenoid compounds, including eucalyptol (1,8-cineole), which is the principal component of eucalyptus oil and has well-documented mucolytic and bronchodilatory properties [94].

In addition to single-ingredient preparations, 45 use reports (13.8%) involved multi-ingredient recipes (R1–R44 in the Recipes data sheet) in which the primary medicinal plant was combined with other ingredients such as mustard oil, honey, black pepper, mint, pomegranate peel, and spices. These combinations likely reflect accumulated knowledge regarding synergistic or palatability-enhancing combinations, and some may represent pharmacologically significant formulations.

For example, the combination of ginger (Adrak) with honey and black pepper for respiratory ailments is consistent with known synergistic antimicrobial and expectorant effects of these ingredients. Table 4.5 presents Methods of preparation, their frequency, percentage and primary routes of administration in Village Foja Dhara.

TABLE 4.5: Methods of preparation and primary routes of administration, Village Foja Dhara

Preparation Method	Frequency (n)	Percentage (%)	Primary Route
Paste	139	42.8	Topical/Oral
Decoction	75	23.1	Oral
Powder	72	22.2	Oral
Inhalation	23	7.1	Inhale
Whole fruit/vegetable	13	4.0	Topical/Oral
Oil extraction	2	0.6	Topical
Total	325	100.0	—

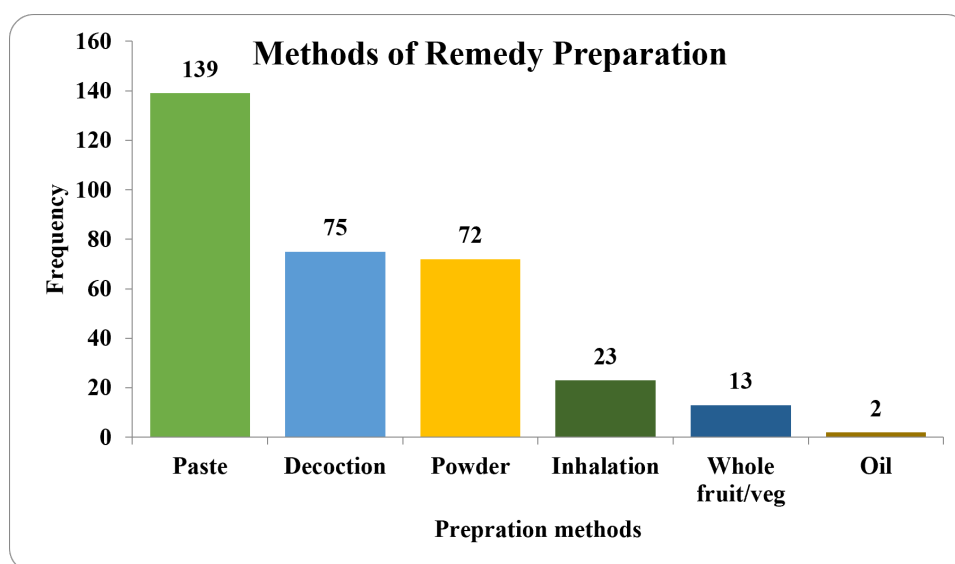


FIGURE 4.8: Frequency of different traditional methods used for preparing herbal remedies, demonstrating the most commonly adopted techniques employed by the local community for medicinal plant processing.

Once the medicinal remedies are prepared, their therapeutic efficacy also depends on the route of administration. Accordingly, the following section describes the different methods of administration adopted by the local community in the different health conditions.

4.8 Routes of Administration

Three routes of administration were recorded. Oral administration was most common, accounting for 191 use reports (58.8%), followed by topical application (111;

34.2%) and inhalation (23; 7.1%). The predominance of oral administration is expected because of wide range of systemic conditions being treated, including metabolic, febrile, hepatic, gastrointestinal, nephrological, and cardiovascular ailments, all of which require systemic delivery of bioactive compounds.

Topical administration was primarily linked with dermatological conditions, including wounds, abscesses, ringworm, paronychia, and skin fungal infections, and with musculoskeletal ailments such as joint pain. Inhalation was confined to respiratory conditions.

The proportion of topically administered remedies (34.2%) in this study is higher than that reported in several comparable studies from mountainous regions of Pakistan, where oral preparations typically dominate more [7].

This difference likely presents high occurrence of dermatological diseases in the study population, which may relate to occupational exposure (farming, outdoor labour) and various environmental factors such as heat, dust, and harsh environment in the semi-arid plains of District Jhang.

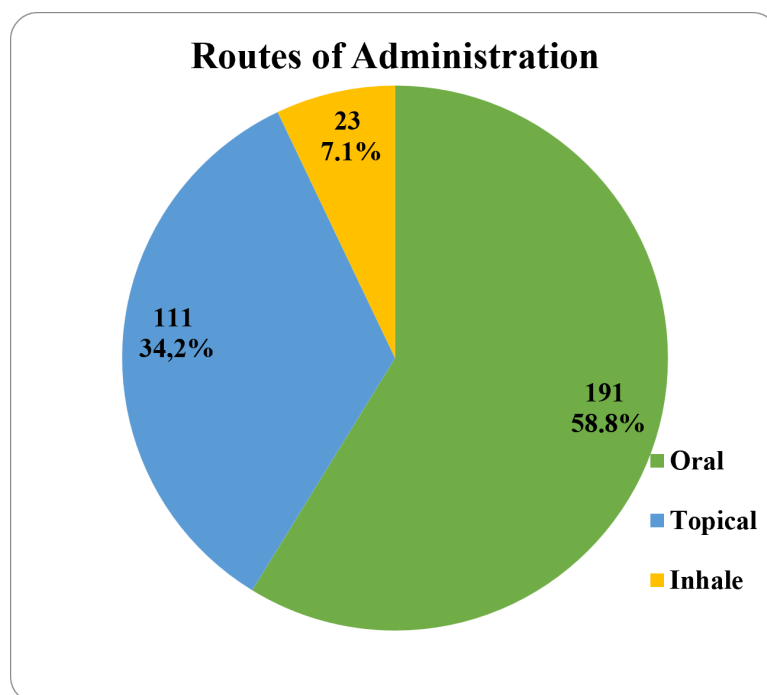


FIGURE 4.9: Distribution of routes of administration of traditional herbal preparations, illustrating the predominant methods through which medicinal plant remedies are administered for therapeutic purposes.

The variety of preparation methods and routes of administration reflects wide variety of medical conditions that are treated with herbal medicinal products. In order to better understand these therapeutic uses, the following section categorises the reported uses by category of disease.

4.9 Ailment Categories and Specific Ailments

A total of 17 disease categories were identified on the basis of the ailments reported by informants (Table 4.6). Dermatological conditions represented the largest category, accounting for 101 use reports (31.1%) and involving 23 plant taxa. This was followed by gastrointestinal (42; 12.9%), respiratory (33; 10.2%), metabolic (29; 8.9%), febrile (21; 6.5%), dental (20; 6.2%), hepatic (20; 6.2%), nephrological (17; 5.2%), and musculoskeletal (12; 3.7%) categories, with smaller numbers of reports in the cardiovascular, oral, gynaecological, neoplastic, psychological, urinary, ophthalmological, and olfactory categories.

The dominance of dermatological ailments in the documented use reports is consistent with patterns observed in ethnobotanical studies from the broader Punjab region [95].

It presents the high prevalence of skin conditions associated with agricultural work, heat, and dust exposure in the semi-arid plains of central Punjab. Within the dermatological category, ring worm (15 reports), wounds (25 reports), abscesses (14 reports), skin fungus (5 reports), eczema (5 reports), and paronychia (7 reports) were among the most commonly treated ailments.

Diabetes was the single most frequently mentioned specific ailment, with 28 use reports, reflecting the known high prevalence of type 2 diabetes in rural Punjab [96]. The wide range of plants used for diabetes, including *Syzygium cumini* (Jamun), *Moringa oleifera* (Suhanjna), *Citrullus colocynthis* (Kor Tumba), *Cucumis melo* (Chibar), and *Avena sativa* (Joe), indicates a diverse local occurrence of this condition. Fever (21 reports) and toothache (21 reports) were equally prominent, followed by cough (21), jaundice (18), and kidney stones (15).

The documentation of neoplastic conditions (cancer; 3 reports) is particularly noteworthy from a pharmacological perspective. All three reports cited *Fagonia cretica* (Dhamasa Booti) as the primary treatment for cancer, reflecting a strong traditional belief in the anticancer potential of this plant in the region. This belief is supported by pharmacological research demonstrating cytotoxic and anti-proliferative activities of *Fagonia cretica* extracts in various cancer cell lines, The consistent citation of a single plant for a specific serious condition is an indicator of both strong community consensus and high ethnopharmacological relevance [97].

The prevalence of some disease categories probably reflects the common health problems faced by rural populations. Occupational exposure, climate conditions, dietary habits and limited access to health care services can all contribute to continued dependence on herbal medicines to treat these common diseases. Table 4.6 shows Distribution of use reports and taxa across disease categories, Village Foja Dhara.

TABLE 4.6: Distribution of use reports and taxa across disease categories, Village Foja Dhara

Disease Category	Use Reports (Nur)	% of Total	No. of Taxa (Nt)	Common Ailments Treated
Dermatological	101	31.1	23	Ring worm, Wounds, Abscesses, Eczema, Skin Fungus, Paronychia, Boils
Gastrointestinal	42	12.9	17	Indigestion, Stomach Ulcer, Piles, Constipation, Bloating, Diarrhoea
Respiratory	33	10.2	5	Cough, Asthma, Flu, Dry Cough, Rhinitis
Metabolic	29	8.9	8	Diabetes
Febrile	21	6.5	4	Fever
Dental	20	6.2	5	Toothache
Hepatic	20	6.2	8	Jaundice, Liver problems
Nephrological	17	5.2	3	Kidney Stones, UTI
Musculoskeletal	12	3.7	8	Joint pain, Wound pain
Cardiovascular	7	2.2	3	Hypertension
Oral	7	2.2	4	Mouth Blisters, Gum Infection

Table 4.6 continued from previous page

Disease Category	Use Reports (Nur)	% of Total	No. of Taxa (Nt)	Common Ailments Treated
Gynaecological	4	1.2	3	Menstrual cramps, Milk production, Postpartum depression
Neoplastic	3	0.9	1	Cancer
Psychological	3	0.9	1	Depression, Postpartum depression
Urinary	3	0.9	2	UTI, Urinary Burning
Ophthalmological	2	0.6	2	Eye Infection
Olfactory	1	0.3	1	Ear Pain
Total	325	100.0	—	—

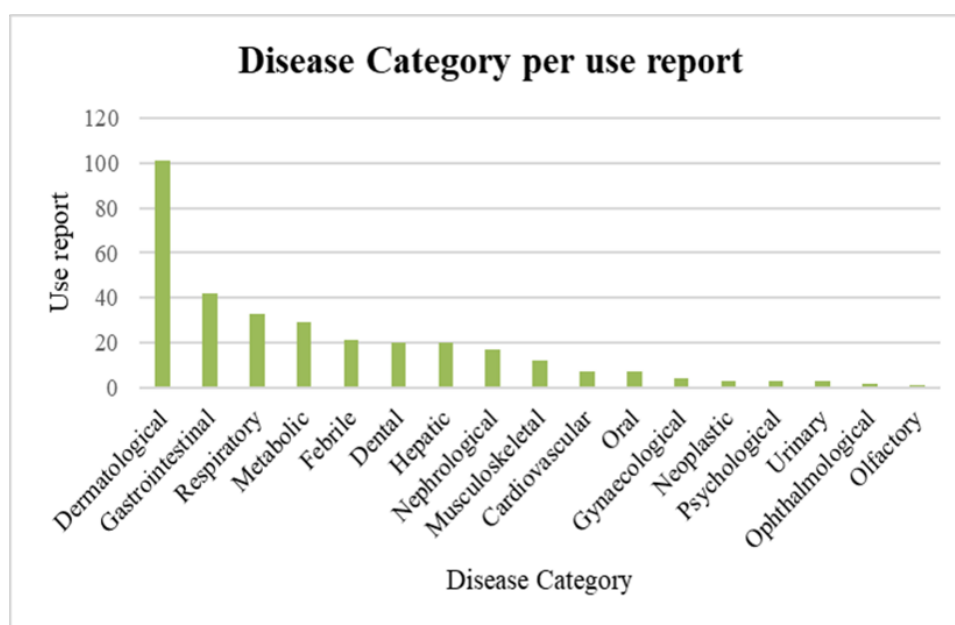


FIGURE 4.10: Number of medicinal plant use reports recorded for each disease category, demonstrating the relative frequency of traditional herbal treatments employed for different health conditions within the study area.

While the disease categories show the range of medicinal uses of plants, quantitative ethnobotanical indices provide profound understanding of their cultural significance, usage patterns in society and helps in the identification of plant species that could be considered for future pharmacological validation . The Ethnobotanical Indices results are discussed in the next section.

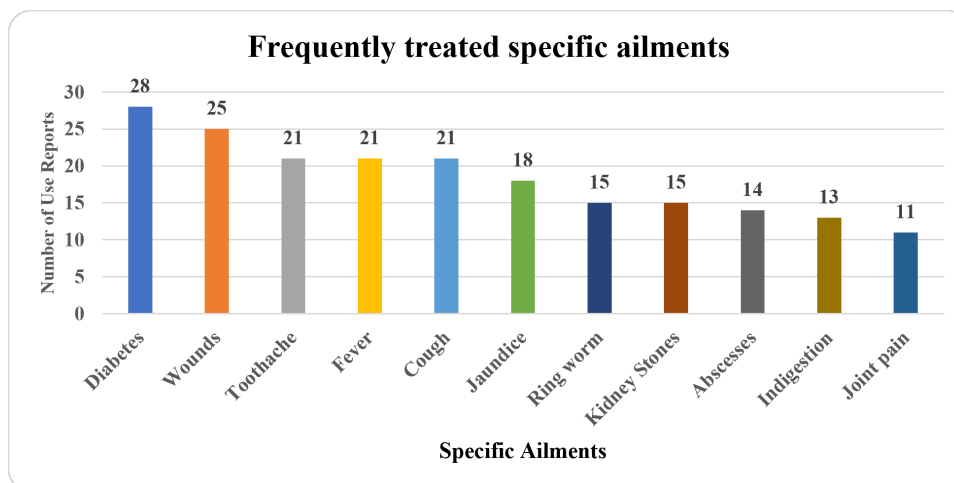


FIGURE 4.11: Most frequently reported specific ailments treated with medicinal plants, highlighting the common health problems managed through traditional herbal medicine by the local community.

4.10 Quantitative Ethnobotanical Analysis

4.10.1 Relative Frequency of Citation and Use Value

Relative Frequency of Citation (RFC) reflects the level of recognition and cultural importance of medicinal plant species within the local community [30]. Plant species with higher RFC values were cited by a greater proportion of informants, indicating that they are well known, readily available, and widely accepted for the treatment of common ailments. Species such as *Ficus benghalensis* exhibited high RFC values, reflecting their long-standing traditional use and the community's confidence in their therapeutic effectiveness. Therefore, species with high RFC values can be regarded as culturally significant components of the traditional healthcare system in Village Foja Dhara.

RFC values ranged from a maximum of 0.175 for *Ficus benghalensis* (Bohar) to a minimum of 0.010 shared by 13 rarely cited species. UV values ranged from 0.072, shared by five species (*Calotropis procera*, *Melia azedarach*, *Ficus benghalensis*, *Eucalyptus tereticornis*, and *Allium sativum*), to 0.010 for species cited for only a single use.

Ficus benghalensis (Bohar) had the highest RFC (0.175), indicating that 17 out of 97 informants had reported *Ficus benghalensis* as a species of concern. Its main use in this community is for respiratory conditions, especially cough and asthma, by inhalation of steam from root smoke or latex products, with other uses reported in diabetes and dental conditions.

The high standard of Bohar reflects its availability as a large cultivated tree in the rural landscape and its deep cultural identity as a traditional remedy. *Ficus benghalensis* has well documented pharmacological properties, including antimicrobial, antioxidant, anti-inflammatory and antidiabetic properties, which lend it scientific credibility for these traditional uses [98].

Cichorium intybus (Kaasni Booti) and *Prosopis cineraria* (Kandyari) both reached a RFC of 0.165 and were therefore the second species most frequently quoted. Kaasni Booti has been reported in particular for febrile (antipyretic) and liver disease, which is in line with its well documented pharmacological profile in the literature [99].

Prosopis cineraria (Kandyari) was almost exclusively reported for dental conditions, especially tooth pain, and informants consistently described using root powder on affected teeth. *Calotropis procera* (Akra) and *Euphorbia helioscopia* (Dadhri Booti) both achieved RFC values of 0.155.

The reason that some recorded species like *Ficus benghalensis*, *Chichorium Intybus* and *Prosopis cineraria* have the highest frequency of citation is that they are the most commonly known plant species of the area and they are most cited because they are used by most of the population because of their therapeutic significance.

Use Value (UV) reflects the relative medicinal importance of a plant species based on the number and diversity of therapeutic uses reported by informants. Plant species with higher UV values are used to treat a wide range of ailments, indicating their broad therapeutic applications and significant role in the local healthcare system. Their extensive use may also suggest the presence of diverse bioactive compounds responsible for multiple pharmacological activities.

Calotropis procera had the highest UV value jointly with four other species (UV = 0.072), reflecting its versatility across seven different ailment types including abscesses, eczema, scabies, warts, wounds, skin fungus, and joint pain.

This high UV underscores the broad pharmacological use of *Calotropis procera*, which is attributed to its diverse secondary metabolite profile including calotropin, calactin, and various flavonoids with anti-inflammatory, antibacterial, and wound-healing activities [100].

In comparison, *Euphorbia helioscopia* (Dadhri Booti) despite its high RFC (0.155) had the lowest UV (0.010) and high FL (100%) of any commonly cited species, indicating that while it is widely recognized in the community, it is almost exclusively used for a single application that is the topical treatment of ring worm with its latex. This pattern of high RFC coupled with very low UV indicates a species that is culturally prominent for one very specific therapeutic use.

The five species sharing the highest UV value (0.072) are *Calotropis procera*, *Melia azedarach*, *Ficus benghalensis*, *Eucalyptus tereticornis*, and *Allium sativum* representing the most therapeutically versatile plants in the Foja Dhara data.

They have high UV values because these species collectively address a wide spectrum of diseases including dermatological, respiratory, gastrointestinal, metabolic, cardiovascular, and dental conditions. Their versatility is consistent with their rich and diverse phytochemical profiles documented in the scientific literature [98].

Plant species with higher RFCs are likely to be those which are more familiar, easily available and perceived as efficient by local populations. Their frequent citations indicate a widespread traditional acceptance and long-standing cultural relevance in the treatment of common diseases. Among all the recorded plant species some have high Use Value because those plants are used for multiple therapeutic purposes and have a wide therapeutic significance according to informants.

These species are well known in the community due to their versatility, availability and accumulated traditional experience of their efficacy. The RFC and UV values for all 49 documented plant species are presented in Table 4.7.

TABLE 4.7: Relative Frequency of Citation (RFC), Use Value (UV), for all documented species (n = 97)

Local Name	Scientific Name	RFC	UV
Bohar	<i>Ficus benghalensis</i>	0.175	0.072
Kaasni Booti	<i>Cichorium intybus</i>	0.165	0.052
Kandyari	<i>Prosopis cineraria</i>	0.165	0.021
Akra	<i>Calotropis procera</i>	0.155	0.072
Dadhri Booti	<i>Euphorbia heliscopia</i>	0.155	0.010
Pathar Booti	<i>Bryophyllum pinnatum</i>	0.144	0.031
Safaيدا	<i>Eucalyptus tereticornis</i>	0.144	0.072
Keekar	<i>Acacia nilotica</i>	0.134	0.052
Bakain	<i>Melia azedarach</i>	0.124	0.072
Neem	<i>Azadirachta indica</i>	0.124	0.052
Thoom	<i>Allium sativum</i>	0.124	0.072
Chibar	<i>Cucumis melo</i>	0.113	0.041
Kor Tumba	<i>Citrullus colocynthis</i>	0.113	0.052
Peelkan	<i>Salvadora persica</i>	0.113	0.052
Papra Booti	<i>Fumaria indica</i>	0.103	0.021
Suhanjna	<i>Moringa oleifera</i>	0.103	0.021
Jaman	<i>Syzygium cumini</i>	0.093	0.031
Pabri	<i>Origanum majorana</i>	0.082	0.041
Bhakhra Booti	<i>Tribulus terrestris</i>	0.072	0.031
Gurhel Ka Phool	<i>Hibiscus rosa</i>	0.072	0.041
Naag Dhawan	<i>Euphorbia tithymaloides</i>	0.072	0.021
Adrak	<i>Zingiber officinale</i>	0.052	0.010
Aloevera	<i>Aloe barbadensis</i>	0.052	0.052
Baathu	<i>Chenopodium album</i>	0.052	0.031
Beri	<i>Ziziphus mauritiana</i>	0.052	0.041
Bukan Booti	<i>Phyla nodiflora</i>	0.052	0.021
Dhamasa Booti	<i>Fagonia cretica</i>	0.052	0.021
Podina	<i>Mentha spicata</i>	0.052	0.031
Shahtoot	<i>Morus alba</i>	0.052	0.021
Paneer Dodi	<i>Withania coagulans</i>	0.041	0.021
Phulai	<i>Senegalia modesta</i>	0.041	0.031

Table 4.7 continued from previous page

Local Name	Scientific Name	RFC	UV
Arand	<i>Ricinus communis</i>	0.031	0.010
Band Gobi	<i>Brassica oleracea</i>	0.031	0.010
Haldi	<i>Curcuma longa</i>	0.031	0.021
Kulfa	<i>Portulaca oleracea</i>	0.031	0.031
Sookay Dhany	<i>Coriandrum sativum</i>	0.031	0.010
Methi	<i>Trigonella foenum</i>	0.021	0.010
Wasal	<i>Allium cepa</i>	0.021	0.010
Amarbail	<i>Cuscuta reflexa</i>	0.010	0.010
Bhangra	<i>Eclipta prostrata</i>	0.010	0.010
Chaye Ki Patti	<i>Camellia sinensis</i>	0.010	0.010
Ganna	<i>Saccharum officinarum</i>	0.010	0.010
Gulab Ka Phool	<i>Rosa rubiginosa</i>	0.010	0.010
Itsit Booti	<i>Trianthema portulacastrum</i>	0.010	0.010
Joe	<i>Avena sativa</i>	0.010	0.010
Kainch Mainch	<i>Solanum nigrum</i>	0.010	0.010
Khajoor	<i>Phoenix dactylifera</i>	0.010	0.010
Putkanda	<i>Achyranthes aspera</i>	0.010	0.010
Saunf	<i>Foeniculum vulgare</i>	0.010	0.010

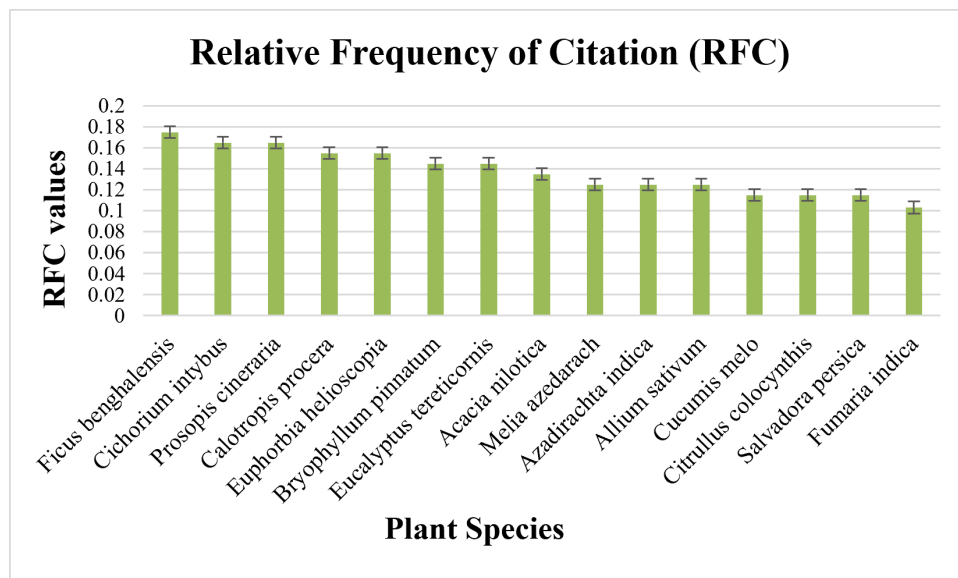


FIGURE 4.12: Top fifteen medicinal plant species ranked according to Relative Frequency of Citation (RFC), indicating the most widely recognized and culturally important species reported by the study participants.

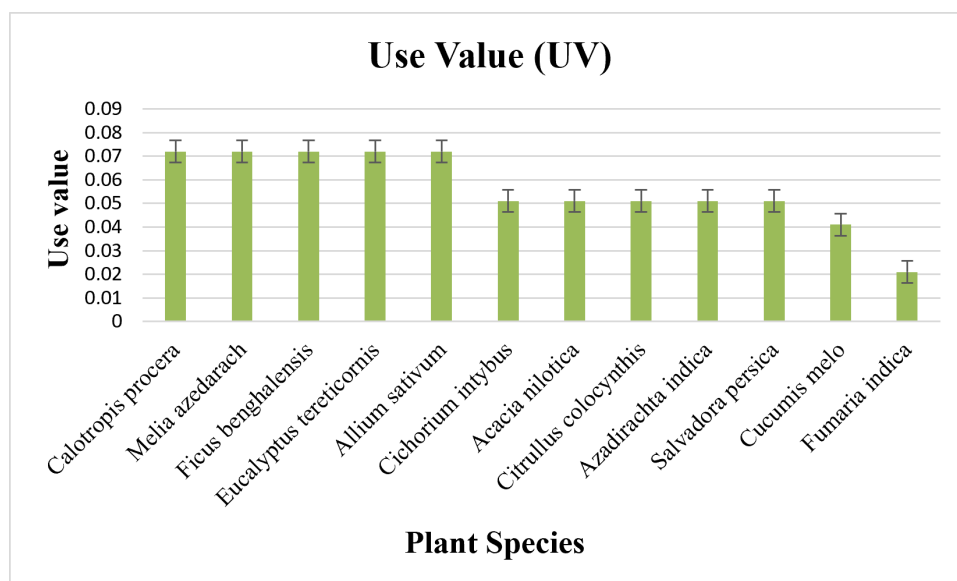


FIGURE 4.13: Top fifteen medicinal plant species ranked according to Use Value (UV), demonstrating the relative medicinal importance and versatility of each species based on the diversity of reported therapeutic applications.

4.10.2 Fidelity Level

Fidelity Level (FL%) was calculated to determine the degree of agreement among informants regarding the use of a particular plant species for treating a specific ailment. It represents the percentage of informants who cited a plant species for the same principal therapeutic purpose relative to the total number of informants reporting that species. High FL values indicate strong consensus among respondents and suggest greater cultural significance and perceived therapeutic effectiveness of the plant species. In the present ethnobotanical survey of Village Foja Dhara, District Jhang, Punjab, Pakistan, FL values ranged from 20.0% to 100%, with an average of approximately 72.9%, indicating a high level of agreement among informants regarding the medicinal uses of the documented plant species.

Several plant species exhibited the maximum FL value of 100%, indicating complete agreement among informants for a single medicinal use. These species included *Euphorbia helioscopia* commonly known as dadhri booti for ringworm treatment, *Camellia sinensis* commonly known as chaye ki patti for treating diarrhea in animals, *Foeniculum vulgare* commonly known as Saunf for bloating, *Brassica oleracea* commonly known as band gobi for joint pain, *Ricinus communis*

commonly known as arand for joint pain, *Cuscuta reflexa* commonly known as amarbail for itching, *Trianthema portulacastrum* commonly known as itsit booti for constipation, *Rosa indica* commonly known as gulab ka phool for treating eye infection, *Trigonella foenum-graecum* commonly known as methi for menstrual cramps, *Solanum nigrum* known as kainch mainch for eye infection, *Eclipta prostrata* known as bhangra for snake bite, *Avena sativa* known as joe for treating diabetes, *Saccharum officinarum* commonly known as ganna for indigestion in animals, *Phoenix dactylifera* known as khajoor for boils, *Allium cepa* known as wasal for hair fall, *Zingiber officinale* known as adrak for cough, *Coriandrum sativum* known as sookhay dhany for mouth blisters, and *Achyranthes aspera* known as putkanda for bloating.

The complete agreement for these species suggests that their medicinal applications are deeply engraved within the traditional knowledge system of the study area and have likely been validated through long-term community experience and repeated use.

Among the highly cited species, *Fumaria indica* represented an FL value of 90.0% for the treatment of fever, while *Prosopis cineraria* showed an FL value of 87.5% for toothache. Similarly, *Euphorbia tithymaloides* commonly known as Naag Dhawan exhibited an FL value of 85.7% for abscesses, whereas *Fagonia cretica* and *Moringa oleifera* known as Dhamasa booti and Suhanjna both displayed FL values of 80.0%, used for cancer and diabetes, respectively. These high FL values indicate strong therapeutic relevance and suggest that these species may possess pharmacological properties that are worthy of further phytochemical and pharmacological validation.

Moderately high FL values were recorded for *Syzygium cumini* commonly known as Jaman (77.8%), *Bryophyllum pinnatum* known as Pathar booti (71.4%), *Tribulus terrestris* known as Bhakra (71.4%), *Senegalia modesta* known as Phulai (50.0%), *Ficus benghalensis* known as Bohar (52.9%), and *Salvadora persica* known as Peelkan (54.5%). These plants are reported to be used for treating multiple conditions. The reason is that these species may contain a broad spectrum of bioactive constituents contributing to their common use in various disease conditions.

However, several species exhibited comparatively low FL values, indicating that informants reported multiple medicinal uses for these plants. The lowest FL value was recorded for *Aloe barbadensis* commonly known as Aloe vera (20.0%), followed by *Calotropis procera* known as Akra (26.7%), *Eucalyptus tereticornis* known as Safaida (28.6%), *Azadirachta indica* known as Neem (33.3%), *Portulaca oleracea* known as Kulfa (33.3%), and *Allium sativum* known as Thoom (33.3%). Lower FL values generally present multipurpose medicinal applications and indicate that knowledge regarding these plants is distributed across numerous therapeutic categories rather than being concentrated on a single or specific ailment.

The observed variation in FL values reflects the diversity of ethnomedicinal knowledge present within the local community. Species with high FL values are often considered culturally important and therapeutically reliable because informants consistently associate them with specific ailments. Such plants are frequently recommended as priority candidates for future pharmacological validation. Comparatively, plants with lower FL values may possess broader therapeutic versatility and are used for a wider range of ailments.

Overall FL analysis presented a strong degree of consensus among the inhabitants of Village Foja Dhara regarding the medicinal use of several plant species. The dominance of high FL values supports the reliability of traditional knowledge documented during the survey and highlights a number of plant species with potential for further scientific validation.

4.10.3 Informant Consensus Factor

A high Informant Consensus Factor (ICF) indicates a strong level of agreement among informants regarding the selection of medicinal plants for the treatment of specific disease categories. This consensus shows that traditional medicinal knowledge is well maintained in society and that specific treatments have gained wide acceptance through repeated, successful use. Disease categories with high ICF values can therefore highlight diseases for which the local population has developed reliable and culturally accepted plant based remedies [16].

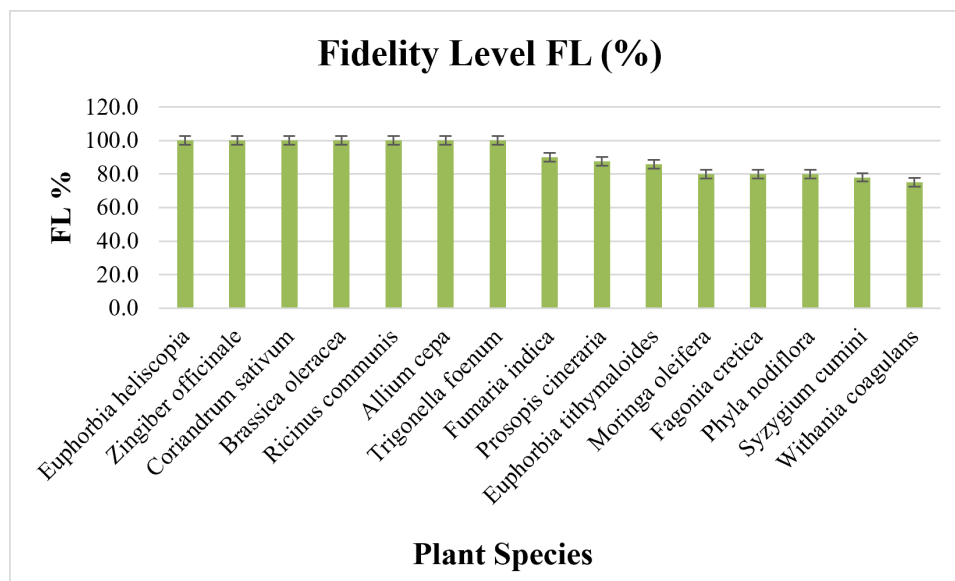


FIGURE 4.14: Top fifteen medicinal plant species ranked according to Fidelity Level (FL), illustrating the degree of informant agreement regarding the use of each species for the treatment of specific ailments.

ICF values were calculated for all 17 identified disease categories and are presented in Table 4.8. ICF values ranged from 0 (for Olfactory and Ophthalmological categories, where the small number of reports and the equal diversity of taxa precluded meaningful consensus calculation) to 1.000 for the Neoplastic and Psychological categories.

The Neoplastic category achieved the maximum possible ICF value of 1.000, as all three cancer-related use reports were related to a single plant species, *Fagonia cretica* (Dhamasa Booti). This represents the strongest possible ethnomedicinal signal, indicating that the community holds a consolidated and specific belief about this plant's anticancer efficacy. High citation rates and strong consensus both increase the prior possibility of finding genuine pharmacological activity and the complete consensus for *Fagonia cretica* in the neoplastic category places this species among the highest-priority candidates for pharmacological validation from this survey.

Similarly, the Psychological category (depression and postpartum depression) achieved ICF = 1.000, with all three reports citing *Hibiscus rosa* (Gurhel Ka Phool) as the primary treatment. The ethnopharmacological basis for this use may be related to the flavonoid content of *Hibiscus rosa*, particularly hibiscin and other

anthocyanins which have been documented earlier for anxiolytic and adaptogenic properties.

The Nephrological (ICF = 0.875) and Respiratory (ICF = 0.875) categories achieved the next highest consensus values. For nephrological conditions, predominantly kidney stones (15 reports) and UTI (4 reports), three plant species are reported including *Bryophyllum pinnatum* (Pathar Booti), *Tribulus terrestris* (Bhakhra Booti), and *Cichorium intybus* (Kaasni Booti) for the majority of use reports. The diuretic and lithotriptic properties of *Bryophyllum pinnatum* are well supported by pharmacological evidence, with studies demonstrating its ability to inhibit calcium oxalate crystal aggregation and promote urinary output [101]. The strong community consensus for these species in the nephrological category thus has a strong pharmacological basis.

Respiratory conditions (ICF = 0.875; 33 reports across 5 taxa) were dominated by *Ficus benghalensis* (Bohar) and *Eucalyptus tereticornis* (Safaida), together accounting for 26 of the 33 respiratory use reports. This high consensus across a substantial number of reports provides particularly strong proof for the pharmacological relevance of these two species in respiratory ailments. The Febrile category (ICF = 0.850; 21 reports across 4 taxa) showed similarly high consensus, with *Cichorium intybus* (Kaasni Booti) and *Fumaria indica* (Papra Booti) most frequently cited as antipyretic remedies among the village community. The dental category (ICF = 0.789) also show high consensus with multiple plants being used to treat the dental ailments. The dermatological category (ICF = 0.773) also do have high consensus with various plants being used to treat wounds, fungal infections and other skin related problems being reported in the area.

The metabolic category (ICF = 0.750) is also considered to be high with multiple plants being used to treat conditions like diabetes. The cardiovascular category (ICF = 0.667) has moderate consensus factor. The Gastrointestinal category, despite generating the second highest number of use reports (42), exhibited a comparatively moderate ICF (0.610) owing to the large number of plant taxa (17) used for this diverse category. This reflects the broad spectrum of gastrointestinal conditions treated ranging from indigestion and bloating to stomach ulcers, piles,

diarrhoea, and intestinal worms each potentially associated with different plant species, thus reducing the overall consensus value for the category as a whole.

High ICF values present a high level of agreement among informants on the choice of medicinal plants for specific categories of diseases. This consensus indicates that traditional knowledge in the community is well maintained and that some remedies have gained wide acceptance through their repeated and successful application. Table 4.8 presents Informant Consensus Factor (ICF) values for disease categories and their interpretation in Village Foja Dhara.

TABLE 4.8: Informant Consensus Factor (ICF) values for disease categories, Village Foja Dhara

Disease Category	Nur	Nt	ICF	Interpretation
Neoplastic	3	1	1.000	Very high consensus; one plant (Dhamasa booti) exclusively cited
Psychological	3	1	1.000	Complete consensus; Gurhel ka phool used for all depression reports
Nephrological	17	3	0.875	Strong consensus; Pathar Booti, Bhakhra Booti, Kaasni Booti dominant
Respiratory	3	5	0.875	Strong consensus; Bohar and Safaida cited most frequently
Febrile	21	4	0.850	High consensus; Kaasni Booti and Papra Booti most cited
Dental	20	5	0.789	High consensus; Kandyari cited by majority for toothache
Dermatological	101	23	0.780	High consensus despite large taxon diversity
Metabolic	29	8	0.750	Good consensus; Jaman, Suhanjna, Kor Tumba primary plants for diabetes
Cardiovascular	7	3	0.667	Moderate consensus; Thoom, Suhanjna, Pabri used
Hepatic	20	8	0.632	Moderate consensus; Peelkan, Pathar Booti, Kaasni Booti common
Gastrointestinal	42	17	0.610	Moderate consensus; high taxon diversity reflects ailment breadth
Oral	7	4	0.500	Moderate; Kandyari and Sookay Dhany most cited
Urinary	3	2	0.500	Moderate; Pathar Booti and Kulfa cited
Musculoskeletal	12	8	0.364	Low-moderate; many plants used for joint pain

Table 4.8 continued from previous page

Disease Category	Nur	Nt	ICF	Interpretation
Gynaecological	4	3	0.333	Low consensus; few informants reported use
Ophthalmological	2	2	0.000	No consensus; single reports only
Olfactory	1	1	0.000	Single report; cannot calculate consensus

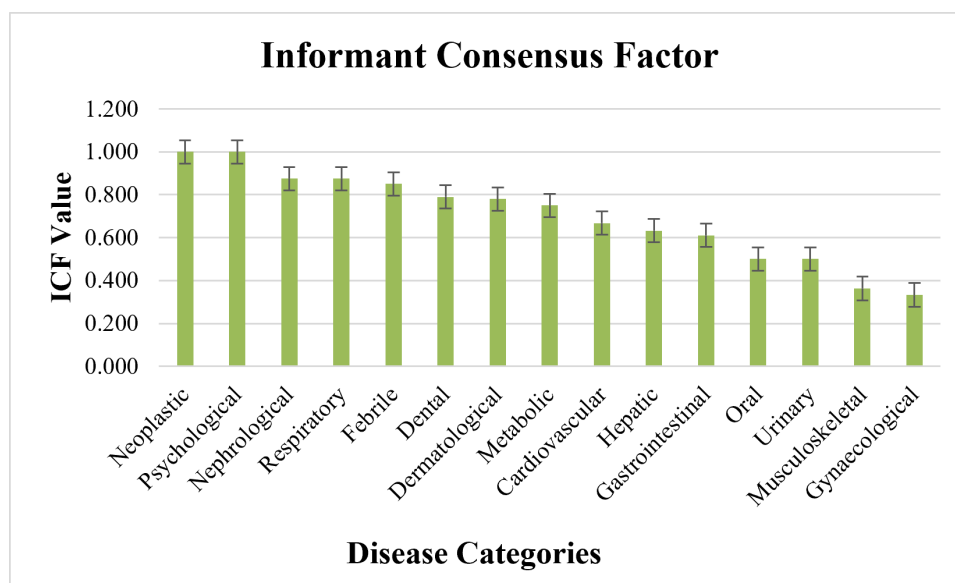


FIGURE 4.15: Informant Consensus Factor (ICF) values across different disease categories, demonstrating the level of agreement among informants regarding the selection of medicinal plant species for the treatment of various health conditions.

In order to place these findings in a wider scientific context, they have been compared with findings reported in earlier ethnobotanical studies considering various aspects to highlight similarities and variations.

4.11 Different Comparison Aspects with Other Ethnobotanical Studies

4.11.1 Comparison of Species Richness

This ethnobotanical survey documented 49 medicinal plant species belonging to 32 botanical families, based on 325 use reports collected from 97 informants in

Village Foja Dhara, District Jhang, Punjab, Pakistan. The number of medicinal plant species recorded in this study falls within the range reported by previous ethnobotanical surveys conducted in Pakistan, indicating comparable levels of medicinal plant diversity documented at the community and regional scales.

For example, a study documented 129 medicinal plants in the Chenab River basin district of Punjab, Pakistan [9]. An earlier survey in Hafizabad district of Punjab recorded 85 medicinal plants [9, 60].

Recent surveys in the Hajirah district Azad Jammu and Kashmir and Kohistan further demonstrate the rich plant diversity of medicinal plants present in various ecological zones in Pakistan [7, 8]. Differences in the total number of documented species among these studies are likely attributable to variations in geographical extent, ecological conditions, sampling intensity, habitat heterogeneity, and the number of informants included in each survey.

Ecological factors have a major role in the differences in richness of species found in ethnobotanical surveys. The Jhang District is characterised by a semi-arid climate, cultivated agricultural land, sparse natural vegetation and a rainfall that is relatively lower than that of the northern mountainous areas of Pakistan. These environmental conditions are inherently less hospitable to medicinal plant species than the highly diverse ecosystems of the Himalayas, where differences in altitude, temperature, precipitation and soil characteristics create many ecological niches for medicinal plants [102]. Consequently, the ethnobotanical surveys carried out in Khyber Pakhtunkhwa, Gilgit-Baltistan and Azad Kashmir generally report a higher diversity of species than surveys conducted in the Punjab [8]. Another strength of this investigation is the documentation of ethnological knowledge from the Jhang district, a region which has received relatively little scientific attention in previous ethnobotanical research. While many surveys have been carried out in the north of Pakistan, in Azad Kashmir and in Khyber Pakhtunkhwa, published information on traditional medicinal plants in the central Punjab is still relatively limited. This study therefore provides new basic information on medicinal plant diversity, local therapeutic practices and indigenous medical knowledge

maintained in the village of Foja Dhara. This documentation is particularly important as rapid urbanisation, modernisation, changing lifestyles and growing dependency on traditional medicines continue to put the intergenerational transfer of traditional medical knowledge at risk.

4.11.2 Comparison of Plant Family Diversity

This ethnobotanical survey recorded 49 medicinal plant species, belonging to 32 botanical families which show a significant degree of taxonomic diversity despite the relatively limited geographical extent of Foja Dhara village. This diversity suggests that the local population uses medicinal plants belonging to a wide range of phylogenetic groups, reflecting both the richness of the environment and the richness of the local indigenous knowledge. The high presence of plant families is generally considered an indicator of a resilient traditional health care system, as it offers multiple treatment options for various diseases [103].

Among the documented families, Fabaceae was most dominant, contributing four medicinal species (8%), followed by Euphorbiaceae and Apiaceae, each represented by three species, while Cucurbitaceae, Asteraceae, Moraceae, Myrtaceae, Solanaceae, Zingiberaceae, Rosaceae, Meliaceae, Amaranthaceae, Alliaceae and several other families contributed two or more species.

The predominance of Fabaceae observed in the present investigation doesn't agree closely with similar studies conducted in Pakistan. Poaceae is identified as one of the leading medicinal plant families in the Chenab Riverine area of Punjab [9].

Another study conducted in Azad Jammu and Kashmir shows Asteraceae as the most prominent family. This difference among studies showing different families as the most predominant families is due to the different biodiversity and ecological conditions of specific areas. Although Chenab riverine area geographically lies closely to Foja Dhara but still it reports a different dominant family due to various contributive factors including ecology, methodology and informants reporting. Table 4.9 summarizes Factors Influencing Differences in Species Richness.

TABLE 4.9: Factors Influencing Differences in Species Richness

Factor	Influence on Species Richness
Geographical extent	Larger study areas generally document more species.
Ecological conditions	Different climates and habitats influence plant diversity.
Habitat heterogeneity	More diverse habitats support more medicinal plant species.
Sampling intensity	Greater sampling effort increases the likelihood of recording additional species.
Number of informants	More informants contribute a greater diversity of ethnomedicinal knowledge.

4.11.3 Comparison of Plant Parts Used

The utilization of different plant parts in traditional medicine represents a crucial aspect of ethnobotanical practices, as the therapeutic potential of medicinal plants is largely influenced by the type, abundance, and distribution of bioactive phytoconstituents present in specific plant parts. In the present study, leaves were identified as the most frequently utilized plant parts, accounting for 51.7% of all reported uses, followed by fruits, roots, seeds, bark, flowers, and whole plants. The predominant use of leaves may be attributed to their accessibility, ease of collection, and rich content of secondary metabolites, which contribute to their widespread application in traditional remedies. This finding shows that the inhabitants of Foja Dhara place great value on the harvesting of parts of aerial plants, especially leaves, for the preparation of medicinal remedies.

The prevalence of leaves observed in this survey is very consistent with ethnobotanical studies carried out in Pakistan that reported that leaves represented around 28 percent of all medicinal plant parts used in the Chenab River basin area of Punjab, another study documented leaves as the most commonly harvested plant organ (33 percent) in the Chail Valley of Swat. Together, these studies show that leaves remain a major source of herbal medicines in the various ecological zones of Pakistan, despite differences in climate, vegetation and cultural traditions. [58, 61].

The share of leaf use recorded in the village of Foja Dhara (51.7 percent) is higher than that reported in many previous Pakistani surveys. This difference may be due to the agricultural landscape of the Jhang district, where many medicinal tree species such as *Azadirachta indica*, *Moringa oleifera*, *Syzygium cumini*, *Acacia nilotica* and *Eucalyptus tereticornis* are readily available at any time of the year. As leaves can be harvested repeatedly without causing permanent damage to the parent plant, they are a preferred source of regeneration for local communities, rather than roots or bark, which encourages more sustainable use of medicinal resources.

A similar prevalence of leaves is reported throughout the Indian subcontinent. Ethnobotanical surveys carried out in Uttarakhand consistently identify leaves as the most commonly used plant organ for medicinal purposes. Similarly, studies in Nepal report leaves and whole plants as the main ingredients in traditional herbal preparations due to their availability, rapid recovery and high concentrations of pharmacologically active ingredients [104, 105].

Unlike leaves, roots and bark were relatively less used in this survey. This observation has important conservation implications, as the harvesting of the underground organs or bark often results in permanent damage to the parent plant or its death. Many ethnobotanists therefore recommend that the collection of roots and bark be restricted, wherever equally useful leaves or fruit may be used. The relatively low dependence on destructive harvesting methods observed in the village of Foja Dhara suggests that local knowledge has evolved towards a relatively sustainable use of plant resources. Table 4.10 shows comparison of dominant plant families in different studies.

TABLE 4.10: Comparison of Dominant Plant Families

Study	Dominant Plant Family	Observation
Present study	Fabaceae	Most dominant family (4 species; 8%)
Umair et al. (2019)	Poaceae	Different dominant family despite geographical proximity
Jabeen et al. (2024)	Asteraceae	Different dominance attributed to ecological variation

4.11.4 Comparison of Preparation Methods

The method of preparation of plant based medicinal remedies is another basic element of ethnomedicine, as extraction techniques affect both the concentration and bioavailability of the pharmacologically active ingredients. The paste (42.8%) was most commonly used preparation method in this study, followed by decoction (23.1%), powder, juice, direct consumption, infusion and smoke inhalation. The predominance of paste is different from many ethnobotanical studies carried out in Pakistan where decoction is generally reported as the main preparation method. Studies from Chail Valley, Swat, Chenab Riverine Punjab [9, 58]. Decoction is identified as the predominant preparation method, as boiling improves the extraction of water-soluble phytochemicals and makes oral administration easier in systemic conditions. Similar findings are reported in northern Pakistan, where decoction remain the preferred formulation for treating respiratory infections, gastrointestinal disorders and febrile illnesses [106].

The comparatively higher frequency of paste preparation in Village Foja Dhara can largely be explained by the disease profile documented during the present investigation. Dermatological disorders represented the largest therapeutic category, accounting for approximately one-third of all medicinal use reports. Because topical skin conditions such as abscesses, wounds, fungal infections, itching, boils and ringworm require direct local application of medicinal material, fresh leaf or seed pastes constitute the most practical and therapeutically appropriate formulation. Consequently, the predominance of paste preparations reflects adaptation of remedy formulation to local healthcare needs rather than differences in traditional knowledge.

Interestingly, similar trends have been reported from Nepal, where recent ethnobotanical reviews documented paste as the dominant preparation method for immediate-care remedies, particularly for wounds, burns, insect bites and skin infections [104].

Although paste was the most used preparation method in this study, decoction remained the second most used, which suggests that decoction remains important

in the traditional healthcare system. Decoction is widely recognised as one of the oldest and most scientifically valid methods of herbal extraction, as it facilitates the breaking of plant cell walls, increases the breakdown of phytochemical polarities, reduces microbial contamination and increases extraction efficiency [107].

4.11.5 Comparison of Routes of Administration

Oral administration was predominant route of administration (58.8%), followed by topical application (34.2%), while inhalation and other routes were relatively rare. This distribution is consistent with ethnobotanical studies carried out in Pakistan, India, Nepal and China [105, 108].

Oral administration remains the main route of administration, as it allows bioactive ingredients to be administered systemically for the treatment of diabetes, fever, respiratory infections, gastrointestinal disorders, hypertension and liver disease. The relatively high share of local administration observed in the Village Foja Dhara study can probably be attributed to the exceptionally high number of dermatological conditions observed during the survey. Communities predominantly involved in agriculture often suffer from wounds, cuts, fungal infections, insect bites and occupational skin diseases as a result of constant exposure to soil, irrigation water, livestock and agricultural machinery.

4.11.6 Comparison of Disease Categories and Therapeutic Uses

The spectrum of ailments treated by medicinal plants provides valuable insight into the healthcare priorities, environmental influences, and cultural practices of a community. In the present ethnobotanical investigation, medicinal plants were used to treat 17 ailment categories, with dermatological disorders accounting for the greatest proportion of use reports (31.1%), followed by gastrointestinal disorders (12.9%), respiratory disorders (10.2%), metabolic diseases (8.9%), febrile

illnesses (6.5%), hepatic disorders (6.2%), dental diseases (6.2%), musculoskeletal disorders (3.7%), cardiovascular diseases (2.2%), psychological disorders, gynecological disorders, nephrological diseases, urinary disorders, ophthalmological conditions, oral disorders, olfactory disorders, and neoplastic diseases. This broad therapeutic spectrum demonstrates that traditional medicinal knowledge in Village Foja Dhara serve as a comprehensive primary healthcare system capable of addressing a wide range of diseases.

The prevalence of dermatological disorders observed in this study is particularly remarkable and sets the Village Foja Dhara apart from other ethnobotanical studies carried out elsewhere in Pakistan. More than a third of all reports of medicinal products were related to skin conditions, including abscesses, wounds, burns, itching, ringworm, boils, fungal infections, paronychia, cutaneous and insect bites. Similar observations were recorded in ethnobotanical surveys conducted in semi-arid areas of Punjab and Sindh where skin disorders are one of the main causes of use of plant based remedies [95]. However, studies in the mountainous areas of Khyber Pakhtunkhwa and Gilgit-Baltistan often report gastrointestinal or respiratory diseases as a more prevalent therapeutic category than dermatological conditions [109]. The exceptionally high incidence of dermatological treatments in Foja Dhara can be explained by the work-related characteristics of the local population. Most of the population is directly involved in agriculture and livestock husbandry, and is exposed daily to soil, irrigation water, crop residue, animal waste, pesticides and environmental allergens. Continuous manual labour at high temperatures also predisposes people to cutaneous wounds, abrasions, fungal infections, insect bites and inflammatory skin conditions. As a result, local herbal medicines have become deeply integrated into local health systems, providing immediate treatment with readily available medicinal products. Similar links between farming and increased use of herbal remedies for skin disorders have been reported in rural India, Nepal and several African countries [110, 111].

The extensive use of plants such as *Calotropis procera*, *Euphorbia helioscopia*, *Cuscuta reflexa*, *Cucumis melo* and *Azadirachta indica* for dermatological conditions demonstrates remarkable agreement with published pharmacological literature.

Numerous experimental studies have confirmed that these species possess antimicrobial, antioxidant, wound-healing and anti-inflammatory activities attributable to flavonoids, terpenoids, tannins and phenolic compounds [24].

The gastrointestinal group was the second largest therapeutic group in this study, comprising medicines used for digestive disorders, abdominal pain, bloating, diarrhoea, constipation, intestinal worms, ulcers and piles. Similar findings are consistently reported across Pakistan, where gastrointestinal disorders are one of the most common reasons for use of traditional remedies [8].

Rural populations often rely on herbal remedies for digestive complaints. The comparatively moderate Informant Consensus Factor ($ICF = 0.610$) observed for gastrointestinal disorders in present study reflects the considerable diversity of plants employed for different digestive ailments. Consequently, the local population uses a wide range of medicinal plants, including *Foeniculum vulgare*, *Coriandrum sativum*, *Achyranthes aspera*, *Trianthemum portulacastrum*, *Saccharum officinarum* and *Portulac oleracea*, each with different pharmacological properties, including carminative, laxative, antiulcer and antimicrobial properties. Similar observations are reported in Mediterranean Europe, where gastrointestinal disorders are also treated with a wide variety of medicinal plant remedies [112].

Respiratory disorders were another major therapeutic category in this study and had one of the highest informant consensus factors ($ICF = 0.875$), indicating strong consensus on medicines used for cough, asthma, flu and respiratory infections among local informants. Most respiratory medicinal products were *Ficus benghalensis* and *Eucalyptus tereticornis*, which together accounted for the majority of respiratory medicinal products reported. This high degree of agreement is particularly significant since the pharmacological activity of both species is well established. A similar reliance on *Eucalyptus* species for respiratory diseases was documented in Pakistan, demonstrating same use [113].

A category of metabolic diseases, mainly represented by diabetes mellitus, represented about 9 percent of all reports of medicinal products. Diabetes is one of the

rapidly growing chronic diseases in the world and a major public health concern in Pakistan [114].

The widespread use of traditional antidiabetic medicinal products documented in the village of Foja Dhara reflects the growing awareness of the disease amongst the population and the continued preference for affordable herbal alternatives. Informants often referred to medicinal species such as *Syzygium cumini*, *Moringa oleifera*, *Citrullus colocynsis* and *Avena sativa* as glycemic controls. These findings are very consistent with ethnobotanical surveys carried out in Pakistan, India, Bangladesh and the Middle East, where the same species is frequently reported as a medicinal product for diabetes [89, 110].

Particularly noteworthy is the prominent use of *Citrullus colocynthis* for diabetes in the present study. Although this species has been reported in several ethnobotanical investigations from arid regions of Pakistan, Rajasthan and Saudi Arabia, it is less frequently documented in northern Pakistani studies. Experimental investigations have explained that cucurbitacins, flavonoids and phenolic compounds isolated from *Citrullus colocynthis* exhibit significant hypoglycaemic and antioxidant activities [115, 116].

The relatively high frequency of citation recorded in Village Foja Dhara therefore suggests that this species occupies a particularly important position within the local ethnomedicinal system and could be further evaluated.

4.12 Comparison of Quantitative Ethnobotanical Indices with Published Studies

4.12.1 Comparison of Relative Frequency of Citation

The relative frequency of citation (RFC) values obtained in this study show that *Ficus benghalensis* and *Calotropis procera* are among the most frequently cited medicinal products, reflecting their widespread recognition and usage by local

populations. Similarly another study reported high RFCs for *Artemisia scoparia* (RFC = 0.14), *Calotropis procera* (RFC = 0.14) and *Justicia adhocoda* (RFC = 0.13), which showed that the communities living in the Chenab River basin also recognised these species in a broad way. An international study carried out among the indigenous communities of the Philippine island of Panay, reported *Artemisia vulgaris* as the species with the highest RFC (0.57), indicating strong cultural recognition and widespread traditional use. Although the species most frequently reported differed between the three studies, all the surveys showed that plants with high RFC were those deeply rooted in local health traditions. These differences may be attributed to differences in plant composition, environmental conditions, climatic features, disease prevalence, availability of plant resources and socio-cultural traditions. Communities generally attach greater importance to medicinal plants that are widely available in the environment and have been shown to be effective in long-term empirical use. Moreover, regional differences in the regional ranking of the RFC are also due to differences in ethnic background, climate change, home-grown knowledge systems and knowledge transfer between generations [117].

4.12.2 Comparison of Use Value

This study recorded the highest Use values for species with multiple therapeutic applications, which indicates their wide therapeutic relevance in the study area. Similarly, high UV values generally reflect both frequent references and extensive use in the treatment of various ailments. A study shown relatively high UV values for *Calotropis procera* (UV = 0.64), which indicate a wide-spread use of these medicinal products in the local population [9]. Compared to another study conducted in Philippines that stated that *Curcuma longa* had the highest use value (UV = 0.79) among the indigenous population due to its wide use in a wide range of diseases [118]. Differences in dominant species between studies reflect differences in local biodiversity, indigenous ethnomedical practices, availability of medicinal plants and cultural preferences. Plant species which are more available and traditionally trusted in the community naturally have higher UV values, as

they are used for a wider range of diseases. Therefore, environmental factors, the type of vegetation and accumulated traditional experience strongly influence the medicinal diversity of various plant species in different geographical areas [117, 119].

4.12.3 Comparison of Fidelity Level (FL)

The Fidelity Level (FL) analysis conducted in the present study revealed a high level of informant agreement regarding the therapeutic application of specific plant species for particular ailments. The elevated FL values indicate strong cultural consensus, reflecting the consistent recognition of certain medicinal plants within the community and highlighting the preservation of specialized traditional knowledge associated with their targeted uses.

A comparable pattern was observed in the Pakistani study [9], where *Calotropis procera* exhibited an FL of 86.4%. Similarly, another study reported that *Chromolaena odorata* achieved the maximum Fidelity Level (FL = 100%) for the treatment of cuts and wounds, reflecting complete agreement among informants regarding its medicinal application [118].

Differences in the plant species showing the highest FL values are expected as the level of adherence depends on local therapeutic preferences, prevalence of the disease, cultural beliefs and accumulated healing experience. Communities living in different ecological zones face different health problems and therefore develop different traditional remedies for these ailments. Therefore, although the specific plant species vary, high FL values consistently indicate strong informant agreement and robust traditional knowledge of the medicinal plants [117].

4.12.4 Comparison of Informant Consensus Factor

The present study exhibited high Informant Consensus Factor (ICF) values across several disease categories, demonstrating a substantial level of agreement among

informants regarding the use of particular medicinal plants for the management of specific health conditions. Elevated ICF values suggest the presence of well-established traditional practices, shared ethnomedicinal knowledge, and consistent selection of specific plant species that have been repeatedly utilized and recognized for their therapeutic effectiveness within the community.

Similarly, Pakistan study reported high ICF values for several disease categories, demonstrating a strong consensus among respondents regarding appropriate herbal treatments within the Chenab River communities [9].

Likewise, the Philippine ethnobotanical investigation reported the highest ICF value (0.80) for respiratory diseases and injuries, poisoning, and external causes, indicating considerable agreement among indigenous healers regarding medicinal plant selection for these disease groups [118]. The observed differences in ICF values and disease categories between studies can be attributed to regional variation in the prevalence of the disease, ecological diversity, availability of health care, socio-economic conditions and cultural practices. Communities affected by similar diseases often come together to use specific medicines, which leads to higher levels of consensus. On the other hand, differences in plant composition and indigenous medical traditions result in differences in the specific disease categories with the highest ICF. Table 4.11 presents comparison of Foja Dhara *Ethnobotanical indices* with other published studies.

Overall, despite differences in the dominant drug species and disease categories, the three studies showed remarkably similar ethnobotanical patterns. Medicinal plants with high RFC and UV consistently represented the most culturally relevant and therapeutically versatile species, while high values of FL and ICF reflected strong community consensus on the specific treatments. Differences between studies can be attributed mainly to ecological differences, plant composition, cultural traditions, disease prevalence, informant characteristics, sample size and methodological approaches rather than to differences in ethnomedicine. This study therefore reinforces existing ethnobotanical evidence from Pakistan by providing the first comprehensive quantitative evaluation of the flora of the village of Foja

Dhara and by extending the regional documentation of the indigenous medical practices.

TABLE 4.11: Comparison of quantitative ethnobotanical indices with published studies

Ethno- botan- ical Index	Present study	Pakistani study	International study	Scientific inter- pretation
RFC	<i>Ficus benghalensis</i> , <i>Calotropis procera</i> and <i>Allium sativum</i> recorded the highest RFC values.	<i>Calotropis pro- cera</i> has the highest RFC.	<i>Artemisia vulgaris</i> had the highest RFC.	Differences reflect local flora, cultural practices, ecological conditions and plant availability.
UV	Highest UV species were those with mul- tiple medicinal appli- cations in the present study.	<i>Calotropis pro- cera</i> .	<i>Curcuma longa</i> had the highest UV.	UV varies according to therapeutic versa- tility and frequency of use within each community.
FL	High FL values in- dicated strong agree- ment among infor- mants.	<i>Calotropis procera</i> , <i>Ner- ium oleander</i> , <i>Artemisia sco- paria</i> .	<i>Chromolaena odorata</i> .	Regional disease patterns and cultural preferences influence plant-specific fidelity.
ICF	High ICF values in- dicated strong con- sensus for major dis- ease categories.	High ICF val- ues reflected strong agree- ment among Chenab River informants.	Highest for respiratory diseases and injuries.	Consensus varies according to disease prevalence, ecological setting and tradi- tional healthcare practices.

4.13 Conclusion of Results and Discussion

The findings of the present ethnobotanical and ethnopharmacological survey demonstrate that the community of Foja Dhara possesses a rich and actively practiced tradition of medicinal plant utilization. A total of 49 medicinal plant species

representing 32 botanical families were documented through interactions with 97 informants, highlighting the considerable diversity of traditional herbal medicine practiced in the study area. The study successfully recorded essential aspects of indigenous medicinal knowledge, including local plant names, utilized plant parts, methods of preparation, routes of administration, and therapeutic applications.

These findings indicate that the primary objective of documenting and preserving the traditional ethnomedicinal knowledge of the local community was effectively achieved. Quantitative ethnobotanical analysis further identified the most culturally relevant species by Relative Frequency of Citation (RFC), Use Value (UV), Fidelity Level (FL), and Informant Consensus Factor (ICF). Species such as *Ficus benghalensis*, *Calotropis procera*, *Allium sativum* and *Fagonia cretica* have been recognised as highly valuable medicinal plants due to their wide acceptance, their therapeutic versatility and their high level of acceptance by informants.

The high ICF values for several disease categories, especially neoplastic, psychological, renal, respiratory and dermatological, indicate a high level of consistency with conventional knowledge and indicate that these species are potential candidates for further pharmacological research.

A comparison of these findings with previously published ethnobotanical studies in Punjab and other Pakistani regions revealed similarities as well as distinct local features. Similarities in the prevalence of leaves as the preferred component of the plant, the major use of topical and oral administration, and the frequent treatment of dermatological, gastrointestinal, respiratory and metabolic diseases in Pakistan demonstrate that Foja Dhara medicinal traditions are in line with wider ethnobotanical practices. At the same time, the variation in the composition of the species and the cultural significance attached to each plant reflects the influence of local biodiversity, environmental conditions and accumulated traditional knowledge.

Overall, the results achieved all the objectives of the survey by documenting the medicinal flora of the village of Foja Dhara, identifying traditional medicinal uses and uses, quantifying cultural importance of the medicinal plants using standard

ethnobotanical indices, comparing the results with previous studies and highlighting species with a high potential for ethnopharmacological effects. These findings give a valuable basis for the conservation of biodiversity, the conservation of indigenous knowledge and the future pharmacological validation of culturally significant medicinal products. The following chapter presents the overall conclusions of the study, its limitations and recommendations for the way forward in the field of research.

Chapter 5

Conclusion

This study provides the first comprehensive quantitative ethnobotanical and ethnopharmacological documentation of medicinal plants used by the residents of Village Foja Dhara, District Jhang, Punjab, Pakistan. The findings demonstrate that traditional herbal medicine continues to play an important role in primary healthcare within the community, where locally available plant species are routinely used to manage a wide range of common ailments. Despite increasing modernization and changing lifestyles, indigenous medicinal knowledge remains actively practiced and is preserved among knowledgeable members of the community, particularly elderly individuals, farmers, housewives, and traditional healers.

The survey documented 49 medicinal plant species belonging to 32 botanical families that were used to treat 17 categories of diseases. The diversity of medicinal plants recorded reflects the rich floral resources of the study area and the close relationship between the local population and their surrounding environment.

Leaves were the most frequently utilized plant part, while paste was the predominant method of preparation and oral administration was the most common route of administration. Dermatological disorders represented the most frequently treated disease category, followed by gastrointestinal, respiratory, metabolic, and febrile conditions, indicating the principal health concerns addressed through traditional medicine in the community.

Quantitative ethnobotanical analysis using Relative Frequency of Citation (RFC), Use Value (UV), Fidelity Level (FL), and Informant Consensus Factor (ICF) successfully identified culturally important medicinal plants and demonstrated the consistency of indigenous knowledge among informants. Species such as *Ficus benghalensis*, *Calotropis procera*, *Allium sativum*, *Moringa oleifera*, and *Fagonia cretica* exhibited high cultural importance and therapeutic relevance, while high consensus values for several disease categories indicated strong agreement regarding the selection of medicinal plants for specific ailments. These findings suggest that the most frequently reported species represent promising candidates for future phytochemical, pharmacological, toxicological, and clinical investigations.

Comparing documented findings with previously published ethnobotanical studies in Pakistan and neighbouring regions, it has been found that there are both common and distinct patterns of medicinal plant use. Many trends in overall use were in line with previous studies, while a few locally relevant species and therapeutic uses reflected the unique ecological characteristics, availability of plants and cultural traditions of Foja Dhara village. These observations enrich the existing ethnobotanical literature and extend the geographical coverage of the documentation of medicinal plants in Punjab.

The study also identified medicinal plant species with a high potential for ethnopharmacological effects. Species with a high citation rate, wide therapeutic applications and strong community consensus are valuable candidates for further phytochemical characterisation, pharmacological validation, toxicological assessment and clinical trials. This prioritisation provides the scientific basis for future research to transform traditional medicinal knowledge into evidence-based therapeutic sources.

Taken together, the findings presents that the study objectives have been successfully achieved and provide a valuable scientific basis for future ethnobotanical, ethnopharmacological and research. More importantly, this work protects a significant part of the cultural heritage of the village of Foja Dhara, while contributing to the ethnobotanical record of Pakistan and supporting future efforts to promote sustainable use, protection of biodiversity and discovery of natural remedies.

This study is an important contribution to ethnobotany and ethnopharmacology by providing the first comprehensive quantitative documentation of knowledge on medicinal plants from the village of Foja Dhara in Jhang district, Punjab province, Pakistan.

It fills a major geographical and scientific gap in the ethnobotanical literature of the Central Punjab by systematically recording native knowledge, which was traditionally orally transmitted and is increasingly threatened by modernization and social and cultural change.

5.1 Limitations of the Study

Although the study successfully achieved its objectives, several limitations should be acknowledged.

- i. The survey was carried out in one village in Jhang district; therefore, findings may not fully represent the ethnobotanical practices in the whole district or in other parts of Punjab.
- ii. The study documented traditional knowledge without testing the pharmacological activity, phytochemical composition, toxicity or safety of the recorded plants.
- iii. Seasonal variations in the availability of plants may have limited documentation of some medicinal products not available during the study period.
- iv. Lack of confidence among informants that hinders the smooth recording of detailed ethnobotanical knowledge.

Despite these limitations, the study presents a reliable and detailed documentation of ethnobotanical knowledge currently in use in Foja Dhara village and provides a valuable basis for future scientific inquiry.

5.2 Recommendations

Based on the findings of the present study, the following recommendations are proposed:

- i. Indigenous ethnological knowledge to be systematically documented in other villages and districts in Punjab before it is lost due to modernisation and changing socio-cultural practices.
- ii. Medicinal plant species with high Relative Frequency of Citation, Use Value, Fidelity Level, and Informant Consensus Factor should be the priority for phytochemical, pharmacological, toxicological, and clinical investigations to scientifically confirm their traditional therapeutic uses.
- iii. Conservation programmes should be developed to protect medicinal plants that grow in natural habitats and to promote the sustainable harvesting and cultivation of such plants.
- iv. Local communities should be educated on the significance of conducting Ethnobotanical Surveys through awareness-raising programmes within the community.
- v. Collaboration between ethnobotanists and health professionals should be encouraged to facilitate scientific development of evidence-based herbal preparations.
- vi. Government agencies and public health authorities should recognise the value of indigenous medicinal knowledge and integrate scientifically validated traditional remedies into relevant community health initiatives, where possible.
- vii. Phytochemical Characterization and Pharmacological validation of the most frequently cited medicinal plants of study area.

5.3 Future Research Directions

The study findings provide several opportunities for future research.

Future investigations should include larger ethnobotanical surveys covering multiple villages and ecological zones of District Jhang to generate a more comprehensive regional database of medicinal plant diversity and traditional knowledge. Laboratory-based phytochemical screening and pharmacological evaluation of highly cited medicinal species should be conducted to identify their bioactive compounds and validate their reported therapeutic activities. Toxicological and safety assessments are also necessary to establish safe dosage ranges and possible adverse effects of traditionally used herbal preparations.

Further studies may investigate seasonal variation in medicinal plant availability, cultivation practices, conservation status, and socioeconomic factors influencing the transmission of traditional knowledge. Molecular and genomic approaches, metabolomic profiling, and advanced analytical techniques may also be employed to identify novel bioactive compounds with pharmaceutical potential. Such multidisciplinary research will strengthen the scientific basis of traditional medicine while contributing to biodiversity conservation, sustainable resource management, and the development of safe and effective plant-based therapeutic agents.

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Appendix - A

Questionnaire

<https://docs.google.com/document/questionnair>

Appendix - B

Pictures of Culturally Important Plant Species of Village Foja Dhara



FIGURE 1: *Eucalyptus tereticornis* (Safaida), one of the medicinal plant species documented during the ethnobotanical survey and traditionally used by the local community for the management of respiratory and other common ailments.



FIGURE 2: *Calotropis procera* (Akra), a culturally important medicinal species traditionally employed for the treatment of dermatological disorders, pain, inflammation, and various other health conditions.



FIGURE 3: *Acacia nilotica* (Keekar), a medicinal tree widely utilized in traditional healthcare for its antimicrobial, anti-inflammatory, and wound-healing properties.



FIGURE 4: *Syzygium cumini* (Jamun), a medicinal plant commonly used in traditional medicine, particularly for the management of diabetes and gastrointestinal disorders.



FIGURE 5: *Melia azedarach* (Bakain), a medicinal tree traditionally valued for its antimicrobial, antiparasitic, and anti-inflammatory therapeutic applications.



FIGURE 6: *Ficus benghalensis* (Bohar), one of the most culturally significant medicinal species documented in the study, widely recognized for its diverse therapeutic uses in traditional healthcare.



FIGURE 7: *Origanum majorana* (Pabli), an aromatic medicinal herb traditionally used for digestive, respiratory disorders due to its therapeutic properties.



FIGURE 8: *Morus alba* (Shahtoot), a medicinal plant traditionally utilized for the treatment of respiratory ailments.



FIGURE 9: *Phoenix dactylifera* (Khajoor), an important medicinal and nutritional plant.



FIGURE 10: *Azadirachta indica* (Neem), a widely recognized medicinal tree extensively used in traditional medicine for the treatment of skin diseases, infections, diabetes, and inflammatory conditions.

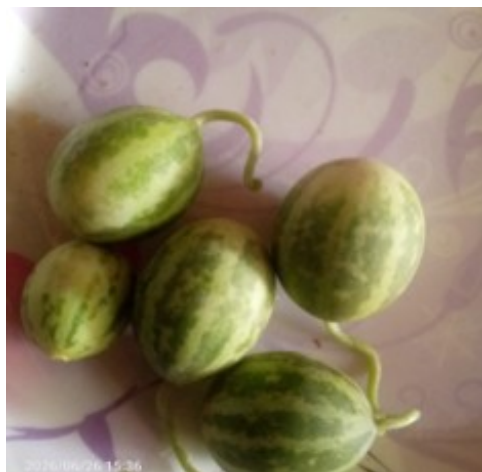


FIGURE 11: *Cucumis melo* (Chibar), a medicinal plant documented during the survey and traditionally used by local inhabitants for the management of dermatological problems and diabetes.



FIGURE 12: *Moringa oleifera* (Suhanjna), a highly valued medicinal species known for its nutritional richness and extensive traditional use in the management of metabolic and inflammatory disorders.



FIGURE 13: *Mentha longifolia* (Podina), an aromatic medicinal herb traditionally employed for digestive disorders and other common health complaints.



FIGURE 14: *Citrullus colocynthis* (Kor Tumba), a medicinal plant traditionally used in folk medicine for diabetes and inflammatory conditions.



FIGURE 15: *Aloe barbadensis* (Aloe vera), a medicinal succulent widely used in traditional healthcare for the treatment of burns, wounds, skin disorders, and gastrointestinal ailments.

Appendix - C

Traditional Herbal Recipes Documented from Village Foja Dhara

Quantitative indices identify the culturally important medicinal plants and the level of agreement among the informants. In order to illustrate how these species are used in practice, the following section describes traditional herbal forms and recipes documented in the field.

Recipe R1: Naag Dhawan (*Euphorbia tithymaloides*) Fresh leaves of Naag Dhawan were collected and properly washed. The leaves were crushed into a fine paste using a mortar and pestle and mixed with a balanced quantity of mustard oil. The resulting paste was applied directly to the affected area as a topical remedy.

Recipe R2: Jaman (*Syzygium cumini*) The seeds of Jaman were dried under sunlight and ground into a fine powder. Equal amounts of mango leaf powder and pomegranate peel powder were added to the powder. The prepared polyherbal powder was being used orally with water.

Recipe R3: Keeker (*Acacia nilotica*) The bark of Keeker was dried and ground into a fine powder. The powder was mixed with ghee and warm milk to prepare a medicinal formulation. The mixture was consumed orally according to traditional remedy.

Recipe R4: Aloe Vera (*Aloe barbadensis*) Fresh leaves of Aloe vera were cut open and the transparent gel was obtained carefully. One part of the gel was mixed with two parts water and a small quantity of mint powder. The mixture was stirred until it became uniform and then consumed orally.

Recipe R5: Pabri (*Origanum majorana*) Fresh leaves of Pabri and mint were washed and crushed separately into fine pastes. Equal quantities of both pastes were combined and then thoroughly mixed. The had an oral use as a traditional herbal remedy.

Recipe R6: Akra (*Calotropis procera*) Fresh latex obtained from Akra was carefully collected and mixed with mustard oil or coconut oil. The ingredients were mixed uniformly. The formulation was then applied topically to the affected area.

Recipe R7: Neem (*Azadirachta indica*) Fresh Neem leaves were washed and ground to make a smooth paste. Mustard oil was added gradually and mixed thoroughly. The resulting paste was applied externally to the affected body part.

Recipe R8: Lehsun (*Allium sativum*) Fresh garlic cloves were peeled and crushed to make fine paste. Mustard oil was added and mixed thoroughly to prepare a formulation. The preparation was applied externally according to local traditional practice.

Recipe R9: Keeker (*Vachellia nilotica*) The flowers of Keeker were shade-dried and then ground to form a fine powder. The powder was mixed with dried mint leaves and boiled in water for few minutes to prepare a decoction. After cooling and filtration, it was administered orally.

Recipe R10: Keeker (*Acacia nilotica*) Dried bark of Keeker was crushed into a fine powder and mixed with clove powder in suitable proportional quantities. The blended powder was consumed orally with water.

Recipe R11: Adrak (*Zingiber officinale*) Fresh ginger rhizomes were washed, peeled, and crushed into a paste. Honey and black pepper were mixed with the paste. The resulting preparation was taken orally.

Recipe R12: Aloe Vera (*Aloe barbadensis* Miller) Fresh Aloe vera gel was carefully extracted and mixed with suitable amount water and castor oil. The mixture was stirred to ensure homogeneity and consumed orally.

Recipe R13: Pabri (*Origanum majorana*) Fresh Pabri leaves were crushed into a paste and were mixed with mint leave paste. Dried pomegranate peel, black pepper, and dried coriander were added to the mixture. All ingredients were blended thoroughly to form a polyherbal formulation for oral administration.

Recipe R14: Chibar (*Cucumis melo*) The fruit pulp of Chibar was crushed to obtain a smooth paste. Mustard oil was added and mixed . The resulting preparation was applied topically to the affected area.

Recipe R15: Neem (*Azadirachta indica*) Fresh Neem leaves were crushed into a paste and mixed with edible oil. The mixture was thoroughly mixed until a uniform consistency was attained and then applied topically.

Recipe R16: Lehsun (*Allium sativum*) Fresh garlic cloves were peeled and crushed into a fine paste. Olive oil was added and mixed until the consistency became homogenous. The preparation was applied externally to the affected area according to traditional practice.

Recipe R17: Gurhel ka Phool (*Hibiscus rosa-sinensis*) Fresh flowers and leaves of Gurhel were washed and crushed separately. The flower paste was mixed with the leaf paste, and olive oil was additionally added to obtain a smooth formulation. The resulting preparation was applied topically.

Recipe R18: Adrak (*Zingiber officinale*) Fresh ginger rhizomes were cleaned and crushed into a paste. Fresh onion juice was added and m thoroughly stirred. The resulting preparation was administered orally.

Recipe R19: Kor Tumba (*Citrullus colocynthis*) The fruit pulp of Kor Tumba was collected and mixed with any of mustard or coconut oil. The ingredients were mixed thoroughly to prepare a medicinal paste, which was applied externally to the affected area.

Recipe R20: Gurhel ka Phool (*Hibiscus rosa-sinensis*) Fresh flowers of Gurhel were crushed into a paste and mixed with honey and water. The mixture was boiled for several minutes to prepare a decoction, allowed to cool, and then consumed orally.

Recipe R21: Lehsun (*Allium sativum*) Fresh garlic cloves were heated in mustard oil until the active constituents were infused into the oil. After cooling, the medicated oil was filtered and applied externally.

Recipe R22: Podina (*Mentha spp.*) Fresh mint leaves were washed and crushed into a paste. A few drops of fresh lemon juice were added and mixed thoroughly. The preparation was administered orally.

Recipe R23: Lehsun (*Allium sativum*) Garlic cloves were crushed into a fine paste and mixed with clove powder. The ingredients were blended thoroughly and consumed orally according to local traditional practices.

Recipe R24: Haldi (*Curcuma longa*) Turmeric powder was mixed with mustard oil to form a paste. The mixture was spread on a piece of freshly prepared flatbread (roti) and tied over the affected area as a topical dressing.

Recipe R25: Gurhel ka Phool (*Hibiscus rosa-sinensis*) The flowers of Gurhel were dried and powdered. The powder was mixed with honey and mint powder to prepare a herbal formulation that was administered orally.

Recipe R26: Dadhri Booti (*Euphorbia helioscopia*) Fresh leaves of Dadhri Booti were crushed into a fine paste and mixed with petroleum jelly (Vaseline). The resulting preparation was applied topically.

Recipe R27: Kaasni Booti (*Cichorium intybus*) Fresh leaves of Kaasni Booti were washed and crushed into a paste. Mint leaf powder was added and mixed well. The formulation was administered orally.

Recipe R28: Kaasni Booti (*Cichorium intybus*) Fresh leaf paste of Kaasni Booti was mixed with honey and boiled in water to make a decoction. After cooling, the preparation was consumed orally.

Recipe R29: Band Gobi (*Brassica oleracea*) Fresh cabbage leaves were washed thoroughly and boiled in water for a specified time. The resulting preparation was used as a traditional remedy.

Recipe R30: Papra Booti (*Fumaria indica*) The leaves of Papra Booti were dried in shade and crushed into a fine powder. The powder was mixed with honey to form a paste that could be consumed orally.

Recipe R31: Jaman (*Syzygium cumini*) Shade-dried Jaman seeds were crushed into a fine powder and mixed with mango peel powder. The mixture was used orally with water.

Recipe R32: Haldi (*Curcuma longa*) Turmeric powder was mixed with olive oil and spread on a hot piece of roti. The medicated dressing was then tied over wounds or inflamed areas for topical treatment.

Recipe R33: Jaman (*Syzygium cumini*) Fresh fruits of Jaman were crushed to obtain the pulp. The pulp was mixed with cold water to form a refreshing drink for oral administration.

Recipe R34: Kor Tumba (*Citrullus colocynthis*) Fresh fruit pulp of Kor Tumba was mixed thoroughly with mustard oil to prepare a topical paste, which was applied topically.

Recipe R35: Akra (*Calotropis procera*) Fresh leaves of Akra were gently heated and coated with olive oil. The treated leaves were placed over painful joints and secured in position according to local traditional practice.

Recipe R36: Adrak (*Zingiber officinale*) Fresh ginger rhizomes were crushed into a paste and mixed with jaggery. The mixture was mixed into animal fodder and administered for veterinary use.

Recipe R37: Bhakhra Booti (*Tribulus terrestris*) The leaves of Bhakhra Booti were dried and crushed into a fine powder. The powder was mixed with milk and administered orally.

Recipe R38: Gulab ka Phool (*Rosa indica*) Fresh rose flowers were crushed into a paste and mixed with olive oil. The resulting preparation was applied topically.

Recipe R39: Chaye ki Patti (*Camellia sinensis*) Tea leaves were boiled in water to make a decoction. Jaggery and cardamom were added to improve flavor and therapeutic potential.

Recipe R40: Bohar (*Ficus benghalensis*) Fresh latex obtained from Bohar was collected and mixed with honey to prepare a uniform paste.

Recipe R41: Methi (*Trigonella foenum-graecum*) Fenugreek seeds were boiled in water to form a decoction. Cinnamon was added and mixed well before oral administration.

Recipe R42: Kainch Mainch (*Solanum nigrum*) Fresh leaves were crushed into a paste and honey was added. The resulting formulation was used as a traditional remedy.

Recipe R43: Arand (*Ricinus communis*) Castor oil extracted from the seeds of Arand was added to almond oil and olive oil. The oil formulation was applied externally.

Recipe R44: Bhangra (*Eclipta prostrata*) Fresh leaves of Bhangra were crushed to form an extract, which was later on mixed with olive oil. The preparation was applied topically to the affected area.

Recipe R45: Chibar (*Cucumis melo*) A mature fruit of Chibar was selected and a small opening was made in the fruit. The affected finger was inserted into the fruit and secured in place. The finger remained inside until the fruit dried naturally and detached, a traditional practice used by local inhabitants. .