

A Review on the Pharmacotherapy and Health Aspects of *Apium Graveolens* (Celery) Plant

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ABSTRACT

Apium plants are part of the Apiaceae family and have been utilized in traditional medicine for millennia across the Mediterranean, tropical, and subtropical regions of Asia and Africa. Highlighted medicinal benefits include the prevention of coronary and vascular disorders. Their phytochemical composition includes bergapten, flavonoids, glycosides, furanocoumarins, furocoumarin, limonene, psoralen, xanthotoxin, and selinene. Their pharmacological properties encompass anticancer, antioxidant, antimicrobial, antifungal, nematocidal, anti-rheumatism, antiasthma, anti-bronchitis, hepatoprotective, appetizer, anticonvulsant, antispasmodic, breast milk inducer, anti-jaundice, antihypertensive, anti-dysmenorrhea, prevention of cardiovascular diseases, and spermatogenesis induction. This review compiles information on the ecology, botany, cultivation, habitat, medicinal properties, phytochemical composition, and pharmacological effectiveness of *Apium* plants. It also offers insights on maximizing the benefits of *Apium* plants for human usage.

KEYWORDS: *Apiumgraveolens*, phytochemistry, medicinal use, phytochemicals; pharmacological properties.

I. INTRODUCTION

Celery, scientifically known as *Apiumgraveolens*, is a plant that grows in marshlands and belongs to the Apiaceae family. It has been grown as a vegetable since ancient times. This genus has approximately 20 species of flowering plants that are found across the globe. These plants are medium to tall, biennial or perennial, reaching heights of up to one meter. They thrive in marshy places found in subtropical and temperate countries. The leaves are either pinnate or bipinnate and have little white flowers grouped in compound umbels. These plants are grown worldwide for their green leaves, bulbous roots, seeds, and petioles (Figure 1).[1] The most notable species in this genus is *Apiumgraveolens* L., commonly referred to as celery. There are three main varieties of *Apiumgraveolens*: *A. graveolens* var. *dulce* (Mill.) Pers, known as cultivated celery or simply celery, *A. graveolens* var. *rapaceum* (Mill.) DC., also known as celeriac, root celery, or turnip-rooted celery, and *A. graveolens* var. *secalinum* Alef, known as leaf celery. [2,3]



(A) (B) (C)

Figure 1. Celery plant (A), seeds (B) and roots (C)

TAXONOMY

Kingdom: Plantae
Division: Spermatophyta
Class: Dicotyledonae
Ordo: Apiales
Family: Apiaceae
Genus: Apium
Species: ApiumgraveolensL.

II. HABITAT AND CULTIVATION OF APIUM PLANTS

HABITAT

The Apium genus comprises edible plants from the Apiaceae family with green blanched leaf stalks. [4] The genus contains 18 confirmed species, with the majority being distributed globally in temperate regions, as reported by The Plant List. Today, it is distributed across South and North America, Southern Europe, Asia, and Africa according to The Plant List. The majority of the species are utilized as herbs, with *A. graveolens* being the only one commercially grown for its leaves (celery, smallage), roots (celeriac), seeds, and essential oil due to its distinctive aroma and health advantages. This plant exemplifies how humans have enhanced a wild species through ongoing selective breeding over the past few centuries. While Apium species have a global distribution, certain species, including *Apiumrepens* and *Apiumbermejoi*, are currently at risk of extinction and have been added to the IUCN Red List. Furthermore, different species within the genus exhibit significant diversity in development patterns and can be located in saltmarshes, wetlands, coastal regions, and aquatic environments. [5,6]

BOTANY OF APIUM GRAVEOLENS

A. graveolens is a scaposehemicryptophyte with slender roots and thin, hollow stems. The plant is a deciduous, upright, herbaceous annual or biennial herb that reaches a height of 0.5 m to 1 m. It has a cluster of rosette celery-like compound leaves with rhombic leaflets and hollow stems. [6] The plant has a superficial taproot system, with a branching, fleshy stem that is ridged. The leaflets are oblong to suborbicular with three lobes, measuring 2–4.5 cm. The flowers are little and creamy white, with well-defined calyx teeth. The seeds are broad, ovoid in globose in shape, measuring 1.5–2 mm in length and width. [7].

CULTIVATION

A. graveolens, also known as celery, is the most popular species in the Apium genus. It consists of three distinct varieties: *A. graveolens* var. *dulce* (celery or stalk celery), cultivated for its edible stalks, leaves, dried fruits, and seeds; *A. graveolens* var. *rapaceum* (root celery, turnip-rooted celery or celeriac), commonly used for its edible fleshy tap roots; and *A. graveolens* var. *secalinum* (smallage or leafy celery), predominantly found in Asian countries and valued for its aromatic leaves. *A. graveolens* originates from the eastern Mediterranean region, however, the presence of various wild ecotypes of the plant complicates the precise determination of its origin. [7] It is often a biennial plant grown as an annual crop, although there are annual cultivars specifically adapted for dry fruit and seed production.

PHYTOCHEMISTRY

The methanol extract of celery seeds was shown to include flavonoids, glycosides, steroids, alkaloids, and carbohydrates during the initial phytochemical study. [8]. Celery has phenolic chemicals and furocoumarins. The furocoumarins included are apigravrin, celereoside, bergapten, osthenol, apiumoside, isoimperatorin, celerin, isopimpinellin, apiumetin, 5-hydroxy methoxypsoralen, and 8-hydroxy methoxypsoralen. Phenols consist of isoquercitrin, apiin, tannin, apigenin, Graurobioside A, Graurobioside B, and phytic acid. [9,10] Celery seeds contain various compounds such as fatty acids, alcohol sesquiterpenes, and essential oils. Some of the isolated compounds include camphene, limonene, terpinolene, cymene, selenin, sabinene, α -pinene, α -thuyene, β -phellendrene, β pinene, γ -terpinene, p-cymene, stearic acid, palmitic, linoleic, petrocellinic, myristic, oleic, myristic, myristoleic, palmitoleic, α -eudesmol, santeudesmol, sedanolide, phthalide, and 3-n-butyl phthalide. Celery tubers contain 5-methoxypsoralen, methoxsalen (8-methoxypsoralen), and preventive allergens (Api gl).

Butylphthalide and sedanolide are the primary compounds that contribute to the scent and flavor of celery. The presence of chemicals like limonene, selinene, furocoumarin glycosides, flavonoids, and vitamins A and C make celery the most commonly utilized plant in traditional medicine. Kooti et al.'s 2017 paper displays the

chemical structures of key components found in

celery (Figure 2).[11]

Figure 2. Some of the phytochemicals of celery

III. SIGNIFICANCE OF APIUM GRAVEOLENS L

(a) CELERYSEED(APIUM GRAVEOLENS) ESSENTIAL OIL

Celery is consumed globally as a vegetable. North America and Europe utilize the crisp petiole (leaf stalk). In Europe, the hypocotyl is utilized as a root vegetable. The leaves have a powerful flavor and are infrequently utilized, mostly as a seasoning in soups and stews or as a dehydrated herb. The "holy trinity" of Louisiana Creole and Cajun cuisine consists of celery, onions, and bell peppers. The French Mirepoix consists of celery, onions, and carrots and is commonly utilized as a foundation for sauces and soups. Celery is a common ingredient in numerous soups. It is utilized in the Iranian dish KhoreshKarafs.

(b) LEAVES

Celery leaves are commonly utilized in culinary applications to impart a subtle pungent taste to dishes, reminiscent to, yet less intense than black pepper. Dried celery leaves can be used as a spice for baked, fried, or roasted fish and meats, as well as in a blend of fresh seasonings for soups and stews. They can also be consumed raw, added to a salad, or used as a garnish.

SEEDS

Celery is cultivated for its seeds in temperate regions. Despite being tiny fruits, these

"seeds" produce a valuable essential oil utilized in the perfume business. The oil includes the chemical molecule apiole. Celery seeds can be utilized as a flavouring or spice, in either whole seed form or crushed.

CELERY SALT

Grinding celery seeds and combining them with salt creates celery salt. Celery salt can be produced from a root extract or by utilizing dried leaves. Celery salt is utilized as a seasoning in several culinary applications such as drinks, particularly to enhance the flavour of Bloody Mary cocktails, on the Chicago-style hot dog, and in Old Bay Seasoning. Celery powder and salt combinations are utilized to season and preserve cured pig and other processed meats as a substitute for industrial curing salt. The inherent nitrites in celery combine effectively with the salt used to cure food.

CELERY JUICE

In 2019, there was a craze in the United States when people consumed celery juice due to claims of "detoxification" found on a blog. The assertions lack scientific evidence, however, they led to a significant increase in celery prices.[12,13]

NUTRITION

Celery in its raw form consists of 95% water, 3% carbs, 0.7% protein, and little fat. A 100-gram portion contains 16 calories and is high in

vitamin K, offering 28% of the Daily Value, with no other major micronutrients. Applying celery root and leaf juices, either alone or with doxorubicin, resulted in increased xanthine oxidase (XO) activity. Ethnobotanics studies indicated the utilization of every component of the celery plant. The seed has anti-spasmodic, anti-rheumatic, anti-bronchitis, and anti-asthma properties. The root is effective in treating kidney stones, while the herb can be used to address conditions related to uric acid, irregular menstruation, high blood pressure, as a tonic, stomachic, and diuretic.[14] *A. graveolens* has demonstrated pharmacological effectiveness in various areas including antimicrobial, antifungal, anti-parasitic, anti-inflammatory, anti-cancer, anti-ulcer, antioxidant, anti-diabetic, anti-infertility, anti-platelet, anti-spasmodic, hepato-protective, cardio-protective, neuro-protective, cytoprotective, hypolipidemic, and analgesic activities.[15]

IV. MEDICINAL AND PHARMACOLOGICAL PROPERTIES

Throughout history, humans have encountered illness and pain and have endeavored to address them using various methods. Herbs are consistently utilized for treating various disorders among all available remedies. Currently, herbal medications are not considered mainstream remedies, but due to their undesired toxicity and side effects, herbal therapy is regaining popularity. Herbal medicine is recognized as a supplemental and alternative therapy alongside conventional treatments worldwide.[16] Currently, there is a growing emphasis on research in the field of herbal medicine worldwide. [17,18]

Figure 4. Description of pharmacological significances of the celery plant.

TRADITIONAL MEDICINAL USE

Al-Asmari et al 2017 mentioned that *Apiumgraveolens* Linn. (Karafs) is utilized in traditional medicine to treat many diseases. They compiled the most referenced and up-to-date material. The latest discoveries highlight the significance of Karafs in traditional medicine and their effectiveness in treating different disorders. This review clearly affirms that *Apium* has proven to be a valuable medicinal resource for treating a variety of ailments. It is necessary to identify and separate the bioactive phytochemicals found in this plant.[16]

INFLAMMATORY BOWEL DISEASE (IBD)

According to Wang et al 2023, dietary fiber and flavonoids show potential as therapeutic agents for treating inflammatory bowel disease (IBD). The connection between dietary fiber and flavonoids in gut health is not well understood. An experiment was conducted to study the therapeutic impact of celery, kale, and red chicory powders on mice with colitis. The mice were housed individually during the study. The study evaluated the effectiveness of several components of celery in protecting against inflammatory bowel disease in mice to determine which specific component(s) contribute to its protective effects. A 3% solution of Dextran sulfate sodium salt (DSS) was utilized to create a colitis model in mice. Various molecular biology techniques were used to assess the severity of colitis in mice and analyze the gut microbial composition of the mice. Kale and red chicory administration dramatically improved body weight, DAI score, and colon length in colonic rats, while celery had the least impact.[19]

SMOOTH MUSCLE RELAXANT

Niedzwiecki et al 2023 showed that the invention pertains to a micronutrient composition that is very efficient in relaxing smooth muscle cells in bronchial and uterine cells during a certain condition. The micronutrient composition consists of the following components: Vitamin C (calcium ascorbate and magnesium ascorbate): 0.01 mg - 5000 mg, Vitamin B1: 0.1 mg - 50 mg, Vitamin B2: 0.1 mg - 50 mg, Vitamin B3: 1 mg - 3000 mg, Vitamin B6: 0.1 mg - 50 mg, Vitamin B12: 10 pg - 300 pg, Folate: 10 meg - 1000 meg, Vitamin D: 10 mg - 400 mg, Magnesium: 5 mg - 2500 mg, Celery extract: 10 mg - 2000 mg, Grape seed extract: 10 mg - 1000 mg, Clove extract: 10 mg - 10000 mg,

Green tea extract: 10 mg - 1000 mg, and L-arginine: 10 mg - 2000 mg.[20]

ANTIHYPERTENSIVE

Rad et al 2022 studied the impact of celery seed extract, including 3-n-butylphthalide, as a pharmaceutical supplement on anxiety and depression in hypertensive individuals. Celery consumption considerably alleviated symptoms of anxiety such as inability to relax, uneasiness, numbness, dizziness, flushed face, perspiration, and difficulty breathing. Celery may alleviate symptoms of depression, including melancholy, crying, loss of energy, insomnia, irritability, exhaustion, loss of interest in sex, and feelings of punishment. There was a considerable decrease in blood pressure measurements during celery therapy. The study showed that celery seed extract has anti-anxiety and anti-depressive effects when used as a supplement in hypertension patients.[21]

NEUROPROTECTIVE EFFECTS

Chonpathompikunlert and colleagues (2018) showed that *A. graveolens* extract had neuroprotective properties against a Parkinson's disease model caused by MPTP in C57BL/6 mice. Male C57BL/6 mice were given MPTP and then received *A. graveolens* extract orally every day for 21 days. Behavioral tests, such as a rotarod device, narrow beam test, drag test, grid walk test, swimming test, and resting tremor evaluation, were conducted. Subsequently, the mice were euthanized, and the activity of monoamine oxidase A and B, lipid peroxidation, and superoxide anion levels were assessed. Immunohistochemical labeling of tyrosine hydroxylase was used to detect dopaminergic neurons. The administration of *A. graveolens* at a dosage of 375 mg/kg showed the most pronounced impact, resulting in notable enhancements in behavioral performance, oxidative stress indicators, and monoamine oxidase A and B activity as compared to the control group ($p < .$). Furthermore, the extract elevated the number of neurons showing positive immunoreactivity for tyrosine hydroxylase expression in comparison to MPTP alone or MPTP plus a positive control medication. *A. graveolens* improved behavior by providing neuroprotection against MPTP-induced Parkinson's disease through antioxidant actions, associated neurotransmitter pathways, and an increase in dopaminergic neuron count.[22]

ANTIPLATELET ACTIVITY

Celery extract exhibits potent antiplatelet activity due to the presence of apigenin components, which function by preventing platelet aggregation generated by adenosine diphosphate, collagen, and arachidonic acid. Apigenin can reduce collagen-adenosine diphosphate-induced blood aggregation.[23]

ANTIOXIDANTACTIVITY

Kooti et al. (2017) conducted a systematic review of the antioxidant properties of celery. Celery possesses potent antioxidant properties due to components like caffeic acid, p-coumaric acid, ferulic acid, apigenin, luteolin, tannin, saponin, and kaempferol, which help eliminate free radicals. Celery's therapeutic benefits can vary due to its varying components and concentrations. Future studies should focus on exploring further the medicinal and industrial properties of celery.[11]

ANTIPARASITES ACTIVITY

Celery seed oil exhibits larvicidal and repellent properties that are effective against *Aedes aegypti* larvae, known vectors of dengue illness. Celery oil containing 5% vanillin was found to be more efficient in repelling mosquitoes than conventional mosquito repellents in a study by Tuetun B in 2005.[24]

ANTI-ULCEROGENIC

Baananou et al. (2013) studied the anti-ulcerogenic properties of *Apium graveolens* extracts. Rats were used to assess the anti-ulcerogenic activity by the HCl/EtOH technique. *A. graveolens* extracts inhibited stomach lesions in a dose-dependent manner, with the aerial component showing a 53-76% reduction and the seeds showing a 51-95% reduction. Both the methanolic and aqueous extracts, administered at a dose of 300 mg kg⁻¹, showed a considerable suppression of gastric lesions (91% and 95%, respectively), comparable to the effect of omeprazole (94%). [25]

ANTIBACTERIAL ACTIVITY

Baananou et al. (2013) studied the antibacterial properties of *Apium graveolens* extracts. The antibacterial activity of essential oil and aqueous extract from *A. graveolens* aerial parts was assessed using the paper disk-diffusion method, minimal inhibitory concentration, and minimal bactericidal concentration. The essential oil from *A. graveolens* showed high inhibition against *Escherichia coli* and moderate inhibition against

Pseudomonas aeruginosa and *Staphylococcus aureus*. The chemical makeup of the volatile oil was analyzed using gas chromatography. The main components detected were β -pinene, camphene, cumene, limonene, α -thujene, α -pinene, β -phellendrene, p-cymene, γ -terpinene, sabinene, and terpinolene.[25]

ANTIFUNGAL ACTIVITY

A 200 μ g/mL concentration of celery methanol extract showed antifungal activity against various fungi including *Aspergillus flavus*, *Fusarium solani*, *Trichophyton longifusus*, *Microsporium canis*, *Candida glabrata*, and *Candida albicans*. [26]

CYTOPROTECTIVE ACTIVITY

Sedanolid is a primary active component found in celery oil. Celery is commonly utilized in treating rheumatism and gout because of its utilization of hydrogen peroxide and tert-butyl hydroperoxide, which are employed in vitro to induce toxicity. Human liver cancer cells and highly specialized colon cancer cells were utilized to assess cytoprotective properties. Cell survival was assessed using a spectrophotometer. Viable cell percentage was determined using the microtetrazolium test. The investigations showed that intestinal cells had higher survivability than liver cells when exposed to high quantities of sedanolid, indicating that sedanolid may have harmful effects on liver cells despite not providing any protection.

HEPATOPROTECTIVE ACTIVITY

The methanol extract from celery seeds exhibits potent hepatoprotective effects against liver damage induced by paracetamol and carbon tetrachloride. Celery extract can lower the risk of hepatotoxicity, including various liver enzymes, as compared to silymarin, a common medication. The histological investigation revealed that the methanol extract from celery seeds can reverse the structural alterations in liver tissue caused by paracetamol. A trial showed that consuming celery along with barley and chicory in the diet can lower triglyceride levels, total cholesterol, and serum liver enzyme levels. [27]

CARDIOPROTECTIVE ACTIVITY

Rabbits were administered water and ethanol extract of celery in a study to evaluate their impact on mean blood pressure and atrial contraction. The study's findings suggest that the

ethanol extract of celery exhibits a more pronounced hypotensive effect compared to the water extract of celery. Atropine (0.3 mg/kg) can inhibit the hypotensive effects of aqueous and ethanol extracts of celery. [28].

HYPOLIPIDEMIC ACTIVITY

Rats were utilized to assess the hypolipidemic effects of an ethanol extract derived from celery. Mice were orally administered ethanol extract of celery at doses of 213 mg/kg and 425 mg/kg for a period of 60 days. The study shows that the ethanol extract of celery can lower total serum cholesterol, triglycerides, and low-density lipoproteins while increasing high-density lipoproteins. This study's findings validate the long-standing use of celery for its hypolipidemic properties. Possible processes may involve suppressing appetite, reducing energy intake from food, increasing energy expenditure, and blocking nutrient absorption in the digestive tract. [29]

ANALGESIC ACTIVITY

Celery seed ethanol extract demonstrates potent analgesic effects in rats with acetic acid-induced pain, as determined by the hot plate and writhing test method [Atta AH, 1998]. The pain-relieving effect of the ethanol extract from celery seeds is linked to celery's impact on cytochrome P450, which was observed to decrease hepatic homogenate. [30]

ANTIDIABETIC ACTIVITY

A study utilized n-butanol extract from celery seeds to examine its antidiabetic effects on male rats with streptozotocin-induced diabetes by assessing its impact on antioxidant levels and lipid peroxidation. The studies show that the n-butanol extract from celery seeds at a dose of 60 mg/kg BW or insulin treatment can control antioxidant enzyme activity, enhance weight gain, alleviate stress complications related to diabetes, and maintain normal blood glucose levels. [31]

CONCLUSION

Celery, scientifically known as *Apiumgraveolens*, is a member of the Apiaceae family. Celery plants are found in Asia, Europe, and some regions of Africa with a tropical environment. Celery is currently grown and eaten worldwide. Celery's phytochemicals, minerals, and pharmacological activity suggest that it has great potential as a therapeutic plant. Further research is

required to confirm the efficacy of celery as a therapy.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this study.

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