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Value added products, chemical constituents, and medicinal uses of Celery (*Apium graveolens* L.) – A review

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Abstract

Celery (*Apium graveolens* L.) is an annual or perennial plant that is widespread in distribution and belongs to the family Apiaceae or Umbelliferae. This plant has long been used for the treatment of various illnesses due to excellent therapeutic potentials and as flavoring agent in several food articles owing to high nutritional value. The genus Apium is known to contain about 20 well-known species of Apiaceae family and its several varieties are found native to Eurasia and are mainly grown in coastal regions. Celery requires relatively high level of humidity and comparatively low level of temperature. Therefore, maximum yield is obtained in cool weather of temperate regions. The aggregated world production of seed oil of celery is estimated to be 51 tons while only India produces 25 tons among all and rest of the contribution is made by United Kingdom, Egypt, France, United States of America and China. Different parts of celery contain fatty acids, volatile essential oils, vitamins and minerals such as potassium, magnesium and calcium along with chlorophyll, silica, β-carotene, fibers, sodium and folic acid. Various post-harvest methodologies and treatment processes for preservation of celery are discussed in detail in this review. Different parts of this plant are used for preparation of medicinal formulations in traditional systems of medicines due to their anti-inflammatory, anti-microbial, anti-fungal, anti-bacterial, anti-virus, anti-cancer, anti-spasmodic, gastro-intestinal and anti-oxidant potentials.

Key words: Annual plant, nutritional value, fatty acids, vitamin C, β-carotene, post-harvesting, therapeutic potentials

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1. Introduction

Celery (*Apium graveolens* L.) is a widespread perennial or annual plant belonging to the Apiaceae or Umbelliferae family. All parts of this plant have been used for thousands of years in number of homemade remedies and used as flavoring agents in food industry [1]. The genus *Apium* contains about 20 species of Apiaceae family and its several varieties are found native to Eurasia. It is mostly grown in coastal regions due to favorable environmental conditions. Celery is widely cultivated in temperate zones as an important garden crop and as a popular vegetable due to bleached leaf stalks [2]. Variability is present in morphology and chemical composition of stem, leaves and flowers of this plant. Celery cross-pollinates very easily while it is incompatible in self-pollination [3]. There is no other plant that has common name "celery". *Apium graveolens* is known by different names in different regions of the world. In English, it is typically called "*Celery*", in Persian it is called "*Karafs*" and known as "*Apio*" in Spanish. It is commonly known as "*Sellerie*" in German. In Arabic, it is known as "*Alkarafs*". Celery is known as "*Khuen chaai*" in Thailand [4]. It is called as "*Tukhme karafs*" in Urdu. *Apium graveolens* is commonly known as "Ajmod" in Hindi and the fruits are popularly known as "celery seeds" [5]. Probably the most familiar celery is the *Apium graveolens*; however this plant has a range of three varieties and cultivars varying in color and flavor.

The most important botanical cultivars of celery plant include, *Apium graveolens var. rapaceum* "celeriac" which is abundantly found in Central Europe, *Apium graveolens var. dulce* "stalk celery or pascal celery" that is grown in Western Europe and the last one is the *Apium graveolens var. secalinum* "golden or leaf celery" that is used as spice as well [6]. The leaves of celery are quite different in pattern and petiole produces more leaves that are relatively thinner having delicate petioles. Colors of the flowers can range from green to pale green and pale green to yellow [7]. This plant is used in the folk system of medicine due to its decorative and medicinal properties. The

economic value of this plant globally increases due to its consumption in the treatment of blood pressure. Celeriac is most popular plant as it is the part of American gourmet eating [8]. The content and chemical composition of the essential oil of celery and other species are widely dependent on the number of factors including both, genetic, ontogenetic and environmental as well as agronomic factors such as fertilization, irrigation, cultivation method and harvesting method [9]. California, India and France produce oil from the seeds of celery and are mainly used in Juices and vegetables and other flavoring foods such as pickles, meat and soups. It is also used in perfumes in minor quantities. Other additional products that are obtained from celery are leaf oil, seed oleoresins and seed or roots extracts. Seed extract of celery contains more sesquiterpenoids and less monoterpenoids as compared to leaf oil. The majority of essential oil is concentrated in the leaves. Small amount of essential oil is also present in the seeds of celery [10].

1.2 History/Origin

Apium graveolens is native to the Mediterranean areas which are derived from wild *Apium graveolens* that grows in mountainous area of Southern Asia and in the marshes of North Africa and Europe [11-12]. It has been cultivated in early 1600s as food plant [13]. The generic name, *Apium* is derived from the Latin word "*apis*" meaning "bee", as its small white flowers have attraction for the bees. The species name "*graveolens*" means "heavy scented". Our English word "*celery*" is derived from the Latin word "*celer*" which means "swift" as celery is considered a fast acting remedy [14]. The history of celery is stepped from the low land area of Italy later extending to other countries such as France and England. In 1623, the first celery food plant was found to be cultivated in France. It was introduced from France to India by trading company in Amritsar, Punjab around 1930 AD. *Apium graveolens* probably originate in Mediterranean regions but now a days, this plant is normally grown in the whole world. It is also cultivated in India in Punjab, western utter Pradesh and Himalayas at north-western side [3]. However, the center of origin of this plant was much extensive. The celery that is well known today is *Apium graveolens var. dulce* named stalk celery and it was selected to cultivate in 16th and 17th century while *Apium graveolens var. rapaceum* was also developed at the same time. This celery is still grown in Southeast Asia [15]. In 1887, the two cultivars of *Apium graveolens* were introduced in North America from France; the first one was self-blanching named "Paris Golden Yellow Self-Blanching" or "White Plume" and second one was the green cultivar named "Pascal" or "Giant Pascal". The above mentioned methods are interrelated and derived from older French cultivars named "solid golden white celery". Therefore, this plant exhibit low variation in genetics [16].

1.3 Demography/Location

Celery is a shade-oriented vegetable thus high light intensity decreases its quality and growth rate. Optimum growth of celery can be obtained in humid and mild growth conditions, and the optimum range of temperature for this plant is approximately 15°C to 22°C. At low temperature, growth is relatively slow [17]. Celery requires comparatively high humidity but does not need high temperature. Therefore its best product comes in cool weather of temperate regions. *Apium graveolens* has a worldwide distribution including most parts of United States, many countries within the Europe such as France, UK, Italy, Germany, Belgium and Hungary, Asia, Africa and several parts of India. This plant is currently cultivated in provinces such as central regions of Khuzestan, Tehran, North East Iran, Semnan, Sistan and Baluchistan and Zabo [18]. Celery is considered very important in China. The most commonly used plant is leaf type and the term "Chinese Celery" is a synonym for this type, which has small and aromatic leaves [19]. In Africa, celery is cultivated in highland regions and for market gardening but more recently also for processing and the food industry [20]. In Iran, best weather conditions for the production of celery are the climatic zones of coastal Caspian [21].

The total world production of celery seed oil is estimated to be 51 tons. India produced 25 tons from 51 tons while remaining seed oil is produced in China, USA, France, Egypt and the UK. In USA, celery is produced on 12,000 ha annually. In Europe, the most extensive production area can be found only in Italy approximately 5000 ha, but Spain and France also has extensive production. In India, it is cultivated in north western Himalayas and in the hills of Uttar Pradesh, Southern India [22]. India produces 40,000 tons of celery annually and exports 29,250 tons [4]. Michigan celery production yields approximately US$ 14,678 annually (based on a five-year average). The current price of seed is Rs.3500/ton and oil price ranges from Rs.1500–1600/kg in India; the price of oil remains fairly stable in world trade. There is a small production and market for celery resinoids. Celery seeds are exported to some of the continental countries like France, Italy, Netherlands and Germany as well as to Australia and New Zealand. California produces about 75% of the USA's celery crop [23].

1.4 Botany, Morphology and Ecology

Apium graveolens is a biennial, branching herb, with approximate height of about 100 cm, have solid fleshy stems and branches. On an average, four to twelve branches are present on each umbrella. The leaves are triangular, spear or diamond shaped that can attain the length of 5-50 mm. The edges of leaves are lobe shaped or saw-teeth [24]. The stem of this plant is ribbed, moist, branched and root system is shallow tape type. The wingless fruit is brown in color with black lines on the outer layer. Seed is 1.5-2 mm wide and have oval shape [25]. The calyx has absolute teethes and the colour of small size flower is white or sometimes greenish white as well. These flowers have five petals, oval shape and floured tips. The ridges are primary

and discrete while carpals are sub pentagonal. The fruit is aromatic, schizocarps, sub-orbicular, 1-2 mm diameter and have two mericarps [3]. The seeds have brown color, ridged nature, ovoid shaped, and small length of about 1.3 mm.

There is one seed in each carpel and two carpel united to make one fruit. The spice has pungent taste and pleasant characteristic aroma. Celery can be used in different forms for flavoring of food such as seeds, oleoresins, stalk, fresh herb and leaves [23]. Celery requires a range of temperature starting from 12°C to 15°C and 22°C to 25°C, dry, long season and cold temperature is the most suitable condition for plant growth. Celery grows on cold and cloudy places and has very low tolerance to heat. March and April are the best months for sowing of seeds, May is the most appropriate month for transplantation of seeds and November is the month for proper harvesting. All types of soil can cultivate the celery plant successfully but alkaline and saline type soils are not favorable while the loamy and water logged soils are the best one. The pH of soil should be 5-7 and this plant is very sensitive to the soil reactions [26].

Fig 1 Grown celery plant

Fig 2 Seeds of celery plant

Fig 3 Leave of celery plant

2. Chemistry

Celery is an impressively aromatic plant that is extensively used as herb and known to have number of pleasant smelling compounds. This plant has a very different smell and due to this type of aroma, it is included in the top vegetables that are called aromatic herbs. Seeds of celery plant can be used as flavoring agents in food, in aromatherapy, in soup, in salad, as spice in stew and in the mixture of cocktail drinks [27]. The most important components responsible for flavor in the oil of seeds are sedanenolide (3-n-butyl-4, 5-dihydrophthalide), sedanolide and 3-n-butyl phthalide. Therefore, celery seed oil is the most important to be used in both fragrance and flavor industries [28]. The oleoresins of this plant contain fixed oil, artifacts, resin, volatile oil and waxes. The total content of volatile oil present in oleoresins acts as a quality parameter. Oleoresins are used as fixative for the volatile compounds and resin part of oleoresin does not contain any flavoring components. Nevertheless, other parts of oleoresins contain components that are responsible for aroma [29]. The most important components of celery oil are 3-n-butyl phthalide, sedanolide, sedanonic anhydride and sedanenolide and that are present in very low concentrations and they cause typical aroma [30]. This oil contains a number of phthalide derivatives due to which it's seed extracts are used extensively as flavoring agent in food products such as meat product, snack food, condiments, puddings, candies, dairy dessert foods, soup, alcoholic beverages, relishes, gravies and gelatins [31].

2.1 Chemical Composition

Celery contains fat contents and it brings high caloric value. It is also known as a rich source of vitamin C and various other minerals. Its seed contains volatile oil, proteins, crude fibers, moisture, starch, ash, carbohydrates and fixed oil [32]. The fatty acids present in the fixed oil are oleic acid, palmitic acid, linolenic acid, stearic acid, linoleic acid and petroselenic acid [33]. This plant is a source of minerals such as calcium, magnesium, potassium and also contains a high concentration of sodium. A cup of celery leaves in chopped form has almost 100 mg of sodium. The essential oil consists of salience, sesquiterpenes, limonene and characteristic aroma. It is a rich source of folic acid, potassium, sodium, fibers, β-carotene, magnesium, silica and chlorophyll [34].

2.2 Phytochemistry

Apium graveolens (celery) has characteristic aromatic odor because of essential oil and volatile compounds, which are largely confined to the green leaves of plant. The scented volatile oils from leaves are chiefly comprises of terpenes, phenol and anhydrides. While oils extracted from seeds are named as a fixed oils and mainly composed of fatty acids. Besides the essential oils or fixed oil, plants are also composed of alkaloids and steroids. The seed extract consists of steroids, glycosides, flavonoids and carbohydrates. Furocoumarins are also present in the plant extract including several other components such as apigravrin, isopimpinellin, apiumoside, celerin, apiumetin, isoimperatorin, bergapten and celereoside. Phenols including apigenin, tannins, isoquercitrin, phytic acid and graveobioside are also present [35].

The essential oil of celery leaves, stem and seeds consists of sesquiterpene, alcohol (1 to 3%) and fatty acids. The components present in this plant are camphene, limonene, sedanenolide, stearic acids, linoleic acid, santalol, oleic acid, terpinene, p-cymene, myristic acid, myristoleic acid, sabinene and terpinolene etc. Celery seed consists of mostly frocoumarin, selinene (10%), frocoumarin flavonoids, glycosides and limonene. Celery seeds are used for the treatment of arthritis, rheumatoid, kidney diseases and consumed as diuretics. Celery seeds are also used in manufacturing of tea that improves sleep and relaxation.

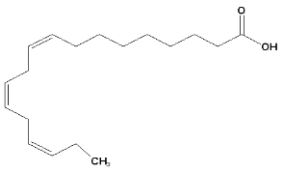

Fig 4 Chemical Structure of α-linolenic acid

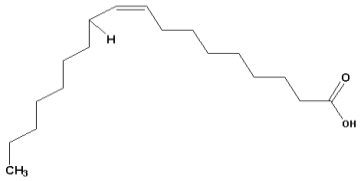

Fig 5 Chemical structure of oleic acid

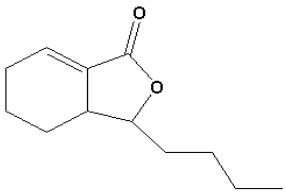

Fig 6 Chemical structure of Sedanolide

Table 1 Fatty acid profile of celery (*Apium graveolens*)

Fatty Acids	Number of Carbon	Relative % Composition
Palmitic Acid	(C16:0)	8.51±0.98
Palmitoleic Acid	(C16:1)	0.38±0.07
Stearic Acid	(C18:0)	2.03±0.04
Oleic Acid	(C18:1)	65.79±1.81
Linoleic Acid	(C18:2)	21.65±0.65
α-linoleic Acid	(C18:3)	1.01±0.09
Arachidic Acid	(C20:0)	0.33±0.07

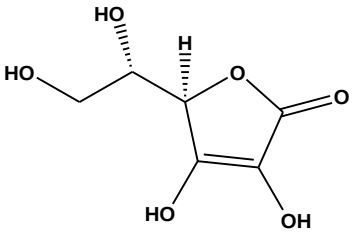

Fig 7 Structures of Vitamin C

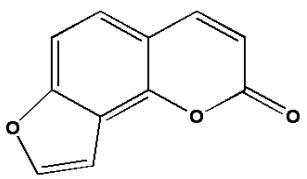

Fig 8 Chemical structure of Furanocoumarins

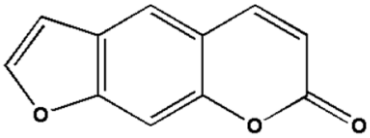

Fig 9 Chemical structure of Psoralen

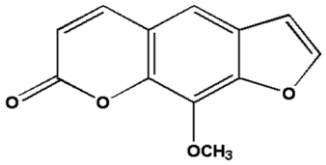

Fig 10 Chemical structure of xanthotoxin

3. Post-Harvest Technologies

Conventionally, the best harvesting time of celery is mild winter season. In the regions, where the winter is so cold the plant should be protected from frost and must be harvested before the freezing season. The celery plant can also be protected from cold by mounding the soil around places of plant [36]. When the stalks of this plant reach about 15 cm (six inches) or more than six inches from soil to the first line of leaf of plant then it should be harvested. The stalk can be cut individually or the whole plant below the line of soil. If the stalk is green, then more nutrients are present in it. The inner part of stalk has good taste in the uncooked form and more tender in nature.

The fresh herbs of celery are stored for short time periods to increase its availability in market. The optimum conditions to store its fresh herb are 0°C temperature and high relative humidity of about 95%. The marketable quality of celery herbs can be maintained for a long period of time by using controlled atmospheric storage. This storage needs 0°C temperature and 4% CO_2, 1-2% O_2 with high relative humidity along with continuous removal of ethylene from atmosphere [37]. The seed crop of celery is harvested and collected and then further allowed to cure and dried for one or two days in thin layer by transportation to threshing floor consequently separating its seed by light threshing. The seeds that are dried in shade have more oil contents than the seeds that are dried in sun. Seeds are cleaned by screening mill and gravity separator, graded by sieving and after that they are stored in cool dry place in gunny bags [38].

4. Processing

Celery, like the other herbal plant is used in a variety of ways and for many purposes. In addition to fresh leaves, its dry leaves, frozen leaves, seeds and essential oils or seed oils can also be used. The ground seed of celery in powder form is used to produce celery salt which is used for flavoring in eggs, salad and fish when mixed with other salts. The plant should be processed and sent to the market as soon as possible but the stalk of celery can be stored for more than one month at 0°C temperature and high humidity. It should be stored separately because this plant absorbs flavors from other plants. Its stalk can also be processed through canning. In western countries, the volatile extract

from seeds is acquired by flaking rather than conventional grinding because the flaking method give a higher concentration of oil as compared to grinding method. The seeds proceed through steam distillation after flaking of seeds and gives 1.76% yield while the oil that is extracted from conventional grinding gives 1.42% yield. Flaking does not affect the flavor of seed oil at different intervals of steam distillation. When the oil is subjected to hydro distillation after steam distillation then this oil contains more amount of phthalides almost 45 mL in 10 kg powder and its flavor is also different from the oil that is obtained through only steam distillation [23]. The seed gives 2% seed oil and that oil are used in fragrance and flavor industry. The essential oil of this plant gives a floral odor to perfumes. The components that are responsible for the flavor or aroma are generally found in very low concentrations including sedanolide, 3-n-butyl-4,5-dihydrophthalide and 3-n-butyl phthalide. Essential oil of celery can be extracted in three forms; seed oils that are collected from its seed, herbal oil that originate from leaves and floral oil that can be extracted from flowers. Hydro-distillation and steam-distillation are the two most commonly used methods for the extraction of essential oils. Celery plant is harvested and its yield is about 1000-1500 kg/ha. Its seeds also produce pale color volatile oil that has pleasant aroma.

5. Value Addition

Apium graveolens is a urinary anti-septic and diuretic plant thus extensively used for the treatment of griping pain and flatulence. It can also be used as a carminative, emmenogogue, sedative, toxic, anthelmintic, diuretic, laxative, stimulant and anti-spasmodic. Celery seed oil, extract and roots are used in dietary enhancement in the medicinal market that control the level of uric acid, joint health and blood pressure [26]. Celery prevents the cardiovascular diseases, strengthen the heart, lower blood pressure and also lower glucose level in diabetes [10]. This plant is consumed in the mixture form of seed, fresh leaves, its extract and powder. In western countries, it is mostly used in salad. Its seeds are used in the preparation of egg dishes, pastries, salad dressings, green salad or potato, sauce, stuffing's, tuna, vegetables, sauerkraut, rolls, calm and tomato juices, soup, hamburger, omelets, bread and in pickling etc. Its seeds are also beneficial for our health such as for liver diseases, stimulant and as a tonic in asthma [2]. Seeds are used as nerve stimulant and sedative in domestic medicine. Its seed oil has also successfully been used for rheumatoid arthritis [39].

6. Uses

Many medicinal plants have been used for the treatment of number of diseases in the traditional system of medicines. Scientific studies show that these plants are used to cure many diseases such as diabetes, cancer, atherosclerosis and many other infectious diseases [40]. *Apium graveolens* is a medicinal plant thus used in medicines that have many health benefits [41]. This plant is used for the treatment of cardiovascular disease, strengthening of heart and lowering of blood pressure. It has anti-coagulant properties and its roots are used to decrease potassium and increase calcium in heart tissues [42]. Essential oils of celery show anti-bacterial activity. Celery leaves and roots are also used to eliminate DPH and OH radicals [43].

6.1 General Uses

Apium graveolens (Apiaceae) is a plant that has excellent medicinal properties and abundantly used as medicine in Tunisia. It is also used for the healing of frostbite disease by using in folk medicines. This plant is widespread in the world and thus used for human nutrition [44]. Celery is eaten both in cooked form or raw form and most famous in Europe. Its aromatic leaves are used for the garnishing of plates as well as for the flavoring of cooked food and are also grown for its seeds in Asia and Eastern Europe. The stalk of celery has two varieties named as "pascal or green celery" and "self-branching or yellow". The self-branching celery stalk is mostly preferred in North America, it is generally used in raw form [45]. Celery is adaptable vegetable that is used in flavoring of casseroles, soups and stew. It is used both in baked and mashed form and mashed celery can be used with other root vegetables such as mash potatoes for a smooth mash. Celery is chopped or grated into small pieces as a classical dish and eaten with the mustard mayonnaise.

Thyme and barks leaves of celery are combined with meats of lamb, pork and duck. Leaves can be processed by freezing, dehydration and canning. Their leaves are used as flavoring salt in dried form. It's essential oil or seed oil is used as flavoring agents [24]. The essential oil of this plant lends floral type odor to the perfumes and imparts clinging and warm notes. Celery's stalk, leaves, herb, oleoresins, volatile oils and seeds are used in tomato products, pickles, meats, sauces and soups for flavoring [46]. *Apium graveolens* is extensively grown as garden crop and leaf stalks as vegetables in the temperate zone. It's essential oils from seeds are also used for seasoning purpose [47]. Celery seed extracts have a characteristic odor because a series of phthalide derivatives are present in it. The essential oil of this plant has flavoring ingredients, therefore it is used in food products such as candy, gravies, baked and snack foods, puddings, all types of beverages, condiments, frozen dairy desserts foods and many others [31].

6.2 Pharmacological Uses

Apium graveolens seeds have anti-oxidant activity [48], anti-nociceptive potentials and anti-inflammatory properties [49]. All parts of plant are gently curative, healthful and stimulant in the weak conditions. Celery stalks and leaves have many medicinal properties that are also present in all other parts of the plants. Their fresh stalks help to stimulate the milk flow if it is used as food and its seeds can help to clear toxins from our system. Celery is

particularly best for joint diseases and for gout. Ayurvedic and Unani medical companies are still using this plant for kidney and stomach disorders [50]. The phytochemical analysis of methanolic extract of seed oil of *Apium graveolens* showed that its seeds are composed of steroids, flavonoids, glycosides, alkaloids and carbohydrates. Because of the presence of these components, they show pharmacological properties. Its seeds are anti-spasmodic as they contain high percentage of essence [51].

The essential oils of this plant have anti-bacterial and anti-fungal effects on *Shiglla dysenteriae, Streptococcus faecalis, Salanacearum, Staphylococcus aureus, Salmonella typhi, Staphylococcus albus* and *Streptococcus pyogenes*. In celery seeds oil, Apigenin is present due to which oil has no effect on *Pseudomonas aeruginosa* and *Escherichia coli* bacteria [52]. Celery seed has many active ingredients that are extracted by methanol thus can be used as fungicides, herbicides insecticides and nematodes killers. Its seeds can be potentially used in the production and development of insect repellents on the commercial level, therefore it can be used as an alternative in the synthetic chemicals that are used commonly to control the insects in the community especially the vectors. The ethanolic extract of this plant's seeds has been found to contain a substance called CAH which is the most effective component in the treatment of infections [13].

When celery seeds are used with other herbs, it has property to reduce the blood pressure and also has medicinal properties that are associated with bronchitis and asthma [2]. Essential oil of its seeds also have been found to have an effect on the central nervous system of human beings [53]. The essential oil that is extracted from celery leaves has an anti-oxidant property as well as used as a natural immuno-toxicities potential compound [54]. Its extract also has been found to show anti-inflammatory effects [55]. The stem and seeds of celery have been used for treatment of urinary issues. It helps to reduce the acidity in whole body and helps kidney to dispose waste products and urate. Its seed and herb is used to cure the obstinate retention of urine and water retention [56].

6.2.1. Anti-Inflammatory Effects

Celery oils have many compounds that show anti-inflammatory activity such as apigenin, bergapten, caffeic acid, cinilide, coumarine, ferulic acid, isopimpinellin, luteolin, mannitol, protocatechuic acid, rutin, thymol, xanthotoxin, α-pinene, ascorbic acid, chlorogenic acid, copper, eugenol, gentisic acid, linoleic acid, magnesium, myristicin, umbelliferone and scopoletin etc. Celery seeds have proved to be very useful in arthritis and in gout [57]. It is regularly taken for the maintenance of healthy joints and it reduces pain and swelling around the joints. Its seeds improve the blood circulation to the joints and muscles and detoxify our body. Celery has nerve stimulant and sedative properties due to which it has been successfully used for the treatment of rheumatoid arthritis and reduces the degeneration of joints that occur with age. The coumarins in seed oils have muscle relaxant property and phthalides have anti-rheumatic activity due to which these seeds are used to cure the pain in muscles of sacrum and neck. Celery also helps to repair the connective tissues as it has minerals including iron, calcium, potash, magnesium, zinc, phosphorous and sodium [58].

6.2.2 Anti-Microbial Activity

The volatile oil of *Apium graveolens* has shown anti-fungal, anti-bacterial and anti-virus properties. It shows anti-microbial activity against many bacteria such as *Pseudomonas Solanacearum, Salmonella typhi, Staphylococcus albus, Streptococcus pyogenes, Staphylococcus aureus, Streptococcus faecalis* and *Shiglla dysenteriae*. This plant cannot show its activity against *Pseudomonas aeruginosa* and *Escherichia coli* bacteria [52].

6.2.3 Anti-Cancer Effects

The celery oil has a most important bioactive components named phthalide that show beneficial effect to health because it shows protection against cholesterol level, cancer and high blood pressure. The most active compound of phthalide is sedanolide which reduce the tumors in the cancer patients. The 3-n-butyl phthalide and sedanolide are two main active components present in the seed oil of this plant and they have high activity to stimulate the detoxifying enzyme in the target tumor tissues called glutathione S-transferase (GST) [59]. This plant also decreases the mutations in the cells by removing the free radicals present in the damaging cells so it decrease the potential of cell to modify and become cancerous cell. This activity is shown by the active compound "coumarins" in the celery. Celery used in the juices when these juices are drunk after a work, it can be a strong electrolyte replacement drink because celery contain high level of sodium and potassium. This plant also control cancer and cholesterol level after improving detoxification [23].

6.2.4 Anti-Spasmodic Potentials

Celery seeds are known to have β-selinene and α-limonene that is found associated with anti-spasmodic activity of this plant. This plant is found to be natural source of organic sodium that is important mineral in blood, useful for joints as well as for lining of stomach and good for gastric disorder. Its oil is used in relieving colic pain, calming digestive system, vomiting, in enhancing appetite and in flatulence.

6.2.5 Hepato-Protective Activity

The methanolic extracts of *Apium graveolens* showed hepato-protective potentials comparable with standard drug silymarin [60].

6.2.6 Anti-Oxidant Activity

The celery plant extract also shows the anti-oxidant property. Methanolic extract showed more anti-oxidant activity as compared to ethanolic extract. The phenolics components are present in its both extracts that are responsible for this property. As the concentration of this

plant extract increase its reducing power increases. The anti-oxidant activity of all bioactive components are related to its capacity of electron donation [61].

7. Summary

Celery (*Apium graveolens*) is a biennial herb belonging to the Apiaceae or Umbelliferae family. It has been cultivated throughout the world and used for thousands of years for food flavoring, essential oil applications and in traditional medicines. Mostly celery is composed of flavonoids and fatty acids. The chemical composition of plant varies depending on factors such as soil type, weather, irrigation, pruning and other horticulture practices. Celery is an essential component of several industrial applications including food, pharmaceutics and manufacturing products. Further research is needed on maximizing yield and oil extraction methods, particularly in the developing world where harvesting and post harvesting methods of celery leaves and seeds are much more similar to least efficient traditional methods.

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