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RESEARCH ARTICLE
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A BRIEF REVIEW ON PHARMACOLOGICAL BENEFITS OF *VERBASCUM THAPSUS L*

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ABSTRACT:
Verbascum Thapsus L., often known as common mullein, is a medicinal plant that is easily located along roadsides, in meadows, and on grazing grounds. It has been used to treat a variety of conditions, including asthma, inflammatory disorders, lung issues, diarrhea, and migraine, headaches. Common mullein has been used medicinally since ancient times, but in recent years, its popularity has grown economically. A growing body of research investigations has been conducted in support of the use of common mullein extracts in folk medicine in recent times. Detailed review and its pharmacological actions are highlighted in this article which can be one of the promising herbs for the treatment of variety of disorders related to inflammatory and allergic conditions.

INTRODUCTION:

The *Verbascum* is the largest genus in the Scrophulariaceae family, with over 2500 species. Ten species that have been used to treat a variety of pathologies have been catalogued by the Spanish Inventory of Traditional Knowledge related to Biodiversity: *Verbascum pulverulentum Vill., V. sinuatum L., V. Thapsus L., V. boerhavii L., V. dentifolium Delile, V. giganteum Willk., V. lychnitis L., V. rotundifolium Ten., and V. virgatum*. (1,2)
Verbascum Thapsus L. is most used and having great pharmacological effects, it is also known as Wooly Mullein, or Common Mullein. It is an erect biennial plant that grows low in the first year as a bluish gray-green rosette. Mature plants bloom in the second year and reach heights of 5 to 10 feet, including the noticeable flowering stalk. Originally from Europe, northern Africa, and Asia, and then introduced in America & Australia. (3,4)

Botanical name*: Verbascum Thapsus*
Family: Scrophulariaceae
Common name: Great or Common Mullein, Velvet Dock, Velvet Plant, Woolly Mullein
Part used: Leaves, stems, roots and flowers**.**
Habitant: The plant grows all over Europe and in temperate Asia as far as the Himalayas, and in North America, Europe, northern Africa.(5)

Medical & histological uses:

Mullein has been used historically to treat respiratory tract conditions, especially irritable coughs with bronchial congestion. Herbalists utilize mullein leaves and flowers expectorant and demulcent qualities to treat respiratory conditions such bronchitis, whooping cough, dry coughs, TB, asthma, and hoarseness. The flowers have a calming and anti-inflammatory impact on the urinary tract in addition to being a moderate diuretic.
Moreover, anodyne, antiseptic, antispasmodic, astringent, emollient, nervine, vulnerary, analgesic, antihistaminic, anticancer, anti-oxidant, antiviral, bacteriostat, cardio depressant, fungicide, hypnotic, and sedative properties are associated with the leaves, roots, and flowers. (6,7,8)

Pharmacological Uses:

Mostly *Verbascum Thapsus* is use in respiratory conditions like asthma, tuberculosis, bronchial conditions and available in different formulations.

1.Expectorant & Demulcent properties:

The Native Americans used mullein to treat mental and respiratory ailments. They smoked the leaves or drank tea made from them. *Verbascum Thapsus* was used for respiratory tract irritation during the 1800s Eclectic movement and is still used today for respiratory disorders in cattle. (9)
Verbascum Thapsus contains mucilage, which is generally thought to be harmless and is known to lessen coughing and tightness in the respiratory system. But one should refrain from utilizing if they have severe catarrh, which is defined as an excessive mucus discharge or accumulation and irritation of the mucous membrane; in that case, taking a decongestant would be helpful.
Expectorant: Mullein's saponin content aids in the removal of mucus from the respiratory tract, relieving congestion and coughing.
Demulcent: Mullein's mucilage covers mucous membranes with a protective layer that soothes inflamed tissues and relieves dry cough. (10)
The most common way to ingest mullein is as a syrup or infusion that is liquid. It may be used on its own or in conjunction with other herbs such as pine leaves, hawthorn blossom, mint, and rosemary. Mullein's plant-based chemicals are known to have expectorant (mucus-thinning) and antitussive (cough-reducing) effects. Additionally, unsolid acid—which some researchers think may be utilized to both prevent and cure COVID-19 infection—is present in mullein. (11)
That being said, the majority of the advantageous flavonoids in mullein have low bioavailability, which means that the body has difficulty absorbing them. To find out if mullein may be used to treat respiratory illnesses, more study is necessary. (12,13)

2. Antibacterial:

Using the agar-well diffusion method and various concentrations (25%, 50%, 75%, and 100%), the antibacterial activity of the methanolic and acetone leaf extracts of *Verbascum Thapsus* was assessed in vitro against medically significant pathogens such as Escherichia coli, Yersinia pestis, Bacillus cereus, Pseudomonas aeruginosa, Listeria monocytogenes, and Staphylococcus aureus. The specified bacterial strains exhibited minimal to substantial antibacterial activity, according to the results. Compared to acetone leaf extract, methanolic leaf extract shown greater efficacy against certain pathogenic bacterial species.
Additionally, gram-positive bacteria were suppressed by the leaf extract of both plants more effectively than gram-negative bacteria. As a result, these plants' leaf extracts might be chosen for additional research to ascertain their medicinal potential. (14)

According to the study, the plant exhibited antibacterial activity against Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, and Klebsiella pneumoniae. The existence of saponins was suggested as the cause of this action. Additionally, the commercial product made from *Verbascum Thapsus* flowers in pure olive oil showed anticancer activity. Here, it was demonstrated that the saponin fraction was in charge. As a result, an effort has been made in the current work to evaluate the antibacterial properties of *Verbascum Thapsus* methanolic and acetone extracts against certain pathogenic bacterial strains. (15,16)

3. Antiviral properties:

Herpes simplex virus type 1 (HSV-1) and influenza virus A were investigated for their in vitro antiviral activity using dye uptake assay systems HSV-1/Vero in the cells and influenza virus A/MDCK cells. With an IC50 of less than 6.25 mg/ml, *Verbascum Thapsus* demonstrated potent anti-influenza virus activity.

In a different investigation, the antiviral activity of 100 methanolic plant extracts against each of the seven viruses was examined. At the non-cytotoxic quantities examined, twelve extracts were confirmed to exhibit antiviral activity. Herpes virus type 1 was susceptible to being infected by the extracts made from *Verbascum Thapsus*. (17)

Decoctions of *Verbascum Thapsus* flowers were shown to have the highest antiviral action. In the Vero cells pseudorabies virus strain RC/79 (herpes virus suis) system, Zanon et al. studied the alcoholic extracts of several species, including *Verbascum Thapsus*. The alcoholic extract of *Verbascum Thapsus* was able to reduce the viral infectivity by at least two logs. The plant components' maximum non-cytotoxic concentration was found to be 1.40 mg/ml. Antiviral agents are recognized for their ability to be non-toxic to host cells, meaning that any observed suppression is likely the result of a direct effect on viral reproduction. The aforementioned findings suggest that *Verbascum Thapsus* should be investigated further for its potential antiviral benefits. (18)

The chemical component contained in the crude extract of common mullein that is responsible for antiviral action should be separated, purified, described, and a clinical trial should be conducted for possible commercial usage, as anti-viral synthetic medications are expensive. (19)

4. Anthelmintic:

Using fresh adult roundworms and tapeworms, the anthelmintic activity of *Verbascum Thapsus* was assessed using the technique outlined by Ajaiyeoba et al. Test samples of *Verbascum Thapsus* aqueous methanolic extract were made in normal saline at concentrations of 10, 20, and 40 mg/ml. Six worms of each species that were around the same size were put in a petri dish with 25 milliliters of the *Verbascum Thapsus* test solutions. The standard and negative controls were solutions of albendazole (10 mg/ml) or distilled water, each containing six test worms. The standards and test solutions were all newly made when the tests were conducted. It was noted how long it took for the worms to become paralyzed. The point at which all movement ceased, with the exception of when the worms were violently disturbed, was referred to as paralysis. The worms were shaken vigorously or submerged in warm (50°C) water, and the point of death was determined by the worms not moving at all. Every experiment was carried out four times. (20,21)

The bioactive chemicals found in the plant are assumed to be the source of the anthelmintic action. These compounds may disrupt the helminths' metabolic activities, causing them to become paralyzed and expel themselves from their host. This suggests that *Verbascum Thapsus* may have use in alternative and conventional therapy to treat parasite illnesses. (22,23)

5. Antioxidant:

It is commonly known that oxygen and nitrogen-containing free radicals cause a number of chronic illnesses, including cancer, atherosclerosis, aging, and Parkinson's and Alzheimer's disease in biological systems. Numerous components found in plants, including carotenoids, vitamin C, vitamin E, and phenolic compounds, as well as specific minerals like zinc and selenium, can counteract the effects of free radicals. Consequently, the beneficial biochemical roles of naturally occurring

antioxidants found in plants are receiving enough attention. The DPPH (Diphenyl-l-picrylhydrazyl) test was used to examine the antioxidant activity of the alcoholic stem extract. In the DPPH experiment, the plant's ethanolic extract inhibited free radicals up to 85% whereas water extract inhibited them up to 40%. (24)

ORAC (Oxygen radical absorbance capacity) is a commonly used indicator of one's ability to scavenge free radicals. The cold-pressed seed oil extracts' ORAC values were calculated. ORAC values were greater than 100 μmol TE/g for parsley, cardamom, and milk thistle seed oils, whereas they were less than 30 μmol TE/g for *Verbascum Thapsus*, onion, and roasted pumpkin seed oils Because antioxidants operate at different cell locations, they range in their ability to quench free radicals. This might account for the various antioxidant effects that various biological tests have shown. (25,26)

Aqueous and ethanolic extract of whole plant had nice antioxidant activity inhibit sebum oxidation and thus prevent body smell and skin aging. Antioxidant activity of 35 plant species traditionally used for symptoms of diabetes or its complications were determined including root extract of *Verbascum Thapsus* using DPPH assay, NBT/XO assay (Nitro blue Tetrazolium/Xanthine Oxidase assay) and DCF/AAPH assay [Dichlorofluorescein/Azo-bis(2-amidinopropane) dihydrochloride assay] (27)

6. Anti-inflammatory:

Nitric oxide radical scavenging activity was discovered in verbascoside, which may help explain some of its anti-inflammatory properties. J774.1 cells were stimulated with lipopolysaccharide (0.1 μg/ml), and the formation of nitrite was decreased (6.3-62.3%) by seven phenylethanoids, including acteoside (verbascoside) at concentrations of 100-200 mM. They reduced 32.2–72.4% of the nitrite buildup in mouse peritoneal exudate macrophages that was generated by lipopolysaccharide (0.1 μg/ml) and interferon-γ (100 U/ml) at 200mM. Moreover, verbascoside prevented human polymorphonuclear leukocytes from producing leukotriene B and the 5-lipoxygenase product 5-HETE. Acteoside, or verbascoside, exhibited potent radical scavenging properties. (27,28)

7. Analgesic:

Verbascoside (acteoside) was given orally to mice at doses of 300 mg/kg and 100 mg/kg, respectively, to alleviate tail pressure discomfort and writhing brought on by acetic acid. Verbascoside also produced mild drowsiness by prolonging the anesthesia produced by pentobarbital and by enhancing the metamphetamine-induced reduction of motility. (29)

Phytochemistry:

Mullein's high concentration of several active chemicals is responsible for its pharmacological potency. Mullein is mostly composed of flavonoids, saponins, mucilage, and antioxidants. Furthermore, mullein's medicinal profile depends on the presence of tannins and iridoid glycosides.

When the floral extract was compared to the positive control, certain flavonoids, phenyl-ethanoic glycoside, and iridoids improved its strong antiviral activity against HCov-229E, HBV, and HSV II, achieving reductions of around 8-folds, 2-folds, and 4-folds, respectively. However, compared to the floral extract, the leaf extract exhibited a 5-fold greater antiviral effect against HCV. Owing to its abundance of phenolic acids, terpenoid, and phenyl-ethanoic glycosides, in particular, the methanol extract of leaves exhibited significantly higher antibacterial activity (50–62%) than that of the flowers (42-44%). The cytotoxic activity of the leaf and floral extracts was found to be modest (≤10%).

Using a chromatographic separation on silica gel, Pascual Teresa et al. (1980) identified four saponins from the capsules of *Verbascum Thapsus*: thapsuine A, thapsuine B, hydroxythapsuine A, and hydroxythapsuine B (TLC). Five kilograms of crushed capsules were extracted using benzene and ethanol before being chromatographed on silicagel and sephadex. 300 mg of thapsuine A and 460 mg of thapsuine B were acquired. (1) For *Verbascum Thapsus* L., an extraction and analytical technique for saponins was developed (Turkeret al., 2003). Four types of plant samples were analyzed: field-grown, commercially purchased leaves, in vitro cultivated, and field-grown capsules. Before doing an HPLC (high pressure liquid chromatography) study, octadecyl (C18) solid phase extraction columns

were utilized in a cleaning process. Digitoxin served as the internal standard and ilwensisaponin A as the external standard. HPLC analysis was performed using a C18 reverse phase column and gradient elations (acetonitrile with 0.1% orthophosphoric acid and water with 0.1% orthophosphoric acid). The saponin content of commercially purchased leaves was greater (0.215 mg/g tissue) than that of other leaves (0.081–0.198 mg/g tissue) or the capsule samples.

Iridoid glycosides

One of the first iridoid glycosides identified from *Verbascum Thapsus* leaves was verbascoside. When compared to the aerial portions, roots had a higher concentration of aucubin. Laterioside, harpagoside, ajugol, and aucubin were identified as iridoid glucosides from an ethanolic extract of *Verbascum Thapsus* roots that exhibited antigermination action on barley seeds. (33)

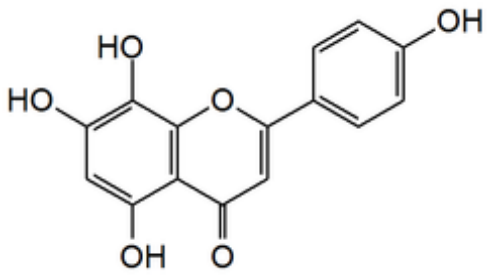
Iridoid glycosides are a type of secondary metabolite found in various plants, including *Verbascum Thapsus* (commonly known as mullein). These compounds are known for their anti-inflammatory, antimicrobial, and analgesic properties, which contribute to the medicinal uses of the plant.

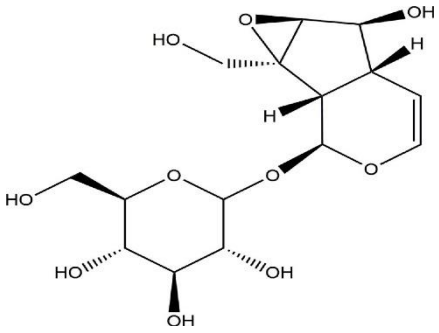
Aucubin: This is one of the primary iridoid glycosides found in *Verbascum Thapsus*. Aucubin has been studied for its hepatoprotective, anti-inflammatory, and antimicrobial activities. It is believed to contribute to the wound-healing properties of the plant.

Catalpol: Another iridoid glycoside present in *Verbascum Thapsus*, catalpol, is known for its neuroprotective and anti-inflammatory properties. It also plays a role in enhancing the medicinal value of the plant.

Verbascoside: Although structurally different, verbascoside is often grouped with iridoid glycosides due to its similar biological activities. It has strong antioxidant and anti-inflammatory effects and is responsible for some of the therapeutic properties attributed to *Verbascum Thapsus.* (34)

Verbascum Thapsus (common mullein) contains various terpenes, which are significant contributors to the plant's medicinal properties. Terpenes are a large and diverse class of organic compounds produced by many plants, characterized by their aromatic qualities and biological activities. In *Verbascum Thapsus*, terpenes play a crucial role in its anti-inflammatory, antimicrobial, and respiratory health benefits. (35)





Aucubin **Catalpol**

Terpenes

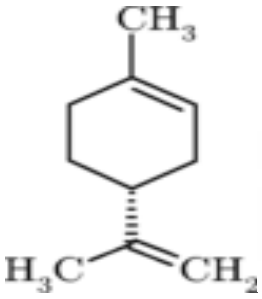
α-Cadinol: This sesquiterpene alcohol is known for its potent anti-inflammatory and antimicrobial properties. It has been studied for its effectiveness against a range of bacteria and fungi, which supports the traditional use of mullein in treating respiratory and skin infections.

β-Caryophyllene: A bicyclic sesquiterpene that exhibits anti-inflammatory, analgesic, and antimicrobial properties. β-Caryophyllene is known to interact with cannabinoid receptors in the body, particularly CB2, which helps modulate inflammatory responses.

Farnesol: This acyclic sesquiterpene alcohol has antimicrobial and anti-inflammatory properties. Farnesol is often associated with skin protection and repair, aligning with mullein's traditional use for treating skin conditions.

Germacrene D: A sesquiterpene with anti-inflammatory and antimicrobial activities. It contributes to the overall medicinal properties of mullein, particularly in respiratory and skin health.

Limonene: A monoterpene with strong antioxidant and anti-inflammatory properties. Limonene is also known for its potential to relieve symptoms of bronchitis and asthma, which correlates with the traditional use of mullein in treating respiratory conditions. (36,37)



Limonene

Farnesol

Flavonoids and carotenoids

Verbascum Thapsus (common mullein) contains various flavonoids and carotenoids, which are important phytochemicals contributing to the plant's therapeutic properties. These compounds are known for their antioxidant, anti-inflammatory, and antimicrobial activities, making *Verbascum Thapsus* a valuable medicinal herb.

Flavonoids in *Verbascum Thapsus*

Apigenin: A flavonoid with strong anti-inflammatory, antioxidant, and antimicrobial properties. Apigenin is known for its ability to inhibit pro-inflammatory cytokines, making it useful in treating inflammatory conditions.

Luteolin: Similar to apigenin, luteolin has significant antioxidant and anti-inflammatory effects. It is known to inhibit the production of reactive oxygen species (ROS) and modulate signaling pathways involved in inflammation.

Kaempferol: A flavonoid with potent antioxidant activity, kaempferol helps protect cells from oxidative stress. It also has anti-inflammatory and antimicrobial properties, contributing to the overall therapeutic profile of *Verbascum Thapsus*.

Quercetin: One of the most studied flavonoids, quercetin is known for its strong antioxidant, anti-inflammatory, and antiviral properties. It supports the traditional use of mullein in treating respiratory issues and infections. (38,39)

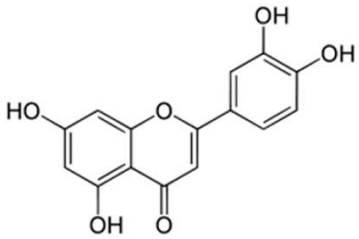
Carotenoids in *Verbascum Thapsus*

β-Carotene: A precursor to vitamin A, β-carotene is a powerful antioxidant that supports eye health and immune function. It also contributes to skin health and has been studied for its role in preventing oxidative damage.

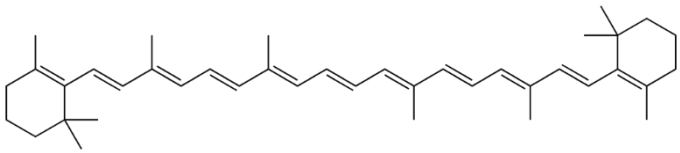
Lutein: Lutein is a carotenoid with a strong protective effect against blue light and oxidative stress, especially in the eyes. It is commonly associated with reducing the risk of age-related macular degeneration.

Zeaxanthin: Another carotenoid found in *Verbascum Thapsus*, zeaxanthin works synergistically with lutein to protect the eyes from oxidative stress and damage caused by high-energy light waves.

The lipid constituents of *Verbascum Thapsus* (common mullein) are lesser-known compared to its more studied components like terpenes and iridoid glycosides. However, the plant does contain various fatty acids and other lipid-based compounds that contribute to its therapeutic properties, especially in skin care and wound healing. (39,40)



β-Carotene



Luteolin

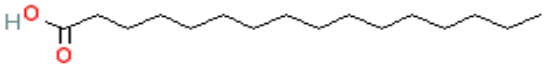
Lipids

Linoleic Acid (Omega-6 Fatty Acid): Linoleic acid is an essential polyunsaturated fatty acid that plays a critical role in maintaining skin health. It is involved in the formation of the skin barrier and has anti-inflammatory properties. In *Verbascum Thapsus*, linoleic acid contributes to its use in treating skin conditions like eczema and dermatitis.

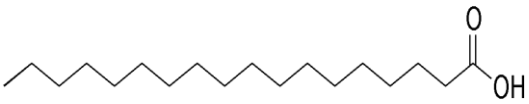
Palmitic Acid: This is a saturated fatty acid commonly found in plant oils. Palmitic acid is known for its emollient properties, making it useful in softening and protecting the skin. It also has antioxidant properties, which help protect cells from oxidative stress.

Oleic Acid (Omega-9 Fatty Acid): Oleic acid is a monounsaturated fatty acid known for its moisturizing and anti-inflammatory properties. It is commonly found in plants and is beneficial for dry and irritated skin. In mullein, oleic acid supports the plant's traditional use in soothing and healing the skin.

Stearic Acid: A saturated fatty acid that acts as an emollient and thickening agent in cosmetic products. Stearic acid contributes to the protective and hydrating properties of mullein extracts, making them effective for skin care formulations. (41)



Palmitic Acid



Stearic Acid

Saponins

Verbascum Thapsus contains several saponins, which contribute to the plant's therapeutic effects. The specific types of saponins identified in mullein include:

Verbascosaponin: A key saponin found in *Verbascum Thapsus*, verbascosaponin is a triterpenoid saponin. It has been studied for its antimicrobial properties, particularly against certain bacterial and fungal strains. Verbascosaponin also exhibits anti-inflammatory effects, which are beneficial in treating respiratory and skin conditions.

Verbascoside: Although primarily a glycoside, verbascoside is sometimes grouped with saponins due to its similar solubility and biological activities. It has potent antioxidant, anti-inflammatory, and antimicrobial effects, contributing to the overall medicinal profile of mullein.

Carbohydrates

Polysaccharides: *Verbascum Thapsus* contains mucilaginous polysaccharides, which are complex carbohydrates that form a gel-like substance when mixed with water. These polysaccharides are responsible for the plant's demulcent properties, which soothe irritated mucous membranes in the respiratory and digestive tracts. The polysaccharides also have immunomodulatory effects, helping to stimulate the immune system. These polysaccharides include arabinogalactans and other heteropolysaccharides, which have been studied for their ability to enhance the body's immune response and provide protective effects against infections.

Monosaccharides and Oligosaccharides: *Verbascum Thapsus* contains simple sugars like glucose and fructose, as well as oligosaccharides, which are short chains of monosaccharides. These sugars contribute to the plant's overall energy storage and metabolic functions. While they are not the primary active constituents, they support the overall health and growth of the plant. (44)
Inulin: In some studies, inulin-like fructans have been identified in the roots of *Verbascum Thapsus*. Inulin is a type of prebiotic fiber that supports gut health by promoting the growth of beneficial bacteria in the digestive tract. Though not the primary focus in mullein, inulin contributes to the overall therapeutic profile of the plant. (45)
In addition to the well-known classes of compounds such as terpenes, flavonoids, saponins, and carbohydrates, *Verbascum Thapsus* (common mullein) contains various miscellaneous constituents that contribute to its overall medicinal properties. These include phenolic acids, coumarins, sterols, and other minor compounds that enhance the plant's therapeutic potential.

Miscellaneous Compounds
Phenolic Acids
Caffeic Acid: Caffeic acid is a phenolic compound known for its antioxidant, anti-inflammatory, and antimicrobial properties. It contributes to the plant's ability to reduce oxidative stress and inflammation, supporting its use in treating respiratory conditions and skin disorders.
Chlorogenic Acid: This is another phenolic acid found in *Verbascum Thapsus*. Chlorogenic acid has strong antioxidant properties and is also known for its role in modulating glucose metabolism and improving cardiovascular health.

Coumarins
Scopoletin: A common coumarin found in mullein, scopoletin has anti-inflammatory, antimicrobial, and spasmolytic properties. It is particularly beneficial for its smooth muscle relaxant effects, making it useful in treating coughs and bronchial spasms.
Aesculin: Aesculin is another coumarin with significant antioxidant and anti-inflammatory activities. It is known for its role in protecting blood vessels and enhancing capillary resistance, which may support circulatory health.

Sterols
β-Sitosterol: This plant sterol is found in *Verbascum Thapsus* and is known for its cholesterol-lowering properties. β-Sitosterol also exhibits anti-inflammatory and immune-modulating effects, contributing to the plant's overall therapeutic profile.
Campesterol: Another sterol in mullein, campesterol, has been studied for its anti-inflammatory and antioxidant properties, as well as its potential to support cardiovascular health.
Tannins: Tannins are astringent compounds found in *Verbascum Thapsus*. They contribute to the plant's ability to tighten and tone tissues, which is particularly useful in treating diarrhea, skin conditions, and wound healing. The astringent nature of tannins helps to reduce secretions and protect irritated tissues.
Iridoid Glycosides: While discussed earlier as a distinct category, iridoid glycosides such as aucubin and catalpol are often included in the miscellaneous category due to their broad range of activities, including antimicrobial, anti-inflammatory, and hepatoprotective effects. (46)

CONCLUSION
Because of its many advantages, Verbascum Thapsus is considered a genuine marvel of nature. Verbascum Thapsus has been the subject of several investigations on various portions of the plant, however the pharmaceutical industry has not yet established this plant as a medicine. Plant identification, cataloging, and documenting require a thorough and methodical investigation, which might contribute significantly to the advancement of traditional knowledge about herbal medicinal plants. It stimulates every facet of the herb and draws attention to the need for researchers to work on

creating its many formulations, which may eventually prove advantageous for both people and animals.

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