Exploring Phytochemical and Pharmacognostical Study of selected medicinal plants of family Cucurbitaceae

Gayatri Ananda Dhangar[1], Utkarsh Ravindra Mandage[2], Pratiksha Bhaiyyasaheb Patil[3], Neetu V. Patil[4], Dr. Pankaj Chaudhari[5], Rohit Shivcharan Patil[6]
[1,2,3,4,5,6]*Shatabdi Institute of Pharmacy*

Abstract: The family Cucurbitaceae encompasses various crops such as cucumbers and melons, which hold significant medicinal value. Plants within this family, collectively referred to as cucurbits, are distinct with no close botanical relatives. They offer numerous medicinal and nutritional benefits, making it crucial to identify their active pharmacological agents. Key phytochemicals found in these plants include Glycosides, Terpenoids, Saponins, Tannins, Steroids, Carotenoids, and Resins. Notably, one of the most prominent substances among them is the terpenoid known as Cucurbitacins. These compounds contribute to the therapeutic properties observed in cucurbitaceous plants, highlighting their importance in both traditional and modern medicine.

Keywords: Cucurbita, Momordica, Cucumis, Citrullus, Trichosanthes, Cucurbitacins.

INTRODUCTION

Plants have been utilized since ancient times for treating diseases and infections due to their affordability and widespread availability. Their medicinal value stems from various chemical substances that exert specific physiological effects on the human body. Key bioactive constituents include alkaloids, saponins, tannins, flavonoids, and phenolic compounds.

Cucurbits constitute a significant group of vegetable crops cultivated extensively in subtropical and tropical regions. All cultivated species belong to the subfamily Cucurbitoideae. The fruit of Cucurbita maxima holds the distinction of being the largest known fruit among all flowering plants and is often featured in contests for the largest pumpkin. Watermelon ranks as the most popular cucurbit globally, followed by cucumber, with China and Turkey leading in production.

The Cucurbitaceae family comprises approximately 130 genera and 800 species. Researchers worldwide have extensively studied various plants within this family. Important genera include Trichosanthes, Lagenaria, Luffa, Benincasa, Momordica, Cucumis, Citrullus, Cucurbita, Bryonopsis, and Corallocarpus. Prominent species that have received significant attention include Momordica charantia, Cucurbita pepo, Cucumis sativus, Cucumis melo, Citrullus colocynthis, Luffa echinata, Trichosanthes kirilowii, Lagenaria siceraria, and Benincasa hispida.

Cucurbit plants have a history of traditional use as herbal remedies for various ailments. Research has shown they possess anti-inflammatory, antitumor, hepatoprotective, cardiovascular, and immunoregulatory properties. Members of this plant family are rich in proteins and exhibit diverse biological activities such as antifungal, antibacterial, antiviral, antidiabetic, antitumor, and anti-AIDS effects. They contain several bioactive compounds including cucurbitacins, triterpenes, sterols, and alkaloids.

This review aims to explore the pharmacologically significant plants and phytochemicals present in cucurbits, shedding light on their diverse pharmacological activities.

Phytochemicals are non-nutritive chemical compounds naturally occurring in plants or derived from them. Phytochemical analysis of plants belonging to the Cucurbitaceae family confirms the presence of various compounds such as tannins, cardiac glycosides, terpenoids, carbohydrates, resins, saponins, carotenoids, and phytosterols.

Glycosides are bioactive compounds that serve crucial roles in living organisms. The first glycoside identified was Amygdalin in 1830. Cardiac glycosides, a type of glycoside, are commonly used in the treatment of heart diseases. They function by increasing cardiac output through enhancing the force of contraction. By elevating intracellular calcium levels, cardiac glycosides promote calcium-induced calcium release, thereby aiding in contraction. They also exhibit anti-

inflammatory properties, provide protection against lethal endotoxemia, and are integral in treating congestive heart failure. For instance, cardiac glycosides are found in the leaves, seeds, and bark of Momordica balsamina, a member of the Cucurbitaceae family.

Terpenoids, also referred to as isoprenoids, encompass a diverse class of naturally occurring organic chemicals akin to terpenes. They are known for their membrane-disrupting properties and inhibitory effects against fungi. Terpenoids, also known as isoprenoids, exhibit a wide range of biological activities including antimicrobial effects against both bacteria and fungi, as well as antineoplastic properties. They are commonly found in Citrullus colocynthis.

Saponins possess various pharmacological properties such as hemolytic activity, cytotoxic effects, expectorant actions, antitumor and antimutagenic activities. They have been shown to lower the risk of human cancers by inhibiting the growth of cancer cells. Saponins are also known for their ability to precipitate and coagulate red blood cells, making them useful in stopping bleeding and treating wounds. Hensleya gracilarioides, a Chinese medicinal plant from the Cucurbitaceae family, contains saponins.

Tannins, also referred to as tannoids, are biomolecules present in plants. They are found in extracts of Cucumis sativa (cucumber) and Praecitrullus fistulosus (tinda). Tannins possess astringent properties and accelerate the healing of wounds and inflamed mucous membranes. They also act as metal ion chelators, proton precipitating agents, and biological antioxidants. Ellagitannins, a subclass of tannins, exhibit free radical scavenging activity.

Steroids, specifically phytosterols, are present in extracts of Momordica charantia (karela), Cucumis sativa (cucumber), and Lagenaria siceraria (loki). Phytosterols are known for their significant hypocholesterolemic effects, helping to lower cholesterol levels.

Carotenoids, which number over 600 in nature, exist in two classes: xanthophylls (containing oxygen) and carotenes (purely hydrocarbons, no oxygen). Carotenoids can be found in watermelon (Citrullus lanatus).

Resins are present in the seed extracts of most cucurbit species except Cucumis sativa (cucumber). They are also found in Momordica balsamina.

The genus Cucurbita, native to the western hemisphere, comprises five domesticated species, including Cucurbita pepo and Cucurbita maxima, which are economically significant worldwide. These species encompass various varieties categorized broadly as pumpkins and squashes.

Cucurbita pepo, also known as gourd or pumpkin, is cultivated for its fruit and edible seeds. The seeds, enclosed in a husk, are chewable with a sweet, nutty flavor. They are rich in oil, primarily containing linoleic and oleic acids, along with active constituents such as Δ7 sterols (avenasterol, spinasterol) and Δ5 sterols (sitosterol, stigmasterol). Additionally, they contain triterpenoids, sesquiterpenoids, squalene, tocopherols (predominantly α-tocopherol), carotenoids, minerals (particularly phosphorus, potassium, magnesium, calcium, iron, zinc, and trace elements), proteins, amino acids, carbohydrates (6-10%), vitamins (thiamine, riboflavin, niacin, pyridoxine, and pantothenic acid), phenolic glycosides, and lignans.

Traditionally, Cucurbita pepo has been used as a diuretic and anthelmintic. Its seeds and oil have been employed for alleviating symptoms associated with enlarged prostate glands and irritable bladder conditions. This treatment's benefits stem from its tonic effect on the bladder and relaxation of the sphincter, which is related to increased nitric oxide (NO) production via the arginine or NO pathway. Furthermore, Cucurbita pepo exhibits antioxidant, antiandrogenic, immunological, antiviral, antifungal, cardiovascular, anti-inflammatory, and hepatoprotective activities. Its seeds demonstrate immunosuppressive effects on peripheral mononuclear blood cells and modulate immunobiochemical pathways induced by interferons. They also possess antibacterial properties.

Cucurbita maxima, commonly known as pumpkin, is widely cultivated globally for both culinary and medicinal purposes. The plant's aerial parts and fruits are consumed as vegetables. Phytochemical analysis reveals the presence of flavonoids, polyphenolics, saponins, proteins, and carbohydrates. It is also a rich source of vitamin A, iron, phosphorus, and calcium. Cucurbitaxanthin, gibberellin, and α-tocopherol have been isolated from this plant.

Pumpkins are known for their antioxidant β-carotene content, which enhances immune function and reduces the risk of diseases like heart disease and cancer.

Traditionally, they are utilized as antidiabetic, antitumor, antihypertensive, anti-inflammatory, and immunomodulatory agents. Proteins and polysaccharides from pumpkin seeds exhibit anticancer properties, particularly against melanoma. Methanol extracts from Cucurbita maxima aerial parts demonstrate activity against Ehrlich Ascites Carcinoma (EAC), a rapidly growing and aggressive carcinoma. This extract significantly reduces tumor volume, packed cell volume, viable cell count, and protects against tumor cell-induced hepatotoxicity.

Overall, Cucurbita pepo and Cucurbita maxima showcase a wide array of therapeutic potentials, making them valuable in traditional and modern medicine alike.While the oil extracted from Cucurbita maxima seeds demonstrated anthelmintic properties in a dose and time-dependent manner, spinasterol derived from its flowers exhibited potential anticarcinogenic, antigenotoxic, and antimutagenic activities. Spinasterol also displayed antibacterial effects against fungi like Aspergillus niger and Candida albicans, as well as bacteria such as Bacillus subtilis and Pseudomonas aeruginosa, although it was inactive against Escherichia coli, Staphylococcus aureus, and Trichophyton mentagrophytes. Additionally, extracts from Cucurbita maxima demonstrated diuretic properties by suppressing renal tubular reabsorption of electrolytes and promoting urine formation in a dose-dependent manner.

Furthermore, Cucurbita maxima shows promise as a central nervous system (CNS) stimulant, which could potentially be harnessed for therapeutic benefits in conditions associated with dizziness and sedation. Alcoholic extracts of Cucurbita maxima have been found to significantly lower fasting blood glucose levels by enhancing insulin's action, either by increasing insulin secretion from pancreatic β-cells, enhancing insulin release, or improving peripheral glucose utilization. Moreover, it exhibits potent antihyperlipidemic effects by reducing total cholesterol and triglyceride levels while increasing HDL-cholesterol levels.

Cucurbita andreana has shown potent anticancer properties and inhibitory effects on cyclooxygenase-2 (COX-2). Cucurbitacins B, D, E, and I isolated from its fruit extract have been studied for their anti-inflammatory effects and inhibition of human colon, breast, lung, and central nervous system cancer cell growth. They also exhibit action on cyclooxygenase enzymes and lipid peroxidation, highlighting their potential therapeutic applications.

Cucurbita ficifolia, also known as fig-leaf gourd, is traditionally used to treat wounds, hemorrhoids, fever, and diabetes type 2.

1. Genus Momordica

Momordica charantia, commonly known as bitter melon or bitter gourd, holds significant economic and medicinal importance within the Cucurbitaceae family. In India, it is often referred to as "Karela." This plant is rich in triterpenes, proteins, and steroids, and several phytochemicals have been isolated from it, including steroidal glycosides, insulinomimetic lectins, and alkaloids.

Steroidal Glycosides: Initially, "Charantin" was identified as a prominent active constituent in bitter melon fruit, composed of l3-sitosterol-D-glucoside and 5, 25-stigmastadien-3-I3-ol-D-glucoside. Subsequently, other steroidal glycosides such as momordicosides and momordicines have been discovered in the fruit, seeds, and vines of Momordica charantia.

Insulinomimetic Proteins: Bitter melon contains insulin-like polypeptides (e.g., "polypeptide-p"), which exhibit hypoglycemic properties. These polypeptides do not cross-react with bovine insulin but demonstrate insulinomimetic effects, causing hypoglycemia in humans and laboratory animals upon parenteral administration. Additionally, P-insulin or V-insulin present in bitter melon can lower blood glucose levels by stimulating insulin release or improving insulin sensitivity.

Alkaloids: Vicine, a pyrimidine nucleoside, has been isolated from bitter melon seeds. Intraperitoneal administration of vicine induces a hypoglycemic response in fasting albino rats. Moreover, cucurbitane triterpenoids such as kuguacins F-S have been identified in Momordica charantia.

Pharmacological Activities: Momordica charantia exhibits a diverse range of biological and pharmacological activities. Traditionally, its unripe fruits are widely used for diabetes treatment due to their marked hypoglycemic effects in both animals and humans. Extracts from bitter melon seeds normalize

antioxidant status in diabetes induced by streptozotocin, mitigating diabetic complications by scavenging free radicals.

Antiviral and Anticancer Activities: Bitter melon extracts inhibit the growth of herpes simplex virus I and human immunodeficiency virus I. Protein fractions from bitter melon fruit and seeds display anticancer properties by suppressing cell growth, guanylate cyclase activity, and ribosomal activity. Notably, bitter melon has shown potential in reducing white blood cell count and increasing blood hemoglobin in leukemia patients.

Additional Medicinal Uses: Apart from its antidiabetic properties, bitter melon is utilized in India as a tonic, emetic, and laxative. It has been employed for treating liver diseases, anemia, jaundice, malaria, cholera, and as an anthelmintic, antiemetic, carminative, and purgative. Externally, mature bitter melon fruits promote rapid wound healing, while internally, they are used for peptic ulcer treatment.

Mechanisms of Action: Studies indicate that bitter melon enhances glucose uptake in muscle tissue, promotes glycogen accumulation in muscle and hepatic tissues, and reduces hepatic gluconeogenesis. It inhibits glucose absorption from the gut and increases insulin release from pancreatic β-cells. These actions contribute to its hypoglycemic effects and potential benefits in diabetes management.

In conclusion, Momordica charantia is a versatile plant with significant therapeutic potential, especially in diabetes treatment, anticancer therapy, and various other medicinal applications.

2. Genus Cucumis

Cucumis sativus, commonly known as cucumber, is a widely cultivated plant in the gourd family, primarily consumed in its unripe, green form. In India, it is locally known as "Khira" or "Sasha." Phytochemical analysis of various parts of Cucumis sativus has revealed a range of bioactive compounds:

Leaves and Stems: Ethanolic and chloroform extracts from leaves and stems contain phytoconstituents such as alkaloids, glycosides, steroids, saponins, and tannins. Flavonoids are notably absent in the ethanolic extract but present in the chloroform extract. These compounds contribute to the medicinal properties associated with cucumber.

Fruits: The aqueous extract of cucumber fruits is rich in glycosides, steroids, flavonoids, carbohydrates, and tannins. Cucumber fruits are known for their high water content and are a good source of vitamins A and C. Flavone glycosides like isovitexin and saponarin, along with acylated flavone C-glycosides, are found in cucumber leaves.

Pharmacological Activities: Cucumber extracts exhibit various pharmacological activities, including:

- Antioxidant: The fruit extract shows free radical scavenging activity, contributing to its antioxidant properties.
- Analgesic: Cucumber extract has demonstrated analgesic effects in mice.
- Gastrointestinal Benefits: Cucumber is known for its carminative (relieving flatulence) and antacid properties. It helps in digestion, aids in removing constipation, and can be beneficial for individuals suffering from indigestion.
- Skin Health: Mature, uncooked cucumbers are beneficial for individuals with celiac disease and promote skin health.
- Traditional Uses: Immature cucumbers, when cooked and consumed, are used to treat dysentery. Cucumber seeds are known for their cooling, tonic, diuretic (increasing urine production), and anthelmintic (expelling parasitic worms) properties.

Citrullus is a genus within the Cucurbitaceae family, comprising several species known for their edible fruits and medicinal properties. Here are some key species within the genus Citrullus:

1. Citrullus lanatus (Watermelon):
   - Description: Watermelon is characterized by its large, round fruit with juicy, sweet flesh. It is consumed fresh and widely cultivated for its refreshing taste.
   - Nutritional Composition: Watermelon is primarily composed of water (about 95%), along with small amounts of proteins, fats, minerals, and vitamins. It is rich in carbohydrates, vitamin A, and contains lycopene, which is an antioxidant and anticancer agent. The dark red varieties have higher lycopene content compared to tomato, pink grapefruit, or guava.

- Medicinal Uses: Traditionally, watermelon has been used to treat cardiovascular diseases and kidney problems. Various parts of the plant, including the rind, root, seed, and leaf extracts, exhibit painkilling and anti-inflammatory effects.

2. Citrullus colocynthis (Bitter apple):
- Local Names: Known as Makkal locally.
- Description: Bitter apple is a wild melon species and the most widely distributed species in the Citrullus genus. It has a bitter taste and small fruits.
- Medicinal Uses: Bitter apple has been traditionally used for its medicinal properties, including treating rheumatism, swellings, gout, and as a laxative. It possesses anti-inflammatory activities attributed to compounds like cucurbitacins.

These species exemplify the diversity within the Citrullus genus, each with distinct nutritional benefits and medicinal uses.

3. Genus Lagenaria

belongs to the Cucurbitaceae family and includes several species commonly known as bottle gourds or calabashes. Here's an overview of the genus Lagenaria:

Lagenaria siceraria (Bottle gourd):
- Description: Bottle gourd is characterized by its elongated or bottle-shaped fruit, which can vary greatly in size. The fruit typically has a smooth, hard outer shell when mature, which is often dried and used as containers or musical instruments.
- Cultural and Culinary Uses: This species is cultivated worldwide for its edible fruits, young fruits can be cooked as vegetables, and mature fruits are used as containers, utensils, or decorations. The tender shoots and leaves are also consumed as greens in some cultures.
- Medicinal Uses: In traditional medicine, various parts of the plant have been used to treat ailments such as digestive disorders, jaundice, and as a diuretic. The seeds are known for their purgative properties and have been used to expel intestinal worms.

2. Other Species:
- The genus Lagenaria includes several other species, though Lagenaria siceraria is the most commonly cultivated and utilized species.

Key Points:
- Nutritional Composition: The nutritional profile of Lagenaria species varies, with the fruit containing water, fiber, and some vitamins and minerals.
- Medicinal Properties: Traditionally, these plants have been valued for their medicinal properties, including their use in treating gastrointestinal issues and as purgatives.
- Cultural Significance: Beyond their utility as food and medicine, the hard-shelled fruits of Lagenaria plants have cultural significance in many societies, where they are used for crafting and traditional purposes.

Overall, the genus Lagenaria encompasses plants that have been integral to human cultures for centuries, providing both practical and medicinal benefits.

Proteins found in cucurbits, specifically members of the Cucurbitaceae family such as pumpkins, squash, gourds, and melons, vary in composition and function. Here's an overview of some proteins that are commonly found in
cucurbits:

Lectins: Lectins are carbohydrate-binding proteins that are widely distributed in plants, including cucurbits. They play roles in defense against pathogens and pests, as well as in plant-microbe interactions. In some cucurbits like bitter melon (Momordica charantia), lectins are known for their insulin-mimetic activity, which can potentially lower blood glucose levels.

Enzymes: Various enzymes are present in cucurbits, serving different biological functions. For instance:
- Papain: Found in papaya (Carica papaya) but also in some members of the Cucurbitaceae family, papain is a proteolytic enzyme used for its medicinal properties, including as a meat tenderizer and in skincare products.
- Amylases and Proteases: These enzymes are involved in carbohydrate and protein metabolism and are present in the seeds and fruits of cucurbit species.

1. Cucurbitacin Proteins: Cucurbitacins are bitter-tasting compounds found in some cucurbits, particularly in the wild varieties. These compounds have anticancer, anti-inflammatory, and insecticidal properties. While not strictly proteins themselves, cucurbitacins interact with

cellular proteins and have significant biological effects.

2. Storage Proteins: Like in many plants, cucurbits contain storage proteins in their seeds. These proteins provide a source of amino acids for the developing seedling. Examples include globulins and albumins, which are soluble proteins found in the seeds of various cucurbit species.
3. Ribosome-Inactivating Proteins (RIPs): These are enzymes that inhibit protein synthesis by depurinating the ribosomal RNA. Bitter melon (Momordica charantia) contains RIPs, which have potential therapeutic applications due to their cytotoxic effects on cancer cells.
4. Other Proteins: Cucurbits may contain a range of other proteins involved in various physiological processes, including seed development, stress responses, and defense mechanisms against pathogens and pests.

Nutritional and Medicinal Significance: Proteins in cucurbits contribute to their nutritional value and have been studied for their potential health benefits, such as antioxidant, anti-inflammatory, and antidiabetic properties. Understanding the composition and functions of these proteins enhances our knowledge of the nutritional and medicinal potential of cucurbit species.

CONCLUSION

After the through literature review we have found that the Plants in Cucurbitaceae Family have tremendous Medicinal properties such as anti-HIV, anxiolytic, antipyretic, anti-diarrhoeal, carminative, antioxidant, antidiabetic, antibacterial, laxative, anthelmintic, antitubercular, purgative and hepatoprotective. It is also Employed as an abortificient, diuretic, and cardiotonic agent. They also show strong anti-inflammatory Antitussive, cytotoxic, and expectorant properties. Apart from biological profile Cucurbitaceae family posses many therapeutically important chemical constituents which required further research to explore the medicinal value of this species. Seeds or fruit parts of some cucurbits are reported to possess purgative, emetic and Antihelmintic properties due to the secondary metabolite cucurbitacin content. A number of Compounds of this group have been investigated for their cytotoxic, hepatoprotective, anti-inflammatory and Cardiovascular effects. Nevertheless some of the plants in this family need further study so that new biomolecules can be isolated and identified and ultimately one can develop new phytopharmaceutical agents which may be used as such or as a lead compound for synthesis and modification. The research and development of herbal formulation is highly relevant as it may be less toxic and can be used for mono or co-therapy with other drugs. The ultimate aim of all medical and pharmacological research is to cure diseases to maintain the health of the individual and to improve the quality of life.

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