An Updated List of Neuromedicial Plants of Pakistan, Their Uses, and Phytochemistry

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Background. Almost every region of Pakistan is stacked with a large number of medicinal plants. Due to high cost and unavailability ofallopathic medicines for the neurological diseases, especially in rural areas, traditional healers prescribe phytotherapy for various neurological diseases like epilepsy, depression, anxiety, insomnia, Alzheimer, and migraine. Such treatments are considered to be most effective by the native people.

Methods. The data was collected from articles published on medicinal plants of various districts of Pakistan, using article search engines like Medline, Pubmed, Web of Science, Science Direct, and Google Scholar. Also, information regarding various neurological uses and mode of applications of medicinal plants was obtained from traditional healers, folk medicine users, and local elderly people having knowledge of medicinal plants.

Results. A total of 54 families were found to be used in various neurological diseases, of which the highest use was of Solanaceae (22.22%), Asteraceae (12.96%), Lamiaceae, Papaveraceae, and Poaceae, 9% each, and Caprifoliaceae, Cucurbitaceae, Rhamnaceae, and Rosaceae, 5.5% each. According to districts, 15% of plants that were effective in neurological affections were found in Bahawalpur, 11% in Swat, 8% in Muzaffarabad, 7% in Malakand, and 6% in Bahawalnagar, Dir, Gilgit, and Sarghoda each, with 5% in Dera ghazi khan and Jhelum each. According to the plant’s habit, out of total of 103 plants, 61.15% were found to be herbs, 22.33% trees, 11.65% shrubs, and 4.85% climbers. According to the part used of plant, whole plant, leaves, fruits, roots, seeds, and flowers were found to be used 32.03%, 24.27%, 20.38%, 16.50%, 13.59%, and 11.65%, respectively. According to disease’s types, 45.63% were found to be effective in insomnia, 31.06% in epilepsy, 12.62% in depression, 6.80% in anxiety, 77.7% in hysteria, and 5.88% in migraine.

Conclusion. Taking into consideration this useful knowledge on medicinal properties of the plants for curing neurologic diseases, it is believed that research in areas of ethnomedicine and ethnopharmacology can bring auspicious results that have potential of adding value to the very rich natural resources of Pakistan. This study will help all the researchers from diverse backgrounds working on plants based medicine for neurological diseases.

1. Introduction

Globally, neurological diseases are among the major contributors to mortality and morbidity, particularly in developing nations. The well-known manifestations of neurological diseases include mood swing, restlessness, hopelessness, poor coordination, seizures, impaired cognition, paralysis, distress of sensation, muscle weakness, pain, and confusion [1]. There are more than six hundred neurological diseases, some of which are relatively common and well known while others are rare or poorly recognized [2]. Demographic, socioeconomic, and geographic conditions are the major factors affecting epidemiology of neurological diseases. Globally, the overall burden of neurological diseases is about 6.5%. In lower income countries, neurological diseases range from 4 to 5%, as compared to high income countries where such diseases...
and maintain complete data of their patients [1]. Public health systems and health-related facilities that provide in advanced countries may be due to their more advanced range from 10 to 11%. This high ratio of neurological diseases in advanced countries may be due to their more advanced public health system and health-related facilities that provide and maintain complete data of their patients [1].

About 45 million people of the world, above 18 years of age, suffer from schizophrenia at some stage of their lives, 340 million are affected by depression, and both these diseases are accountable for 60% of all suicides, while Alzheimer and epilepsy affect about 11 and 45 million people, respectively, around the world accounting for 1% of the total disease burden in the world [3].

In Pakistan, about 10% people suffer from mental diseases, representing a foggy picture with 2% prevalence of epilepsy, 5% depression, 1% Alzheimer, and 1.5% schizophrenia [4] as shown in (Table 1). These mental morbidities are responsible for high suicidal rate. Major factors contributing to this alarming increase in mental diseases are unemployment, poverty, political unreliability, violence, and other social horrors and evils beyond the genetic and biological susceptibility [5].

Medicinal plants have been used from the very beginning in health care systems. Studies have been carried out globally to verify their efficacy and some of the findings have led to the production of plant-based medicines. Due to limited access to modern medicine, the local population uses medicinal plants to treat most diseases [6, 7]. Recent focus on plant research has increased worldwide and most evidence has been collected to determine the immense potential of medicinal plants [8]. Medical plants have therapeutic benefits and fewer side effects in comparison with synthetic drugs [9]. Drugs used for neurological diseases along with their side effects are given in (Table 2).

Herbs may provide a source of new compounds including many drugs that are derived from plant sources. For several neurological diseases, modern medicine offers symptomatic treatment that is often expensive and associated with side effects. Indian system of medicine has traditionally been used in several neurological conditions. The accessibility, cost effectiveness, and lower incidence of side effects of plant products offer considerable advantages [10].

Various plant extracts have been screened and investigated for their potential neuropharmacological activities in different experimental models of animals comprising mice and rats. Herbal extracts and natural products including Bacopa monnieri, Cannabis sativa, Solanum nigrum, Withania somnifera, Papaver somniferum, Zizyphus jujube, Tribulus terrestris, and Verbena officinalis showed different neuropharmacological activities. These agents can be used alone or as adjuncts to standard drugs, used for various neurological diseases like depression, epilepsy, schizophrenia, Alzheimer, Parkinson, hysteria, melancholia, and dementia, for increasing their efficacy and decreasing side effects.

In developing countries, plant-based medicines are being used by 75-80% of population [11]. The knowledge of indigenous medicinal plants is a part of Pakistan culture and traditionally, majority of Pakistani people use herbal medicines for various diseases [12].

In Pakistan, folk medicines have more use in rural and less developed areas for the treatment of various diseases because of easy access, cost effectiveness, less side effects, and unavailability of allopathic therapeutic agents [13]. This type of treatment, using traditional medicinal flora, is practiced regularly in homes and transferred from generation to generation as a cultural virtue. However, this tradition and associated knowledge are diminishing rapidly due to negligence and less interest of new generation to receive this gift of ethnomedicinal prosperity from their ancestors. Various parameters like industrialization, migration from rural to urban areas for education and jobs, passion towards advanced lifestyles, deforestation, and allopathic medicine might have brought this change in behavior. Therefore, before it is lost forever, this valuable traditional knowledge needs to be urgently collected and systematically documented for the interest of humanity [14].

2. Materials and Methods

First the articles published on the medicinal plants of various districts of Pakistan were searched in online research database, i.e., Medline, PubMed, Web of Science, Science
| Drug Class | Subclasses | Drugs | Side effects | References |
|------------|------------|-------|--------------|------------|
| **Antidepressants** | TCA | Imipramine, Amitriptyline, Desipramine, Nortriptyline, Doxepin | weight gain, sedation, dry mouth, nausea, blurred vision, constipation, tachycardia, dry mouth, constipation, hypotension, increased heart rate | [92] |
| | MAOI | Isocarboxazid, Phenelzine, Tranylcypromine, Selegiline | weight gain, fatigue, sexual dysfunction, nausea, hypotension, dry mouth, diarrhea or constipation, headache, drowsiness, insomnia, headache, sedation, dizziness, nervousness, somnolence, extrapyramidal effects, nausea, dry mouth, diarrhea, agitation, insomnia, sexual dysfunction, weight gain | [93] |
| | SSRI | Fluoxetine, Paroxetine, Fluvoxamine, Sertraline, Citalopram | nausea, insomnia, dry mouth, headache, increased blood pressure, sexual dysfunction, weight gain, urinary retention, hyponatremia, tremors, vertigo, tachycardia, shock-like sensations, paresthesia, myalgia, tinnitus, neuralgia, ataxia | [92, 94] |
| | SNRI | Venlafaxine, Duloxetine, Desvenlafaxine, Levomilnacipran | nausea, insomnia, weight gain, urinary retention, hyponatremia, tremors, vertigo, tachycardia, shock-like sensations, paresthesia, myalgia, tinnitus, neuralgia, ataxia | [92, 94] |
| | Atypical | Bupropion, Mirtazapine, Trazodone, Vilazodone | headache, agitation, insomnia, sweating, sedation, increased appetite, weight gain, nausea, dizziness | [92] |
| **Anxiolytics** | BZDs | Alprazolam, Clonazepam, Lorazepam, Mida zolam, Diazepam | sedation, memory disturbances, tolerance, fatigue, dependence, drowsiness, lethargy, At higher dosages, impaired motor coordination, dizziness, vertigo, slurred speech, blurry vision, mood swings, euphoria | [95] |
| | Azapirones | Buspirone, Binospirone, Gepirone, Tandospirone | dizziness, drowsiness, headaches, restlessness, nausea, diarrhea | [96] |
| | BAR | Phenobarbital, Amobarbital, Secobarbital, Butabarbital, Pentobarbital | dizziness, drowsiness, headaches, restlessness, nausea, diarrhea | [97] |
| **Anti-Alzheimer** | AChEIs | Donepezil, Rivastigmine, Galantamine | vomiting, diarrhea, weight loss, bradycardia, insomnia, nausea, agitation, syncope | [98] |
| | Anti-β | Bapineuzumab, Solanezumab, Gantenerumab | microhemorrhage, vasogenic edema, arrhythmia, skin and subcutaneous tissue disorders | [99] |
| | NMDAR Antagonists | Memantine | psychosis, nausea, vomiting, memory impairment, and neuronal cell death, drowsiness | [99] |
| **Anti-Parkinson** | DA | Bromocriptine, Pergolide, Cabergoline, Pramipexole | nausea, hypotension, confusion, delirium, pulmonary fibrosis, vasospasm, erythro malalgia, sleep attacks | [100] |
| | COMT Inhibitors | Entacapone, Tolcapone | dyskinesia, nausea, confusion, urine discoloration, diarrhea, abdominal pain | [100] |
| | MAO-B | Selegline | confusion, delirium, hallucinations, unusual thoughts or behavior, dizziness, nausea, insomnia, trouble breathing | [99] |
| **Antiepileptic** | Sodium Channel Blockers | Phenytoin, Carbamazepine, Lamotrigin e, Lacosamide, Oxcarbazepine, Gabapentin, Lamotrigine | dizziness, drowsiness, diplopia, nausea, vomiting, fatigue, ataxia, neurotoxicity, cardiac arrhythmias, hirsutism, hepatotoxicity, steven-johnson syndrome | [101] |
| | Calcium Channel Blockers | Ethosuximide, Zonisamide, Valproate, Trimethadione | nausea, vomiting, headache, mental status changes, neuropathy, change in weight | [102] |
| | GABA transaminase Inhibitors | Vigabatrin, L-Cycloserine, Ethanolamine-O-Sulfate, Valproate | drowsiness, nystagmus, hyperexcitability, insomnia, fever, memory impairment, depression, confusion, agitation, asthma, laryngitis, weight gain, vomiting | [103] |

TCA: tricyclic antidepressant; MAOI: monoamine oxidase inhibitor; SSRI: selective serotonin reuptake inhibitor; SNRI: serotonin norepinephrine reuptake inhibitor; BZDs: benzodiazepines; BAR: barbiturates; AChEIs: acetylcholinesterase inhibitors; Aβ: amyloid beta; NMDAR: N-methyl-D-aspartate receptor; DA: dopamine agonists; COMT: catechol-O-methyl transferase; MAO-B: monoamine oxidase B; GABA: gamma-aminobutyric acid.
4 Evidence-Based Complementary and Alternative Medicine

Attock
Azad Jammu & Kashmir
Bahawalnagar
Bahawalpur
Bannu
Battagram
Buner
Dera Ghazi Khan
Dir
Gilgit
Gujrat
Hafizabad
Haripur
Himalaya
Islamabad
Jhelum
Koti
Malakand
Mianwali
Muzaffarabad
Sargodha
Swat
Zairat

Figure 1: District-wise percentage of plants used for neurological diseases.

Direct, and Google Scholar, by using special key words “medicinal plants”, herbal plants, neurological diseases, specific districts names, antialzheimer, antiparkinson, antidepress, sedative, anxiolytic, antiepileptics, epidemiology, and prevalence, from January to March 2018, and downloaded. These entire articles were then viewed and the data of medicinal plants, which have neurological effects, were collected and tabulated in (Table 3). We have personally visited districts Bahawalpur, Bannu, Buner, Dir, Gilgit, Islamabad, Jhelum, Malakand, Mianwali, Rawalpindi, Sargodha, and Swat in April-June 2018 and collected information regarding plants local names, local use, mode of applications, and administration of these plants in neurological diseases from local traditional healers, folk medicine users, and local elderly people of those districts having knowledge of medicinal plants. Information was also collected from distant districts with the help of friends living there via social media (phone calls, text messages, WhatsApp calls and messages, and emails).

3. Results and Discussion

A total of 54 families were found to be useful in various neurological diseases, of which the highest use was of Solanaceae (22.22 %), Asteraceae (12.96 %), Lamiaceae, Papaveraceae, and Poaceae, 9 % each, and Caprifoliaceae, Cucurbitaceae, Rhamnaceae, and Rosaceae, 5.5 % each (Table 3). As per district point of view, 15% plants, effective in neurological affections, were found in Bahawalpur, 11% in Swat, 8 % in Muzaffarabad, 7% in Malakand, and 6% in Bahawalnagar, Dir, Gilgit, and Sargodha each, with 5% in Dera ghazi khan and Jhelum each (Figure 1).

This district-wise plant distribution will help the researchers, who are willing to research in neuropharmacological area, to easily collect the target plants from the regions to which the plants belong. According to the plant’s habit, out of total of 103 plants, 61.15% were found to be herbs, 22.33 % trees, 11.65% shrubs, and 4.85% climbers (Figure 2).

The habit of plants shows that herbs are most important according to neuropharmacological point of view which is another benefit for researchers working in neuropharmacological area to concentrate on herbs more while selecting neurological active plants. According to the part used of plant, whole plant, leaves, fruits, roots, seeds, flowers, and other parts (bulbs, latex, gum, tubers, and rhizome) were found to be used 32.03 %, 24.27 %, 20.38 %, 16.50 %, 13.59 %, 11.65 %, and 15.53 %, respectively (Figure 3). As some plants
have more than one part to be used for various neurological diseases, so such plants were counted into percentage of all respective parts. This division of neuropharmacological plants ensures the researchers to select the most appropriate parts of plants having specific neuropharmacological activities, for their research, as used by traditional healers and folk medicine users.

According to disease’s types, 45.63 % were found to be of therapeutic value in insomnia, epilepsy (31.06%), depression (12.62%), anxiety (6.80%), hysteria (7.77%), and migraine (5.88%) and 20.38% in other neurological diseases (neuralgia, mania, Parkinson, schizophrenia, and nerve pain) (Figure 4). As some plants are used for multiple neurological ailments, so such plants were counted into percentage of all respective diseases. This disease-wise plant division will help the local researchers to select their interest areas in the field of neuropharmacology, by selecting the neurological disease, for which most of the plant’s percentage was found to be used by traditional healers and folk medicine users in various districts of Pakistan.

The pharmacological activities of plants are due to the presence of various phytochemicals mainly alkaloids, flavonoids, tannins, saponins, resins, glycosides, terpenoids, phenols, sterols, essential oils, vitamins, and nutrients. Some of these are effective in the treatment of neurological diseases; some are useful for cardiovascular, respiratory, and gastrointestinal diseases while others have chemotherapeutic and antibacterial effects. Some of the important phytochemicals of the plants (Table 4) including alkaloids (like nicotine and scopoline) are reported to have anxiolytic, antidepressant, and anti-Parkinson activities [15–18], saponins (like bacosides) have been reported for anxiolytic, antiepileptic, anti-Alzheimer, and neuroprotective and memory enhancement activities [19–22], terpenoids (like cannabigerol, tetrahydrocannabinol, and cannabidiol) are reported for their neuroprotective effects [23], flavonoids (like kaempferol, luteolin, quercetin, rutin, and hesperidin) have been reported for their anxiolytic, antidepressant, antiepileptic, anti-Alzheimer, and neuroprotective and memory enhancement activities [24–30], glycosides (like hastatoside and verbena) are reported for sleep promoting activity [31], steroids (like sitoindosides VII–X and withaferin-A) have been reported for anxiolytic activity [32].

_Bacopa monnieri_ plant is reported for anxiety, depressant, epilepsy, and Parkinsonism and contains alkaloids (Brahmin, nicotine, herpestine, and bacosides A & B), saponins (her-saponin and monninerin), flavonoids (luteolin and apigenin), and sterols like b-sitosterol and stigma-sterol. These constituents are already reported for such neuropharmacological properties and so might be responsible for said activities of this plant [33–36].

_Cannabis sativa_ L. has been reported for the treatment of depression, anxiety, convulsion, Alzheimer, dementia, and insomnia and its constituents responsible for these properties are cannabigerol, tetrahydrocannabinol, and cannabidiol [37–41].

_VERBENA OFFICINALIS_ Linn. has been reported as anxiolytic, antidepressant, anticonvulsant, and sedative and its constituents responsible for these activities are verbienin, verbena, hastatoside, kaempferol, luteolin, verbascoside, aucubin, and apigenin [42–44].

_Withania somnifera_ has been shown to have anxiolytic, antidepressant, anticonvulsant, and anti-Parkinson effects, mainly due to the presence of withanolides, sitoindosides VII–X, and withaferin-A [45–48].

These chemical constituents of plants act on the central nervous system through various mechanisms including regulation of neurotransmitters like adrenergic, cholinergergic and serotonergic activity, acting through receptor like GABA and N-methyl-D-aspartate, and ion channels like sodium, potassium, and calcium ion channels. Some of the plant-based drugs and phytochemicals which either are approved or are under clinical trials for the treatment of neurological diseases, mechanism of actions, and their current status in clinical trials are given in (Table 5).

Taking into consideration this useful knowledge on the medicinal properties of plants for curing neurologic diseases, it is believed that the research in the areas of ethnomedicine and ethnopharmacology can bring auspicious results that have potential of adding importance to the very rich natural resources of Pakistan. Various phytochemicals from the above medicinal plants can be further researched under clinical trials and better drugs for treatment of neurological diseases can be obtained with outstanding results and lesser side effects. This study will help all the researchers, especially from Asian countries including Pakistan, China, Iran, India, Sri Lanka, and Bangladesh, working on plants based medicine for neurological diseases.

### 4. Conclusion

The mental illnesses are one of the major problems of the world mainly in communities presenting with poor socioeconomic conditions. In Pakistan and other countries...
Table 3: Traditionally used medicinal plants for the treatment of various neurological diseases.

| S# | Botanical Name       | Local Name | Family      | Habitat | Part Used       | Used for               | Mode of Applications                                      | Location | Reference |
|----|----------------------|------------|-------------|---------|-----------------|------------------------|-----------------------------------------------------------|----------|-----------|
| 1  | Achyranthes aspera   | Ayokanda   | Amaranthaceae | Herb    | Leaves and Shoot | Nerve tonic            | Paste of dried leaves and shoots is applied on head        | Sargodha | [104]     |
| 2  | Ailanthus altissima  | Backyanra  | Simarubacea  | Tree    | Bark            | Hysteria               | Decoction of bark to make tea                             | Malakand | [105]     |
| 3  | Albizia lebbeck      | Sirin      | Mimosaceae   | Tree    | Roots           | Depression, Migraine and Anxiety  | Decoction of root to make tea                             | Mianwali | [106]     |
| 4  | Allium sativum       | Ooga       | Amaryllidaceae | Herb    | Bulbs and Leaves | Hysteria and Epilepsy | Decoction of bulbs and leaves                             | Swat     | [107]     |
| 5  | Ahus nitida          | Geiray     | Betulacea    | Tree    | Flowers         | Insomnia               | Powder of dried flowers mixed with water and used orally   | Dir      | [108]     |
| 6  | Alternanthera sessilis| Waglon     | Amaranthaceae | Herb    | Leaves          | Neuralgia and Sedative | Sniffing of leaves sap                                    | Bahawalpur | [109]    |
| 7  | Anagallis arvensis    | Billy booti| Primulaceae  | Herb    | Whole plant     | Nervine, mania and Epilepsy | Extract of whole plant                                   | Bahawalpur | [109]    |
| 8  | Artemisia scoparia    | Jaukay     | Asteraceae   | Herb    | Roots           | Epilepsy               | Powder of roots taken with water                          | Dir      | [108]     |
| 9  | Asparagus officinalis | Phala-moosa| Asparagaceae | Herb    | Leaves          | Insomnia               | Tea of leaves are used on empty stomach                   | Lahore   | [110]     |
| 10 | Atropa accuminata     | Bargak     | Solanaceae   | Herb    | Leaves          | Insomnia and narcotic | Powder of leaves are taken with water                     | Dir      | [108]     |
| S # | Botanical Name       | Local Name | Family      | Part Used | Used for                        | Mode of Applications                                      | Location       | Reference |
|-----|----------------------|------------|-------------|-----------|---------------------------------|------------------------------------------------------------|----------------|-----------|
| 11  | Avena fatua          | Jodal      | Poaceae     | Herb      | Seeds                           | Depression and nervous exhaustion                         | Dera Ghazi Khan | [111]    |
| 12  | Avena sativa         | Jai        | Poaceae     | Herb      | Seeds                           | Nerve tonic and Insomnia                                  | Islamabad      | [112]    |
| 13  | Bacopa monnieri      | Brahmi sak | Scrophulariaceae | Herb    | Whole plant                     | Epilepsy                                                   | Mianwali       | [106]    |
| 14  | Buglossoides arvensis| Kalu       | Boraginaceae | Herb      | Leaves                         | Infusion of leaves is used orally                         | Kotli          | [113]    |
| 15  | Caltha alba          | Makanpat   | Ranunculaceae | Herb     | Whole plant                     | Insomnia                                                   | Dir            | [108]    |
| 16  | Campanula pallida    | Beli Flower| Campanulaceae | Herb     | Flowers                        | Insomnia                                                   | Kotli          | [113]    |
| 17  | Cannabis Sativa      | Bhang      | Cannabaceae | Herb      | Flowers                         | Insomnia                                                   | Bannu          | [114]    |
| 18  | Capparis decidua     | kdler      | Capparidaceae | Shrub     | Flowers, fruits and shoots      | Insomnia                                                   | Gawadar        | [115]    |
| 19  | Capparis spinosa     | Kawir      | Capparidaceae | Shrub     | Whole plant                     | Mental disorders                                           | Gilgat         | [116]    |
| 20  | Carthamus tinctorius | Tukhmiga-rtum| Asteraceae  | Herb      | Roots, oil and flowers          | Insomnia                                                   | Rawalpindi     | [117]    |
| S # | Botanical Name     | Local Name     | Family        | Habitat  | Part Used     | Used for       | Mode of Applications                                      | Location    | Reference |
|-----|--------------------|----------------|---------------|----------|---------------|----------------|-----------------------------------------------------------|-------------|-----------|
| 21  | Celtis australis    | Karr           | Cannabaceae   | Tree     | Bark          | Epilepsy       | Decoction of bark is used orally                          | Sargodha    | [118]     |
| 22  | Cenchrus pennisetiformis | Cheetah-gha   | Poaceae       | Herb     | Leaves and fruits | Epilepsy       | Extracts and juice of leaves and fruits                   | Hafizabad   | [119]     |
| 23  | Citrulus colocynthis | Tumma         | Cucurbitaceae | Climber  | Roots and fruits | Epilepsy       | The extract of roots is taken with water while fruit’s powder is mixed with sugar | Jhelum      | [120]     |
| 24  | Citrus limon       | Nimboo         | Rutaceae      | Tree     | Whole plant   | Anxiety and Depression | whole plant extract                                      | Bahawalpur  | [109]     |
| 25  | Citrus medica      | Khatti         | Rutaceae      | Tree     | Leaves, seeds, latex | Insomnia       | Powder of leaves, seeds and dry latex are taken orally with water | Bahawalpur  | [109]     |
| 26  | Colebrookia oppositifolia | Lansa       | Lamiaceae     | Shrub    | Leaves and roots | Epilepsy       | Fresh leaves extract and roots decoction tea is taken orally | Malakand    | [121]     |
| 27  | Commiphora wightii | Guggul, Mukul | Burseraceae   | Herb     | Gum           | Nervous diseases | The aqueous extract of gum is used                        | Muzaffarbad | [122]     |
| 28  | Convolvulus arvensis | Baily         | Convolvulaceae | Herb     | Whole plant   | Epilepsy       | whole plant extract                                      | Malakand    | [121]     |
| 29  | Cucurbita maxima   | Walayti kadoo  | Cucurbitaceae | Climber  | Fruits        | Nervous disorders | Juice of both unripe and ripe fruits is used              | Azad Jammu & Kashmir | [123] |
| 30  | Cuscuta reflexa    | Bepari, Kasus | Cuscutaceae   | Tree     | Seeds         | Insomnia       | An infusion of seed is used                               | Muzaffarbad | [122]     |
| 31  | Cymbopogon citratus | Lemon-grass   | Poaceae       | Herb     | Oil of whole plant | Nervous system tonic | Oil is externally applied on head                        | Bahawalpur  | [109]     |
| S# | Botanical Name          | Local Name | Family    | Habitat | Part Used | Used for                        | Mode of Applications                          | Location             | Reference |
|----|------------------------|------------|-----------|---------|-----------|--------------------------------|-----------------------------------------------|----------------------|-----------|
| 32 | *Cynodon dactylon*     | Lawn grass | Poaceae   | Herb    | Whole plant | Epilepsy and Hysteria          | Extracted juice of plant is used               | Dera Ghazi Khan     | [111]     |
| 33 | *Cyperus rotundus*     | Deela      | Cyperaceae| Herb    | Tubers     | Epilepsy                       | Oil obtained from tubers are used              | Bahawalnagar         | [124]     |
| 34 | *Datura alba*          | Datura     | Solanaceae| Shrub   | Leaves and seeds | Neuralgia, Epilepsy, Hysteria and Insomnia | Lotion of seeds powder is applied locally for neuralgia while tea of leaves is used for Epilepsy | Bahawalpur          | [109]     |
| 35 | *Datura innoxia*       | Datura     | Solanaceae| Herb    | Leaves     | Epilepsy and Insomnia          | Extract of leaves in water                     | Dir                  | [108]     |
| 36 | *Datura metel*         | Dhaturo    | Solanaceae| Herb    | Leaves and seeds | Epilepsy and Insomnia          | Leaves extract and seed's decoction are used   | Muzaffarabad         | [122]     |
| 37 | *Datura stramonium*    | Datura     | Solanaceae| Herb    | Whole plant | Insomnia and Parkinson         | Extraction of whole plant is used              | Dera Ghazi Khan     | [111]     |
| 38 | *Daucus carota*        | Gajar      | Apiaceae  | Herb    | Whole plant | Nerve tonic                    | Eaten as a whole or its juice is used          | Sargodha             | [104]     |
| 39 | *Eclipta alba*         | Bhringaraj | Asteraceae| Herb    | Roots, oil and leaves | Insomnia                      | Oil is externally applied while roots and leaves extract is used orally | Bahawalpur          | [109]     |
| 40 | *Erucasativa*          | Tara meera | Cruciferace| Herb    | Whole plant | Epilepsy                       | Fluid extraction of plant is used              | Islamabad            | [112]     |
| 41 | *Evolvulus alsinoides* | Sankha-holi| Convolvulaceae| Herb  | Whole plant | Epilepsy                       | Decoction of whole plant is used              | Islamabad            | [112]     |
| 42 | *Ficus lysata*         | Beeri patta| Moraceae  | Tree    | Leaves     | Migraine                       | Extraction of leaves is used orally            | Bahawalpur          | [109]     |
| S # | Botanical Name | Local Name | Family | Habitat | Part Used | Used for | Mode of Applications | Location | Reference |
|-----|----------------|------------|--------|---------|-----------|---------|----------------------|----------|-----------|
| 43  | Flueggea leucopyrus | Shina | Phyllanthaceae | Shrub | Roots | Epilepsy | Decoction and extraction of roots are used | Dir | [125] |
| 44  | Fumaria indica | Pitpapra | Fumariaceae | Herb | Leaves and stem | Insomnia | Fresh juice of leaves and stem is used | Rawalpindi | [117] |
| 45  | Gmelina arborea | Kumbar | Lamiaceae | Tree | Roots | Epilepsy | Extraction and decoction of roots tea is used | Sargodha | [118] |
| 46  | Hyoscyamus niger | Ajwain-i-Khurasani | Solanaceae | Herb | Leaves and seeds | Insomnia and Nervous affection | Extraction of fresh leaves and powder of seeds are used orally | Gilgat | [126] |
| 47  | Hypericum perforatum | Bulhsana | Hypericaceae | Herb | Whole plant | Depression and Insomnia | Fresh extract of whole plant is used orally | Gujrat | [127] |
| 48  | Hyssopus officinalis | Zufa, Zupa | Lamiaceae | Herb | Whole plant | Nervous affection | Extraction of fresh whole plant | Ziarat | [128] |
| 49  | Indigofera heterantha | Kainthi | Papilionaceae | Shrub | Whole plant | Epilepsy and neuropathy | Extract of whole plant is used | Gilgat | [116] |
| 50  | Jasminum grandiflorum | Chanbeli | Oleaceae | Climber | Whole plant | Anxiety, tension and Depression | Oil or tea of leaves and flowers extract are used | Bahawalpur | [109] |
| 51  | Jasminum officinale | Chanbeli | Oleaceae | Climber | Whole plant | Insomnia | Oil is rubbed on heart as nerve sedative | Swat | [107] |
| 52  | Juglans regia | Ghuz | Juglandaceae | Tree | Fruits | Depression | Fruits are taken as whole orally | Malakand | [105] |
| 53  | Lactuca serriola | Berham dandi | Asteraceae | Herb | Whole plant | Memory Enhancing | Fresh plant is ground in water along with black pepper | Jhelum | [120] |
| S# | Botanical Name       | Local Name | Family    | Habitat | Part Used | Used for                  | Mode of Applications                                                                 | Location | Reference |
|----|----------------------|------------|-----------|---------|-----------|---------------------------|-------------------------------------------------------------------------------------|----------|-----------|
| 54 | Linum usitatissimum  | Alsi       | Linaceae  | Herb    | Stem      | Depression, Schizophrenia and Anxiety | Extraction of fresh stem is used                                                     | Kodi     | [113]     |
| 55 | Lycopersicon esculentum | Tamator   | Solanaceae | Herb    | Fruits    | Nervous weakness          | Eaten as a whole or its juice is used                                                | Sargodha | [104]     |
| 56 | Matricaria chamomilla | Babuna     | Asteraceae | Herb    | Whole plant | Insomnia          | Extraction of whole plant is used orally and oil massage or aromatherapy into skin of head is performed | Rawalpindi | [117]     |
| 57 | Martinia annua       | Bichhu-butti | Martyniaceae | Herb    | Leaves and fruits | Epilepsy | Juice of leaves or leaves are cooked to make curry and fruits are taken as dry powder with water | Kodi     | [113]     |
| 58 | Melia azedanach     | Bakyana    | Meliaceae  | Tree    | Leaves    | Hysteria                  | Decoction of leaves to makes tea                                                    | Malakand | [105]     |
| 59 | Mimordica dioca     | Jhungli karela | Cucurbitaceae | Climber | Fruits and seeds | Insomnia | Fruit's extract and seed oil are used                                                | Mianwali | [129]     |
| 60 | Moringa oleifera   | Sohan-jana | Moringaceae | Tree    | Seeds and bark | Migraine  | Seeds oil used externally while powder of leaves                                   | Gujrat   | [127]     |
| 61 | Ocimum basilicum    | Niazbo     | Lamiaceae  | Herb    | Leaves, flowers, seeds and roots | Migraine, Insomnia and Depression | Juice of fresh leaves and flowers while oil of seeds is applied externally on head | Bahawalnagar | [124]     |
| 62 | Paeonia emodi       | Mamaikh   | Paeoniaceae | Herb    | Rhizome    | Epilepsy                  | Rhizome powder is given 1/2 teaspoon twice a day                                   | Malakand | [105]     |
| S# | Botanical Name       | Local Name | Family       | Habitat | Part Used | Used for   | Mode of Applications                                      | Location | Reference |
|----|----------------------|------------|--------------|---------|-----------|------------|----------------------------------------------------------|----------|-----------|
| 63 | *Papaver dubium*     | Koko-kanga | Papaveraceae | Herb    | Flowers   | Insomnia   | Fluid extract of flowers is used                         | Kotli    | [113]     |
| 64 | *Papaver hybridum*   | Post       | Papaveraceae | Herb    | Fruits    | Insomnia   | Fruit and its decoction are used                         | Jhelum   | [120]     |
| 65 | *Papaver nudicaule*  | Zangali kashkash | Papaveraceae | Herb    | Flowers   | Insomnia   | Fluid extract of flowers is used                         | Buner    | [130]     |
| 66 | *Papaver rhoas*      | Alak jinai | Papaveraceae | Herb    | Flowers   | Insomnia   | Fluid extract of flowers is used                         | Buner    | [130]     |
| 67 | *Papaver somniferum* | Qash-Qash  | Papaveraceae | Herb    | Fruit's latex | Insomnia | Latex of unripe fruit is dissolved in water and used orally | Swat    | [107]     |
| 68 | *Parthenium hysterophorus* | Ragweed | Asteraceae | Herb    | Leaves    | Insomnia   | Leaves extraction is used                                | Buner    | [130]     |
| 69 | *Peganum harmala*    | Harmal     | Zygophyllaceae | Herb    | Seeds     | Hysteria   | A small amount of seeds added to sufficient grapes juice, boiled to make thick solution and used orally | Dera Ghazi Khan | [111]     |
| 70 | *Populus caspica*    | Nakhtar    | Pinaceae     | Tree    | Fruits    | Insomnia   | Whole raw fruits are consumed                             | Malakand | [105]     |
| 71 | *Primula veris*      | Cowslips   | Primulaceae  | Herb    | Flowers   | Insomnia   | A tasty wine of flowers is made which is used orally      | Gilgit   | [126]     |
| 72 | *Prunus persica*     | Ardou      | Rosaceae     | Tree    | Leaves, flowers and fruits | Insomnia | Extract of leaves & flowers and fruits are taken as such | Gilgit   | [126]     |
| S# | Botanical Name | Local Name | Family          | Habitat | Part Used | Used for                  | Mode of Applications                  | Location            | Reference |
|----|----------------|------------|-----------------|---------|-----------|---------------------------|---------------------------------------|---------------------|-----------|
| 73 | *Punica granatum* | Darrona    | Punicaceae      | Shrub   | Fruits    | Memory enhancing          | Fruits' juice or fresh seeds are eaten as such | Azad Jammu & Kashmir | [123]    |
| 74 | *Pyrus communis*  | Nashpatai  | Rosaceae        | Tree    | Fruits    | Insomnia                  | Fruits are eaten as such              | Dir                 | [131]    |
| 75 | *Pyrus pashia*    | Tangai     | Rosaceae        | Herb    | Fruits    | Insomnia                  | Fruits are eaten as such              | Swat                | [107]    |
| 76 | *Ranunculus muricatus* | Ziar Gulay | Ranunculaceae   | Herb    | Whole plant | Sciatic and nerve pain  | Extraction of dried whole plant is used | Swat                | [132]    |
| 77 | *Raphanus sativus* | Mooli      | Brassicaceae    | Herb    | Seeds     | Nervous weakness          | Decoction of seeds is used            | Sargodha            | [104]    |
| 78 | *Ricinus communis* | Arand      | Euphorbiaceae   | Shrub   | Roots, seeds, leaves | Insomnia and as narcotic | Extract of leaves and roots while oil of seeds are used | Rawalpindi        | [117]    |
| 79 | *Salvadora oleoides* | Peelu     | Salvadoraceae   | Tree    | Whole plant | Epilepsy                  | Fruit is eaten as raw while tea of leaves and roots are also used | Bahawalpur      | [109]    |
| 80 | *Schinus molle*   | False pepper | Anacardiaceae | Tree    | Bark and leaves | Depression                 | Decoction of bark and leaves to make tea | Sargodha            | [118]    |
| 81 | *Scutellaria chamaedrifolia* | Skullcap | Lamiaceae | Herb | Shoots | Insomnia and Depression | Decoction of shoots to make its tea | Swat                | [133]    |
| 82 | *Solanum minutum* | Peelak     | Solanaceae      | Herb    | Whole plant | Insomnia | whole plant decoction is mixed with sugar | Jhelum             | [120]    |
| 83 | *Solanum nigrum*  | Mako       | Solanaceae      | Herb    | Whole plant | Insomnia                  | Juice of whole plant                  | Bahawalpur         | [109]    |
| 84 | *Solanum Surratense* | Wara-mara ghinrye | Solanaceae | Herb | Fruits | Melancholia and Depression | The paste of fruits crushed powders is applied on head externally | Bannu              | [114]    |
| S# | Botanical Name       | Local Name | Family      | Habitat | Part Used          | Used for        | Mode of Applications                                                                 | Location | Reference |
|----|----------------------|------------|-------------|---------|--------------------|----------------|--------------------------------------------------------------------------------------|----------|-----------|
| 85 | *Taxus baccata*      | Banhya     | Taxaceae    | Tree    | Leaves and fruits | Epilepsy       | Extraction of dried leaves and fruits are consumed as such                           | Swat     | [134]     |
| 86 | *Taxus wallichiana*  | Barmi      | Taxaceae    | Tree    | Bark, leaves and fruits | Epilepsy and Insomnia | Extract of dried bark and leaves while flesh of fruits are consumed               | Battagram | [135]     |
| 87 | *Terminalia arjuna*  | Arjun      | Combretaceae | Tree    | Fruits, bark and leaves | Anxiety        | Bark infusion left whole night, then its decoction taken early in the morning and used orally | Bahawalpur | [109]     |
| 88 | *Tribulus terrestris*| Bakhra     | Zygophyllaceae | Herb    | Whole plant      | Epilepsy and Depression | Powder of dried whole plant                                                       | Bahawalnagar | [124]     |
| 89 | *Valeriana jatamansi*| Mushk-bala | Vahliaceae  | Herb    | Whole plant      | Epilepsy and neurosis | Fresh extract of whole plant                                                      | Muzaffarabad | [122]     |
| 90 | *Verbascum thapsus*  | Jungle tambako | Scrophulariceae | Herb    | Roots             | Migraine       | Decoction of root to make tea to use as drink                                      | Mianwali  | [106]     |
| 91 | *Verbena officinalis*| Shamkay    | Verbenaceae  | Herb    | Whole plant      | Depression, Migraine and Epilepsy | Extract of dried whole plant is used                                             | Battagram  | [135]     |
| 92 | *Viburnum cotinifolium* | Guch    | Caprifoliaceae | Shrub    | Stem's bark      | Insomnia       | Extract of stem's bark                                                              | Muzaffarabad | [122]     |
| 93 | *Viburnum opulus*    | Sunaira Phul | Caprifoliaceae | Shrub    | Bark             | Insomnia and Hysteria      | Decoction of bark is used                                                        | Muzaffarabad | [122]     |
| S# | Botanical Name       | Local Name | Family         | Habitat | Part Used     | Used for                      | Mode of Applications                           | Location      | Reference |
|----|----------------------|------------|----------------|---------|---------------|-------------------------------|-----------------------------------------------|---------------|-----------|
| 94 | *Viburnum prunifolium* | Blackhaw   | Caprifoliaceae | Tree    | Root’s bark   | Hysteria, Anxiety and Epilepsy | Decoction of root’s bark is used             | Muzaffarabad  | [122]     |
| 95 | *Vicia sativa*        | Muttri     | Papilionaceae  | Herb    | Flowers       | Epilepsy and nervous disorders | The juice of flowers petals is used            | Kotli         | [113]     |
| 96 | *Viola betonicifolia* | Banafsh    | Violaceae      | Herb    | Whole plant   | Epilepsy and nervous disorders | Fresh extract of whole plant orally           | Malakand      | [105]     |
| 97 | *Viola canescens*     | Banafsha   | Violaceae      | Herb    | Whole plant   | Insomnia and Epilepsy         | Extract and decoction tea of whole plant      | Swat          | [133]     |
| 98 | *Withania coagulans*  | Paneer doda| Solanaceae     | Herb    | Fruits, roots and leaves | Nervous Exhaustion, memory loss and tension | Extract of leaves, roots and fruits are used | Bahawalnagar  | [124]     |
| 99 | *Withania somnifera*  | Asgandh    | Solanaceae     | Shrub   | Roots         | Insomnia                      | Powder of roots is taken with water           | Bahawalpur    | [109]     |
| 100| *Xanthium strumarium* | Chota dhatura| Asteraceae    | Herbs   | Fruits, seeds and roots | Insomnia                      | Decoction of fruits, roots and seeds to make tea | Attock        | [136]     |
| 101| *Ziziphus jujuba*     | Beri       | Rhamnaceae     | Tree    | Leaves, roots and fruits | Anxiety and Insomnia           | Extract of leaves, decoction of roots and dried fruits are consumed | Bahawalnagar  | [124]     |
| 102| *Ziziphus mauritiana* | Ber         | Rhamnaceae     | Tree    | Roots         | Nerve tonic                   | Decoction of roots is used as tea             | Sargodha      | [104]     |
| 103| *Ziziphus nummularia* | Jangli beri| Rhamnaceae     | Shrub   | Leaves and fruits | Insomnia                      | Extract of leaves while fruits are taken as such | Attock        | [136]     |
Table 4: Phytochemical constituents and pharmacological properties of some well-known medicinal plants.

| S.# | Medicinal Plants | Pharmacological Properties | Part used | Phytochemical Constituents | Chemical Compounds Identified | References |
|-----|------------------|-----------------------------|-----------|---------------------------|-------------------------------|------------|
| 1   | *Allium sativum* | 1. Antidepressant 2. Anti-convulsant 3. Anti-Alzheimer | 1. Dried bulbs 2. Oil 3. Whole garlic | Thiosulfinates, sapogenins phenols, saponins, volatile compounds, antioxidants, flavonoids, vitamins, minerals and proteins | Alliin, allixin, 1,2-vinylidithiin, ajoenes, S-allyl-cysteine sulfoxide, calcium, Potassium, vitamin B and vitamin C | [137–140] |
| 2   | *Bacopa monnieri* | 1. Antidepressant 2. Anxiolytic 3. Anti-convulsant 4. Anti-Parkinson | 1. Leaves 2. Stems and leaves 3. Leaves 4. Conc. tincture of plant | Alkaloid, tannin, saponin, phlobatannin, glycoside, terpenoid, flavonoid, sterols, phenol, steroid, anthraquinone and carbohydrate | Brahmin, nicotine, herpestine, bacosides A & B, hersaponin, beta-hydroxy acid, monnieri, apigenin, b-sitosterol, stigma-sitosterol and luteolin | [33–36, 141] |
| 3   | *Cannabis sativa* | 1. Antidepressant and anxiolytic 2. Anti-convulsant 3. Anti-Alzheimer and antidementia 4. Sedative | 1. Leaves 2. Leaves 3. Flowers 4. Whole plant | Alkaloid, flavonoids, tannins, phenols, resins, cardiac glucosides, terpenes, steroids, volatile oils and balsam | Cannabinoids, cannabidiol, dronabinol, cannabigerol, tetrahydrocannabinolic acid, cannabichromenic acid, cannabidiolic acid, anadamide, cannabigerolic acid and cannabichromene | [37–40, 142, 143] |
| 4   | *Hyoscyamus niger* | 1. Antidepressant 2. Anti-seizure 3. Anti-Parkinson | 1. Leaves 2. Seeds 3. Seeds | Alkaloids, withanolide steroids, lignanamides, tyramine derivative, steroidal saponins, glycosides, lignans, coumarinolignan, and flavonoids | Apoatropine, L-DOPA, Cuscohygrine, choline Daturamine, Hyoscine, tropine, hyoscylicpin, phytin, aphoyosine, alpha and beta belladonine and Skimmianine | [144–148] |
| 5   | *Solanum nigrum* | 1. Anti-seizure 2. Sedative | 1. Leaves 2. Fruits | Alkaloids, flavonoids, tannins, saponins, glycosides, proteins, carbohydrates, coumarins and phytosterols | Pinoresinol, syringaresinol, medioresinol, scopoletin, tetraoxosalic acid and beta-sitosterol | [149–152] |
Table 4: Continued.

| S.# | Medicinal Plants            | Pharmacological Properties | Part used           | Phytochemical Constituents | Chemical Compounds Identified                                                                 | References |
|-----|----------------------------|-----------------------------|---------------------|----------------------------|---------------------------------------------------------------------------------------------|------------|
| 6   | *Withania somnifera*       | 1. Anti-Parkinson           | 1. Whole plant      | Alkaloids, steroidal lactones, saponins and iron | Withanolides, withaferins, Withanine, isopellertierine, anferine, Anahygrine, Cuscohygrine, Beta-Sisterol, Chlorogenic acid, Scopeotin, choline, Somniferiene, Somniferinine and Tropanol | [45–47, 153] |
|     |                            | 2. Anxiolytic and antidepressant | 2. Roots           |                            |                                                                                             |            |
|     |                            | 3. Anticonvulsant           | 3. Stems and roots  |                            |                                                                                             |            |
| 7   | *Papaver somniferum*       | 1. Anticonvulsant           | 1. Seeds            | Alkaloids, glycosides, tannins, Phytosterols, Terpenoids, Flavanoids and Carbohydrates | Morphine, Codeine, thebaïne, noscapine, papaverine, Salutarifine, meconidine, codeine, neoprene, lanthothine, rophyroxine, narcotisline and papaveramine | [154–159] |
| 8   | *Ziziphus jujube*          | 1. Sedative and hypnotic    | 1. Seeds            | Triterpenic acids, flavonoids, saponins, cerebrosides, amino acids, phenolic acids, vitamins, total sugars and nucleosides | Zizybeoside I and II, Chryseoriol, Swertisin, Quercetin, Jujubasaponin IV, Lotoside I and II, Zizyphus saponin I and II | [160]      |
|     |                            | 2. Anxiolytic               | 2. Leaves           |                            |                                                                                             |            |
|     |                            | 3. Anti-seizure             | 3. Fruits           |                            |                                                                                             |            |
| 9   | *Tribulus terrestris*      | 1. Anxiolytic               | 1. Leaves           | Saponins, flavonoids, glycosides, alkaloids and tannins | Tigogenin, neotigogenin, rutin, chlorogenicin, caffeoyl, ruscogenin, kaempferol, tribulosid, terrestribisamide, quercetin, β-sitosterol, stigmasterols, harmane, norharmane and tribulusterine | [161–164] |
|     |                            | 2. Antidepressant           | 2. Whole plant      |                            |                                                                                             |            |
|     |                            | 3. Sedative                 | 3. Whole plant      |                            |                                                                                             |            |
| 10  | *Verbena officinalis*      | 1. Antidepressant           | 1. Leaves           | Alkaloids, flavonoids, diterpenes, proteins, amino acids, tannins, saponins, phytosterols and phenolic compounds | Verbenin, oleanolic acid,verbalin, hastatoside, alpha-sitosterol, ursolic acid, kaempferol, aucubin, luteolin, verbascoside, apigenin, scutellarein, limonene and spathulenol | [42, 43]  |
| S.# | Medicinal Plants | Pharmacological Properties | Part used | Phytochemical Constituents | Chemical Compounds Identified | References |
|-----|------------------|----------------------------|-----------|---------------------------|------------------------------|------------|
| 11  | Albizia lebbeck  | 1. Anticonvulsant 2. Nootropic and anxiolytic | 1. Leaves 2. Leaves | Alkaloids, flavonoids, phenols, saponins; steroids and terpenoids | Albizia saponins A, B and C, albizin, melacidin, catechin lebbecacidin, friedelin, and β-sitosterol | [165–168] |
| 12  | Avena sativa     | 1. Antidepressant 2. Anxiolytic | 1. Seeds 2. Whole plant | Carbohydrates, alkaloids, flavonoids, steroids, glycosides, saponins, amino acids, gums and mucilage | Gramine, flavone, apigenin and luteolin, flavonolignans, saponins and ferulic acid | [169–171] |
| 13  | Capparis decidua | 1. Sedative and anticonvulsant | 1. Flowers and fruits | Alkaloids, glycosides, terpenoids, sterols, flavanoids, phenols and fatty acids | Capparine, cappariline, capparinine, β-sitosterol, capparidisine, capparazine, codonocarpine, Capric acid, cadabacin, quercetin and rutin l-stachydrine | [172, 173] |
| 14  | Citrus limon     | 1. Anticonvulsant 2. Sedative, anxiolytic and antidepressant | 1. Essential oil of leaves 2. Essential oil of leaves | Phenols, flavonoids, terpenoids, essential oils, carotenoids, citric acid and ascorbic acid | Limonene, α-pinene, β-pinene, linalool, α-terpineol, linalyl acetate, acetate geranyl, nerolidol, acetate neryl, farnesol, sabinen, myrcene, cineol and geranial | [174–176] |
| 15  | Citrullus colocynthis | 1. Anticonvulsant 2. Antidepressant | 1. Fruits 2. Fruits | Alkaloids, flavonoids, glycosides, saponosides, Phenolic compounds and ascorbic acid | Colocynthin, colocynthin, colocolythin, Cucurbitane type triterpen glycoside, quercetin and | [15, 16, 177] |
| 16  | Datura metel     | 1. Antiepileptic 2. Sedative and hypnotics | 1. Leaves 2. Seeds | Alkaloids, resins, flavonoids, reducing sugars, tannins, terpenoids and steroid glycosides | Hyoscyamine, scopolamine, atropine, daturabietatriene, daturasterol, b-sitosterol and Melatonin and serotonin | [17–21] |
### Table 4: Continued.

| S.# | Medicinal Plants          | Pharmacological Properties                  | Part used     | Phytochemical Constituents                                                                                                                                                                                                 | Chemical Compounds Identified                                                                 | References                  |
|-----|---------------------------|----------------------------------------------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------------|
| 17  | Hypericum perforatum      | 1. Antidepressant 2. Anti-Parkinson 3. Neuroprotective 4. Anticonvulsant 5. Anti-Alzheimer 6. Anxiolytic and sedative | 1. Flowers 2. Flowers and leaves 3. Whole plant 4. Flowers and leaves 5. Flowers 6. Flowers | Phenylpropanes, flavonoids, biflavones, phloroglucinols proanthocyanidins, amino acids, essential oil and naphthodianthrones                                                                                             | Hyperoside, adhyperforin Quercitrin, Rutin, Hypericin, Kaempferol, Biapigenin and Hyperforin              | [22–28]                    |
| 18  | Jasminum grandiflorum     | 1. Antidepressant 2. Anticonvulsant           | 1. Essential oil of plant 2. Leaves | Coumarins, steroids, cardiac glycosides, essential oils, flavonoids, phenolics and saponins                                                                                                                              | Rutin, kaempferol, quercetin, β-primeveroside, kaempferol, hesperidin Methyl jasmonate, methyl anthranilate, linalool β-rutinoside, oleuropein and daucosterol | [29–31]                    |
| 19  | Lycopersicon esculentum   | 1. Antidepressant 2. Anticonvulsant 3. Memory enhancement 4. Anti-Parkinson | 1. Fruits 2. Dried fruit extract 3. Dried fruit extract 4. Seeds | flavonoids, tannins, saponin, glycosides, Steroids, fatty acids, carbohydrates and proteins                                                                                                                         | Chlorogenic acid, rutin, naringenin, noradrenaline lycopene, dopamine, tomatin, tomatoside-A, ascorbic acid, bergapten, serotonin and adrenaline | [32, 178–180]              |
| 20  | Ocimum basilicum          | 1. Antidepressant 2. Anticonvulsant 3. Anxiolytic and sedative 4. Enhance memory retention | 1. Essential oil 2. Leaves 3. Aerial parts 4. Leaves | Terpenoids, essential oil, polyphenols, tannins and flavonoids                                                                                                                                                           | Cineole, geraniol, linalool, cardanol and sabine, methyl chavicol, β-caryophyllene and neral, quercetin, myricetin, kaempferol, catechin and eugenol | [181–184]                  |
| 21  | Punica granatum           | 1. Antidepressant 2. Anxiolytic and anticonvulsant 3. Anti-Alzheimer 4. Memory enhancement | 1. Fruits 2. Leaves 3. Fruits 4. Fruit’s peel | Flavonoids, glycosides, amino acids, pectin, indoleamines, tannins, sterols, polyphenols, carbohydrates, ellagitannins, anthocyanins and triterpenoid                                                                 | Catechin, rutin, quercetin epicatechin, estrid, luteolin kaempferol, anthocyanins, gallaglycidacton, stigmasterol, β-sitosterol, testosterone, tocopherol and isoflavones | [185–188]                  |
| Sr # | Phytochemicals   | Source               | Family         | Disease                  | Mechanism                                                  | Development stage         | Trade Name                        | Reference |
|------|------------------|----------------------|----------------|--------------------------|------------------------------------------------------------|---------------------------|----------------------------------|-----------|
| 1    | Cannabidiol      | Cannabis sativa      | Cannabaceae    | Epilepsy                 | Modulation of intracellular calcium and neuronal inhibition | FDA approved, 2018         | Epidiolex as 5-10 mg/kg/day       | [189]     |
| 2    | Cannabidiol      | Cannabis sativa L.   | Cannabaceae    | Chronic Neuropathic pain | CB1 and CB2 receptor activation                           | FDA approved, 2005         | Sativex Spray (CBD 25mg/ml + THC27mg/ml) | [190]     |
| 3    | Capsaicin        | Capsicum annum L.    | Solanaceae     | Postherpetic neuralgia   | TRPV1 activator                                           | FDA approved, 2010         | Qutenza as Patch (179mg capsaicin) | [190]     |
| 4    | Curcumin         | Curcuma longa        | Zingiberaceae  | Dementia                 | Anti-amyloid, AChEI                                       | phase II                  |                                  | [191]     |
| 5    | Galantamine      | Galanthus nivalis    | Amaryllidaceae | Alzheimer                | AChEI, allosteric modulation of nicotinic ACh receptor     | FDA approved, 2004         | Razadyne as 8-12 mg BD           | [192]     |
| 6    | Huperzine A      | Huperzia serrata     | Huperziaceae   | Alzheimer                | AChEI, inhibits NMDA and glutamate toxicity               | approved in China          |                                  | [193]     |
| 7    | Ibogaine         | Tabernanthe iboga    | Apocynaceae    | Parkinson                | Dopaminergic agonist, NMDA antagonism                     | preclinical                |                                  | [193]     |
| 8    | Psychollatine    | Psychotria umbellate | Rubiaceae      | Parkinson                | MAO inhibitor                                             | preclinical                |                                  | [193]     |
| 9    | Resveratrol      | Vitis vinifera L.    | Vitaceae       | Alzheimer                | Reduces Aβ formation and promote Aβ decomposition         | phase II                  |                                  | [194]     |
| 10   | Scyllo-Inositol  | Cornus florida L.    | Cornaceae      | Alzheimer                | Breakdown of neurotoxic fibrils, allowing amyloid peptides to clear the body rather than form amyloid plaques | phase II                  |                                  | [195]     |

FDA: food and drug administration; TRPV1: transient receptor potential vanilloid 1; CB1 and CB2: cannabinoid receptor type 1 & type 2; Ach: acetylcholine; AChEI: acetylcholinesterase inhibitor; CBD: cannabidiol; THC: tetrahydrocannabinol; BD: bis in die; NMDA: N-methyl-D-aspartate; MAO: monoamine oxidase; Aβ: amyloid beta.
of this region, there is no accurate and up to date record of the neurological ailments. In order to find any treatment for these diseases, first realistic survey would be required to find out the exact percentage of various neurological diseases. Being an alarming psychiatric problem, Alzheimer opens a new area of research, affecting an enormous part of world population, but it is still untreatable. A lot of attempts have been conducted but still there is no such drug that can either slow or stop the process of Alzheimer disease. Allopathic medicines are available for psychological diseases including anxiety, depression, epilepsy, Parkinson, and Alzheimer, but these are either not so effective or costly or have serious associated adverse effects. The world is full of natural medicinal resources, of which the main source is plant. We should invest money and go for systemic scientific investigations to perceive such drug candidates’ form these plants, which are most efficacious, have minor side effects, and are cost friendly. For this purpose, this study is a gift for researchers who have interest to design and perform research based activities in the field of neuropharmacology by evaluating the unexplored medicinal plants mentioned here for their folkloric uses, determining its mechanistic pathways and identifying chemical constituents responsible for therapeutic effects.

Data Availability
No personal data was collected from the interviewees and therefore no such data is kept or shared in any form.

Consent
Prior informed consent was obtained from all participants before conducting interviews. This manuscript does not contain any individual person’s data and further consent for publication is not required.

Conflicts of Interest
The authors declare that they have no conflicts of interest.

Authors’ Contributions
Abdul Waheed Khan, Arif-ullah Khan, and Syed Muham- mad Mukarram Shah designed the study, performed field work, and researched various medicinal plants articles on scientific search engines. Aziz Ullah, Muhammad Faheem, and Muhammad Saleem analyzed the data and drafted the manuscript. All authors read and approved the final manuscript.

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