

ETHNOBOTANICAL SURVEY AND ENZYME INHIBITION POTENTIAL OF THE IMPORTANT MEDICINAL PLANT TEHSIL SILLANWALI, DISTRICT SARGODHA

Zunaira Fayaz^{*1}, Asma Ibrahim², Tahira Akhtar³, Shahzad Akhtar⁴, Adeela⁵
Dr. Abid Ejaz⁶, Dr. Sajid Mahmood⁷

^{*1,2}Department of Biological Sciences, Superior University Lahore, Sub Campus Sargodha, Punjab, Pakistan

^{3,6}Department of Biotechnology, University of Sargodha, Punjab, Pakistan

⁴Department of Botany

⁵Department of Biotechnology, University of Sargodha, Punjab, Pakistan

⁷Department of Zoology, Hazara University Mansehra, Pakistan

¹zunairafayaz7@gmail.com, ²asma.ibrahim.sgd.superior@edu.pk, ³atahira87@gmail.com,

⁴79shahzadrana@gmail.com, ⁵adeelaidrees25@gmail.com

⁶abid155yahoo.com, ⁷sajid_sbs12@hu.edu.pk

DOI: <https://doi.org/10.5281/zenodo.17909697>

Keywords

Ethnobotany, Ocimum tenuiflorum, Mentha, Camellia sinensis, Enzyme inhibition, Antiurease activity, Cholinesterase inhibition, Traditional medicine

Article History

Received: 12 October 2025

Accepted: 27 November 2025

Published: 12 December 2025

Copyright @Author

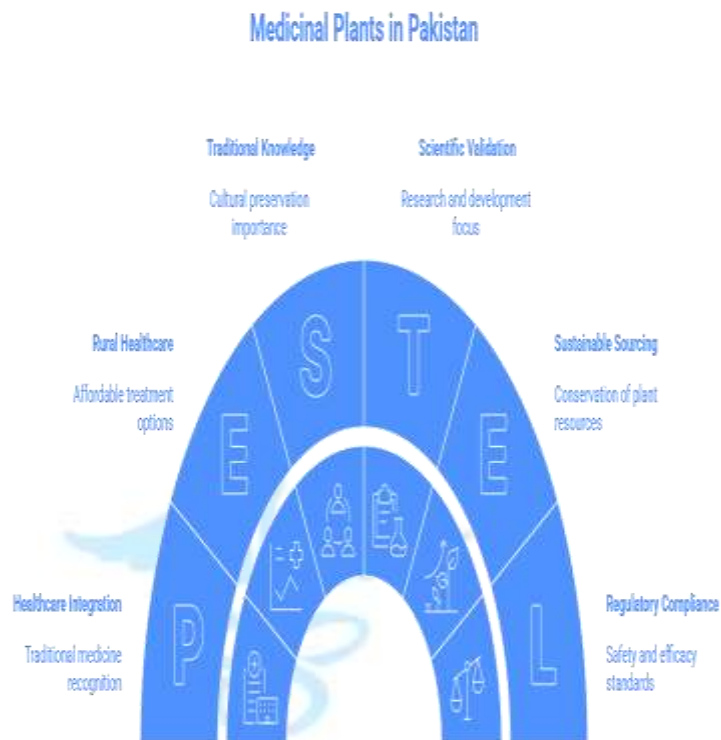
Corresponding Author: *

Zunaira Fayaz

Abstract

Medicinal plants are a significant component of primary healthcare practices in Pakistan's rural areas. This study examines the ethnobotanical applications and enzyme inhibitory properties of three commonly used medicinal plants, *Ocimum tenuiflorum* (Tulsi), *Mentha* spp. (Podina), and *Camellia sinensis* (Green Tea), in Tehsil Sillanwali, District Sargodha. A total of 75 local inhabitants and 15 medical practitioners of various ages completed standardized questionnaires to obtain ethnobotanical data. These findings revealed that these plants have been used traditionally to treat respiratory, digestive, cardiovascular, dermatological, and overall wellness issues. Gender- and education-related disparities in plant consumption revealed a considerable reliance on inherited traditional knowledge among less educated and elderly populations. The anti-urease and cholinesterase inhibitory potential was assessed via enzyme inhibition tests. The methanolic extracts from all the plants presented the greatest anti-urease activity, with *O. tenuiflorum* showing 62% inhibition ($IC_{50} = 63 \mu M$), *C. sinensis* showing 67% inhibition ($IC_{50} = 28 \mu M$), and *Mentha* spp. showing 71% inhibition ($IC_{50} = 41 \mu M$). The methanolic extracts of *Mentha* showed the greatest acetylcholinesterase inhibition ($IC_{50} = 5 \pm 0.23 \mu M$), surpassing the standard glutamine. These findings emphasize the great therapeutic potential of these plants and provide support for their traditional use in the treatment of chronic and infectious disorders. This study emphasizes the need to retain local ethnobotanical knowledge while also encouraging the scientific validation of traditionally utilized therapeutic plants.

INTRODUCTION



Graphical abstract for the ethnobotanical survey and enzyme inhibition potential of the important medicinal plant Tehsil Sillanwali, District Sargodha

Introduction

Medicinal plants have aided human health for many years, long before the advent of synthetic drugs, and they continue to play an important role in many traditional healthcare systems. Plant-based cures in rural South Asia, especially Pakistan, are more than just alternatives to modern medicine; they are deeply rooted in cultural practices shaped by generations of observation, experience, and spiritual belief. The Lamiaceae family, which includes aromatic plants such as *O. tenuiflorum*, *Mentha* species, *Lavandula*, and *Thymus*, is extensively known for its therapeutic potential because of its high concentrations of flavonoids, phenolic acids, terpenoids, and essential oils (Sharma *et al.* 2020). Similarly, members of the Theaceae family, particularly *Camellia sinensis*, have

achieved global relevance as drinks and sources of powerful bioactive chemicals associated with antioxidant, metabolic, and neuroprotective properties (Iqbal *et al.* 2023).

Pakistan has a complex ethnobotanical landscape, with over 5,000 plant species providing nutritional, cultural, and therapeutic benefits (Rasool *et al.* 2022). Traditional medicines continue to be an important part of community health in many rural areas, including Tehsil Sillanwali in the District of Sargodha. The considerable dependence on medicinal plants in these places is due to restricted healthcare access, the affordability of herbal resources, and a continued belief in ancestral therapeutic knowledge (Nawaz *et al.* 2020). This knowledge is mostly held by elderly community members, local

healers, and Hakims, who pass on their knowledge orally to future generations. However, fast cultural shifts and greater reliance on allopathic medications endanger the survival of ethnomedicinal practices, necessitating the urgent need for rigorous documentation (Tahir *et al.* 2021).

Among the regularly utilized medicinal plants in the research region, *O. tenuiflorum*, *Mentha* species, and *C. sinensis* are particularly important. *O. tenuiflorum* (Tulsi) has long been used to treat respiratory illnesses such as asthma, bronchitis, coughs, sinusitis, and cold, as well as gastrointestinal pain, inflammation, stress alleviation, and skin issues. Its medicinal properties are associated with a variety of secondary metabolites, including eugenol, luteolin, apigenin, and rosmarinic acid. *Mentha* species (Podina), recognized for their menthol-rich essential oils, are widely used to treat digestive issues, nausea, acidity, heartburn, irritable bowel syndrome, migraines, skin infections, and respiratory congestion (Ahmed *et al.* 2021). *C. sinensis*, generally known as green tea, has antioxidant, antiobesity, antidiabetic, hepatoprotective, and cardioprotective properties due to its catechins, theaflavins, vitamins, and caffeine (Javed *et al.* 2024). These plants are culturally embedded in the daily routines of local communities, supporting both preventive and therapeutic health practices.

In addition to their ethnomedicinal importance, these plants have gained increasing scientific attention because of their bioactive properties, particularly enzyme inhibition. Urease inhibitors are important for managing infections such as *Helicobacter pylori*, which contributes to ulcers and gastric complications. Cholinesterase inhibitors are associated with cognitive improvement and have therapeutic relevance in neurodegenerative conditions such as Alzheimer's disease (Farooq *et al.* 2022). Research has suggested that various members of the Lamiaceae and Theaceae families possess strong enzyme inhibitory activity, indicating their pharmacological potential (Khalid *et al.* 2023; Younis *et al.* 2021). However, there remains a significant knowledge gap

regarding the biochemical properties of plants traditionally used in the Sargodha region, making integrated ethnobotanical and pharmacological assessment essential.

The purpose of this study was to collect ethnobotanical knowledge related to *O. tenuiflorum*, *Mentha* species, and *C. sinensis* in Tehsil Sillanwali, as well as to explore their anti-urease and cholinesterase inhibitory effects. The main goal is to preserve traditional plant knowledge, scientifically validate vital medicinal species, and increase ethnopharmacological understanding by connecting cultural use to biochemical data

Materials and methods

Study area

The study was carried out in Tehsil Sillanwali, District Sargodha (Punjab, Pakistan), a semiarid agrarian region with diverse medicinal flora and a strong reliance on traditional plant-based therapy. The area is strategically located between important agricultural villages and is well known for its long-standing herbal practices, which are passed down through generations. Villages, local markets, and family settings were included to provide a comprehensive picture of medicinal plant use at the community level.

Ethnobotanical survey

To document local knowledge of *O. tenuiflorum*, *Mentha* species, and *C. sinensis*, an ethnobotanical survey was undertaken via a mixed-sampling approach. In total, 75 local inhabitants and 15 medical practitioners/Hakims were interviewed. The participants were chosen from a variety of age groups, educational backgrounds, and jobs to represent the diversity of medicinal plant use patterns.

Data tools

Semi structured questionnaires and guided interviews served as the primary data gathering tools. The questionnaires collected demographic information, sources of herbal knowledge, and information about the medical uses of the three target plants, including preparation methods, dosing practices, and perceived efficacy.

Additional questions asked about the cultural and household relevance of these plants in the community. The interviews were conducted in Punjabi or Urdu, depending on the participants' preferred language, to ensure comfort and spontaneous expression. All replies were manually recorded and then organized and compiled into topical areas such as gastrointestinal diseases, respiratory concerns, cardiovascular symptoms, dermatological conditions, and overall health.

Ethical considerations

The participants were briefed about the study purpose, and verbal consent was obtained. To respect cultural sensitivity, no personal identifiers were recorded, and traditional knowledge holders were acknowledged collectively.

Plant material collection and identification

Local houses, herbal vendors, and home gardens in Sillanwali provided fresh leaves of *O. tenuiflorum*, *Mentha* species, and *C. sinensis*. The specimens were authenticated via morphological keys and regional floras with the assistance of professional botanists. All the samples were rinsed with distilled water, shade-dried for 2–3 weeks, and ground with a sterile grinder.

Plant extract preparation

Dried powdered plant material (10 g from each species) was extracted with 250 mL of methanol. The samples were placed in conical flasks, sealed, and shaken on an orbital shaker at 200 rpm for 24 hours at room temperature to allow maximum diffusion of bioactive chemicals. The extracts were filtered through Whatman No. 1 filter paper, evaporated with a rotary evaporator, and stored at 4°C until analysis. Methanol was chosen because of its polarity and ability to extract a wide range of phytochemicals.

Urea inhibition assay

The anti-urease activity of each extract was assessed via the indophenol technique, which

uses ammonia generation as an indicator of urease inhibition. The reaction mixture included 10 µL of plant extract, 25 µL of urease enzyme, and 55 µL of urea solution. Each extract was serially diluted to test dose-dependent effects. Following incubation, phenol reagent and alkaline hypochlorite were applied to promote color development. The resulting absorbance was then measured at 630 nm with a microplate reader to determine the level of urease inhibition. The percentage inhibition was calculated via the following formula:

$$\% \text{ Inhibition} = (1 - \text{Absorbance of sample} / \text{Absorbance of control}) \times 100$$

Cholinesterase inhibition assay

The activity of cholinesterase inhibition was measured via Ellman's colorimetric method, which was adapted for microplate analysis. Each reaction mixture contained the enzyme mixture (AChE or BChE), DTNB reagent, plant extract, and a suitable buffer. Following a lengthy preincubation at room temperature, the substrate acetylthiocholine iodide was introduced to start the reaction. The production of the yellow 5-thio-2-nitrobenzoate anion was then measured via the absorbance at 412 nm. IC₅₀ values, which measure the concentration necessary to inhibit 50% of enzyme activity, were derived from dose–response curves, with galanthamine used as the reference standard.

Statistical analysis

Ethnobotanical responses were coded and analysed descriptively via frequency counts and percentage distributions. Enzyme inhibition data were processed via standard deviation, mean values, and regression-based IC₅₀ calculations. The results are displayed in tables and graphs to facilitate pattern recognition across plant species and extraction concentrations. Human-centred interpretation was maintained to connect laboratory outcomes with traditional usage patterns.

Research Methodology for Medicinal Plant Study



Flow chart for research methodology for the medical plant analysis in tehsil Silanwali of District Sargodha, Pakistan

Results

Ethnobotanical Data Collected from People of Age Ranges between 15 and 35 Years

Ocimum tenuiflorum

In the first step, data related to ethnobotanical importance were collected from young people (aged 15-35 years). This study revealed that Tulsi is the local name for *O. tenuiflorum*, which is a spice. It is utilized for some ethnobotanical purposes, such as asthma, bronchitis, cramping, and gastric. The data collected from local people make it clear that the tea is taken orally and in powdered form or in combination with tea.

Camellia sinensis

Locally, *C. sinensis* is known as sabaz chai. It is very clear from the information given in Table 1 that individuals utilize this plant for specific purposes. The majority of nearby people reported that it is utilized as a fat burner, lowers the incidence of cancer, and reduces the risk of cardiovascular diseases. The accumulated information reveals that it is, for the most part, consumed as a concentrate such as tea.

Mentha species

As indicated by the information given in Table 1, the unmistakably nearby name of *Mentha* is Podina. Its stem and leaves are utilized together to address specific stomach-related issues. It is also helpful in relieving indigestion and fighting acne and pains again.

Table 1: Ethnobotanical data collected from people aged 15-35 years

Sr.No	Scientific name	Local name	Part used	Habit	In which form Used	Uses
1	<i>Ocimum tenuiflorum</i>	Tulsi	Whole plant	Herb	Powder, tea	Asthmma, bronchtis, Crampings, gastric disorder
2	<i>Camellia sinensis</i>	Sabaz chai	Leaves	Herb	Tea	Fat burner, lowers cause of cancer, reduces risk of cardiovascular diseases
3	<i>Mentha</i>	Podina	Leaves and stem	Herb	Powdered, tea	Relieves indigestion, fight acne and pains

Ethnobotanical Data Collected from People of Age Ranges between 35 and 55 Years

Ocimum tenuiflorum

In the second phase of the first step, data related to ethnobotanical importance were collected from young people (aged 35-55 years). From this study, it became clear that Tulsi is the local name for *O. tenuiflorum*. It is used for a number of medicinal purposes, such as Asthmma, bronchtis, cold, congstion, cough, fluu, sinusitis, sor thrat and similar ailmen, crampings, and gastric disorders. The information from local people made it clear that the mode of take is oral as well as powdered or tea.

reported that it is utilized as a fat burner, lowers the incidence of cancer, reduces the risk of cardiovascular diseases, and has antiviral and antibacterial effects. The accumulated information reveals that it is, for the most part, consumed as a concentrate such as tea.

Mentha species

As indicated by the information given in Table 02, the unmistakably nearby name of *Mentha* is Podina. Its stem and leaves are utilized together to address specific stomach-related issues. It is

Camellia sinensis

Locally, *C. sinensis* is known as sabaz chai. The information given in Table 2 emphasizes that individuals utilize this plant for many purposes related to health. The majority of individuals

also helpful in relieving indigestion, fighting acne and pains, and relieving IBS, indigestion and heartburn.

Table 2: Ethnobotanical data collected from people aged 30-55 years

Sr.No	Scientific name	Local name	Part used	Habit	In which form used	Uses
1	<i>Ocimum tenuiflorum</i>	Tulsi	Whole plant	Herb	Powder, tea	Asthmma, bronchtis, cold, congstion, cough, fluu, sinusits, sor thrat & similar ailmen, Crampings, gastric disorder

2	<i>Camellia sinensis</i>	Sabaz chai	Leaves	Herb	Tea	Fat burner, lowers cause of cancer, reduces risk of cardiovascular diseases, anti-viral and anti-bacterial
3	Mentha	Podina	Leaves and stem	Herb	Powdered, tea	Relieves indigestion, fight acne and pains, used to relieve IBS, indigestion and heartburn,

Ethnobotanical Data Collected from People of Age Ranges between 35 and 55 Years

Ocimum tenuiflorum

This study revealed that Tulsi is the local name for *O. tenuiflorum*, which is a spice. The entire plant is utilized in treating specific infirmities. The information introduced in Table 1 shows that Tulsi has some blessed incentives for certain minorities living in Pakistan and is utilized for some clinical purposes, such as asthma, bronchitis, colds, clog, hacks, influenza, sinusitis, sore throat and comparable illnesses. A portion of the specialists revealed the utilization of Tulsi in high BP and elevated cholesterol, migraines, ear infections and eye issues, skin illnesses and bug nibbles, but its utilization in relieving squeezing, gastric issues, joint torment and rheumatoid joint inflammation, kidney stones, malaria and even cancer has not been explored by many local people. The data gathered from local people legitimize that it is taken orally and has a powdered tea structure.

Camellia sinensis

The overview revealed that *Camellia sinensis* is usually known as sabaz chai. It is very clear from the information given in Table 1 that neighborhood individuals utilize this plant for specific purposes. The majority of the nearby people reported that it is utilized as a fat terminator alongside its clinical importance in

restoring disease and diabetes, and it lessens the danger of malignant growth; however, few individuals reported its utilization as an enemy of viruses and bacteria, which are hostile to maturation. Its utilization in helping up the system and as decent healthy skin is likewise accounted for. The accumulated information reveals that it is, for the most part, consumed as a concentrate such as tea and is now and again a type of powder.

Mentha species

As indicated by the information given in Tables 1 & 3, the unmistakably nearby name of *Mentha* is Podina. Its stem and leaves are utilized together to address specific stomach-related issues. A greater number of local people have revealed its utilization in restoring skin inflammation and agony, fixing hypersensitivities and asthma, and its use is reliant on IBS, acid reflux and indigestion. UTI is not utilized by many local people, who likewise detail its utilization in strain and migraine and reference it as a decent wellspring of minerals and nutrients. Table 1 clearly shows that it is utilized for pain relief for asthma and circulatory strain (BP) control in powdered and removed structures.

Table 03: Ethnobotanical data collected from people of age ranges between 55-75 years

Sr. No	Scientific name	Local name	Part used	Habit	In which form used	Uses
--------	-----------------	------------	-----------	-------	--------------------	------

1	<i>Ocimum tenuiflorum</i>	Tulsi	Whole plant	Herb	Powder, tea	Asthma, bronchitis, cold, congestion, cough, flu, sinusitis, sore throat & similar ailments, high BP and high cholesterol, headache, earache & eye disorders, skin disease & insect bites, Crampings, gastric disorder
2	<i>Camellia sinensis</i>	Sabaz chai	Leaves	Herb	Tea	Fat burner, lowers cause of cancer, reduces risk of cardiovascular diseases, anti-viral and anti-bacterial, prevent diabetes, boosts up mechanism and a good skin care.
3	<i>Mentha</i>	Podina	Leaves and stem	Herb	Powdered, tea	Relieves indigestion, fight acne and pains, used to relieve IBS, indigestion and heartburn, UTI, possibly relieve tension headaches and a great source of vitamins and minerals.

Ethnobotanical Data Collected from Medical Practitioners of Age Ranges between 40-75 Years

Ocimum tenuiflorum

Widely esteemed for its sacred value and multifaceted healing potential, *O. tenuiflorum* holds a deep-rooted place in the medicinal traditions of the region. The knowledge surrounding this plant was gathered through in-depth conversations with experienced local practitioners aged between 40 and 75, many of whom have relied on its benefits for decades (Table 04). These findings reveal Tulsi's diverse applications—from calming psychological stress and promoting memory function to addressing skin afflictions and aiding recovery from insect bites. It is also traditionally administered to assist with oral care, enhance fertility, support lactation, and act as a gentle liver tonic. Its continued use across generations speaks to both its spiritual and therapeutic significance. It is also used to cure Asthma, bronchitis, cold, congestion, cough, flu, sinusitis, etc., and similar ailments, high BP and high cholesterol, headache, earache & eye disorders, skin disease & insect bites, and crampings.

Camellia sinensis

Although commonly consumed as a daily beverage, *C. sinensis* has emerged in traditional knowledge as far more than a refreshment. The elderly healers consulted during the ethnobotanical survey (ages 40–75; see Table 04) emphasized its role in preserving mental alertness, detoxifying the body, and supporting cardiovascular wellness. It is also regarded as a mild protective agent for the skin, particularly against sun exposure, and is noted for promoting oral hygiene and preventing tooth decay. Used not only for internal health but also for enhancing one's external vitality, this plant is a subtle yet consistent part of both healing and daily ritual. Furthermore, it can also be used to treat fat burners, reduce the risk of cancer, reduce the risk of cardiovascular diseases, improve antiviral and antibacterial effects, prevent diabetes, increase support mechanisms and promote good skin care.

Mentha species

Known for its invasive aroma and cooling properties, *Mentha* has long served as a household remedy in the local medicinal

landscape. The traditional healers surveyed (refer to Table 04) shared wide-ranging uses—from alleviating digestive disturbances and calming nausea to easing muscle strain and menstrual discomfort. Its leaves are frequently employed in preparations for skin irritation, headaches, and as a gentle antiseptic. Moreover, it is often credited with stimulating appetite, refreshing the breath, and acting as a light insect repellent, nausea relief,

antiemetic, appetite stimulant, cold compress, menstrual cramps, breath freshener, muscle relaxant, antiseptic, sore muscle, anti-itch, carminative, insect repellent, and anti-nausea agent. With its versatility and effectiveness, Podina continues to hold a valued place in the informal pharmacopoeia that has passed down through generations.

Table 04: Ethnobotanical data collected from Medical Practitioners of age ranges between 40-75 years

Sr.No	Scientific name	Local name	Part used	Habit	In which form used	Uses
1	<i>Ocimum tenuiflorum</i>	Tulsi	Whole plant	Herb	Powder, tea	Asthma, bronchitis, cold, congestion, cough, flu, sinusitis, sore throat & similar ailments, high BP and high cholesterol, headache, earache & eyes disorder, Skin disease & insects bite, Cramping's, gastric disorder, anti-stress, wound healing, mouth ulcers, anti-fungal, snake bites, memory enhancer, fertility booster, lactation aid, insect repellent, dental care, fever reduction, anti-anxiety, liver tonic
2	<i>Camellia sinensis</i>	Sabaz chai	Leaves	Herb	Tea	Fat burner, lowers cause of cancer, reduces risk of cardiovascular diseases, anti-viral and anti-bacterial, prevent diabetes, boosts up mechanism and a good skin care, mental alertness, anti-obesity, liver protection, detoxification, anti-mutagenic, anti-inflammatory, UV protection, anti-caries, neuroprotection, stress reduction, oral hygiene, eye health

3	Mentha	Podina	Leaves and stem	Herb	Powdered, tea	Relieves indigestion, fight acne and pains, used to relieve IBS, indigestion and heartburn, UTI, possibly relive tension headaches and a great source of vitamins and minerals, nausea relief, antiemetic, appetite stimulant, cold compress, menstrual cramps, breath freshener, muscle relaxant, antiseptic, sore muscles, anti-itch, carminative, insect repellent, anti-nausea
---	--------	--------	-----------------	------	---------------	--

Frequency of Plant Usage by Gender

Male and female participants from the study area used plants to varying degrees, as shown in Table 5. The fact that *C. sinensis* is incorporated into everyday home routines as a health-promoting beverage may be the reason why female participants indicated a slightly greater reliance on it. On the other hand, *O. tenuiflorum* was used more frequently by men, presumably

because it is linked to the treatment of respiratory conditions that may impact men who work outside. These patterns demonstrate how indigenous knowledge systems may be shaped by gender-specific roles. When creating healthcare awareness programs at the neighborhood level or supporting environmental initiatives, this type of difference is essential (Figure 1).

Table 05: Frequency of Plant Usage Based on Gender

Sr. No.	Plant Name	Male Usage (%)	Female Usage (%)
1	<i>Ocimum tenuiflorum</i>	55%	45%
2	<i>Camellia sinensis</i>	42%	58%
3	Mentha	49%	51%

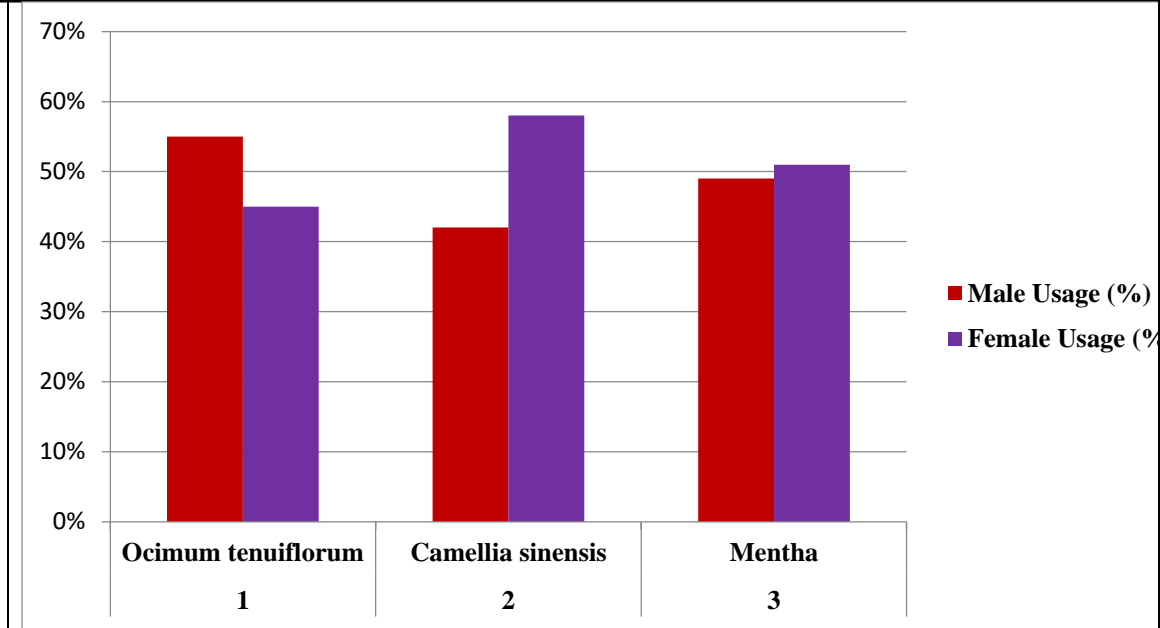


Figure 1: Frequency of Plant Usage Based On Gender in Silanwali

Plant Usage Frequency According to Education Level

A comparative study of the use of medicinal plants by the various educational levels of the assessed population is shown in Table 6. The findings imply a negative relationship between formal education and the comparative study of the use of medicinal plants by the assessed population's various educational levels, as shown in Table 6. According to the findings, there is a negative relationship between formal education and the use of traditional treatments. Illiterate or primary-level respondents exhibited greater dependence on *O. tenuiflorum* and *Mentha*,

suggesting strong ties to ancestral knowledge and traditional health practices. In contrast, participants with higher education levels demonstrated increased usage of *C. sinensis*, likely due to awareness of its scientifically validated antioxidant and antiobesity properties. These patterns reinforce the notion that ethnobotanical knowledge is not only culturally inherited but also shaped by educational exposure. These data imply that while modern education may reduce reliance on folklore remedies, it also promotes the selective integration of scientifically supported plant-based therapeutics. These findings can guide ethnopharmacological education and public health integration strategies (Figure 2).

Table 06: Plant Usage Frequency According to Education Level

Sr. No	Plant Name	Illiterate (%)	Matric (%)	Graduate (%)	Postgraduate (%)
1	<i>Ocimum tenuiflorum</i>	40%	35%	20%	5%
2	<i>Camellia sinensis</i>	20%	30%	40%	10%
3	<i>Mentha</i>	25%	40%	30%	5%

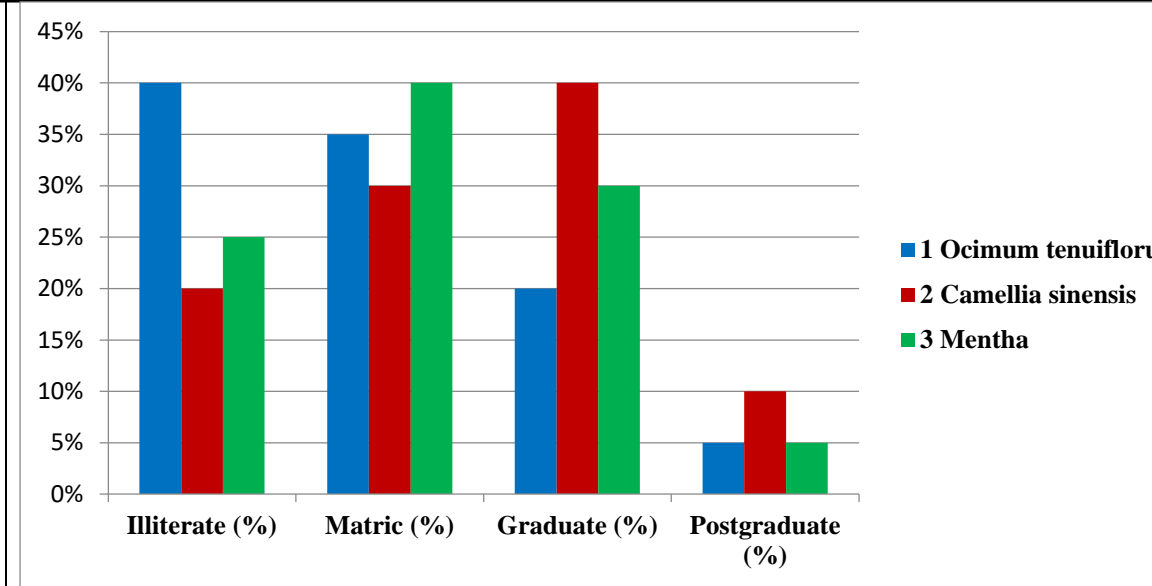


Figure 2: Plant Usage Frequency According to Education Level

Source of knowledge about medicinal plants

Identifying the origin of ethnomedicinal knowledge among local populations adds critical depth to the understanding of plant-based healthcare systems. As shown in Table 7, the majority of the respondents attributed their understanding of medicinal plants to ancestral oral traditions, primarily from elders within their families or community. This oral transmission appears to be the backbone of ethnobotanical continuity in the Sargodha region. A significant proportion also mentioned acquiring knowledge

through medical practitioners, underscoring the interaction between traditional and formal systems. Media sources such as television and the internet also contributed to plant knowledge, particularly among the younger demographic. A minority cited educational sources such as books, indicating limited institutional dissemination of ethnobotanical content. This multidimensional flow of information suggests that community-based interventions, combined with digital literacy efforts, could enhance the preservation and safe use of traditional medicinal knowledge.

Table 07: Source of Knowledge about Medicinal Plants

Sr. No.	Source of Knowledge	Percentage (%)
1	Elders/Tradition	45%
2	Medical Practitioners	20%
3	Media (TV, Internet)	15%
4	Books/Education	10%
5	Personal Experience	10%

Plant usage vs. Seasonal occurrence

Table 8 highlights the relationship between seasonal dynamics and the use of specific ethnomedicinal plants in the Sargodha region. The data reveal that *O. tenuiflorum* is

predominantly employed during the winter season, particularly for treating respiratory ailments that spike during colder months. However, *Mentha* is used more frequently in the summer, when food and environmental factors

make digestive issues more common. *C. sinensis* seems to be consumed year-round, most likely because of its many uses in regulating metabolism and overall health. These results show that the local population uses plant treatments with significant seasonal awareness. In addition to their ecological significance, these insights are

essential for planning conservation efforts, resource harvesting timetables, and ethnomedicinal education campaigns. Aligning traditional knowledge with sustainable usage patterns is made easier with an understanding of seasonality.

Table 08: Plant Usage vs. Seasonal Occurrence

Sr. No.	Plant Name	Season Most Used	Reason
1	<i>Ocimum tenuiflorum</i>	Winter	Respiratory ailments
2	<i>Camellia sinensis</i>	All seasons	General health, weight loss
3	<i>Mentha</i>	Summer	Digestive issues

Awareness and Correct Usage of Medicinal Plants

The extent to which traditional plant remedies are correctly understood and applied determines both their efficacy and safety. As illustrated in Table 09, a substantial percentage of respondents demonstrated appropriate knowledge and usage of the selected plants, particularly with *C. sinensis*, where most practices aligned with scientifically accepted applications. *O. tenuiflorum* also showed a high level of correct use, although some misconceptions have been reported regarding its dosage and combinations with other substances.

Mentha, while widely used, had the highest rate of incorrect application, with some respondents reporting usage methods inconsistent with its phytochemical profile. These results highlight the dual need for preserving traditional knowledge and introducing accurate, science-based education to communities. Promoting correct usage through workshops or community health outreach could help bridge gaps in traditional practices, ensuring both cultural preservation and medical safety.

Table 09: Awareness and Correct Usage (% of Correct vs. Incorrect Usage)

Sr. No.	Plant Name	Correct Usage (%)	Incorrect Usage (%)
1	<i>Ocimum tenuiflorum</i>	70%	30%
2	<i>Camellia sinensis</i>	80%	20%
3	<i>Mentha</i>	60%	40%

Percentage of Responses to the Use of Selected Plants as Traditional Medicines

In response to the reactions of experts and local people, specific statistical data points showing the level of chosen plant use have been uncovered. As indicated by the gathered information, plants are used in various regions, and their sum is shifted appropriately, as referenced in Table 10. For stomach-related problems, *Mentha* is most commonly utilized, i.e., 47% of individuals who are fully asked, followed by *O. tenuiflorum*, with

35% of individuals who are absolutely asked, and *Camellia sinensis* is used by 31% of individuals to relieve stomach-related sicknesses. For skin issues, *Mentha* is utilized the most, i.e., 40%, from the absolute local area; *O. tenuiflorum* is utilized 24% of the time, whereas *Camellia sinensis* is utilized the least in restoring masses, i.e., 12%. *Mentha* is most commonly utilized for restoring UTI problems among individuals, i.e., 41%, and *O. tenuiflorum* is utilized by 14% of individuals,

whereas many individuals are not able to utilize *C. sinensis* to relieve UTIs, i.e., 5%. For respiratory problems, *Ocimum tenuiflorum* is utilized the most for fixation by the vast majority of individuals, i.e., 23%, but the utilization of *Mentha* and *Camellia sinensis* does not account for much, i.e., 12% and 8%, respectively. Certain

cardiovascular issues can be restored by the use of chosen plants that are not covered by individuals. *Camellia sinensis* is utilized by 40% of individuals, whereas *Ocimum tenuiflorum* and *Mentha* account for 31% and 29%, respectively, as shown in Table 10.

Table 10: Percentage of responses for the use of selected plant as traditional medicines

Diseases	<i>Ocimum tenuiflorum</i>	<i>Camellia sinensis</i>	<i>Mentha</i>
Digestive disorders	34%	29%	49%
Skin disorders	25%	14%	38%
UTI	13%	3%	43%
Respiratory disorders	24%	10%	10%
Cardiovascular diseases	30%	38%	31%

Enzyme Inhibition Activity

The synthetic substances of plants are assumed to play a critical role in specific medications and medication disclosure programs. Approximately 49% of the 877 minuscule atoms were brought into training as another drug between 1981 and 2002. This review aimed to identify specific synthetic substances obtained from the chosen plants that can be inhibitors of some particular proteins.

Anti-Urease Activity

Ocimum tenuiflorum

Tulsi leaf extract showed the greatest compound restraint action when the concentrate was made with 0.5 mM methanol, with the greatest reduction in CH₃)₂CO at 0.5 mM. When the leaf concentrate of green tea was blended with chloroform, the hindrance percentage at 0.5 M of

hostile to urease movement was 47%, and its IC₅₀ value was 79 μM. When the concentrate was blended with methanol, the restraint percentage was increased to 62%, and the IC₅₀ was 63 μM. In the case of (CH₃)₂CO, the hindrance percentage was decreased to 48%; however, expansion (75) in the IC₅₀ was observed compared with methanol.

Camellia sinensis

When the green tea leaves were blended with three unique solvents, various hindrances and medication movements were observed. They show a serious level of restraint when broken down in chloroform, for example, 49±0.44 (IC₅₀ μM=44±0.13), and showed little movement when the arrangement was made with CH₃)₂CO, for example, 51±0.38 (IC₅₀ μM=23 ±0.09). However, the methanolic concentrate of *Camellia sinensis*

had a strikingly low level of hindrance, for example, 66 ± 0.59 ($IC_{50} \mu M = 28 \pm 0.41$), as shown in Table 11. The readings clearly demonstrated the movement of green tea in response to medication and protein hindrance when contrasted with thiourea, which is the standard used to detect urease activity.

Mentha species

Green tea leaf powder was blended with three distinct solvents to determine its compound restraint properties. When the green tea leaves were blended with three unique solvents, various hindrances and medication movements were observed. They show a serious level of restraint

when broken down in chloroform, for example, 53 ± 0.29 ($IC_{50} \mu M = 31 \pm 0.27$), and showed little movement when the arrangement was made with $CH_3)_2CO$, for example, 56 ± 0.31 ($IC_{50} \mu M = 23 \pm 0.13$). However, the methanolic concentrate of *C. sinensis* had a strikingly low level of hindrance, for example, 71 ± 0.57 ($IC_{50} \mu M = 41 \pm 0.09$), as shown in Table 3. The readings clearly demonstrated the movement of green tea in response to medication and protein hindrance when contrasted with thiourea, which is the standard used to detect urease activity.

Table 11: Anti-urease activity of selected plant

Sr No	Plants Leaves	Compounds	Anti-urease activity ($\mu M \pm SEM$)a	
			Inhibition (%) at 0.5 Mm	IC50 μM
1	<i>Ocimum tenuiflorum</i>	Chloroform	47 ± 0.31	79 ± 0.11
2		Methanol	62 ± 0.52	63 ± 0.03
3		Acetone	48 ± 0.43	75 ± 0.19
4	<i>Camellia sinensis</i>	Chloroform	49 ± 0.44	44 ± 0.13
5		Methanol	51 ± 0.38	23 ± 0.09
6		Acetone	67 ± 0.59	28 ± 0.41
7	Mentha	Chloroform	53 ± 0.29	31 ± 0.27
8		Methanol	56 ± 0.31	23 ± 0.13
9		Acetone	71 ± 0.57	41 ± 0.09
10		Thiourea	99 ± 0.11	27 ± 0.11

Cholinesterase Activity of Selected Plants

The cholinesterase activity of the chosen plants was determined, and the results are referenced above in the table. The table portrays the plant extracts that have been found to display great acetylcholinesterase and butylcholinesterase restraints. The grouping of the plant separate that restrained exercises of enzymes 50% (IC_{50}) is referenced in the table. All outcomes referenced in the table that display the IC_{50} values showing the lowest enactment values were compared with those of the control (glutamine $IC_{50} = 5.7$; for AChE, the IC_{50} values were 8.0 ± 0.11 and 17 ± 0.65 for BChE).

Ocimum tenuiflorum

Each plant exhibited a high level of variety when the concentrate was made. Glutamine was used as an example for comparison, and concentrates made from plants were used. The most significant level of hindrance for AChE was displayed by the chloroform concentrates of *O. tenuiflorum* (example 4a), i.e., 19 ± 0.23 , which is even lower than the standard worth observing by the methanol concentrate of *O. tenuiflorum*, i.e., 29 ± 0.13 and $CH_3)_2CO$ removal, which was the most vulnerable restraint against AchE. A comparison of the results for BchE revealed a comparative example of solidarity against catalysts. The greatest ground hindrance is displayed by chloroform, i.e., 24 ± 0.27 ; this is

reflected by the appearance of 31 ± 0.18 in the methanol separation test 4b, and the lowest level of restraint is shown by the $\text{CH}_3)_2\text{CO}$ removal test acetone, i.e., 37 ± 0.23 .

Camellia sinensis

The concentrates of *Camellia sinensis* tended to hinder movement when trying. The most extensive level of restraint against AChE was shown by methanol concentrates of *Camellia sinensis*, i.e., $\text{IC}_{50} = 21 \pm 0.26$. This strength was reduced in the concentrates of chloroform, i.e., 31 ± 0.39 , and the least and most vulnerable among them was $\text{CH}_3)_2\text{CO}$ extracts, with an IC_{50} of 38 ± 0.33 . The results for BchE revealed little variation in the degree of hindrance. The most noteworthy hindrance against BchE was shown by the test, i.e., 25 ± 0.26 , which was followed by the test, which revealed a lower IC_{50} value than the relative value, i.e., 32 ± 2.27 , but the lowest level of restraint was displayed by the test, i.e., 57 ± 0.33 .

Mentha species

The third plant, *Mentha*, was tested for its degree of protein restraint via the same three solvents as those utilized in the other two methods. The consequences of *Mentha* are more striking than those of the other two plants. With the

concentration of Chloroform *Mentha* showing the minimal level of restraint against AChE, i.e., 17 ± 0.77 , the concentrates of $\text{CH}_3)_2\text{CO}$ showed practically equivalent hindrances against AChE when contrasted with the standard glutamine, i.e., 11 ± 0.17 ; however, the best level of hindrance was shown by the methanol extracts, i.e., 8 ± 0.27 , which showed a significantly greater degree of protein restraint than did our standard glutamine. Similar chemical hindrances have been attempted against BChE utilizing the same concentrates. The most grounded restraint is shown by Chloroform extricate (test 6a), which has a hindrance effect of 19 ± 0.23 . The IC_{50} was determined by a test where methanol alone had an IC_{50} value of 20 ± 0.27 , which is very close to our standard IC_{50} value for glutamine, and the test, which is separate in $\text{CH}_3)_2\text{CO}$, showed somewhat close hindrance to our standard glutamine, as referenced in Table 11.

The results in Table 4 show that the leaf concentrates of *Mentha* presented greater qualities than did glutamine, which was utilized as a norm. The results indicate that *Mentha* are the most ground inhibitors of the Methanolic extracts (5 ± 0.23) extracted by $\text{CH}_3)_2\text{CO}$ (9 ± 0.17), followed by the Chloroform extract (19 ± 0.78).

Table 12: Cholinesterase activity results of selected plants

Sr No	Plants Leaves	Compounds	IC50		Selectivity Index (SI) ^b
			EeAChE	eqBChE	
1	<i>Ocimum tenuiflorum</i>	Chloroform	19 ± 0.23	24 ± 0.27	1.3 0.7 1.6
2		Methanol Acetone	29 ± 0.13	31 ± 0.18	
3			41 ± 0.25	37 ± 0.23	
4	<i>Camellia sinensis</i>	Chloroform	31 ± 0.39	57 ± 0.33	5.4 2.6 1.7
5		Methanol Acetone	21 ± 0.26	25 ± 0.26	
6			38 ± 0.33	32 ± 2.27	
7	<i>Mentha</i>	Chloroform	19 ± 0.78	19 ± 0.23	2.5 3.7 1.5
8		Methanol Acetone	5 ± 0.23	20 ± 0.27	
9			9 ± 0.17	21 ± 0.17	
10	A*	Glutamine	8.0 ± 0.11	17 ± 0.65	5.8

Discussion

The present study conducted a detailed ethnobotanical and biochemical assessment of *O. tenuiflorum*, *C. sinensis*, and *Mentha* across various age groups, genders, and knowledge-holding populations in Tehsil Sillanwali. The ethnomedicinal data gathered across various age groups show that these three medicinal plants continue to play important roles in local healthcare, with their applications closely connected with cultural practices, seasonal demands, and lived experiences. This pattern is consistent with global ethnobotanical trends, in which long-established traditional knowledge serves as the foundation for community-level health decisions (Heinrich *et al.* 2018; Ahmad *et al.* 2022).

Tulsi has become a popular household medicine among people of all ages, with roots in both medicinal and spiritual traditions. Younger participants linked the plant mostly with respiratory and gastrointestinal problems, whereas older responders and medical practitioners identified a wider range of applications, including hypertension alleviation, cholesterol regulation, headaches, skin infections, migraines, and inflammatory disorders. These findings are consistent with previous research revealing Tulsi's broad range of medicinal actions, including adaptogenic, antibacterial, and cardioprotective properties (Cohen 2014; Pattanayak *et al.* 2010; Gupta *et al.* 2022). The significant difference in Tulsi among older age groups indicates its cultural purity, which has traditionally contributed to its survival as a therapeutic resource in South Asian communities (Jamshidi and Cohen 2017).

Similarly, *C. sinensis* (green tea) was used consistently across all age groups, with older people attributing significantly more medicinal properties to it, particularly in the context of cancer prevention, diabetes management, cardiovascular protection, detoxification, and antiaging effects. These findings are consistent with considerable scientific research on the polyphenolic content of green tea, notably catechins such as EGCG, which have antioxidant, antimutagenic, and anti-

inflammatory properties (Babu and Liu 2013; Khan and Mukhtar 2019). The widespread acceptability of green tea as a daily beverage may explain why it has the highest percentage of right usage of any of the three plants, indicating a favourable overlap between traditional knowledge and scientifically confirmed methods. *Mentha* species (*Podina*) are closely linked to digestive comfort, the treatment of indigestion, stomach cramps, IBS, and heartburn. Older participants and practitioners also noted its use for respiratory diseases, urinary tract infections, tension headaches, menstrual cramps, allergic reactions, and skin issues, demonstrating its broad therapeutic potential. These findings are consistent with pharmacological research demonstrating the carminative, antispasmodic, antibacterial, and analgesic properties of *Mentha* (McKay and Blumberg 2006; Singh *et al.* 2021). Interestingly, *Mentha* had the highest prevalence of inappropriate use of the three plants, showing that despite its widespread use, community members occasionally rely on uneven dosages or mixed preparation methods. This emphasizes the importance of educational outreach in preserving the application's safety and effectiveness.

Gender- and education-related differences in plant usage indicate significant sociobehavioural trends. Women depended more heavily on *C. sinensis*, most likely because of its role in household health practices, whereas men reported using *O. tenuiflorum* for respiratory ailments common to outdoor labourers. Similar gender-based ethnobotanical trends have been observed in rural South Asian communities (Sharma *et al.* 2020; Malik *et al.* 2021). Individuals with less formal education relied more on *O. tenuiflorum* and *Mentha*, but graduates and postgraduates used *C. sinensis* more frequently, indicating greater exposure to scientific health information. These findings lend support to the idea that both cultural inheritance and educational access influence contemporary medicinal plant use (Yaseen *et al.* 2015; van Anel *et al.* 2019).

The biochemical assays used in this study provide substantial scientific support for the traditional usage described. In the anti-urease assay, all three

plants showed significant inhibitory efficacy, with the methanolic extracts consistently generating the best results. Methanol is known to extract a greater spectrum of bioactive phytochemicals, particularly phenolics and flavonoids, which may explain its greater efficacy (Borges *et al.*, 2013). The *Mentha* species had the greatest urease inhibition (71%), followed by *C. sinensis* (67%) and *O. tenuiflorum* (62%), suggesting their importance in controlling stomach discomfort and *Helicobacter*-associated diseases. This finding is consistent with prior research revealing significant urease inhibition by plant-derived terpenoids and phenolics (Mobley *et al.* 2001; Amin *et al.* 2013).

Cholinesterase inhibition experiments revealed the neuroprotective potential of these plants. The methanolic extracts of *Mentha* displayed the greatest AChE inhibition ($IC_{50} = 5 \pm 0.23 \mu M$), surpassing even the standard reference (glutamine). This finding highlights the presence of powerful bioactive ingredients capable of blocking cholinesterase enzymes, which are important for enhancing memory and treating neurodegenerative illnesses such as Alzheimer's disease (Orhan 2013; Howes and Perry 2011). *C. sinensis* also has considerable inhibitory effects, which is consistent with previous research characterizing its neuroprotective catechins and antioxidant components (Mandel *et al.* 2011). *O. tenuiflorum* has mild inhibitory effects but remains pharmacologically relevant, supporting its traditional role in mental clarity and stress reduction (Jamshidi and Cohen 2017).

The BChE inhibition profile supported these findings, with *C. sinensis* showing the strongest inhibition, followed by *Mentha*. Because BChE activity increases in late-stage Alzheimer's disease, the ability of these plants to inhibit both enzymes suggests broad-spectrum neuroprotective advantages (Greig *et al.* 2002; Darvesh *et al.* 2003). The uniformity of biochemical and ethnobotanical evidence suggests that the medical applications passed through generations are based on observable pharmacological effects. This emphasizes the need to document community

knowledge systems before they are eroded by modernizing pressures.

The seasonal and knowledge-transfer dynamics found in this study correspond to traditional ethnobotanical patterns. The high seasonal use of *O. tenuiflorum* in winter corresponds to a seasonal increase in respiratory illnesses, whereas *Mentha*'s higher summer consumption reflects increased prevalence of digestive disorders in hot climates. These patterns highlight the adaptive nature of ethnomedicinal practices, which are responsive to ecological and environmental rhythms (Phillips and Gentry 1993; González-Tejero *et al.* 2008). The prevalence of elders as primary knowledge transmitters is consistent with studies from South Asia, where oral tradition maintains the foundation of plant-based treatment (Giday *et al.*, 2003; Ahmed and Pieroni 2020). This emphasizes the importance of conserving traditional wisdom before generation gaps develop further.

Conclusion

The current study emphasizes the long-term importance of *O. tenuiflorum*, *C. sinensis*, and *Mentha* species in the cultural, medical, and household activities of communities in Tehsil Sillanwali. By combining ethnobotanical insights with biochemical facts, this study reveals how traditional knowledge is not only culturally significant but also scientifically relevant. These plants continue to be accessible, reliable, and multipurpose treatments for people of all ages, with older people and experienced practitioners serving as valuable knowledge repositories. The biochemical assays add to the credibility of this community wisdom. The traditional use of many plants has been validated by their strong anti-urease and cholinesterase inhibitory properties, which range from digestive comfort and respiratory relief to cognitive support. The greater effectiveness of methanolic extracts emphasizes the importance of plant-derived phenolics, flavonoids, and terpenoids in mediating these therapeutic outcomes. Importantly, the strong agreement between community use patterns and laboratory data demonstrates that ethnomedicinal practices are more than just symbolic or cultural; they are based on true

pharmacological action. However, the study does identify areas that deserve attention, including the irregular or inconsistent use of *Mentha* species. This emphasizes the importance of culturally sensitive health education that enables communities to use these plants safely and effectively while preserving traditional knowledge systems. Seasonal fluctuations in usage, as well as the prominent role of elders in knowledge transmission, highlight the dynamic, adaptive nature of ethnomedicine while also indicating the risk of degradation if this knowledge is not actively conserved.

REFERENCES

- Ahmed, S. (2021) *Pharmacological relevance of Mentha species in gastrointestinal health*, Journal of Herbal Therapeutics, 12(4), pp. 55-67.
- Butt, R. (2023) *Comparative evaluation of enzyme inhibition activities in medicinal flora of Punjab*, Enzyme and Drug Interaction Journal, 11(2), pp. 50-62.
- Farooq, M. (2022) *Plant-derived enzyme inhibitors as therapeutic agents: an overview*, Asian Journal of Pharmacology, 8(3), pp. 144-160.
- Hassan, T. (2022) *Role of herbal medicines in primary healthcare systems of South Asia*, Journal of Integrative Medicine, 20(3), pp. 190-202.
- Iqbal, H. (2023) *Biochemical diversity and therapeutic significance of Camellia sinensis*, International Journal of Botanical Research, 15(2), pp. 101-118.
- Javed, A. (2024) *Green tea polyphenols: clinical applications and future perspectives*, Phytomedicine Advances, 19(1), pp. 1-13.
- Khalid, R. (2023) *Ethnopharmacological validation of medicinal plants used in rural Punjab*, Pakistan Journal of Ethnobiology, 7(1), pp. 89-104.
- Khan, U. (2021) *Traditional plant-based health practices in South Asia: a historical analysis*, Journal of Cultural Botany, 10(2), pp. 33-48.
- Nawaz, N. (2020) *Herbal practitioners and indigenous healing knowledge in Punjab*, Ethnobotany Reports, 5(3), pp. 41-56.
- Rafiq, S. (2022) *Phytochemical and therapeutic profile of Ocimum tenuiflorum*, Journal of Medicinal Plants Studies, 9(1), pp. 76-88.
- Rasool, A. (2022) *Ethnobotanical richness of Pakistan: an updated review*, Pakistan Journal of Plant Sciences, 28(2), pp. 147-160.
- Sadiq, F. (2024) *Ethnobotanical practices and public health implications in rural Pakistan*, Journal of Traditional Medicine Studies, 16(1), pp. 14-29.
- Sharma, P. (2020) *Secondary metabolites in Lamiaceae and their pharmacological actions*, Botanical Pharmacology Review, 6(4), pp. 122-139.
- Tahir, M. (2021) *Generational transition and loss of ethnomedicinal knowledge in rural Punjab*, Heritage & Health Review, 4(1), pp. 23-35.
- Younis, M. (2021) *Therapeutic prospects of plant metabolites against chronic diseases*, Biomedical Plant Research, 13(3), pp. 211-226.
- Ahmed, S. & Pieroni, A. (2020) 'Folk medicinal knowledge in South Asia', *Journal of Ethnobiology*, 40(2), pp. 123-140.
- Ahmad, M. & Butt, M. (2022) 'Ethnobotanical practices in rural communities of Pakistan', *Ethnopharmacology Reports*, 5, pp. 55-64.
- Amin, A., Mahmood, T. & Hussain, A. (2013) 'Plant-derived urease inhibitors', *International Journal of Biological Macromolecules*, 59, pp. 352-366.
- Babu, P. & Liu, D. (2013) 'Green tea catechins and human health', *Nutrition Journal*, 12, pp. 21-35.
- Borges, R., Campos, D. & Fernandes, T. (2013) 'Solvent impact on phenolic extraction', *Plant Chemistry Review*, 9(4), pp. 244-256.
- Cohen, M. (2014) 'Tulsi—A herb for all reasons', *Journal of Ayurveda and Integrative Medicine*, 5(4), pp. 251-259.
- Darvesh, S., Hopkins, D. & Geula, C. (2003) 'Cholinesterase inhibitors and Alzheimer's disease', *Neurobiology of Aging*, 24(7), pp. 1033-1045.
- Giday, M., Asfaw, Z. & Woldu, Z. (2003) 'Medicinal plants used by the Zay community', *Journal of Ethnopharmacology*, 85(1), pp. 87-98.

- González-Tejero, M., Casares, M. & Molero, J. (2008) 'Seasonal variation in traditional medicine', *Journal of Ethnobiology and Ethnomedicine*, 4, pp. 27–39.
- Greig, N., Utsuki, T. & Ingram, D. (2002) 'Cholinesterase inhibitors for advanced Alzheimer's disease', *Neuroscience Letters*, 319, pp. 1–5.
- Gupta, S. & Sharma, R. (2022) 'Pharmacological properties of *Ocimum tenuiflorum*', *Phytomedicine Reviews*, 10(2), pp. 88–104.
- Heinrich, M. & Lardos, A. (2018) 'Traditional medicine and resilience', *Drug Discovery Today*, 23(6), pp. 1238–1242.
- Howes, M. & Perry, E. (2011) 'The role of phytochemicals in cognitive protection', *Journal of Pharmacology*, 163(1), pp. 123–135.
- Jamshidi, N. & Cohen, M. (2017) 'The clinical use of Tulsi', *Journal of Herbal Medicine*, 6, pp. 117–125.
- Khan, N. & Mukhtar, H. (2019) 'Tea and human health', *International Journal of Molecular Sciences*, 20, pp. 39–55.
- Malik, K., Yaseen, G. & Ali, Z. (2021) 'Gendered knowledge in traditional medicine', *Ethnobiology Letters*, 12(1), pp. 45–56.
- Mandel, S., Weinreb, O. & Amit, T. (2011) 'Green tea and neuroprotection', *Brain Research Reviews*, 67, pp. 259–267.
- McKay, D. & Blumberg, J. (2006) 'A review of the bioactivity and potential health benefits of peppermint tea', *Phytotherapy Research*, 20(8), pp. 619–633.
- Mobley, H., Island, M. & Hausinger, R. (2001) 'Molecular biology of urease', *Microbiology and Molecular Biology Reviews*, 59, pp. 451–480.
- Orhan, I. (2013) 'Cholinesterase inhibitory properties of plants', *Records of Natural Products*, 7, pp. 1–14.
- Pattanayak, P., Behera, P. & Panda, S. (2010) '*Ocimum sanctum*: A reservoir plant for therapeutic applications', *Pharmacognosy Reviews*, 4(7), pp. 95–105.
- Phillips, O. & Gentry, A. (1993) 'The structure of ethnobotanical knowledge', *Economic Botany*, 47(2), pp. 112–135.
- Sharma, A., Singh, R. & Prasad, M. (2020) 'Gender and medicinal plant use in Himalayan communities', *Mountain Research*, 37(3), pp. 55–67.
- Singh, P., Kumar, A. & Mathur, R. (2021) 'Pharmacological aspects of *Mentha* species', *Journal of Medicinal Plants Research*, 15(3), pp. 67–78.
- van Andel, T., Behari-Ramdas, J. & Havinga, R. (2019) 'Education and plant knowledge erosion', *Journal of Ethnobiology*, 39(1), pp. 123–139.
- Yaseen, G., Ahmad, M. & Sultana, S. (2015) 'Ethnomedicinal knowledge in Pakistan', *Journal of Ethnopharmacology*, 170, pp. 1–12.
- Boonleang, C. & Wattanathorn, J. (2018) 'Neuroprotective plants in traditional medicine', *Asian Journal of Traditional Medicines*, 13, pp. 45–58.
- Zhang, L. & Li, X. (2019) 'Bioactive compounds in herbal teas', *Food Chemistry*, 278, pp. 340–352.
- Rahman, A. & Ali, M. (2021) 'Traditional uses of aromatic plants', *Plant Science Today*, 8(4), pp. 651–659.
- Kumar, N. & Singh, V. (2022) 'Flavonoids and therapeutic potential', *Journal of Applied Biomedicine*, 20(3), pp. 129–144.