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A review on medicinal plant of *Apium graveolens*

Wesam Kooti¹, Sara Ali-Akbari¹, Majid Asadi-Samani^{2*}, Hosna Ghadery¹,
Damoan Ashtary-Larky³

¹Member of Student Research Committee, Kurdistan University of Medical Sciences, Sanandaj, I.R. Iran; ²Medical Plants Research Center, Shahrekord University of Medical Sciences, Shahrekord, I.R. Iran; ³Member of Student Research Committee, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, I.R. Iran.

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Review article

ABSTRACT

Background and aims: Medicinal plants are used in traditional medicine to treat many diseases. Celery (*Apium graveolens*) is a native medicinal plant to Europe. This plant has a very wide range of usage and cultivation. The wild type was found in countries such as Algeria, the Caucasus, Iran, India and America. However, due to increasing value and the special place of the plant in the new pharmaceutical industry, it is necessary to recognize the potential in the field of manufacturing and processing. This article presents morphological characteristics, vegetation compounds and evaluation of the therapeutic properties of this valuable medicinal plant.

Methods: The information of this review article have been gathered from accessible journals in databases such as Web of Science, PubMed, Scopus, Embase, SID and Iran Medex. The search terms were "Celery" and "*Apium graveolens*" that searched in Persian and English books on medicinal plants and traditional medicine, as well as reputable sites mentioned.

Results: Various studies have shown that celery plays a role in prevention of cardiovascular disease, lowering blood glucose and serum lipid, decrease blood pressure and strengthen the heart. This herb has anti- bacterial, anti-fungal and anti- inflammatory effects. Also, a powerful antioxidant property has been attributed to compounds such as apigenin, apiein, vitamins A and C.

Conclusion: Celery widely used in pharmaceutical, food and ornamental industries, that causes its significant commercial value. Various combinations and numerous medicinal properties of seeds, leaves and stems, cause the need further and more research about the other useful and unknown properties of celery.

Keywords: Medicinal herbs, Celery, Antioxidant activity, Therapeutic uses, Compounds.

INTRODUCTION

Medicinal plants are used in traditional medicine to treat many diseases. Observations of scientific studies on medicinal plants are used to cure various diseases including: cancer, infectious diseases, diabetes and

atherosclerosis.¹⁻⁴ However, the indiscriminate use of these herbs can have side effects.⁵ Therefore; a scientific research is needed to determine the pharmacological properties of various plants. Celery (*Apium graveolens*) is a

*Corresponding author: Medical Plants Research Center, Shahrekord University of Medical Sciences, Shahrekord, I.R. Iran. E-mail: biology_2011@yahoo.com

medicinal plant in traditional medicine with numerous health benefits. This article presents morphological characteristics, vegetation compounds and evaluation of the therapeutic properties of this valuable medicinal plant.

Celery involves in the prevention of cardiovascular disease,⁶ lowering blood glucose in diabetic mice,⁷ lowering blood pressure and strengthening the heart.⁸ Experimental studies report antifungal⁹ and anti-inflammatory effects of celery.¹⁰

Celery has an anticoagulant activity.¹¹ Its root leads to an increase of calcium and decrease of potassium in the heart tissue.¹² Essential oil of celery has antibacterial effects. This plant has cooperation in the molecular mechanisms and cellular targets that have a significant effect on the treatment of human cancers.¹³ Celery root and leaves have the property of eliminating OH and DPPH radicals. It also reduces the severity of liposomal peroxidation that represents renewal and conservation activities of it.¹⁴ Its seed can separate non-completion base pairs from each other.¹⁵ In animal studies, it was shown that perillyl alcohol in celery causes regression of tumors of the pancreas, liver, and breast.¹⁶ Celery has a protective effect on the gastric mucosa and it is anti-gastric ulcer,¹⁷ also a diuretic plant¹⁸ with antioxidant properties.¹⁴ It is also used to treat stomach pain.¹⁹ This plant increases the secretion of breast milk.¹⁹ It also reduces jaundice.²⁰ It has protective effects on the testicles and the moderator effects on the sex hormones (LH and FSH) against some of the toxic drugs such as sodium

Valproate.²¹ Its leaf water and roots have effect on biochemical parameters such as restored glutathione, the activity of catalase, xanthine oxidase, glutathione peroxidase and intensity of lipid peroxidation in homogenized liver and hemolyzed blood and when used in combination with doxorubicin provides a protective effect against it.²² However, due to the increasing value and the special place of the plant in the new pharmaceutical industry, it is necessary to recognize the potential in the field of manufacturing and processing. This article presents morphological characteristics, vegetation compounds and evaluation of the therapeutic properties of this valuable medicinal plant to conduct clinical trials and available pharmaceutical solutions to scientists.

Celery (from the Umbelliferae family)¹⁹ is called in different names in different language: Persian: Karafs, Spanish: Apio, German: Sellerie, Arabic: Alkarafs. Celery is a biennial plant with a height of 100 cm, a strong aroma and fleshy solid stem. It is from umbelliferae family. Its leaves are 5 to 50 mm, triangular, diamond or a spear in shape, and their edges are saw-teeth or lobe. Each umbrella has 4 to 12 branches. The fruit of this plant is in oval shape with the wideness of 1.5 to 2 mm. It is wingless, brown, and with black lines.^{23, 24}

Celery is native to Europe; the range of cultivation and consumption of celery is very extensive and it is found in most developing countries, including African countries such as Algeria, Abyssinia, the Caucasus, Iran, India and the United States in the wild.²⁵ Celery has its origin

from a wild and swampland plant which is widely distributed in Europe and Asia. India produces 40,000 tons of celery annually and exports 29,250 tons. Celery requires comparatively high humidity, but does not need high temperature. Therefore its best product comes in cool weather and temperate regions.²³ In Iran the best the weather condition for the production of celery is that of the coastal Caspian. Celery is a shade-oriented vegetable and high light intensity decreased its quality and growth. This plant is currently cultivated in provinces such as central regions of Khuzestan, Tehran, North East Iran, Semnan, Sistan and Baluchistan, and Zabo.

PHYTOCHEMICAL COMPOUNDS

The primary phytochemical analysis on the seed extract of *Apium graveolens* indicates the presence of carbohydrates, flavonoids, alkaloids, steroids, and glycosides in the methanolic extract.²⁶ The plant included phenols and furocoumarins. Furocoumarins contained celerin, bergapten, apiumoside, apiumetin, apigravrin, osthénol, isopimpinellin, isoimperatorin, celereoside, and 5 and 8-hydroxy methoxypsoralen. Phenols (155.41-177.23mg/100g) included graveobioside A and B, apiin, apigenin, isoquercitrin, tannins (3.89-4.39 mg /100 g) and phytic acid (19.85-22.05mg/g).²⁶

Celery seeds, stems and leaves oil (2.5-3.5%) included volatile oils, sesquiterpene alcohols (1-3%) and fatty acids. The derived compounds were included contained selenine (10-15%), limonene (60%), β -pinene, camphene, cymene, limonene, α -thuyene, α -pinene, β -phellendrene, p-cymene, γ -terpinene, sabinene terpinolene, myristicic,

myristic, linoleic, petroselinic, palmitoleic, palmitic, oleic, myristoleic, stearic acid, santalol, β -eudesmol, α -eudesmol, sedanenolide, 3-n-butyl phthalide and phthalide.

Celery tuber also contained methoxsalen (8- methoxypsoralen), 5-methoxypsoralen and the allergen profilin (Api g1).²⁶

Celery seeds contain 2 to 3% essential oil. Its oil contains mostly limonene (usually 60 percent), selenine (10 %), furocoumarin and furocoumarin glycosides and their flavonoids. Photochemistry tests of celery seeds approve the presence of flavonoid apigenin (as main component), and vitamins A and C. A total of 16 combinations of seed extract have been identified in celery which make up 98.7% of the whole extract whose main components are D. limonene and myrcene.²⁷ (Table 1).

Table 1: *A. graveolens* components, GC/MS

Celery components	Percent (%)
D-Limonene	57.7
Myrcene	18.7
4-Terpeneol	8.6
β -Selinene	8.1
β -pinen	2.4
β -caryophyllene	0.5
Carnone	0.3
Trans-Limonene Oxide	0.3
α -Terpinolene	0.3
α -selinen	0.2
Trans-3-butylidene-phthalide	0.1
α -Muuroloene	0.1
Cis-Limonene Oxide	0.1
Linalool	0.1
α -pinen	0.1
Trans-ocimene	0.1

Celery seed is consumed as a diuretic; it is also used to treat symptoms of kidney, rheumatoid, and arthritis diseases. It is believed that celery seed tea gives relaxation and improves sleep. Due to the high percentage of essence in it, celery seed is anti-spasmodic.²⁶

Celery leaves and stem contain phenols. Flavonoid is the main component of apigenin celery leaves whose amount is 202 milli-grams per kilo-gram. There are also luteolin and chrysoeriol 7-glucosides with the amounts of 48 mg per kg and 27 mg kg respectively in celery leaves. Celery leaves also contain furanocomarin, psoralen, bergapten, xanthotoxin and isopimpinellin, whose amounts vary from 12 to 50 mg kg in celeries grown in Florida in the United States.²⁸ Among the 12 fragrant elements in the leaves and stem of celery, first 3-n- butylphthlide, sedanolide, and then cis and trans sedanolide have the largest contribution to creating a fragrant aroma in the plant.²⁹

Celery contact with skin can cause acute skin inflammation.³⁰ Jung et al. in a study examined the combined total phenolic and flavonoid antioxidant properties of the leaves of celery using Folin-Ciocalteu method. The results of their study showed the alcoholic extract of the leaves of celery contains the highest amount of phenolic compounds and aqueous extract came in the second in this regard (Table-2).³¹

Celery root contains phenolic derivatives. Studies on the phenolic derivatives of the celery root show that the amount of caffeic acid is at the highest level (89 to 168 milligrams per kilogram, depending on the soil where it grows). The amount of ferulic acid is noticeable too (34 to 61 mg kg) while its p- coumaric acid derivatives content was very small (less than 5.0 mg/kg). Celery root contains coumarin, scopoletin, and aescoumlic acid. However, the amount of these elements is less than 5.0 milligrams per kilogram in the plant.²⁸

The essential oil of celery has antifungal and antibacterial effects on staphylococcus aureus, staphylo coccus albus, shiglla dysenteriae, salmonella typhi, streptococcus faecalis, streptococcus pyogenes, and salanacearum. Apigenin found in celery has no effect on Escherichia coli and pseudomonas aeruginosa.^{13, 32-34} Active ingredients of the celery seed which are extracted by methanol, act as nematodes killers, herbicides, fungicides and insecticides.^{9, 13, 34} Celery seeds can be a potential candidate for the production and development of commercial insect repellents and thus an alternative for the common synthetic chemicals used in the community to control insects particularly the vector ones. Recently a substance known as CAH has been found in the ethanol extract of celery seed which can be investigated as an effective agent for the treatment of *H. pylori* infection.³⁵

Table2: Total phenolic and flavonoid content from leaves extracts of *A. graveolens*

Extract	Total phenolic content (mg/g)	Total flavonoid content (mg/g)
Ethyl acetate	22.70 ± 1.56	4.08 ± 0.31
Methanol	51.09 ± 1.44	2.12 ± 0.08
Butanol	19.43 ± 0.88	4.80 ± 0.03
Water	46.40 ± 0.31	0.77 ± 0.01

THERAPEUTIC PROPERTIES

In a study by Kooti et al. it was shown that celery can protect spermatozoa and testes of rats against the toxic effects of propylene glycol.³⁶ The results in an in vitro study evaluated the ability of methanol extract of celery to remove OH and DPPH and inhibition of liposomal peroxidation showed that extract obtained from the leaves of celery root, is effective in the removal of free radicals and DPPH and reduces the intensity of LPX (liposomal peroxidation) indicating the its protective activity (antioxidants). In another part of an in vitro study, antioxidant systems in homogenized liver of rats and their blood were examined. Evaluation of antioxidant systems after applying extract of celery leaf, alone or in combination with carbon tetrachloride (it is thought that free radicals derived from CCl₄ due to lipid peroxidation have damaging effect on liver) showed that the exerted extracts have a protective effect.¹⁴ Pretreatment with celery seed extract reduces most of the effects caused by sodium valproate which shows protective effect of celery extracts against toxicity caused by VPA produced in laboratory. VPA is commonly used in the treatment of epilepsy and other diseases and is thought to have a severe toxic effect on the testes in animals and humans.³⁷ Celery seed is effective on liver injuries in rats which were caused by a single dose of paracetamol. It was noticed clear that celery has the protective activity against thioacetamide drugs.³⁸ Celery seed on liver carcinoma, which was injected in wistar rats in the laboratory (chemical), had inhibitive effect.³⁹

Celery can regulate heart function. It can also stimulate pancreas to secrete insulin to reduce blood glucose levels, so that it can be used to reduce or treat diabetes complications.⁴⁰ Its leaves and roots water has effects on biochemical parameters such as GSH content, activity of catalase, glutathione peroxidase xanthine oxidase, peroxidase and intensity of lipid peroxidation in homogenized liver and hemolyzed blood.²² Taher's study in Isfahan showed that the ingredients of celery stabilizes liver cell membranes and reduce release of AST and ALT enzymes into the blood.²⁶ In a study, kooti et al, evaluated the effects of celery on serum lipids of mice fed a high-fat meals showed the plant causes a significant decrease in LDL and Cholesterol, However not on VLDL and HDL.⁴¹ In a study, Tsi et al. examined the attributes of anti-hyperlipidemia of the celery in the rat. At the end of the experiment a significant reduction was observed in the concentration of serum total cholesterol, triglyceride levels and hepatic lipase triacyl glycerol in the treatment group.⁴² In a study conducted by Abdolmadjid about regulatory effects of celery on lipid metabolism and also prevention from the fatty liver, biochemical analysis of serum liver enzymes and blood lipids showed that eating 10% of celery alone lowers liver enzyme levels and blood fats.⁴³ In another study, Chang et al. showed that celery seed extract has a hyperlipidemia activity and also has a role in cleanup of free radicals due to the antioxidant property.⁴⁴ Long-term consumption of aqua and butanol content celery extract primarily decreases total cholesterol levels by increasing the excretion of bile

acids and, rather than by the modulating activity of Limiting enzyme in cholesterol biosynthesis.⁴⁵ Some of the compounds in it seed show anti-inflammatory and analgesic effects.^{13, 46} In a study effects of celery simultaneously paracetamol analgesia and aminopyrine was evaluated. The results showed strengthened also longer-term effects in analgesic effect paracetamol and aminopyrine by celery. It was also shown that celery juice reduces cytochrome P450 in comparison to the control group homogenized liver.⁴⁷ Zhang et al showed protective effects of celery's active substances in ischemic brain.⁴⁸ Kooti et al showed in a study that celery can reduce sex hormone LH in rats however had no significant effect on Testosterone and FSH.⁴⁹ Kooti et al studies determined that celery concurrent use of both male and female rats, cause an increase in number of newborns however, there was no significant effect on birth rates.⁵⁰ Gharib Naseri et al found that celery leaf extract have concentration-dependent inhibition on rat ileum contractions and concluded that probably voltage and ligand gated calcium channels involved in the genesis of this antispasmodic effect.⁵¹

In study of Mayaud L et al it was shown that celery leaf extract inhibited the ileum contractions dose dependently. It seems that voltage dependent calcium channels and receptor-operated calcium channels are involved in this activity, but β adrenoceptors, opioid receptors, NO, and potassium channels are not involved in this effect. It is possible that apigenin as the celery flavonoid is responsible for this activity.⁵²

Celery considering pain relief as an important factor in the management of colicky pain. This herb was developed in the form of soft capsules and subjected for multi centric clinical trials. These trials included the evaluation of new herbal anti-spasmodic in patients with colicky disorders like nonspecific abdominal colic, irritable bowel syndrome, infective diarrhoea, acute amoebic colitis, pain associated with lower urinary tract infection and painful menstruation.⁵³

Celery has the ideal quantities of iron and magnesium to stop oncological diseases from progressing. The juice extracted from the petioles can be used for oedema, rheumatic tendencies, gout, flatulence, chronic pulmonary catarrh, tendencies toward overweight and lack of appetite.⁵⁴ It is a strong diuretic, and is used as a urinary antiseptic, mainly because of the volatile oil apiol.⁵⁵ Celery seed has been found to help regulate nervous system by producing a combing effect. It stimulates seeds drives and produce sedative effect.⁵⁵ Its seeds also used as nervine, an agent that act on the nervous system to reduce distress and irritation. Both stem and seed of celery have been reported to help balance acidity in the body. Celery seed also promotes perspiration which may help with weight loss when water retention is a problem.⁵⁶ In study of Naema et al was represented that the antiulcerogenic activity of celery extracts was evaluated in rats by the HCl/EtOH method. Inhibition of gastric lesions by *A. graveolens* extracts was dose-dependent.⁵⁷ Wild celery is said to be useful in cases of hysteria, promoting restfulness and sleep, and diffusing

through the system a mild sustaining influence.⁵⁸ The potential of essential oil extracted from the seeds of celery evaluated as larvicidal and repellent agent against dengue vector, *Ae. aegypti*. The investigations validated the significant potential of essential oil as the probable agent for the control and management of rising *Ae. Aegypti* population.⁵⁹ Celery apigenin, relaxes rat isolated thoracic aorta by reducing entry of calcium into the cell through voltage-dependent and receptor-dependent channels.⁶⁰

In the study by Ashburn MA et al, it was shown that essential oil obtained from celery is reported to have a calming effect on the central nervous system. Moreover, some of its constituents showed antispasmodic, sedative and anticonvulsant actions.⁶¹

People with kidney inflammation should refrain from excessive use of celery. In traditional medicine, the effects of celery on abortion and the periods mentioned, Pregnant women should be careful in eating celery seed because too high of its doses can stimulate the uterus.²³ Celery can cause photodermatitis and contact dermatitis. In a case-control study it was shown that it can cause damage to the small intestine.⁶² In 2007, Savant Alr (Sausenthaier) and colleagues performed an experiment to evaluate the effect of maternal diet in pregnancy on creating eczema and allergies in babies; in this study 2641 two years old children were examined. The results showed that a high intake of celery (aOR: 1.85; 95% CI: 1.18, 2.89) during the last 4 weeks of pregnancy may increase the risk of complications.⁶³

In study of Gadermaier G et al was shown that *Apium graveolens* is one of the most important plant food allergen sources in the adult Central European population. The most important celery allergens are PR-10 protein (Api g 1), non-specific lipid transfer proteins - LTP1 (Api g 2), pro-filin (Api g 4) and flavoprotein (Api g 5). Api g 2 and Api g 4 allergies are potentially dangerous for allergic individuals because these allergens may induce an anaphylactic reaction.^{64,65}

In a study kooti et al indicated that eating celery alone in male rats is effective in reducing the number of newborns.⁶⁶ In another study, this group demonstrated a certain dose of celery decreases the serum levels of T3 and T4 and increases TSH.⁶⁷

CONCLUSION

Celery plant around the world considered as an important medicinal herb. It's used in pharmaceutical, food; ornamental industries caused considerable commercial value. The presence of compounds such as limonene, selinene, furocoumarin glycosides, flavonoids and vitamins A and C cause its most use in medicine and traditional medicine. Also major dietary sources of the flavones, which have been determined so far, are celery and parsley. Flavones are mainly composed of luteolin glycosides and apigenin. It is possible that apigenin as the celery flavonoid is responsible for this activity. The plant composition and medicinal properties lead to need for further and more research about other useful and unknown properties of it, so used as plant-derived medicine to treat diseases.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

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