

ETHNOBOTANICAL INVESTIGATION AND PHYTOCHEMICAL SCREENING OF MEDICINAL PLANTS USED AGAINST GASTROINTESTINAL DISORDERS IN DISTRICT BAJAUR, PAKISTAN

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Abstract

Gastrointestinal disorders (GIDs) are among the most common health problems in developing countries, including Pakistan, where limited access to modern healthcare encourages the use of traditional medicinal practices. This study aimed to systematically document ethnomedicinal plants used for the treatment of GIDs in District Bajaur, Khyber Pakhtunkhwa, Pakistan and to evaluate the phytochemical screening of selected plant species. Ethnobotanical data were collected from 140 informants through semi-structured interviews, group discussions and field surveys. Quantitative ethnobotanical indices including Use Value (UV), Relative Frequency of Citation (RFC) and Fidelity Level (FL) were calculated to determine the cultural significance and reliability of reported medicinal plants. A total of 56 medicinal plant species belonging to 38 families were documented. Leaves were the most frequently used plant part (41%), followed by fruits (28%), while decoction (45%) and powder (32%) were the dominant methods of preparation and administration. Phytochemical screening of selected species revealed the presence of major bioactive compounds including alkaloids, flavonoids, tannins, saponins, glycosides and terpenoids which are known for their therapeutic properties. The highest UV values were recorded for *Mentha longifolia* (0.84) and *Foeniculum vulgare* (0.85), indicating strong traditional preference and medicinal importance. The study statistically validates indigenous knowledge regarding gastrointestinal disease management and emphasizes conservation of medicinal flora. Further pharmacological, clinical, and toxicological investigations are recommended to develop safe and effective plant-based anti-gastrointestinal therapies.

INTRODUCTION

Medicinal plants have been used for centuries across diverse traditional medical systems for the prevention and treatment of human diseases. These plants are rich in bioactive compounds,

commonly referred to as phytochemicals which possess demonstrated therapeutic properties and have inspired the development of many modern drugs (Cheng *et al.*, 2022; Saadonyet *et al.*, 2023). In

developing countries, particularly in rural communities medicinal plants remain an affordable and accessible source of healthcare due to limited access to conventional medical facilities. In Pakistan, a substantial proportion of the population relies on herbal remedies and traditional systems such as Unani medicine (Mahmood *et al.*, 2018; Shah *et al.*, 2025a). The documentation and scientific validation of indigenous knowledge are therefore essential not only for preserving cultural heritage but also for promoting sustainable utilization of plant resources and fostering local economic development (Ahmadi *et al.*, 2022). Ethnobotanical research plays a crucial role in bridging traditional knowledge with modern scientific approaches and facilitating the discovery of novel bioactive compounds (Hu *et al.*, 2022).

Gastrointestinal diseases (GDs) represent one of the most prevalent global health concerns, significantly affecting quality of life and imposing substantial healthcare burdens (Wolfe *et al.*, 2023). Disorders such as irritable bowel syndrome (IBS) and functional dyspepsia (FD) are widely reported and are now categorized under functional gastrointestinal disorders. In Pakistan, the incidence of gastrointestinal disorders is exacerbated by poor sanitation, unsafe food and water and limited healthcare access (Khoja *et al.*, 2022). Although pharmaceutical agents such as proton pump inhibitors and anti-inflammatory drugs are widely used, they may be associated with side effects and economic burden. Consequently, many communities continue to rely on medicinal plants to manage digestive ailments. Various plant species, including *Zingiber officinale*, *Curcuma longa*, *Mentha piperita*, *Glycyrrhiza glabra* and *Aloe barbadensis*, have traditionally been used to alleviate gastrointestinal symptoms due to their anti-inflammatory, antioxidant, antimicrobial and gastroprotective properties (Nankaya *et al.*, 2021; Manik *et al.*, 2023). However, many of these traditional claims require systematic scientific validation.

Phytochemical screening is a fundamental step in evaluating the medicinal potential of plants. This process involves the identification and qualitative or quantitative analysis of secondary metabolites such as flavonoids, alkaloids, tannins, terpenoids, glycosides and phenolic compounds (Novitasari *et al.*, 2023). These bioactive constituents are responsible for diverse biological activities, including antimicrobial, anti-ulcer, anti-inflammatory and antioxidant effects (Davidescu *et al.*, 2022). Through phytochemical study, researchers can identify promising compounds that may serve as precursors for innovative therapeutic agents. Nevertheless, the absence of standardized protocols may lead to inconsistencies in results, emphasizing the need for methodological uniformity and cautious interpretation of findings (Mustarichie, 2017; Zakaria *et al.*, 2008). Given the rich biodiversity and long-standing ethnomedicinal traditions in District Bajaur, systematic documentation and phytochemical evaluation of medicinal plants used for gastrointestinal disorders are highly warranted. Scientific validation of these plants can contribute to the development of safe, effective and culturally acceptable treatments while preserving indigenous knowledge. Therefore, the present study aims to document traditional medicinal plants used for gastrointestinal problems and to screen selected species for their phytochemical constituents, thereby providing a foundation for future pharmacological and clinical investigations.

MATERIALS AND METHODS

Study Area

The study was conducted in District Bajaur, Khyber Pakhtunkhwa, Pakistan, a mountainous region characterized by diverse flora and a strong tradition of ethnomedicinal practices. District Bajaur has a total area of 1290 km². The district shares a 52-kilometer border with Afghanistan, which is very important to Pakistan. The area of the study is situated between latitudes 34° 30' and 34° 58' and longitudes 71° 11' and 71° 30' at an elevation of 1126 metres above sea level (Shah *et al.*, 2025b; Shah *et al.*, 2026). The area comprises remote rural communities where

traditional herbal medicine is commonly used for the treatment of gastrointestinal disorders.

gastrointestinal ailments.

Research Design

A quantitative research design was adopted to document ethnobotanical knowledge and to evaluate the phytochemical constituents of selected medicinal plants. The study involved systematic collection of numerical ethnobotanical data through structured surveys and interviews, followed by laboratory-based qualitative phytochemical screening. Statistical tools were applied to analyze ethnobotanical indices, allowing objective assessment of the relative importance of plant species used against

Demographic Characteristics of Respondents

Demographic analysis showed that respondents ranged from 17 to 90 years of age, with relatively even distribution across age groups. The majority of respondents were male (96.4%), while females constituted 3.6% of the sample. Occupationally, farmers represented the largest group (35%), followed by shopkeepers (22.1%) and teachers (10%). Educational analysis revealed that 25% of respondents had no formal education, and 17.9% had completed middle-level education, reflecting limited educational opportunities in the region (Table: 1).

Table 1. Demographic Characteristics of Respondents (N = 140)

Variable	Category	n	%
Gender	Male	135	96.4
	Female	5	3.6
Occupation	Farmers	49	35.0
	Shopkeepers	31	22.1
	Teachers	14	10.0
	Others	46	32.9
Education Level	Illiterate	35	25.0
	Primary	28	20.0
	Middle	25	17.9
	Secondary & Above	52	37.1

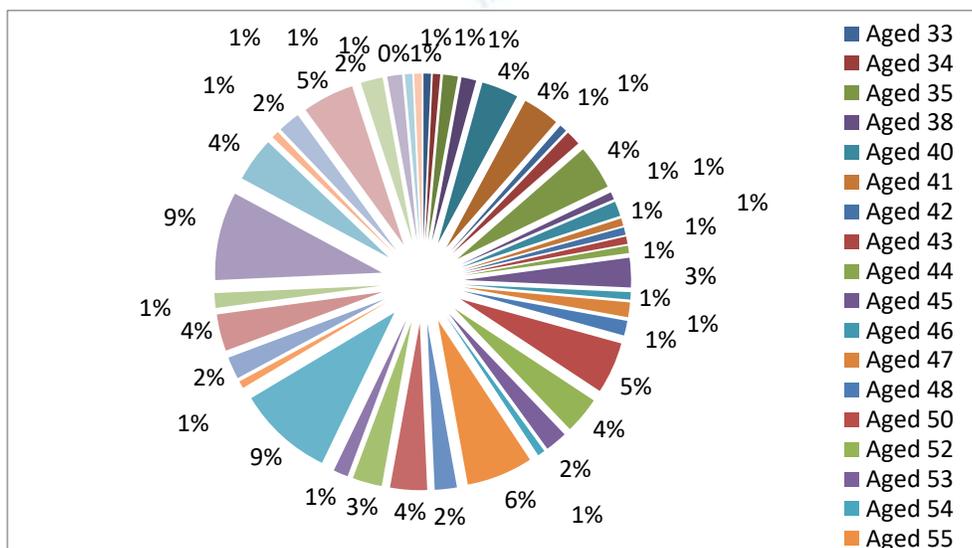


Fig. 1: Contributions Based on Age Groups

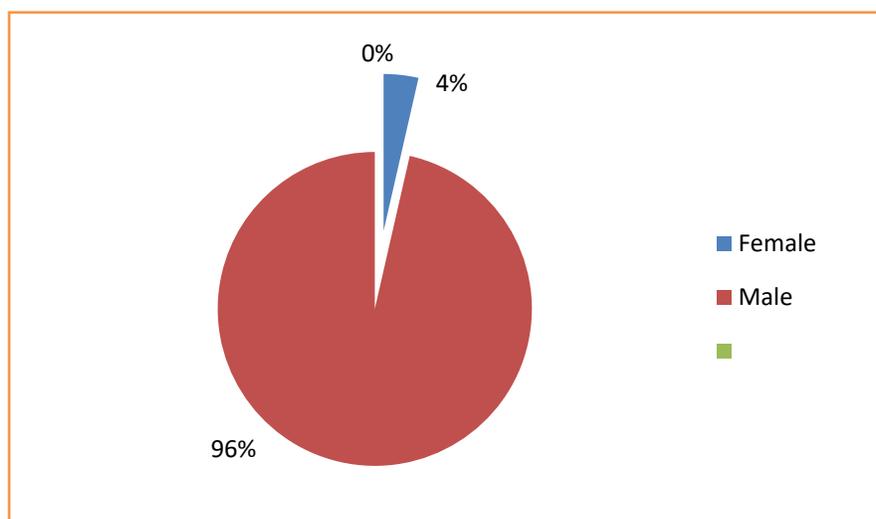


Fig. 2: Contributions Based on Gender

Ethnobotanical Survey and Data Collection

A field survey was conducted to document traditional knowledge related to medicinal plants used for gastrointestinal disorders (GIDs). Ethnobotanical information was gathered through open-ended, semi-structured and key informant interviews as well as group discussions and participatory observations. Informants included herbalists, elderly community members and local residents of different age groups. Information collected included local plant names, plant parts used, preparation methods, modes of administration, therapeutic uses and distribution. Verbal consent was obtained from respondents prior to interviews and data were carefully recorded and cross-verified to ensure reliability.

Plant Collection and Identification

Plant specimens reported during the survey were collected from their natural habitats. The collected samples included leaves, stems, roots, bark, fruits and other medicinally used parts. Each specimen was properly labeled with its local name, scientific name, collection site, date, and habitat description. Taxonomic identification was carried out by a qualified plant taxonomist using standard floristic literature and herbarium comparison techniques. Voucher specimens were

assigned accession numbers and deposited in the Herbarium of Qurtuba University of Science and Technology, Peshawar, for future reference and verification.

Data Analysis

Ethnobotanical data were quantitatively analyzed using established indices to determine the cultural significance and medicinal importance of recorded species.

Use Value (UV)

Use Value was calculated to determine the relative importance of each plant species using the formula:

$$UV = \Sigma U/n$$

Where U represents the number of use reports cited by informants for a given species and n is the total number of respondents interviewed.

Relative Frequency of Citation (RFC)

The local significance of each species was assessed using:

$$RFC = FC/N$$

Where FC is the number of informants mentioning a species and N is the total number of informants participating in the survey. RFC values range between 0 and 1.

Fidelity level (FL)

The Fidelity Level (FL) indicates the percentage of informants who use a particular plant species for the same main purpose. It is calculated as:

$$FL\% = Np/N \times 100$$

Where Np is the number of informants who reported the plant for the same major ailment and N is the total number of informants who mentioned the plant for any ailment.

Phytochemical Screening

Selected medicinal plants were subjected to qualitative phytochemical screening to detect the presence of bioactive constituents. Plant materials were air-dried, powdered and extracted using appropriate solvents. Standard procedures were followed for chemical tests.

Test for Alkaloids

Crude extracts were treated with Dragendorff's reagent. The appearance of pink, reddish, or brown precipitates indicated the presence of alkaloids.

Test for Flavonoids

One milliliter of extract was mixed with neutral ferric chloride solution. Development of a brown coloration indicated the presence of flavonoids.

Test for Saponins

Approximately 0.5 g of plant extract was boiled in distilled water, cooled and vigorously shaken. Formation of stable froth indicated saponins.

Test for Glycosides

Extracts were treated with glacial acetic acid, ferric chloride solution and concentrated sulfuric acid. A brown ring formation indicated the presence of cardiac glycosides.

Test for Tannins

Boiled and filtered extracts were treated with ferric chloride solution. Brownish-green or blue-black coloration confirmed tannins.

Test for Steroids

Ethanollic extracts were mixed with acetic anhydride and concentrated sulfuric acid. A color change from violet to blue or green indicated steroids.

Test for Reducing Sugars (Fehling's Test)

Fehling's solutions A and B were added to the extract and heated. A brick-red precipitate indicated reducing sugars.

Test for Proteins (Millon's Test)

Millon's reagent was added to the extract. Formation of a white precipitate turning red upon heating confirmed proteins.

Test for Triterpenoids and Phytosterols

Extracts were treated with chloroform and concentrated sulfuric acid. Yellow coloration indicated phytosterols, while red coloration at the base of the test tube confirmed triterpenoids

RESULTS AND DISCUSSION**Medicinal plants diversity**

The ethnobotanical survey conducted in District Bajaur documented a total of 52 medicinal plant species belonging to 42 families used for the treatment of gastrointestinal disorders (GDs). The area is characterized by rich biodiversity and strong indigenous knowledge systems. Data were collected from 140 respondents through interviews, group discussions, and participatory observations. The findings revealed that local communities possess extensive knowledge regarding plant identification, preparation methods and therapeutic applications for digestive ailments such as diarrhea, dysentery, constipation, gastric ulcers, stomachache, vomiting, cholera and abdominal pain.

Table 2: Botanical name, ethnobotanical uses and quantitative ethnobotanical indices of plants in District Bajaur.

Botanical name	Local Name	Family name	Disease	Part used	Usage	FC	RFC	UR	UV
<i>Zingiber officinale</i> Roscoe	Adrak	Zingiberaceae	Gastric	Roots	Chewing	90	0.64	62	0.69
<i>Diospyrus kaki</i> L.f.	Amlok	Ebeanaceae	Diarrhea	Fruits	Direct	65	0.46	30	0.46
<i>Ficus carica</i> L.	Anzar	Moraceae	Ulcer	Fruits	Dried	72	0.51	42	0.58
<i>Ricinus communis</i> L.	Aranda	Euphorbiaceae	Constipation	Seed	Oil	109	0.78	80	0.73
<i>Fragaria vesca</i> L.	Balmangai	Rosaceae	Constipation	Leave	Crushing	45	0.32	23	0.51
<i>Polygonum aviculare</i> L.	Bandakai	Polygonaceae	Dysentery	Whole plant	Crushing	62	0.44	45	0.73
<i>Periploca aphylla</i> Decne.	Bararra	Apocynaceae	Constipation	Latax	Chewing	77	0.55	39	0.50
<i>Datura stramonium</i> L.	Batora	Solanaceae	Ulcer	Leaves	Crushing	85	0.61	64	0.75
<i>Lathyrus aphaca</i> L.	Chelwog	Fabaceae	Diarrhea	Leaves	Chewing	107	0.76	83	0.78
<i>Chenopodium album</i> L.	Chalwai	Amaranthaceae	Laxative	Leaves	Boiling	45	0.32	29	0.64
<i>Rheum australe</i> D.Don	Chutyal	Polygonaceae	Constipation	Roots	Chewing	43	0.31	20	0.47
<i>Mentha longifolia</i> (L.) L.	Enaley	Lamiaceae	Dysentery	Leaves	Dried Powder	83	0.59	70	0.84
<i>Fumaria indica</i> (Hauskn.) Pugsley	Genger	Papaveraceae	Diarrhea	Whole plant	Decoction	89	0.63	72	0.81
<i>Juglans regia</i> L.	Ghoz	Juglandaceae	Antihelmintic	Leaves	Chewing	86	0.61	45	0.52
<i>Vitis Jacquemontii</i> R.Parker	Kowar	Vitaceae	Cholera	Leaves	Juice extract	101	0.72	76	0.75
<i>Solanum americanum</i> Mill.	Kachmaacho	Solanaceae	Gastric ulcer	Fruits	Decoction	34	0.24	18	0.53
<i>Carthamus oxyacantha</i> M.Bieb	Kareza	Asteraceae	Stomachache	Seed oil	Boiling	41	0.29	19	0.46
<i>Berberis lyceum</i> Royle	Kwaray	Berberidaceae	Dysentery	Whole plant	Powder	69	0.49	41	0.59
<i>Foeniculum vulgare</i> Mill.	Kagelanay	Apiaceae	Diarrhea/ Vomating	Leaves/fruit	Decoction	102	0.72	85	0.83
<i>Rubus fruticosus</i> L.	Karwarra	Rosaceae	Diarrhea	Leaves	Crushing	79	0.56	57	0.72
<i>Berberis vulgaris</i> L.	Kawary	Berberidaceae	Stomach ulcer	Roots	Crushing	77	0.55	59	0.76
<i>Isodon rugosus</i> (Wall.ex Benth.) Codd	Krachay	Lamiaceae	Vomiting	Leaves	Decoction	84	0.60	65	0.77
<i>Musa acuminata</i> Colla	Kilaa	Musaceae	Diarrhea	Fruits	Direct	79	0.56	57	0.72
<i>Ocimum basilicum</i> L.	Kashmalay	Lamiaceae	Laxative	Seed	Crushing	64	0.46	49	0.76
<i>Eucalyptus camaldulensis</i> Dehnh.	Lachi	Myrtaceae	Diarrhea	Leaves	Powder	37	0.26	19	0.51
<i>Vincetoxicum arnottianum</i>	Laram booty	Apocynaceae	Diarrhea	Leaves	Extract	71	0.51	42	0.59

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<i>Paeonia emodi</i> Wall. ex Royle	Mamakh	Paeoniaceae	Used as a purgative	Roots	Boiling	89	0.63	67	0.75
<i>Euphorbia helioscopia</i> L.	Mandaro	Euphorbiaceae	Laxative	Stems	Crushing	44	0.31	23	0.52
<i>Myrtus communis</i> L.	Manro	Myrtaceae	Diarrhea	Leaves	Decocotion	92	0.65	70	0.76
<i>Vitex negundo</i> L.	Marwandai	Lamiaceae	Diarrhea	Leaves	Leaf extract	99	0.71	81	0.82
<i>Solanum surattense</i> Burm.f.	Maraghonay	Solanaceae	Constipation	Whole plant	Boiling	44	0.31	23	0.52
<i>Pinus roxburghii</i> Sarg.	Nakhtar	Pinaceae	Diarrhea	Gum	Chewing	85	0.61	68	0.80
<i>Citrus limon</i> (L.) Osbeck	Nembo	Rutaceae	Vomiting	Fruits	Boiling	42	0.30	21	0.50
<i>Phoenix dactylifera</i> L.	Qajora	Arecaceae	Constipation	Fruits	Direct	76	0.54	54	0.71
<i>Chenopodium murale</i> L.	Sarmay	Amaranthaceae	Laxative	Whole plant	Powder	44	0.31	22	0.50
<i>Rumex dentatus</i> L.	Shalkhay	Polygonaceae	Diarrhea,	Whole plant	Decocotion	64	0.45	46	0.72
<i>Melia azedarach</i> L.	Shandai	Meliaceae	Abdomen	Leaves	Powder	99	0.71	80	0.81
<i>Trifolium repens</i> L.	Shawtal	Fabaceae	Stomach Problem	Leaves	Boiling	63	0.45	32	0.51
<i>Taraxacum officinale</i> F.H.Wigg.	Shodafai	Asteraceae	Constipation	Leaves	Decoction	59	0.42	40	0.68
<i>Gymnosporia senegalensis</i> (Lam.) Loes.	Soorazgy	Celastraceae	Stomach Problem	Roots	Crushing	61	0.43	32	0.52
<i>Carum copticum</i> L.	Sperkai	Apiaceae	Gastric problem	Leaves	Chewing	35	0.25	18	0.51
<i>Morus alba</i> L.	Spen toot	Moraceae	Laxative	Fruits	Direct	39	0.28	17	0.43
<i>Nasturtium officinale</i> R.Br.	Tarmera	Brassicaceae	Stomach ache	Leaves	Boiling	37	0.26	21	0.57
<i>Rumex hastatus</i> D.Don	Tarooky	Polygonaceae	Enhance digestion	Whole plant	Crushing	43	0.31	20	0.46
<i>Diospyros lotus</i> L.	Tooramlook	Ebenaceae	Dysentery/carminative	Leaves	Powder	55	0.39	24	0.43
<i>Morus nigra</i> L.	Tooth	Moraceae	Laxative	Fruits	Direct	67	0.48	37	0.55
<i>Melia dubia</i> L.	Torashandy	Meliaceae	Digestive	Leaves	Crushing	56	0.40	39	0.70
<i>Oxalis corniculata</i> L.	Trewakay	Oxalidaceae	Anti-acid for digestive	Leaves	Chewing	80	0.57	43	0.53
<i>Rumex dentatus</i> L.	Shalkhy	Polygonaceae	Gastric ulcer	Leaves	Decoction	78	0.56	42	0.54
<i>Bupleurum neesii</i> DC.	Tura panra	Apiaceae	Stomach Ulcer	Whole plant	Decoction	56	0.40	35	0.62
<i>Vitis vinifera</i> L.	Angoor	Vitaceae	Laxative	Fruits	Chewing	49	0.35	32	0.65
<i>Ranunculus muricatus</i> L.	Zeyrgulay	Ranunculaceae	Laxative and Diarrhea	Whole plant	Crushing	82	0.59	60	0.73

Plant Parts Used in Gastrointestinal Treatments
 Analysis of plant parts used indicated that leaves were the most frequently utilized part (41.4%), followed by fruits (27.9%), bark (13.6%), whole plant (5.7%) and roots (4.3%). Minor usage was

reported for flowers, gum, latex, seeds and stems. The dominance of leaves and fruits suggests ease of availability, sustainable harvesting practices and high concentration of bioactive compounds in these parts.

Table. 3: A Comprehensive Examination of Frequency and Percentage Data

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Bark	19	13.6	13.6	13.6
	Flower	2	1.4	1.4	15.0
	Fruits	39	27.9	27.9	42.9
	Gum	1	0.7	0.7	43.6
	Latex	1	0.7	0.7	44.3
	Leaves	58	41.4	41.4	85.7
	Roots	6	4.3	4.3	90.0
	Seed	1	0.7	0.7	90.7
	Seed	1	0.7	0.7	91.4
	Stem	2	1.4	1.4	92.9
	Stems	2	1.4	1.4	94.3
	Whole plant	8	5.7	5.7	100.0
	Total	140	100.0	100.0	

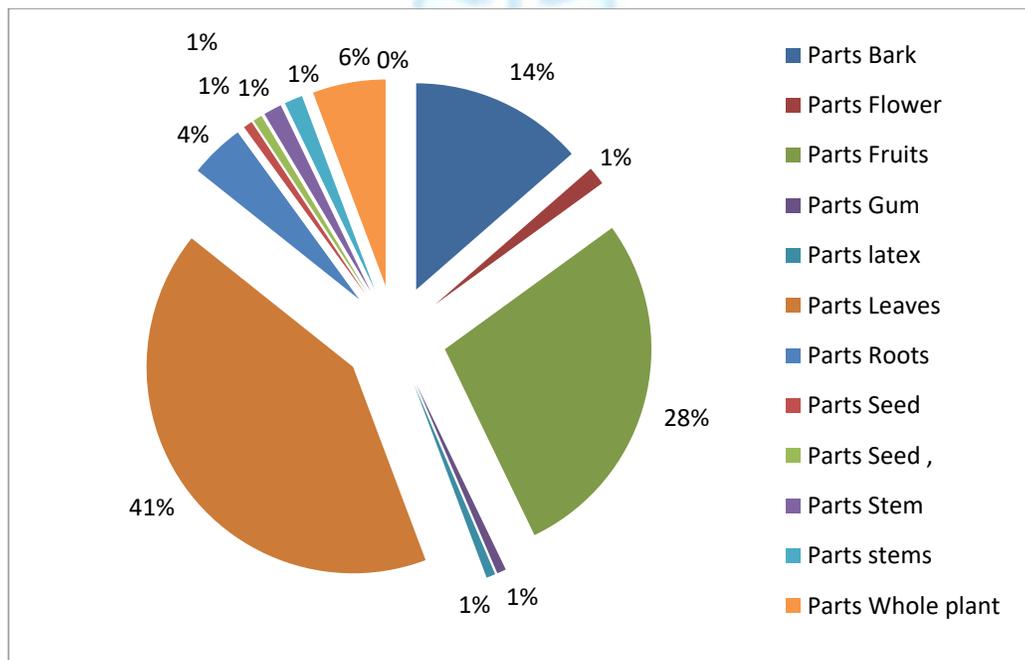


Fig. 3: Plant Parts Used in Gastrointestinal Treatments

Methods of Plant Administration

Regarding preparation methods, crushing (28.6%) and powder form (27.1%) were the most common techniques, followed by direct consumption (16.4%), chewing (11.4%), boiling

(7.1%) and decoction (5%). Other minor methods included mixing with black tea, oil application, and paste formation. These findings indicate a preference for simple, locally adaptable

preparation techniques requiring minimal equipment.

Table. 4: Methods of Plant Administration

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	With Black Tea	2	1.4	1.4	1.4
	Boiling in water	10	7.1	7.1	8.6
	Carminative	1	0.7	0.7	9.3
	Chewing on Teeth	16	11.4	11.4	20.7
	Crushing in pestle & mortar	40	28.6	28.6	49.3
	Decoction in water	7	5	5	65
	Direct eating	23	16.4	16.4	70.7
	Dried	1	0.7	0.7	71.4
	Oil massage	1	0.7	0.7	72.1
	Past	1	0.7	0.7	72.9
	Powder	38	27.1	27.1	100.0
	Total	140	100.0	100.0	

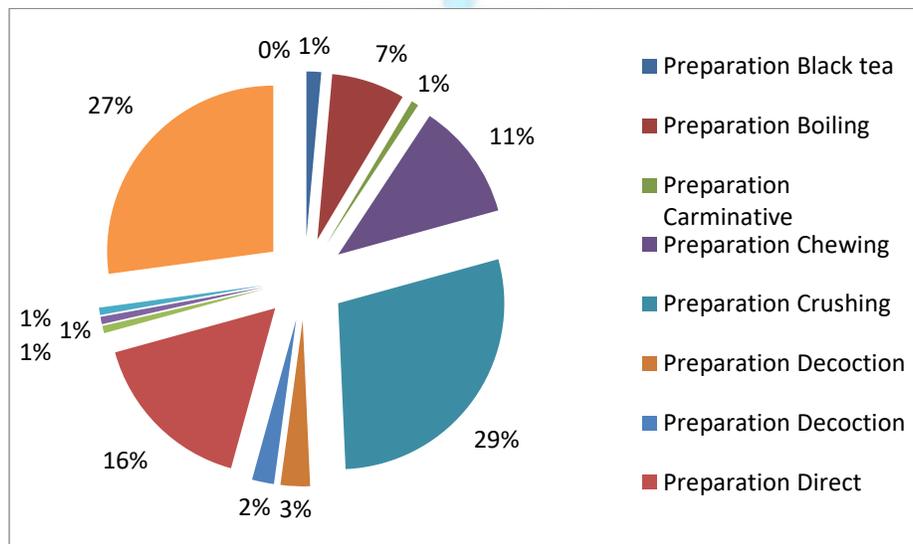


Fig. 4: Administration Methods of Medicinal Plants

Phytochemical Screening

Phytochemical screening of selected medicinal plants revealed the presence of important bioactive compounds. Species such as *Cichorium intybus* showed the presence of tannins; *Calendula officinalis* contained alkaloids; *Euphorbia helioscopia* tested positive for saponins; *Artemisia vulgaris* showed cardiac glycosides; *Dalbergia sissoo*

contained flavonoids; *Cassia fistula* showed terpenoids; and *Allium cepa* tested positive for proteins. The results indicated that phytochemical composition varied depending on the solvent (methanol or ethanol) used for extraction, highlighting the importance of solvent selection in phytochemical investigations.

Table. 5: Phytochemical Screening of Selected Species.

Plant Name	Plant Test	Methonal	Ethanol
<i>Cichorium intybus</i>	Tannins	+	+
<i>Calendula officinalis</i>	Alkaloids	+	-
<i>Euphorbia helioscopia</i>	Saponins	+	+
<i>Artemisia vulgaris</i>	Cardiac glycosides	-	+
<i>Derbergia sissoo</i>	Flavonodis	+	-
<i>Cassia fistula</i>	Tempendoids	+	+
<i>Allium cepa</i>	Proteins	+	+
<i>Allium sativa</i>	Phenol	+	-



Phytochemical screening revealed the presence of important bioactive compounds, supporting the traditional use of these species in gastrointestinal treatments.

The study confirms strong community reliance on medicinal plants for gastrointestinal disorders. The dominance of leaves and fruits suggests sustainable harvesting practices and high bioactive compound concentration. Simple preparation methods such as crushing and powdering reflect practical indigenous knowledge systems.

Phytochemical screening validated the presence of secondary metabolites like alkaloids, flavonoids, tannins, saponins, glycosides, and terpenoids, which are known for antimicrobial and anti-inflammatory properties. These findings scientifically support traditional therapeutic claims and highlight the potential for further pharmacological investigation.

CONCLUSION

The present study provides a comprehensive ethnobotanical and phytochemical evaluation of medicinal plants used for the treatment of gastrointestinal disorders (GDs) in District Bajaur, Pakistan, highlighting the richness of indigenous knowledge and the continued dependence of local communities on traditional herbal remedies for primary healthcare. The findings identify an important gap in the scientific validation of these medicinal plants, emphasizing the need for further pharmacological and clinical investigations to confirm their efficacy, safety and proper dosage. Phytochemical screening revealed the presence of significant bioactive compounds that support traditional therapeutic claims and indicate strong potential for future drug development. The study also underscores the importance of conserving medicinal plant biodiversity and preserving traditional knowledge systems in the face of modernization and environmental pressures. Overall, integrating ethnobotanical documentation with scientific research can contribute substantially to sustainable resource management, improved community health and

the development of safe, effective and affordable plant-based medicines in the region and beyond.

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