

PHYTOCHEMICAL, ETHANOBOTANICAL USES AND PHARMACOLOGICAL VALUES OF *BARLERIA CRISTATA* LINN

Abstract

Herbs have traditionally been use the main kind of medication. Medicinal plants have therapeutic properties because they contain a variety of complex chemicals with varying chemical compositions. Globally, the study of medicinal herbs has recently generated significant interest. The promising potential of medicinal herbs are extensively employed in many conventional, complementary, and alternative modalities for the treatment of human illnesses has been established by a substantial body of proof. Drugs derived from plants generally have lower adverse effects, are easier to obtain, and are well tolerated. The ability of medicinal plants to treat disease is caused by a number of phytoconstituents. Therefore, the initial screening tests are helpful in identifying bioactive principles and may facilitate the identification and creation of novel medications. One of the larger and most well-known genera of herbs and shrubs in the Acanthaceae family is *Barleria*. Fast-growing ornamental shrub *Barleria cristata*, a member of the Acanthaceae family, is frequently grown in gardening for its colorful flowers. *Barleria cristata* also known as Philippine violets is native to Southeast Asia and India, has a large presence in Central and South India. It is known as Kala Bansa and is an herbal remedy. It blooms as a shrub 60-100 cm tall. Leaf surfaces are darkest green in colour on the top and pastel greenish colour on the bottom. They are elliptic to narrowly ovate. The funnel-shaped, pink or violet flowers are around 5 cm long. The fruits are ellipsoid capsules that are roughly 1.5 cm tall. The phytochemical tests demonstrate the occurrence of steroid hormones, glycosides, alkaloids, tannins, phenolic chemicals, flavonoids, carbohydrates, proteins, amino acids. The plants contain highest amount of ascorbic acid than vitamins. The results of TLC analysis of methanolic extract point to the

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presence of a high level of phytoconstituents. This plant's leaf extract was analysed using GCMS. This study identified the 15 chemicals. The plant has been used ethnopharmacologically for illnesses such as tuberculosis, hepatic obstruction, diabetes, fever, snake bite, anaemia, toothache, and lungs ailments. The plant's antioxidant, hepatoprotective, anti-inflammatory, antibacterial, anti-diabetic, and anti-fungal, anticancer, antihyperlipidemic, and thrombolytic properties were also studied. The objective of the aforementioned review was to provide a scholarly overview of *Barleria Cristata*, focusing on its ethnobotanical features, geographical range, medicinal uses, phytochemical composition, and pharmacological properties, as well as conducting a critical analysis of research gaps and identifying future research prospects pertaining to this plant species. This information may be useful for future studies aimed at enhancing human health care.

Keywords: *Barleria cristata*, Phytoconstituents, Medicinal plants, Pharmacological activity, Philippine blue.

I. INTRODUCTION

Throughout history, plants have been universally acknowledged as a significant reservoir of medicinal compounds. Because of their affordable prices, fewer adverse consequences, and growing trust in traditional therapeutics. According to the World Health Organisation, a significant proportion of individuals, over 80%, predominantly depend on traditional plants as their primary source of medicinal remedies. [1, 2]. Natural biodiversity, in accordance with WHO, emphasises a critical role for their nutritional and therapeutic benefits to effectively control and direct the prevention and containment of illnesses. [3, 4]. According to evidence found in old books and other artefacts, ancient people employed plants in their healing rituals. India was renowned among the ancient civilizations as a rich source of medicinal plants. In India, the forest is the primary reservoir of a huge variety of plants with medicinal and aromatic properties that are gathered as raw materials for the production of pharmaceuticals and perfumery goods. In India's AYUSH system, almost 8000 herbal treatments have been codified. In India, Ayurveda, Unani, Siddha, homoeopathy, and folk (tribal) medicines are the primary indigenous medical systems. In India, therapeutics herbs has been utilised extensively to cure a wide range of ailments since the Rig Veda time, 5600 BC. Based on the accumulated knowledge of the herb, tribal peoples created a well-defined herbal pharmacopoeia [5]. Plants have various enriched nutrients having positive physiological effects to the human body. They are referred to as nutraceuticals, and they have significance for the development of new treatments [6]. India is home to an estimated 8% of the world's biodiversity [7-13].

The acanthaceae family, which includes the genus *Barleria*, has its highest species richness in open forest and is indigenous to the tropical regions of Asia and Africa. With 300 species, *Barleria* stands third among genera in the Acanthaceae family. For India, Balkwill [14] listed 32 species; however, Karthikeyan and colleagues [15] found one subspecies, six variants and 29 species. Philippine violet is a shrub that has no connection to the Philippine Islands or violets, despite the fact that its flowers are undoubtedly violet in colour. *Barleria cristata*, the ornamental plant, is an evergreen subshrub of the acanthus family that is dense, upright, hairy-stemmed, and normally grows to a height of 3 to 4 feet is now widely grown in South East Asia, South China, and tropical and subtropical India. This shrub may be grown in Florida, southern Texas, Louisiana, Arizona, and California in the US. It is regarded as a potential invasive plant species in waste areas and along the side of the road [16-18]. In India, this plant is found growing as a hedge surrounding fields, gardens, etc. The potential utilisation of *Barleria cristata* as a traditional medicine in order to treat of blood illnesses, inflammatory problems, diabetes, anaemia, snake bites, and toothaches has also been supported by ethnomedical accounts.

Triterpenes, flavonoids, phenolic compounds, iridoids, and phenylethanoid glycoside have all been identified in the phytochemical profile of *Barleria cristata* [19, 20]. Biological activities exhibited by *Barleria cristata* included hepatoprotective, antiplasmodial, antibacterial, antifungal, antidiabetic, anti-inflammatory, and antioxidant activities [21]. As a result, the purpose of this review was to emphasise the significance of *Barleria cristata* as a possible origin of bioactive chemicals and to summarise the therapeutic applications as well as phytopharmacological investigations to emphasise this plant's potential for the future. The significance of phytochemical ingredients and the activities of *Barleria cristata* are demonstrated in this, which may be helpful to scientists, research scholars, health

professionals, and students working connected to phytochemical and pharmacological activities from medicinal plants. This review study outlined the scientifically supported facts concerning the pharmacological and phytochemical activities. The review also includes information on the plants' characteristics and ethanomedical applications.

II. TAXONOMY OF *BARLERIA CRISTATA* [22,23]

1. **Kingdom:** Plantae
2. **Subkingdom:** Tracheobionta
3. **Division:** Magnoliophyta
4. **Class:** Magnoliopsida
5. **Subclass:** Asteridae
6. **Order:** Scrophulariales
7. **Family:** Acanthaceae
8. **Genus:** Barleria
9. **Species:** Cristata

III. SYNONYMS

1. *Barleria ciliate* Roxb
2. *Barleria dichotoma* Roxb
3. *Barleria laciniata* Wall. and
4. *Barleria napalensis* Wall

IV. VERNACULAR NAME [24, 25, 26, 27]

1. **English:** Blue bell barleria, bluebell, Philippine violet
2. **Japan:** Barureria
3. **Philippines:** Kolintang, violeta
4. **Thailand:** Kaanchang, luemthaoyai, thong ra- aa
5. **Tibet:** Sa ha ra ca, sa ha ratsap, sa- ha- tsa
6. **Vietnam:** Hoach[oo]ng
7. **India:** Hindi – Raktajhinti; Oriya – Banpatoli; Tamil – Nilamulli, Semmulu; Telugu – December Puvvulu, Peddagorinta; Sanskrit – Artagala, Bana, Dasi; Bengali – Jati, Jhinti, Swetjhanti; Madhya Pradesh – Morani, mukaro; Arunachal Pradesh – Vahaka; Assam-Sajhia

V. GEOGRAPHICAL DISTRIBUTION AND HABBITAL

Barleria Cristata has been discovered all over the world in gardens and woodlands in Africa, the Pacific region, tropical Asia, and temperate Asia [28]. It can be found throughout the Asian tropical region, including Indochina include the countries of Thailand, Vietnam, Myanmar, Cambodia, Laos, and Myanmar. and the Indian subcontinent (Nepal, Pakistan, Bangladesh, India and Bhutan) [29, 30]. It can be found in India's subtropical north-eastern (Kashi Hills, Sikkim, and the Himalaya) and southern (typically at 1350 m) regions. (31)

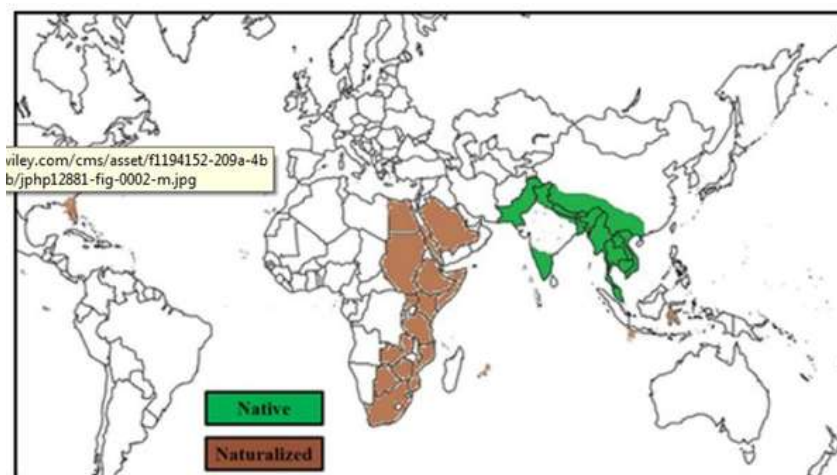


Figure 1 : The Geographical Distribution of *Barleria Cristata*, With a Specific Focus on Identifying its Native and Naturalised Ranges.

Barleria cristata may be grown by streams, on the sides of roads, and in xeric vegetation at elevations ranging from 100 metres to 2600 metres. It was also been grown as ornamental plants in garden naturalized along ruderal sides and habitats that were semi-natural in wet and dry regions [32]. *Barleria cristata*, a rapidly developing perennial botanical species, is frequently planted within horticultural settings due to its visually striking blossoms. The naturalisation of this type of species in disturbed areas, deserted gardens, riverbanks, and by the sides of roadways has occurred on several occasions[33].

VI. BOTANICAL DESCRIPTION

A huge, branching, tall, and everlasting shrub called *Barleria cristata* L. thrives in a region of the terrain with good, soil that drains well which remains alkaline and is exposed to either full sun or moderate shade. The stem is made up of densely hairy nodes and appressed trichomes. The leaves are elliptic-lanceolate in shape, 2.5–10 cm long, ciliate at the margins and acute-acuminate shape at its tip, and are typically attenuate near the base. The top of the midrib is hair-covered and has 5-7 pairs of lateral veins. The petioles on the leaves, which are between 3 and 8 millimetres long, are green, typically the lower surface is pale green. Funnel-shaped flowers at the tips of the stalks, about 2 cm long, and white pink. Axillary or terminal dense ovoid spikes make up the majority of inflorescence. The bracteoles are varied, linear, toothed at the borders, acute edges with membrane pubescence and veining at the tip. Bracts are missing [34]. The calyx exhibits persistence, with a length of 2 centimetres, green in hue, and laciniately serrated in shape. The Corolla exhibits a length of around 6-7 cm, characterised by its slender tubular structure. It possesses wings on its upper portion, while its limb displays a coloration ranging from violet to nearly white. The inside of corolla tube is rectangular, pinkish in colour, exterior downy, and is characterized by a border consisting of two distinct lips. It has glandular hairs. The lower lip is wider but shorter and whole, while the upper lip has four divisions. Flowers have four 2.5 centimetres in length, hairy stamens, three millimetres long anthers, and five millimetres in length staminodes which possess anther cells[35]. Nectar is the lower half of the germ that is cupped on both lips [36].

The stigma has two pink lobes that are larger, pierced between two short and rounded lips, and the ovary bears each locule contains two ovules. The style has a concise and compact structure, inflated at the apex, and a presence of fine hairs around its foundation [37].The seeds are compact, oval, and silky-hairy [38].In the Indian subcontinent, flowering and fruiting season runs from September to February [39].



Figure 2: Flower



Figure 3: Plant



Figure 4: Leaves

1. *Barleria cristata*: Crested Philippine Violet.

a) Description

Height: 4 to 6 feet
Spread: 3 to 4 feet
Plant habit: upright
Plant density: dense
Growth rate: fast
Texture: medium

b) Foliage

Leaf arrangement: alternate
Leaf type: simple
Leaf margin: entire
Leaf shape: ovate
Leaf venation: bowed; pinnate
Leaf type and persistence: evergreen
Leaf blade length: less than 2 inches
Leaf color: green
Fall color: no fall color change
Fall characteristic: not showy

c) Flower

Flower color: pink; white
Flower characteristic: summer flowering;
fall flowering

d) Fruit

Fruit shape: no fruit
Fruit length: no fruit
Fruit cover: no fruit
Fruit color: not applicable
Fruit characteristic: inconspicuous and not
showy

e) Trunk and Branches

Trunk/bark/branches: not particularly
showy; typically multi-trunked or
clumping stems
Current year stem/twig color: green
Current year stem/twig thickness: thin

VII. MORPHOLOGICAL PARAMETERS

The cuticle provides protection to a specific layer of the epidermis. as a single layer, according to the longitudinal segment of *Barleria cristata*.The polygonal parenchymatous cell was seen to possess a monolayer structure, with the presence of trichomes providing surface coverage was visible in the outermost and lower layers of the epidermis.. A network of collenchymatous cells that was 5-7 layers thick followed the epidermal layer. The ground

tissue layer was located next to this one and was made up of parenchymatous cells that were interspersed with intercellular gaps. The vascular bundle was located in the centre, and the phloem was bordered by a radial row of xylem arteries. The sort of vascular bundle that was already there was open and having bilateral symmetry (A layer of xylem was situated between two levels of phloem).

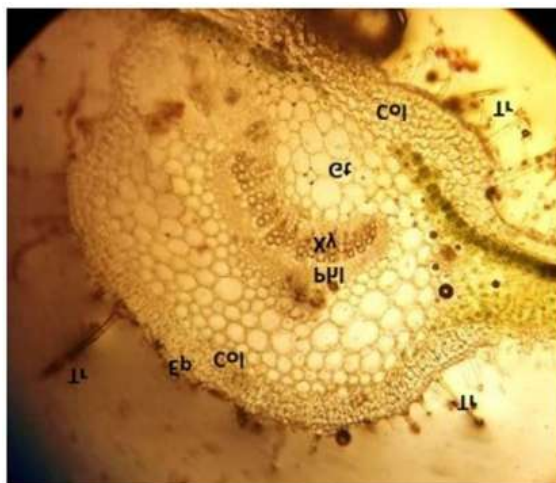


Figure 5: The Transverse Section the Leaf of Barleria Cristata Linn. Was Seen with a Magnification of 10x.

Phl: Phloem. **Ep:** Epidermis, **Tr:** Trichomes, **Col:** Collenchyma, **Gt:** Ground tissues, **Xy:** Xylem,

VIII. ETHNOMEDICINAL USES

It fulfils a variety of conventional functions and qualities. *Barleria cristata* L. The whole plant has been traditionally employed as a medicinal remedy for conditions such as diabetes, infertility, injuries, burns, gum inflammation, and nocturnal emissions. Additionally, it is advised in common health issues that individuals may have include cough, skin infections, anaemia, and TB. In addition to being chewed for toothache relief, leaves are frequently used to lessen irritations. During the rainy season, a paste is commonly administered to the foot in order to mitigate the occurrence of cracks. Additionally, the juice derived from certain plants is sometimes utilised for the treatment of fever and phlegm [40]. The root's decoction is used for anaemia and cough. However, The application of root infusion has been employed as a therapeutic intervention for the treatment of boils, ulcers, and toothache, with the aim of minimising swelling [41, 42]. Wherever dry bark is administered to treat whooping cough, The stem bark contains a pungent liquid is used as an expectorant and diaphoretic [43]. It is regarded as a precious medicinal plant, particularly for the he management of respiratory ailments such ascoughing, tuberculosis, asthma, and bronchitis.

IX. PHYTOCHEMISTRY

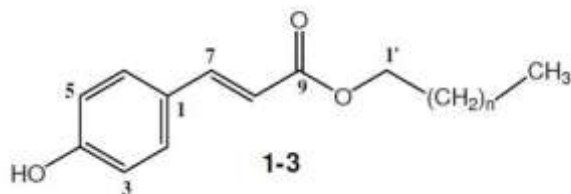
The investigation of phytochemical constituents in *Barleria cristata* has caused the isolation and characterization of bioactive chemicals such as glycosides, polysaccharides, triterpenes, notably oleanolic acid, and derivatives of the 4-hydroxy transcinnamate. Studies also showed that the ethanolic extract of *Barleria cristata* leaves included secondary phytoconstituents such as proteins, amino acids, triterpenes, phenols, flavonoids, alkaloids, saponins, tannins, and steroids [44]. Phenolic chemicals, phenylethanoid, iridoidal glycosides and flavonoid are the main bioactive compounds among the huge variety of phytoconstituents present in plant. *Barleria cristata* L. callus cultures were used to successively identify desrhamnosyl acteoside, acteoside, and poliumoside are three phenylethanoid glycosides that were described utilising chromatography and spectroscopic methods. The identification of additional chemicals from leaves includes two iridoidal glycoside (methyl ester of Barlerin and Schanshiside.), two flavonoids (luteolin and 7-methoxyluteolin), and two phenolic substances (p-coumaric acid and tocopherol). Barlacristone and cristabarlone are two anthraquinones discovered in the roots. Additionally, it has been discovered that flowers contain apigene, naringenin, apigenin 7-glucuronide, sitosterol, quercetin, and quercetin 3-D glucoside [45,46,47]. The elements copper, nickel, cadmium, iron, chromium, lead, and zinc are just a few of the trace metals that have been found in the plant's leaf extract [46].

- 1. Polyphenols:** Polyphenols are naturally occurring substances that can be found in large quantities in vegetables, cereals, fruit, and drinks. In both health and disease, phytopolyphenolic substances serve as dietary antioxidants [48]. These typically serve a role in defence against UV radiation or pathogen attack [49].
- 2. Phenolic Acid:** From a petroleum ether extract of *Barleria cristata* leaf, p-coumaric acid and α -tocopherol were obtained. Tocopherol is widely recognised as the most biologically active and chemically potent variant of Vitamin E, renowned for its prominent antioxidant properties. [51,52]. A tiny monomeric phenolic acid called p-coumaric acid (4-hydroxycinnamic acid) inhibits the formation of free radical chains by acting as an oxygen radical scavenger in a number of biological systems (53-56). It enhances probiotics' functional effectiveness by activating powerful antioxidant and detoxification processes (57-60). Additionally, it effectively destroys microorganisms and reduces the peroxidation of low-density lipoprotein (LDL). Numerous pharmacological effects of p-coumaric acid has been identified to possess several effects both *in vivo* and *in vitro* including anxiolytic, hypoglycemic, antiplatelet, and antimelanogenic. (61) The maintenance of human health heavily relies on the vital biological functions of p-coumaric acid.
- 3. Flavonoids:** Flavonoids are the predominant class of polyphenolic chemicals, exhibiting a wide range of health-promoting properties. The presence of luteolin and 7-methoxy luteolin chemicals was documented in the ethyl acetate extract derived from the leaves of *Barleria cristata*. The most prevalent class of polyphenolic chemicals with a variety of health benefits are called flavonoids. It was discovered that *Barleria cristata* leaf ethyl acetate extract produced the compounds luteolin and 7-methoxy luteolin. A common dietary flavonoid called luteolin is essential for certain anti-inflammatory, antioxidant, and anticancer effects (62,63).

- 4. Glycosides:** A series of glycosides known as iridoidal glycosides, specifically barlerin and shanshiside methyl ester, were discovered in the leaves through an ethanolic extraction. Barlerin is identified as dimethyl 5-hydroxy-7-methyl-1-((2R, 3S, 4S, 6S)-3,4,5-trihydroxy-6-(hydroxymethyl) tetrahydro-2H-pyran-2-yloxy)-1, 4a, 5,6,7,7 a-hexahydrocyclopentan pyran-4,7-dicarboxylate, while shanshiside methyl ester is characterised as 5,7-dihydroxy-7-methyl-1-(3,4,5-trihydroxy-6-hydroxymethyl) tetrahydro-2H-pyran-2-yloxy)-1,4a,5,6,7,7-a (hexahydrocyclopentapyran-4-carboxylic acid).

In addition, the ethanolic extraction of the callus culture derived from shoots of *B. cristata* demonstrated the existence of phenylethanoid glycosides, namely β -[(3',4'-Dihydroxyphenyl)-ethyl]-(4''-O-caffeoyl)- β -D-glucoside (also known as desrhamnosylacteoside) and β -[(3',4'dihydroxyphenyl)-ethyl]. The compound referred to as acteoside, also known as -(3''-O-L-rhamnosyl)-(4''-O-cafeoyl)- β -Poliumoside, also known as -(3'',6''-O Phenylethanoid glycosides are a class of compounds that has a phenyl group attached to an ethanoid molecule. Phenylethanoid glycosides have been shown to possess significant pharmacological activities, including immunosuppressive, antiproliferative, antifungal, antiviral, antibacterial, analgesic, and cardiovascular system effects(64). The compound acteoside has previously been documented for its antioxidant, hepatoprotective, and anti-inflammatory properties(65).

- 5. Triterpenes:** Oleanolic acid was the name of the triterpene that was isolated from the entire plant. This compounds has been shown to have anti-inflammatory, anticancer, hepatoprotective, antibacterial, antiulcer, hypoglycemic, anticariogenic, antifertility, and antihyperlipidemic qualities (66, 67).
- 6. Aromatic Compounds:** Protecting against insects and pathogens is the primary function of aromatic chemicals with plant origins (68). From all parts of *Barleria cristata*, aromatic substances such derivatives of 4 hydroxy transcinnamate have been found. Nipa Chowdhury *et al* was isolated three aromatic compounds, namely derivatives of 4-hydroxy-trans-cinnamate, were investigated in this study(69).



The chemical structure of derivatives of 4-hydroxy-trans-cinnamate. (1-3)

X. PHARMACOLOGICAL ACTIVITY

Several extracts from the leaves, bark, seeds, and entire plant of *Barleria cristata* have demonstrated pharmacological action in both *in-vivo* and *in-vitro* models. The antibacterial, anti-inflammatory, anti-diabetic, antioxidant, hepatoprotective, and antifungal action has been the subject of several preclinical research.

1. Antibacterial Activity: The anti-microbial activity of extracts derived from the bark of *Barleria cristata* was seen against four pathogenic bacterial strains. This activity was observed at concentrations spreading across 0.025 to 0.095 mg/ml. The extracts were made using several solvents, namely chloroform, ethyl acetate, and ethanol, and the diffusion technique was employed to assess their efficacy. The diameters of the inhibition zones varied between 28 and 15 millimetres against *Bacillus subtilis*, *Staphylococcus aureus* and *Streptococcus mutans*, with the exception of *Escherichia coli*, the ethanolic extract shown the best effectiveness. The efficacy of the ethanolic extract was shown to be better, which was thought to be owing to its flavonoid concentration, after comparing the antibacterial activity exhibited by the three extracts of bark of *Barleria cristata* tested against the bacterial strains. The gossypetin 8-methylether had the best antibacterial activity among the discovered flavonoids, which promoted the usage of the ethanolic extract and/or active ingredient in modern medications(69).

K. Amutha and D. Victor Arokia Doss worked on *Barleria cristata* L. dry leaf extract's saponin profile was determined using a simple HPTLC procedure. *Barleria cristata* L. dried leaves from the saponin fraction were tested *in vitro* against four bacterial species using the agar disc diffusion methods. The efficacy of the saponin fraction extract was observed to be significant against *Salmonella paratyphi* (8 millimetres), *E. coli* (9 millimetres), *S. aureus* (9 millimetres), and *Klebsiella pneumonia* (10 millimetres) among the four bacterial pathogens examined. Pure saponin has a zone of inhibition comparable to that of antibiotics such conventional Ciprofloxacin (5 g/disc). According to the current research, the saponin fraction has high antibacterial activity and might be exploited to create a new antimicrobial drug. (70)

S. Baskar et al has discovered antipathogenic activity, the disc diffusion test is employed to differentiate between gram-positive and gram-negative microorganisms. The utilisation of Mullar Hinton Agar (MHA) and Potato Dextrose Agar (PDA) plates in bacterial studies has led to the observation of a zone of inhibition when two doses, specifically 0.60 and 1.20 mg/disc, were investigated. In this investigation, elevated at 1.20 milligrammes concentrations were more sensitive to all strains than lower (0.60 mg) concentrations. This study has shown that *Barleria cristata* contains secondary metabolites that contribute to its exceptional antimicrobial properties. These compounds include steroids, triterpenes, alkaloids, phenols, flavonoids, and tannins. These compounds encompass the potential to serve as antimicrobial agents in novel pharmaceutical formulations aimed at preventing infectious diseases in the human population(71).

In a recent study, gold nanoparticles of *Barleria cristata* leaves extract were shown to be significant antibacterial activity has studied by S. Baskar and co-worker. To explore the production of gold nanoparticles, the leaves of *Barleria cristata*, which are regarded as one of the key therapeutic plants in indigenous systems of medicine and one of the dietary components used as a digestive in India, were employed. A significant amount of activity has been shown by the Au nanoparticles against various human diseases. According to research, gold has the best antibacterial properties of all the metals in the following order: Au>Zn>Fe>Mn>Mo>Sn. In the current investigation, all of the examined microorganisms responded more sensitively to higher (30 L/disc) Au sample concentrations compared to lower (15 L/disc) sample concentrations (72).

The present study focuses on the manufacture of zinc oxide nanoparticles utilising the leaves extract of *Barleria cristata*. Additionally, the antibacterial potency of the synthesised nanoparticles will be investigated by G. Madan Kumaret aland his team .The researcher explores an environmentally friendly approach to synthesising physiologically active zinc oxide (ZnO) nanoparticles by the utilisation of zinc nitrate (ZnNO₃) by using *Barleria cristata* leaf extract's bioactive components.The synthesis of ZnO nano crystallites, characterised by an the average size range observed is within the region of 30-35 nm., was achieved by rapid , easy and ecologically friendly process zinc oxide nanoparticles have been examined using scanning electron microscopy (SEM) and X-ray diffraction (XRD) methods.The resulting particles are agglomerates of Nano crystallite and are spherical in shape. The hexagonal crystal form of ZnO is revealed by the X-ray patterns. The antimicrobial efficacy of zinc oxide (ZnO) against four specific pathogens, namely *Staphylococcus aureus* MTCC 3160, *Bacillus subtilis* MTCC 441, and *Escherichia coli* MTCC 443, was investigated.The study indicate that zinc oxide nanoparticles possess significant antibacterial capabilities (73).

The present study examined the anti-fungal and anti-bacterial characteristics of the ethanolic extract of *Barleria cristata* based on the dimension of the inhibition zone against the ten bacteria tested by Darling Chellathai et al. The plant extract demonstrated a strong antibacterial effect against *Vibrio spp.* with an inhibition zone diameter of 15 mm, followed by *Staphylococcus aureus* with a 14 mm diameter. *Salmonella*, *E. coli*, *Pseudomonas*, *Vibrio parahaemolyticus*, and *Aeromonas spp.* all exhibited moderate antibacterial activity at the same concentration, with inhibition zone sizes of 6 to 8 mm. In comparison to *Klebsiella* and *Proteus* species, the plant extract demonstrated the least antibacterial properties(74).

- 2. Antifungal Activity:** K. Amutha and D. Victor Arokia Doss (70) have conducted a study on the antifungal properties of the saponin fraction derived from *Barleria cristata* leaf. The study focused on evaluating the *in-vitro* antifungal activity of this saponin fraction against four fungal species, namely *Aspergillus niger*, *Aspergillus fumigates*, *Aspergillus parasites* and *Candido albicans*. The agar disc diffusion method was employed, with Cotrimazole serving as the standard for comparison.The saponin fraction exhibited the highest level of activity against *Aspergillus parasites*, with a diameter of inhibition zone measuring 12 mm. This was followed by *Aspergillus parasites*, *Aspergillus fumigates*, and *Candido albicans*, all of which had inhibition zones measuring 9 mm.

S. Baskar et al (71) has investigated antifungal potency of ethanolic solvent extract of *Barleria cristata* leaf against *Cryptococcus sp.*, *Microsporium canis*, *Trichophyton rubrum*, *Candida albicans*, by using Itraconazole (10mcg/disc) as a standard.It has shown effectiveness against *Trichophyton rubrum*. In contrast, a lesser impact was reported in *Cryptococcus sp.*

S. Baskar et al (72) has reported Antifungal activity of gold nanoparticles AuNps derived from *Barleria cristata* leaves.against *Candida albicans* , *Cryptococcus sp.**Microsporium canis*,*Trichophyton rubrum* by using Itraconazole (10mcg/disc) as a standard. Plant showed maximum activity against *Candida albicans* (10mm) followed by, *Cryptococcus sp.**Microsporium canis* (9 mm).

G. Madan Kumar et al (73) has worked on antifungal potential of ZnO nanoparticles using leaf Extract of *Barleria cristata* against *Aspergillus niger* at 12.5 g/ml and 6.25 g/ml respectively. Zinc oxide nanoparticles were shown to have a minimum fungal count and a minimum inhibitory concentration of 12.5 g/ml and 6.25 g/ml, respectively.

Darling Chellathai et al has examined the ethanolic leaf extracts' antifungal properties of *Barleria cristata*. Among the five fungal species studied, the maximum zone of inhibition was shown by *Aspergillus niger* species which was only around 6mm diameter at 1000µg/ml. The other fungal species exhibited a moderate level of sensitivity, as demonstrated by inhibition zones of between 3 and 5 mm in diameter(74).

- 3. Anti-Inflammatory Activity:** Gambhire et al. (75) conducted the study. The aim of this investigation is to examine the anti-inflammatory potency of certain fractions derived from the methanol extract of *Barleria Cristata* leaves. This investigation will be conducted using acute and chronic models of inflammation. The current investigation aimed to examine the anti-inflammatory characteristics of several fractions (petroleum ether, chloroform and methanol) derived from the extract of *Barleria Cristata*. The evaluation of these fractions was conducted using two experimental models: rat paw edoema carried on by carrageenan and granulomas carried on by cotton pellets. The administered doses for the evaluation were 50, 100, and 200 mg/kg. The positive control utilised in the study was indomethacin at a dosage of 10 mg/kg. The study's findings indicate that the chloroform fraction exhibited a modest level of anti-inflammatory activity, while the methanol fraction shown a considerable and anti-inflammatory efficacy that was dose-dependent in both of the tested animals. The administration of methanol fraction at a dosage of 200 mg/kg and indomethacin at a dosage of 10 mg/kg resulted in substantial inhibition ($P < 0.05$) of 65.21% and 69.07% respectively. The present study examines the occurrence of rat paw edoema following the administration of carrageenan, with a specific focus on the 4-hour time point. In the granuloma carried on by cotton pellets approach, three different fractions, as well as indomethacin, exhibited statistically vital activity ($P < 0.05$) compared to the control group. The methanolic fraction, administered at a dosage of 200 mg/kg, exhibited a the wet cotton exhibited a maximum inhibition of 62.37%, whereas the dry cotton showed a maximum inhibition of 53.84%. In comparison, indomethacin, administered at a dosage of 10 mg/kg, shown inhibition rates of 68.04% on wet cotton and 59.61% on dry cotton in the context of the induction of granuloma in rats using cotton pellets. The data obtained from the experiment were subjected to statistical analysis using a one-way analysis of variance (ANOVA) followed by Dunnett's multiple comparison test. A significance level of $P < 0.05$ was used to determine if the observed differences were statistically significant when compared to the control group. The current investigation has provided evidence that the methanol fraction derived from the leaves of *Barleria Cristata* Linn possesses noteworthy anti-inflammatory properties.

A study was conducted by Shahnaz Banu to conduct an investigation the potential anti-inflammatory activity of the methanolic extract of roots in rats. The extract, when administered orally at dosages of 250 and 500 mg/kg b.w., had a substantial and dose-dependent anti-inflammatory effect in both acute inflammation generated by carrageenan-driven hind paw edoema and chronic inflammation in the cotton pellet

granuloma models. The animals that were administered a dosage of 500 mg/kg had the highest level of inhibition, with statistical significance ($p < 0.001$). The anti-inflammatory activity of BCW extract can be attributed to four therapeutically active flavonoids, namely apigenin, quercetin, naringenin, and luteolin. Flavonoids have been observed to exert inhibitory effects on prostaglandin formation, hence exhibiting potential therapeutic properties in the management of inflammation (76).

Gambhire et al. (77) conducted a search to examine the possible anti-inflammatory effects of the methanolic extract derived from the roots of a certain plant species. The study utilised rats as the experimental subjects. The extract, when administered orally at dosages of 250 and 500 mg/kg b.w., had a substantial and dose-dependent anti-inflammatory effect in both acute inflammation generated by carrageenan-driven hind paw edoema and chronic inflammation using the cotton pellet granuloma models. The animals that were administered a dosage of 500 mg/kg had the highest level of inhibition, with statistical significance ($p < 0.001$). Therefore, the current study has provided pharmacological data to substantiate the traditional belief that *Barleria cristata* Linn. possesses anti-inflammatory properties.

The anti-inflammatory efficacy of the methanolic extract of *Barleria Cristata* leaves (BCM) was assessed by M. Gambhire (78) by *in vivo* and *in vitro* methodologies. In the experiments conducted to evaluate inflammation in living organisms, it was shown that BCM had a strong inhibitory effect on edoema caused by histamine and serotonin in rats. Additionally, BCM demonstrated a dose-dependent reduction in acetic acid-induced vascular permeability in mice. The present investigated the potential mechanism by which BCM exerts its effects on inflammatory conditions using *in vitro* experiments. Specifically, the effects of BCM on red blood cells (RBCs) were examined in relation to their exposure to a hypotonic solution and thermally induced protein denaturation. The results of the study demonstrated that BCM had a notable property of stabilising the cell membrane. The extract had a strong inhibitory effect on thermal-induced protein denaturation. The effect was evaluated by comparing it to the activity of indomethacin and cyproheptadine, which served as reference standards for various forms of inflammation. The study's findings indicate that BCM exhibits anti-inflammatory properties.

- 4. Anti- Hyperglycaemic Activity:** *Barleria cristata* leaf extracts have been studied for their *in vitro* antidiabetic potential by Sakthivel Vasanth et al. (79) The present research aimed to examine the potential anti-diabetic activities of the ethanol and petroleum ether extracts derived from the leaves and roots of *Barleria cristata*. The evaluation of the fractions' potential efficacy was conducted by examining their effect on the *in vitro* antidiabetic activity of α -amylase and α -glucosidase. The results suggest that the ethanol and petroleum ether leaf extracts derived from *Barleria cristata* demonstrate a dose-dependent enhancement in their inhibitory effects on α -amylase and α -glucosidase enzymes, as compared to the control group. In comparison to the petroleum ether extract, the ethanolic leaf extract exhibited the most pronounced *in vitro* antidiabetic action. According to the current identifying, *Barleria cristata* is capable of inhibiting alpha-glucosidase and alpha-amylase enzymes *in vitro* in a dose-dependent manner. In the experimental rat model of alloxan-induced diabetes, it was shown that the ethanol extracts derived from *Barleria cristata* seeds had a dose-dependent inhibitory effect on

alpha-amylase activity. Furthermore, this inhibition was found to be associated with a considerable reduction in blood glucose levels.

Barleria cristata (EtBc) ethanolic leaf extract was designed by Narmadha Rajasekaran et al. to test the antihyperglycemic effects in diabetic rats induced by streptozotocin at a dosage level of 400mg/kg of body weight over a period of 45 days. Blood sugar levels in diabetic rats significantly decreased ($P < 0.05$) after EtBc administration. Modifications in body and organ weight were further seen, and the blood concentration of glycemic markers, such as insulin, C-peptide, total haemoglobin, and glycosylated haemoglobin levels, were restored to a comparable level as that of the control rats. So it was proposed that *Barleria cristata* could be effective by potentiating insulin release from the pancreas or by enhancing glucose absorption by muscle cells. (80)

Barleria cristata Linn leaf extract was tested for its antidiabetic effects in rats by Mohd Nazam Ansari et al. Alloxan (150 mg/kg) was administered intraperitoneally (IP) once to each of the seven groups of rats to cause diabetes. For a total of 21 days, ethyl acetate extract of leaves (EALE) and hydro-alcoholic leaves extract (HALE) were administered to animals at lower (250 mg/kg) as well as high (500 mg/kg) doses. Each week, blood sugar levels (BGL) and body weight were measured. On the 21st day of the experiment, the rats died while under the influence of mild ether anaesthesia, blood and vital organs were taken to calculate biochemical values and examine histological alterations. In all of the groups, only one dose of alloxan led to hyperglycemia. When compared to the normal control, the toxic control groups showed a consistent rise in BGL. Daily oral administration of the usual medication (Glimepiride, 5 mg/kg) along with the extracts (HALE and EALE) dramatically decreased high BGL ($p < 0.001$) and helped diabetic rats restore their body weight. The recovery of the biochemical profile showed that the extract treatment also enhanced the liver and kidneys' ability to operate normally. The research showed that *B. cristata* has potential anti-diabetic properties. (81)

Ranjit Singh et al. aims to investigate the potential anti-diabetic activity of the ethanolic extract derived from the seeds of *Barleria cristata* using a screening process. Alcoholic extracts of *Barleria cristata* dry seeds were tested for their ability to lower blood sugar levels in Wistar rats (150–200 g). A digital glucometer was used to determine the blood sugar level. Taking seeds extracts orally at doses of 200 mg/kg led to a significant reduction in blood glucose levels. This provided the framework for investigating the substances in such anti-diabetic plants that are responsible for their hypoglycemic effects. (82)

The objective of K. Amutha et al. (83) was to assess the herb *Barleria cristata* L.'s hypoglycemic effects. *Barleria cristata* L. crude powdered leaf extract underwent phytochemical screening, which identified a number of bioactive phytoconstituents. In an acute toxicity investigation, *Barleria cristata* L. leaf extract in 50% hydroethanol was found to be safe for oral administration at all typical therapeutic levels. Alloxan was injected intraperitoneally into test subject rats to cause diabetes. The blood glucose levels of rats administered with a 50% hydroethanolic extract of *Barleria cristata* L. exhibited a reduction similar to that observed in rats treated with Glibenclamid.

5. **Antiherlipidemic:** *Barleria cristata* Linn's hypolipidemic action in rats was examined by Mohd Nazam Ansari et al. (81). To ascertain the normal functioning of essential organs including the liver and kidney, alloxan-treated groups had their blood lipid composition, serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), creatine kinase, urea measured.

The investigation conducted by K. Amutha et al. focused on evaluating the hypolipidemic properties of a hydroethanolic extract derived from the leaves of *Barleria cristata*, with a concentration of 50%. Rats afflicted with hyperlipidemia (HLD) and subjected to treatment with a plant extract had a hypolipidemic effect that was seen to vary in intensity according on the dosage administered. The levels of all lipid components, including total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL) cholesterol, and very low-density lipoprotein (VLDL) cholesterol, shown a significant decline. Conversely, high-density lipoprotein (HDL), commonly referred to as good cholesterol, demonstrated an elevation. The findings of the present study clearly demonstrate that the leaf extract of *Barleria cristata* L., obtained using a 50% hydroethanol solvent, has hypolipidemic action.

6. **Cardio Protective Activity:** The study conducted by Kowsalya J et al (84) aimed to assess the cardioprotective effects of the ethanolic extract derived from the leaves of *Barleria cristata* Linn. in an in vivo setting, utilising *Daphnia magna* as the experimental model. The study involved evaluating the effects of different concentrations (20, 40, 60, 80, and 100µg/ml) of the ethanolic extract derived from *Barleria cristata* on lactose-induced arrhythmia in *Daphnia magna*. The results were then compared to the effects of a typical medication, metoprolol. The cardioprotective effects of ethanolic extracts derived from *Barleria cristata* Linn. were individually assessed in four groups of *Daphnia magna*: control, lactose-induced, metoprolol-treated, and ethanolic extract-treated groups. The findings indicated that the ethanolic extract derived from the plant had a cardio-protective effect in *Daphnia magna*, with the extent of this effect being dependent on the dosage administered.
7. **Thrombolytic Activity:** Tasnuva Sharmin et al was worked on the positive control used in this study was streptokinase, whereas the negative control was water. The findings of this study indicate that the water soluble fraction had a clot lysis rate of 0.22%. The constituents derived from *Barleria cristata* exhibited a level of thrombolytic activity ranging from mild to moderate. The soluble fraction in an aqueous solution exhibited a clot lysis rate of 45.0±0.22%, whereas the conventional streptokinase (85) achieved a clot lysis rate of 65.66%.
8. **Hepatoprotective Activity:** The ethanolic leaf extracts of *Barleria cristata* have been shown to have in-vivo hepatoprotective efficacy of carbon tetrachloride (CCl₄) on Wistar rats, administered at dosages of 100 and 200 mg/kg body weight, according to Balaji et al. (86) The ethanol-based extract of *Barleria Cristata* considerably reduces the blood levels of hepatospecific enzymes such as SGPT, SGOT, ALP, and total bilirubin levels, as well as total protein levels, cholesterol, and triglycerides levels (P < 0.001). A well-known hepatoprotective medication utilised as a comparator, Silymarin (25 mg per kg), shown considerable efficacy (P<0.001). Until a dosage of 2000 mg/kg body weight, the

extract showed no signs of mortality. The biochemical analyses were supported by histopathological studies.

- 9. Cytotoxic Activity:** The research conducted by Tasnuva Sharmin and colleagues has focused on The cytotoxic activities of the methanol extract, hexane extract, carbon tetrachloride extract, chloroform extract, and water soluble partitionates of *Barleria cristata* leaves were screened. In the context of the brine shrimp lethality bioassay, it was observed that all the fractions exhibited significant cytotoxicity against *A. salina*, as shown by the LC₅₀ values that varied between 1.52 and 340.83 µg/ml. The portion soluble in hexane had the most pronounced cytotoxic activity, as evidenced by its LC₅₀ value of 1.52±0.34 µg/ml, which was higher than the LC₅₀ value of 0.451 µg/ml seen for Vincristine sulphate. (85)

Mukul Pathy and its co-worker (87) has reported on cytotoxic activities of leaf and bark extracts. The solvents hexane, chloroform, acetone, and methanol were synthesised using a sequential extraction process. The cytotoxic activity of all the extracts was evaluated through the use of the Brine shrimp lethality assay. The methanol extract of both the leaf and bark exhibited significant levels of activity, with the leaf extract exhibiting a potency of 94% and the bark extract showing a potency of 83%.

Ali M. El-Halawany et al. (88) focused on the analysis of phenolic compounds derived from *Barleria cristata* var. *Alba* as potential inhibitors of carcinogenesis. Specifically, the researchers investigated the ability of these compounds to counteract the cytotoxic effects of menadione by inducing and protecting quinone reductase activity. The ethyl acetate fraction obtained from *B. cristata* var. *alba* included five previously described chemicals, namely verbascoside (1), isoverbascoside (2), dimethoxyverbascoside (3), p-hydroxy benzoic acid (4), and apigenin-7-O-glucoside (5). Isoverbascoside (2) shown significant potency in inducing the activity of the enzyme in a way that is dependent on the dosage, based on the compounds that were tested. Compound 2 exhibited the highest efficacy in protecting Hepa-1c1c7 cells from the toxic effects induced by menadione, a quinone substrate known to interact with NQO1, thus serving as a reliable functional test for detoxification.

S. Baskar et al (72), the authors have documented the utilisation of *Barleria cristata* leaf extract for the green production of gold nanoparticles (AuNP) in order to facilitate various pharmacological investigations. The biological mechanism of gold nanoparticles (AuNPs) was investigated using the Hela cell line to assess their potential as anticancer agents. The anticancer activity of the AuNPs was validated by the MTT test conducted on Hela carcinoma cells, which revealed IC₅₀ values of the extract at a concentration of 50 µg/mL.

10. Antioxidant Activity

- **In-vivo Antioxidant Activity:** Narmadha Rajasekaran (88) conducted research on the impact of antioxidants found in ethanolic leaf extracts of *Barleria cristata* (EtBc) on streptozotocin-induced diabetic rats. The rats were administered a dose of 400mg/kg body weight for a duration of 45 days, with the intention of evaluating the potential therapeutic effects. After the administering of EtBc and glibenclamide, the

rats who received treatment exhibited a significant increase in the activity levels of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), and glutathione reductase (GR) compared to the rats with diabetes. The obtained outcome demonstrates the effectiveness of EtBc in reducing oxidative stress. Particularly, the administration of the extract to diabetic control rats resulted in a substantial increase in the level of GSH. This suggests that the extract has the potential to enhance the production of GSH, mitigate oxidative stress hence minimising GSH breakdown, or maybe exert both of these actions simultaneously.

Mohd Nazam Ansari carried out studies on the in-vivo assessment of the antioxidant properties of *Barleria cristata* extracts. Antioxidant markers, such as TBARS, protein carbonyl, SOD, catalase, and GSH, are crucial in their function of neutralising the detrimental effects of free radicals produced inside the human body. A statistically significant increase ($p < 0.001$) in the levels of TBARS and protein carbonyls was reported in the diabetes control group compared to the normal control group. Upon initiation of therapy with a low dosage of EALE, a notable reduction in levels of TBARS and Protein carbonyl was detected, with statistical significance indicated by a p-value of less than 0.001. Conversely, when a high dosage of EALE was administered, a major drop in TBARS levels was found, again with a p-value of less than 0.001, while a moderate decrease in Protein carbonyl levels was observed, with statistical significance indicated by a p-value of less than 0.01. [81].

- **In-vitro Antioxidant Activity:** Sakthivel Vasanth and (79) his co-worker were to study the *in-vitro* antioxidant activity of *Barleria cristata* leaves extracts. The antioxidant activity of the leaf and root of *Barleria cristata* was evaluated using several assays, including DPPH and FRAP, with the use of ethanol and petroleum ether extracts. The results indicate that there is a positive correlation between the content of *Barleria cristata* plant extract and its DPPH free radical scavenging ability, as shown in the DPPH activity assay. The results of the ferric reducing ability of plasma test indicate that the ethanol extracts derived from *Barleria cristata* exhibited a greater inhibition of ferric reducing activity in comparison to the petroleum ether extract.

The antioxidant profiles of the leaf and bark of the ornamental plant *Barleria cristata* were investigated by Mukul Pathy et al. (87) through the use of qualitative and quantitative tests. The qualitative approach involved the utilisation of thin layer chromatography in conjunction with the DPPH test. On the other hand, the quantitative analysis encompassed the assessment of nitric oxide radical scavenging, DPPH radical scavenging, and ferric reducing antioxidant power (FRAP). The leaf extracts exhibited a greater number of antioxidant bands compared to the bark extracts. This finding was further confirmed using the quantitative DPPH radical scavenging experiment, where the acetone leaf extract shown a radical scavenging activity over 80%. As a result, it was shown that none of the bark extracts exhibited radical scavenging activity over 60%. Significant antioxidant activity were observed in the methanol and acetone extracts of both leaf and bark samples.

The study conducted by Mohd Nazam Ansari et al. (81) focuses on the in-vitro assessment of the antioxidant activity of extracts derived from *Barleria cristata*.

The antioxidant capacity of three leaf extracts (HALE, EALE, and HLE) derived from *Barleria cristata* was evaluated using the DPPH and H₂O₂ radical-scavenging assays. The results indicate that the three extracts of *Barleria cristata* exhibit favourable antioxidant capabilities in comparison to the standard antioxidant, ascorbic acid. It is important to highlight that the substances HALE and EALE exhibited notable antioxidant activity, as evidenced by their respective IC₅₀ values in the DPPH-scavenging assay (92 mg/ml and 332 mg/ml for HALE, and 332 mg/ml for EALE). Additionally, HALE demonstrated significant antioxidant activity in the H₂O₂-scavenging assay (IC₅₀: 464.83 mg/ml), while EALE exhibited notable activity in the H₂O₂-scavenging assay (IC₅₀: 544.19 mg/ml). Consequently, these substances were selected for further investigation in animal studies. In contrast, the HLE extract exhibited minimal antioxidant activity, therefore rendering it unsuitable for use in animal research.

Tasnuva Sharmin conducted a study on the methanol extract of leaves from *Barleria cristata* L. Additionally, the hexane, carbon tetrachloride, chloroform, and aqueous soluble partitionates derived from the extract were examined for their antioxidant properties. The assessment of antioxidant capacity was conducted using DPPH and Folin-Ciocalteu reagents, with butylated hydroxytoluene (BHT) and ascorbic acid serving as reference standards. In the DPPH free radical scavenging experiment, it was shown that all the fractions exhibited a low level of free radical scavenging activity. The IC₅₀ value of the carbon tetrachloride soluble fraction was determined to be 300.82±0.33 µg/ml, which showed a correlation with its phenolic content of 89.22±0.12 mg of gallic acid equivalents (GAE) per gramme of extractives (85).

- **Toxicity Report:** The acute toxicity tests of the ethanolic leaf extract of *Barleria cristata* were conducted by Narmadha, R et al. The results indicated that the extract was found to be safe in rats at a dosage level of up to 2000 mg/kg p.o. The experiment was conducted on Wistar albino rats and evaluated at regular intervals for signs of toxicity and mortality during a 24-hour period, followed by daily monitoring for the subsequent 14 days (88).

During the 24-hour observation period, no adverse effects or mortality were seen in the mice that were orally administered a methanolic extract of the root of *Barleria cristata* at doses up to 5 g/kg. The doses for the anti-inflammatory action were established at a fixed value of 250 mg/kg body weight, based on the obtained results (76).

XI. TLC, AND GC-MS ANALYSIS OF *BARLERIA CRISTATA* LINN.

Harini and his co-worker (89) conducted an investigation on the examination of the methanol extract of *Barleria cristata* Linn leaves using Thin-Layer Chromatography (TLC) and Gas Chromatography-Mass Spectroscopy (GCMS). The methanolic extract was subjected to thin-layer chromatography (TLC) to analyze the presence of five key phytoconstituents, namely alkaloids, flavonoids, saponins, glycosides, and triterpenoids. The methanol extract derived from *Barleria cristata* Linn exhibited the presence of several compounds, including Alkaloid (Rf Value 0.42), Flavonoids (Rf Value 0.65), Saponin (Rf

Value 0.33), Glycosides (Rf Value 0.54), and Terpenoids (Rf Value 0.17). The analysis of the methanolic extract by TLC profiling indicates the presence of a significant amount of phytoconstituents.

The methanolic extract of *Barleria cristata* leaves was subjected to GC-MS analysis, resulting in the identification of a total of 15 compounds. Each of these compounds exhibited unique phytochemical characteristics. The major components present in leaves of *Barleria cristata* are Decanal, 4-Azido-Heptane, 2-Hydroxymethyl-9-[Beta-D-Ribofuranosyl]Hypoxanthine, 11-Tridecen-1-ol, Methyl Ester 13,16-Octadecadienoic Acid, N-[4-Bromo-N-Butyl]-2-Piperidinone, N-Methyl-N-Nitroso-1-Octanamine, 2-Methyl-6-Methylene-Octa-1,7-Dien-3-ol, 4-Acetamido-1-Hexanol, 1-(2-Propenyloxy)-Pentane, 4-Undecanone, (R, S)-2-Propyl-5-oxohexanal, 10-Methyl-4-undecanone, 1-Tetradecanamine, and N-Methyl-1-octadecanamine. The chemical compounds referred to as N-[4-Bromo-N-Butyl]-2-Piperidinone has been documented as a potent bactericidal inhibitor with the potential to effectively cure conditions such as bladder spasms, shrinkage, and ulcer inflammation. (90) Additionally, Decanal, a chemical compound, has been found to be often utilised in the production of fragrances (91). The compound 11-Tridecen-1-ol has been documented to possess antibacterial properties, (92). The use of 4-undecanone as an antibacterial agent in medicinal formulations has been documented (93). The gas chromatography-mass spectrometry (GC-MS) technique is a direct analytical methodology commonly used for the identification of phytochemicals. This method allows for the analysis of phytochemicals using just a little quantity of plant extract, typically a few grammes. The observed biological action of several compounds underscores the importance of our research. Hence, based on the findings of this investigation, it can be inferred that the methanolic extract derived from *Barleria cristata* Linn. The capacity to serve as an alternative source of therapeutic drugs is attributed to its composition of phytoconstituents and other bioactive components.

XII. SYNTHESIS OF NANOPARTICULAR

- 1. Synthesis of Zinc Oxide Nanoparticles:** Madan Kumar et al. successfully synthesised physiologically active zinc oxide (ZnO) nanoparticles using zinc nitrate ($ZnNO_3$) and the bio components extracted from leaves of *Barleria cristata*. The synthesis of ZnO nano crystallites with an average size range of 30-35 nm has been achieved using a quick, simple, and environmentally sustainable approach. The characterization of zinc nanoparticles was conducted via the use of scanning electron microscopy (SEM) and X-ray diffraction (XRD) techniques. The particles obtained exhibit a spherical morphology and consist of agglomerations of nanocrystallites. The X-ray diffraction patterns indicate that ZnO has a hexagonal crystal structure. Zinc oxide nanoparticles have robust antibacterial and potent antifungal properties as compared to regular zinc oxide particles, specifically targeting certain types of bacteria and fungi. In the future, it is possible that nanoparticles might serve as substitutes for traditional preservatives in cosmetic products (73).
- 2. Gold Nanoparticle:** S. Baskar and colleagues carried out studies on the green production of gold nanoparticles (AuNP) utilising an extract derived from the leaves of *Barleria cristata*. A variety of human diseases were employed to assess the antibacterial characteristics of gold nanoparticles (AuNPs), while the potential anticancer effects of

these nanoparticles were investigated using the Hela cell line. The aqueous extract, with a pH of 7.4 (which is the intrinsic pH of the extract), was subjected to a reaction with a 1 mM concentration of Chloroauric acid ($\text{HAuCl}_4 \cdot 3\text{H}_2\text{O}$) and maintained at ambient temperature. The rapid transition in colour from a light yellow shade to a pink shade was indicative of the reduction of Au^{3+} ions to Au^0 . The synthesised gold nanoparticles (AuNPs) were monitored using a UV-Visible spectrophotometer. The techniques employed in this study include X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), and Dynamic Light Scattering (DLS). The antibacterial activities of the extract were verified by the disc diffusion technique on several human infections. Additionally, the extract's anticancer activity was validated using the MTT test on Hela carcinoma cell lines, which revealed IC_{50} values of the extract at a concentration of 50 $\mu\text{g}/\text{mL}$. Gold nanoparticles (AuNPs) derived from leaves of *Barleria cristata* have significant antibacterial and anticancer properties when tested against various microorganisms and human cancer cell lines. The biosynthesised gold nanoparticles exhibit promising promise for many medicinal applications. (72)

XIII. CONCLUSION

The pharmacological and phytochemical investigations have confirmed that this particular traditional medicinal plant possesses significant potential for many therapeutic uses, such as the treatment of TB, diabetes, skin infections, snakebites, bronchitis, toothaches, inflammation, and anaemia. It is known that *Barleria cristata* is recognised for its many biological activities, including antibacterial, anti-inflammatory, antidiabetic, antifungal, antioxidant, hepatoprotective, and cytotoxic action. In addition, this source contains a wide range of compounds with diverse chemical structures, including triterpenes such as oleanolic acid and β -Sitosterol, phenylethanoid glycosides such as desrhamnosyl acteoside, acteoside, and poliumoside, phenolic compounds such as p-Coumaric acid and α -Tocopherol, flavonoidal compounds such as luteolin, 7-methoxyluteolin, apigene, and naringenin, as well as iridoidal glycosides such as Barlerin and Schanshiside methyl ester. Collectively, the research presented provides robust evidence to substantiate the potential therapeutic efficacy of this plant in treating certain illnesses.

Despite the presence of scientific data relating to the therapeutic benefits of *Barleria cristata*, there remain some knowledge gaps around the many uses of this botanical species. One significant exclusion is the need for more pharmacological study on the crude extracts and active ingredients derived from *Barleria cristata*. This research would serve to establish standardised medical applications for this plant and establish a scientific foundation for the future development of novel medications derived from it.

The majority of the evidence about the pharmacological activity of plant extracts has been acquired through in-vitro and animal-based research. Future study should focus on the bioassay-guided isolation of specific compounds or classes of compounds that exhibit the most promising pharmacological activities, including cytotoxic, antihyperglycemic, antibacterial, anti-aging, and antifungal effects. This research is necessary to elucidate the underlying mechanisms of these activities. It is important to conduct pharmacological activity tests on a significant number of isolated substances.

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