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A REVIEW ON PHYTOCHEMICAL PROFILE AND MEDICINAL VALUES OF PHYSALIS ANGULATA

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ABSTRACT:

Physalis angulata, commonly known as wild gooseberry or balloon cherry, is a medicinal plant from the Solanaceae family, found in tropical and subtropical regions. It is rich in bioactive compounds such as withanolides, alkaloids, flavonoids, saponins, tannins, and sterols. Withanolides, in particular, are noted for their complex structures and therapeutic potential. The plant exhibits anti-inflammatory, antioxidant, anticancer, antimicrobial, antimalarial, and antidiabetic properties. Traditionally, it has been used to treat fever, wounds, asthma, and rheumatism. Studies highlight its withanolides' effectiveness against cancer cells and its antioxidants' role in reducing oxidative stress. While its pharmacological potential is promising, further research is needed to fully understand its mechanisms of action and ensure safety for clinical applications.

KEYWORDS: *Physalis angulata*, phytochemicals, withanolides, antioxidant, anti-inflammatory, anticancer, antimicrobial, medicinal plant, traditional medicine, pharmacological activities, drug discovery, cytotoxicity, oxidative stress, bioactive compounds.

INTRODUCTION

Around the world, societies employ plants with therapeutic properties as first aid for a variety of illnesses. The active ingredients in these medicinal plants have a broad spectrum of action against several major disorders. Phytocines have made a substantial contribution to modern treatment in recent years. Therefore, a variety of health issues may be treated with medicinal herbs. Herbal medicines are also easily accessible, affordable, and extensively available. Rural dwellers in several nations still use herbal remedies to cure all of their medical problems. In contemporary medicine, phytomedicine is widely utilized to treat a number of illnesses, such as cancer and diabetes. Numerous published research have examined the use of phytomedicine in the treatment of cancer. According to the World Health Organization (WHO), 60% of people worldwide utilize herbal medicine, while over 80% of those living in underdeveloped nations rely on it nearly exclusively. Their basic medical care is necessary for this [1–3]. Physalis angulata belongs to the Solanaceae family, which has around 120 species with a range of persistent habits and herbal characteristics. 4. This prickly annual herb, which may reach a height of around 50 cm, is glabrous or has little, simple hairs. 5. It features bell-shaped blooms and fruit that falls in the shape of a balloon. Fruit from Physalis angulata is delicious and nourishing [6]. Often found in tropical and subtropical regions, this plant is also called camapu, cut-leaf ground cherry, wild tomato, and winter cherry. Research suggests that Physalis angulata might be utilized as a natural remedy for a variety of ailments. It is widely used in cooking, particularly to prepare sauces, and is highly valued for boosting the immune system [7, 8]. In many parts of the world, people have traditionally utilized the extracts or infusions of this plant to treat conditions including dermatitis, asthma, and malaria. Separated phytoconstituents from Physalis angulata have been shown in vitro to be anti-tumor efficacious against many cancer cell lines [9, 10]. Because of its antipyretic properties, it is widely used in Japan. In addition, the plant is used to treat intestinal and digestive issues as well as a number of skin ailments, such as wounds, boils, and ulcers. They even consume the leaves in salads. Numerous therapeutic properties, including as immunomodulatory, anti-allergic, anti-asthmatic, anti-leishmanial, and antimalarial activities, have been demonstrated by research on Physalis angulata [11–13]. Phyto-chemical investigations have identified a wide range of primary and secondary metabolites in the plant, including as lipids, vitamins, minerals, carbohydrates, and phytosterols. The plant is rich in steroid lactones belonging to the physaline and withanolide families, which include compounds like withangulatin A, withanolide T, physalins A–I, and physagulin A–G. Withanolides are characterized by a C-28 ergostane-type steroid structure with a δ-lactone group at C-22 and C-26. The plant also contains a flavonol glycoside called myricetin 3-O-neohesperidoside [14–18].


- **HERBAL MEDICINE:** Herbal medicine, also known as herbalism, phytomedicine, or phytotherapy, is the study of pharmacognosy and the use of medicinal plants, which serve as a foundation for traditional medicine.
- **AYURVEDA:** Ayurveda, or Ayurvedic medicine, is a traditional system of medicine from India. It incorporates various treatments such as panchakarma (five actions), yoga, massage, acupuncture, and herbal remedies to promote health and overall well-being.

TAXONOMIC CLASSIFICATION.

Kingdom	Plantae
Sub-kingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Asteridae
Order	Solanales
Family	Solanaceae
Genus	Pysalis.L
Species	PhysalisangulateL.

PARTS USED: Whole plant, leaves, roots, fruits.

EXTRACTION OF SEEDS FROM *PHYSALIS ANGULATA*.

It is commonly known as the cut leaf ground-cherry, involves several steps to ensure that the seeds are viable and clean for planting or research purposes. Here's a detailed overview of the extraction process:

1. **Collection of Fruit**

-**Timing:** Harvest the fruits when they are ripe, typically indicated by their yellow or orange color. Ripe fruits often naturally drop from the plant.

- **Method:** Gently collect the fruits to prevent any damage.

2. **Separation of Seeds from Fruit**

- **Mechanical Separation:**

Place the harvested fruits in a container and gently crush them to break open the husks without damaging the seeds.

-Use a sieve or mesh to separate the seeds from the pulp and skin. Gently shake or rub the mixture to ensure the seeds are sifted out without causing damage.

- Water Extraction:

-Soak the crushed fruit in water for several hours. The seeds will sink to the bottom while the pulp will float. Carefully decant the pulp and collect the seeds.

3. Cleaning the Seeds

- Rinse the collected seeds under running water to remove any remaining pulpor debris.
- Use a fine mesh sieve to ensure small pieces are removed.

4. Drying the Seeds

- Spread the cleaned seeds on a paper towel or a drying tray in a single layer.
- Allow the seeds to air dry in a cool, dark place for several days. Ensure they are completely dry to prevent mold growth during storage.

5. Storage

- Store the dried seeds in a cool, dry place in air tight containers, such as glass jars or sealed bags, to maintain viability.
- Label containers with the species name and date of extraction.

MORPHOLOGY

Physalis angulata is an annual plant that typically grows to a height of one meter. It is mostly hairless, however some plants, particularly the younger ones, may contain tiny, appressed hairs. The leaves are dark green, somewhat spherical, and often have serrated edges. Their petioles are oblong to lanceolate, 4 -10 cm long, and 3-6 cm wide, with a maximum length of 4 cm. Although they can occasionally be smooth, the leaf bases are irregular, and the leaf margins are frequently irregularly serrated. The pale yellow, five-sided flowers are carried on stalks that range in length from 5 to 40 mm. The corolla is typically golden and pristine, yet some flowers may have distinct markings.
The length and breadth of the corolla are 4-12 mm and 6-12 mm, respectively. The bluish or violet anthers, which may reach a length of 2.5 mm, are attached to stalks that can reach a maximum length of 5 mm. The green outer layer (calyx) is 4-7 mm long, with triangular lobes that are the same length as the tube. The yellow-orange fruits are encased in a balloon-like calyx. As it grows around the fruit, the calyx, which is 20-35 mm long and 15-25 mm wide, becomes ribbed or 10-angled. It has a stalk that is 1-4 cm long. The ovate cotyledons have reddish petioles and no discernible midvein. The early leaves resemble the cotyledons in form, but they have a sharper tip and more pronounced venation.

PHYTOCHEMICAL CONSTITUENTS OF PHYSALIS ANGULATA L.:

By using phytochemical investigations of Physalis angulata L., several physiologically active compounds have been found, such as flavonoids, alkaloids, plant steroids known as physalins (B, D, F, and G), withanolides, and secosteroids. The other substances that have been discovered include ayanin, choline, ixocarpanolide, myricetin, phygrine, physagulin A–G, physalin A–K, physangulide, sitosterol, vamonolide, withaminimin, withangulatin A, withanolide D, withanolide T, and withaphysanolide (Ramachandra Row et al., 1980; Chen et al., 1990; Baseyet al., 1992; Shingu et al., 1992). Recent clinical research has focused on Physalis angulata L. due to its antibacterial properties, toxicity against leukemia and other cancers, and promise as an immune stimulant.
Physalins, the plant's steroids, have shown potent in vitro and in vivo action against a variety of human and animal cancer cells, including glioma (brain) cancer, lung, colon, nasopharynx, liver, cervix, and melanoma. Beginning in Thailand and the United States in the early 1980s, this study was subsequently validated at the University of Taiwan in 1992, when notable results were noted against three animal cancer cell lines and five human cancer cell lines. A novel compound from Physalis angulata L. was discovered by researchers at the University of Houston in 2001. It demonstrated exceptional toxicity against lung and nasopharyngeal cancer cells, as well as leukemia in mice. Two physalins were shown to prevent the growth of five different forms of acute leukemia, including lymphoid (T & B), promyelocytic, myeloid, and monocytic, in a 1992 study reported by Taiwanese researchers.

THE ACTIVE COMPOUNDS IN PHYSALIS ANGULATA L.

Name of chemical	Plant part	Activities
PhysalinA	Roots	Anti-parasitic/antileishmanial
PhysalinB	Stem Whole plant Root	Immunomodulatory, Anti-inflammatory Anti-inflammatory, antiparasitic Antibacterial, Anticancer/Antifibrosis

PhysalinD	Stem Whole plant Root	Immunomodulatory Anti-inflammatory Anti-inflammatory
PhysalinE	Root Whole plant	Antiparasitic Immunomodulatory, Anti-inflammatory
PhysalinF	Stem Whole plant Root	Immunomodulatory Anti-inflammatory Antiparasitic, Antibacterial
PhysalinG	Stem Whole plant Root	Immunomodulatory Anti-inflammatory Antiparasitic, Antibacterial
PhysalinH	Root	Antiparasitic
WithangulatinA	Fruit	Antidiabetic
PhysagulinA	Leaves and stems	Anti-inflammatory
PhysagulinC	Leaves and stems	Anti-inflammatory
PhysagulinH	Leaves and stems	Anti-inflammatory

PHYTOCHEMICALS:

Phytochemicals	Hexane	Chloroform	Ethyl acetate	Acetone	Methanol
Alkaloids	+	+	+	+	+
Phenols	+	+	+	_	_
Tannins	+	+	_	+	+
Saponins	_	_	_	_	_
Glycosides	+	+	+	_	+
Carbohydrates	+	+	+	+	+

CHEMICAL CONSTITUENTS:

Flavonoids, alkaloids, physalins (B, D, F, G), withanolides, and secosteroids are among the active chemicals found in Physalis angulata L. according to phytochemical investigations. Ayanin, choline, chlorogenic acid, ixocarpanolide, myricetin, and physagulin A–K are other substances. Chen et al., 1990; Basey et al., 1992; Shingu et al., 1992; Ramachandra Row et al., 1980). Clinical studies have demonstrated its antibacterial qualities, toxicity against a variety of malignancies, including leukemia, and promise as an immune stimulator. Strong action against malignancies of the lung, colon, liver, cervix, and other organs has been demonstrated by physalins. Research started in the 1980s, was verified in Taiwan in 1992, and the University of Houston discovered a hazardous component in 2001. Additionally, physalins prevent the formation of several leukemia types.

TRADITIONAL USES:

Physalis angulata is used medicinally by indigenous cultures in the Amazon. The leaves and fruits are said to have anti-inflammatory, narcotic, and disinfecting qualities in Colombia. Leaf juice is used in the Peruvian Amazon to cure rheumatism, worms, earaches, liver problems, malaria, and hepatitis. Brazilian tribes treat jaundice with roots and earaches with sap. In Solomon Islands, the plant is also used to treat female problems and fertility, and in Jamaica and the West Indies, a tea is created to help women avoid miscarriages. It is used in Brazil to treat liver, kidney, and gallbladder problems, fever, vomiting, skin conditions, and chronic rheumatism.

MEDICINAL IMPORTANCE OF PHYSALIS ANGULATA L.

The annual herb Physalis angulata L. is indigenous to tropical areas of the Americas, especially the Amazon, Asia, and Africa. Traditional medicine has utilized it to treat a number of illnesses, including fever, malaria, sore throats, asthma, and stomach discomfort (Chhaya Rathore et al., 2011; Lin et al., 1992; Bastos et al., 2008). It is referred to as camapu in the Amazon and is used as an earache reliever, sedative, and anti-rheumatic. Additionally, the plant is used to cure cancer in Western Africa (Lawal et al., 2010) and diabetes, hepatitis, and asthma in Taiwan (Hsiehetal., 2006). It is utilized as a supplementary cancer treatment in both Americas and to treat viral and bacterial infections (Taylor and Leslie, 2003). It cures earaches, rashes, and skin lesions on the outside (Branch, 1983). In many places, the mature fruit is eaten, but too much of it might make you feel lightheaded. Salads are made using the bitter leaves.

ANTI-INFLAMMATORY, ANTI-ARTHRITIC AND IMMUNO- MODULATORY ACTIVITY:

Several researchers examined the anti-inflammatory and anti-arthritic properties of P. angulata (L.) leaf extracts in aqueous, ethanolic, and methanolic forms. Using the protein denaturation technique and HRBC membrane stabilization, respectively, they examined the anti-inflammatory and in-vitro anti-arthritic activity at varying doses and discovered that all of the extracts they employed produced favorable results [19]. In a different study, rats' subcutaneous air pouches were injected with 1% carrageenan, and the inflammatory reaction was managed using an aqueous lyophilized root extract of P. angulata (L.). Adenosine deaminase (ADA) activity, nitrite level, and prostaglandin E (2) level were used to assess the effect of inflammatory mediators. Tumor growth factor beta level was employed as a bio-indicator in immunomodulatory response. The aqueous extract demonstrated strong immunomodulatory and anti-inflammatory properties [20]. Macrophages treated with lipopolysaccharide and interferon-g produced less nitric oxide as a result of the immunomodulatory effects of physalins B, F, or G from P. angulata. Following a lipopolysaccharide challenge, the animals treated with physalin Bhad had lower blood TNFα levels than the control mice. Following a deadly polysaccharide challenge, mice injected with physalins B, F, or G survived.These findings suggest that seco-steroids are potent immunomodulatory drugs and work through a mechanism different from that of dexamethasone [21]. For studying immunomodulatory activity the distinct Physalis angulata (L.) extracts fraction (PA-VII, PA-VII-A, PA-VII-B and PA-VII-C) produced [22]. The results showed that PA-VII and PA-VII-C significantly increased the response to sblastogenesis, whereas PA-VII-B exhibited moderate activity and PA-VII-A had only a little impact on cell proliferation. B-cells were stimulated by PA-VII and PA-VII-C, but T-cells were little affected. PA-VII, PA-VII-B, and PA-VII-C also had antibody reactions, but not PA-VII-A.

AMINOCICEPTIVE ACTIVITY:

Bastos and colleagues examined the aminociceptive properties of the P. angulata root aqueous extract. Half an hour or more before the acetic acid therapy that triggers the contractions, an aqueous extract is administered to prevent the contractions. In the hot plate test, mice treated with extract or morphine showed a much longer response time. According to the findings, the aqueous extract significantly reduced the inflammatory pain responses brought on by formalin and the visceral discomfort caused by acetic acid in mice [23].

ANTI-DIABETIC ACTIVITY AND ACUTE TOXICITY:

In a different experiment, Sateesh and associates used a variety of solvents (n-hexane, chloroform, ethyl acetate, acetone, and methanol) to extract the fruit of Physalis angulata and documented its in-vitro anti-diabetic potential. The methanol extract's substantial anti-diabetic effects were demonstrated by the strongest inhibition of the α-amylase and α-glucosidase enzymes [24]. Abo and Lawal examined alloxan-induced diabetic rats with aqueous and methanolic extracts, as well as column fractions of the entire plant. Blood glucose levels were considerably reduced by the extracts, with the fraction demonstrating a greater decrease than those of crude extracts [25]. Additionally, in rats with diabetes caused by alloxan, the effects of an ethanolic root extract on fasting blood glucose and lipid profiles were assessed. While raising levels of high-density lipoprotein, the extract markedly decreased levels of low-density lipoprotein, triglycerides, cholesterol, and blood glucose [26].

ANTI-CANCEROUS ACTIVITY:

By targeting NF-kappa B and producing reactive oxygen species, the researchers found that P. angulata's physalin-F causes human cancer cells to undergo cell death. According to the findings, physalin-F is a promising anti-cancer drug that may see more clinical development [27].

ANTI-MICROBIAL ACTIVITY:

The antibacterial activity of zinc oxide ointment and P. angulata crude extracts against Staphylococcus aureus and Pseudomonas aeruginosa was investigated by Donker and colleagues. The unformulated crude extract had the most inhibitory effect against S. aureus. The usefulness of plant fruit extract in reducing S. aureus infections has been shown by these data [28]. The antibacterial activity of essential oils isolated from the aerial and root sections of P. angulata was tested using stains such as Bacillus subtilis, Pseudomonas aeruginosa, Klebsiella pneumonia, and Staphylococcus aureus. The experiment used Candida torulopsis, Candida albicans, and Candida stellatoidea as the fungus. For Klebsiella pneumonia and Bacillus subtilis, the aerial and root extracts had minimum inhibitory values between 3.75 and 4.0 mg/ml. The essential oils from the plant's aerial and root sections were introduced to the fungal strains. The plant's use in traditional medicine to treat wounds, sores, and certain skin disorders was supported by this investigation. Chloroform-prepared leaf and callus extracts were shown to be more effective against pathogenic fungi and bacteria [29].

ANTI-LEISHMANIASIS ACTIVITY:

In this study, Elisalva and colleagues tested the anti-leishmanial activity of physalins extracted from P. angulata. Physalins B, D, and F were evaluated against intracellular amstigotes of Leishmania major (MHOM/RI/-/WR-173) and Leishmania amazonensis (MHOM/BR88/BA125). The in vivo investigation was carried out on BALB/c mice that had been subcutaneously infected with Leishmania amazonensis. According to the findings, physalin-F is a very effective anti-Leishmania substance that may be utilized to create novel therapeutic medications for cutaneous leishmania [30].

ANTI-ASTHMATIC ACTIVITY:

Researchers used ovalbumin to induce asthma in albino mice in order to assess the anti-asthmatic properties of Physalis angulata alcoholic root extract. By lowering the release of inflammatory mediators, the extract successfully prevented ovalbumin-induced asthma, proving its anti-asthmatic qualities [31].

MOLLUSCICIDAL ACTIVITY:

Physalis angulata extracts, fractions, and physalin-modified steroids were investigated for their molluscicidal properties by Santos and associates. A combination of physalins from the stem and leaves, ethanolic extracts of the roots, and ethyl acetate and acetone extracts from the entire plant were shown to be effective against Biomphalaria tenagophila [32].

ANTI-MALARIAL ACTIVITY:

Significant anti-plasmodial and anti-malarial action was demonstrated by the methanolic and dichloromethane extracts of Physalis angulata against Plasmodium berghei-infected mice both in vitro and in vivo [33]. These tests (DPPH, superoxide, nitric oxide, hydrogen peroxide, and hydroxyl radical) were used to assess the antioxidant and cytotoxic properties of methanolic extracts from the stem, leaves, fruit, and roots. Because the fruit and leaves had larger levels of phenol and flavonoids, the fruit and leaf extracts were shown to be more effective than the stem and root extracts [34].

COLLECTION:

The methanolic and dichloromethane extracts of Physalis angulata showed significant anti-plasmodial and anti-malarial efficacy against Plasmodium berghei-infected mice in vitro and in vivo [33]. The antioxidant and cytotoxic qualities of methanolic extracts from the stem, leaves, fruit, and roots were evaluated using these assays (DPPH, superoxide, nitric oxide, hydrogen peroxide, and hydroxyl radical). The fruit and leaf extracts were shown to be more efficient than the stem and root extracts due to the higher quantities of phenol and flavonoids found in the fruit and leaves [34].

CONCLUSION

Physalis angulata is a versatile medicinal plant with a rich phytochemical composition and a wide range of pharmacological activities. Its bioactive compounds, particularly withanolides, demonstrate significant therapeutic potential, including anticancer, antioxidant, and anti- inflammatory effects. Traditional uses and scientific studies highlight its value intreating various ailments, but further research is needed to fully understand its mechanisms, isolate key compounds, and ensure its clinical safety. As a promising resource for drug development and phytomedicine, P. angulata offers immense potential for advancing modern healthcare.

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