



“RESEARCH ON LUTEOLIN: PHARMACOLOGY ACTION”

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Abstract:

Secondary metabolites that organisms make and use for defense or adaptation are known as natural products. Throughout history, people have utilized plants and their parts extensively to treat a wide range of illnesses. Secondary metabolites that organisms make and use for defense or adaptation are known as natural products. Throughout history, people have utilized plants and their parts extensively to treat a wide range of illnesses. Secondary metabolites that organisms make and use for defense or adaptation are known as natural products. Throughout history, people have utilized plants and their parts extensively to treat a wide range of illnesses. Any phytochemical obtained from food and its byproducts offer an abundance of novel anti-cancer substances. Flavonoids like luteolin (3,4,5,7-tetrahydroxy flavone) are present in a variety of plants, including fruits, vegetables, and medicinal herbs. It functions as an anticancer agent against a variety of human cancers, including pancreatic, lung, breast, glioblastoma, prostate, and colon cancers. Additionally, it prevents the growth of cancer in vivo and in vitro by preventing the growth of tumor cells, shielding them from carcinogenic stimuli, triggering cell cycle arrest, and triggering apoptosis via various signaling pathways. Furthermore, luteolin can reverse the epithelial-mesenchymal transition (EMT) by downregulating the mesenchymal biomarkers vimentin, N-cadherin, and snail as well as inducing the expression of the epithelial biomarker E-cadherin through cytoskeleton shrinkage.

Keywords:

Anti-inflammatory effect, Anticancer effect, Antioxidant, Antiviral effect, Heart Protective effect, Neurological Impairments protection, phytochemistry.

Introduction:

Natural substances called flavonoids are found in all members of the plant kingdom. An aromatic A-ring, a heterocyclic C-ring, and an aromatic B-ring joined by a carbon-carbon bridge make up the fundamental structure of flavonoids. Flavonoids are classified into six subclasses: flavones, flavonols, flavanones, catechins, or flavanols, anthocyanidins, and isoflavones, based on heterocyclic C-ring variation. Luteolin is a flavone, a kind of flavonoid that resembles yellow crystals. Since at least the first millennium B.C., the plant *Reseda luteola* has been utilized as a source of yellow dye, mostly from the chemical luteolin. When luteolin was initially isolated in its pure form, it was discovered that cancer, a group of disorders characterized by aberrant cell proliferation with invasive potential, was a serious global health issue. Numerous environmental and genetic factors, including a high body mass index, a low intake of fruits and vegetables, a lack of physical exercise, tobacco use, alcohol use, radiation exposure, chronic illnesses, and genetics, contribute significantly to the incidence and mortality of cancer. Based on their specific molecular targets, innovative bioactive components with natural origins, especially from plant sources, may be a new and dependable therapeutic factor to treat many human cancer types. Furthermore, oxidative stress is a major factor in the pathogenesis of several cancer forms. Antioxidants have so received a lot of attention as a potential cancer treatment approach. Plant-derived bioactive chemicals have been described as innovative health-promoting agents for the prevention and/or mitigation of various human diseases, including cancer, inflammation, cardiovascular disease, and neurological diseases, throughout the past 20 years. Among these substances, over 5000 flavonoids have been shown to be present in a variety of plants. These flavonoids have been classified into ten groups based on their chemical structures; six of these groups—flavones, flavanones, anthocyanidins, flavonols, isoflavones, and catechins—are frequently found in the diets of humans. Numerous of these flavonoids have been shown to exhibit anticancer properties in cellular and animal model systems. Important natural antioxidants with strong anticancer properties that work both in vivo and in vitro are flavonoids like luteolin. Natural flavonoids, such as luteolin (3,4,5,7-tetrahydroxy flavone; Fig. 1), are widely distributed in a wide range of plant species. Fruits and vegetables like celery, chrysanthemum flowers, sweet bell peppers, carrots, onion leaves, broccoli, and parsley are especially rich in it. Plants high in luteolin have been used in Chinese traditional medicine to treat conditions like cancer, inflammatory disorders, and hypertension. Luteolin functions as both an antioxidant and a pro-oxidant biochemically, and it demonstrates a variety of biological benefits including anti-inflammatory, anti-allergy, and anti-cancer properties. Furthermore, there's a chance that luteolin's biological effects are connected to one another on a functional level. For instance, luteolin's anti-inflammatory action might be connected to its anticancer feature.

Aim & Objective:

Aim: Research on luteolin Objective:

- 1)Antioxidant, anti-inflammatory, and anti-tumor characteristics.neuroprotective substance
- 2)Minimizes brain inflammation associated with aging and the resulting memory impairments.
- 3)Benefits of Luteolin
- 4)Blocks the activity of platelets by attaching itself to the thromboxane A2 receptor.
- 5) sourcesof Luteolin

Need & Novelty:

A diet high in antioxidants, which have an anti-inflammatory effect, may help lessen the burden of chronic diseases, according to a substantial body of research. Nutrients called carotenoids are found in many foods, particularly fruits and vegetables, and they seem to have antioxidant qualities. The health benefits of carotenoids have drawn more attention in the past few decades. A high dietary intake of these compounds has been linked to improvements in a number of systemic diseases as well as visual disorders, including protection of the retina against phototoxic light damage. The carotenoid lutein (L), which has been linked to a lower risk of age-related disorders and has a potent antioxidant action in vitro, has been the subject of the majority of research.

Pharmacology

Anti-inflammatory effects: -

Infectious microorganisms, including bacteria, viruses, and fungi, typically cause inflammation when they enter the body, settle in certain tissues, or move through the bloodstream. It may occur as a result of degeneration, ischemia, malignancy, tissue damage, and cell death. Anti-inflammation is one of the most well-reported biological activity of natural plant products among those that have been published to date. The primary treatment for chronic pharyngitis, which is defined as a common inflammation of the pharyngeal mucosa, is anti-inflammatory medication. Citrus grandis (PCG) polysaccharides bind to luteolin and inhibit macrophage production of proinflammatory cytokines such as interleukin-6 (IL-6), interleukin-12 (IL-12), and tumor necrosis factor alpha (TNF- α).

Luteolin increases the expression of mannose receptor C type 1 (Mrc1) and arginase (Arg1), which in turn promotes macrophage M2 polarization. PCG combined with luteolin inhibits the expression of interferon regulatory factors 1 (IRF1) and 5 (IRF5) as well as the activation of nuclear factor kappa-light-chain enhancer of activated B cells (NF- κ B). PCG and luteolin work synergistically to reduce inflammation and treat chronic pharyngitis by polarizing M1 macrophages and inhibiting the NF- κ B pathway. The combined anti-inflammatory properties of luteolin and tangeretin were studied by the authors.

Their findings demonstrated that the combination, as opposed to luteolin or tangeretin alone, produced synergistic inhibitory effects on LPS-stimulated production of nitric oxide (NO) and stronger suppression on the overexpression of proinflammatory mediators induced by LPS, including prostaglandin E2 (PGE2), interleukin (IL)-1 β , and IL-6. The combination of luteolin and tangeretin considerably reduced the LPS-

induced protein and mRNA expression of cyclooxygenase-2 and inducible nitric oxide synthase, according to immunoblotting and Real-Time PCR studies.

Anticancer effects: -

Regardless of advancements in the instruments for illness detection, treatment, and prevention, cancer remains one of the primary causes of mortality and is a severe manifestation of the metabolic syndrome. It is one of the leading causes of death and illness worldwide, with a projected 21 million cases by 2030. The number of cases is rising steadily. It's a terrifying illness that ranks among the greatest health problems facing humanity and necessitates an early treatment plan. Plants offer a promising avenue for cancer research since they are reservoirs for novel chemical entities. Fruits, vegetables, and medicinal herbs all contain luteolin, which functions as an anticancer agent against a variety of human cancers, including glioblastoma, lung, breast, prostate, colon, and pancreatic cancers. Additionally, it prevents the growth of cancer in vivo and in vitro by preventing the growth of tumor cells, shielding them from carcinogenic stimuli, triggering cell cycle arrest, and triggering apoptosis via various signaling pathways. Additionally, luteolin can reverse the epithelial-mesenchymal transition by downregulating the mesenchymal biomarkers N-cadherin, snail, and vimentin, as well as by shrinking the cytoskeleton and enhancing the expression of the epithelial biomarker Ecadherin. Furthermore, by inducing mitochondrial dysfunction in glioblastoma cells and activating the lethal endoplasmic reticulum stress response, luteolin raises intracellular reactive oxygen species (ROS). It also activates the expression of endoplasmic reticulum stress-associated proteins, such as phosphorylation of eIF2 α , PERK, CHOP, ATF4, and cleaved-caspase 12. Luteolin also inhibits the growth of tumors by deactivating a number of signals and transcription Lanan Wassy Soromou Himalayan Journal of Health Sciences, Volume 7, Issue 2, pages 1–12, e-ISSN: 2582-0737, 2022 mechanisms that are necessary for cancer cells [6].

Its ability to induce apoptosis and limit cell growth, metastasis, and angiogenesis is linked to its anticancer properties. By inhibiting cell survival pathways like phosphatidylinositol 3'-kinase (PI3K)/Akt, nuclear factor kappa B (NF-kappaB), and X-linked inhibitor of apoptosis protein (XIAP), as well as by promoting apoptosis pathways like those that trigger the tumor suppressor p53, it makes cancer cells more susceptible to therapeutically induced cytotoxicity. In 2019, Lee J et al. conducted more research and examined the distinct effects of luteolin and its glycosides on triple-negative breast cancer cells, MDA-MB-231.

They discovered that luteolin exhibited cytotoxic and antimetastatic properties on MDA-MB-231 cells, and they draw the conclusion that it might be recommended as a viable option for treating breast cancer. In a different study, researchers used a cell-based screening method to find Anoctamin 1 inhibitors, which may be useful as anticancer therapeutics for prostate cancer. The findings concluded that luteolin is a new and potent inhibitor of anocotamin 1, potently inhibiting the activity of the ANO1 chloride channel with an IC50 value of 9.8 μ m, while leaving PC-3 prostate cancer cells' intracellular calcium signaling intact. Additionally, it significantly reduced the levels of Anoctamin 1 protein expression. Furthermore, it was discovered that luteolin decreased PTN expression and increased miR-384 expression in both colorectal cancer tissues and cells.

They showed that luteolin modulates PTN via miR-384 expression to produce anticancer effects on CRC cells, indicating that PTN may be a promising candidate for therapeutic uses in the treatment of CRC. Using p53-wild type and p53-null HCC cells treated with luteolin, researchers examined the significance of endoplasmic reticulum stress in anti-carcinogenic effects. The findings imply that luteolin-induced ER stress may have anticancer benefits that are p53-independent. According to other studies, luteolin caused A375 cells to undergo apoptosis, restricted their migration, invasion, and proliferation, and increased their expression of TIMP-1 and TIMP-2. It also decreased the expression of MMP-2 and MMP-9. Moreover, it prevented A375 cell tumor growth in a mouse model using xenografts.

Through the PI3K/AKT pathway, it functions as a lowering agent of MMP-2 and MMP-9 expressions and is a potentially effective anti-cancer treatment for human melanoma. Through the upregulation of Nrf2 and its interaction with the tumor suppressor, the inhibition of HCC growth in vitro and vivo, and the safe therapeutic effect in reducing breast cancer, a number of experimental results shed light on the action and mechanism of luteolin that underlies the anticancer effects of luteolin on colon cancer. Lutein enhanced apoptosis in vitro and in vivo and hindered cell cycle progression, colony formation, proliferation, migration, and invasion, according to a growing body of research. It might be another naturally occurring product-derived therapeutic agent that inhibits mTOR signaling and upregulates p21 to fight bladder cancer. It also inhibits the PI3K/AKT/mTOR/SREBP cascade and lipogenic gene expression to treat human choriocarcinoma cells.

It might be a useful, non-toxic, naturally occurring anticancer substance that might be applied to treat breast cancers accelerated by progestin. Even after treatment was stopped, luteolin's suppressive effects on tumor incidence and volume, as well as its capacity to lower VEGF and blood vessels, remained. Additionally, luteolin partially through autophagy triggered apoptosis in human liver cancer SMMC-7721 cells. Luteolin induced the expression of Beclin 1, accelerated the conversion of LC3B-I to LC3B-II, and increased the amount of intracellular autophagosomes. Therefore, luteolin may be employed in the therapy of hepatocellular carcinoma as an autophagy regulator.

When treating cancer cells that have high levels of the oncoprotein PTTG1 expressed, luteolin is helpful. When exposed to luteolin, PTTG1-knockdown cells showed a decrease in apoptotic proteins while retaining larger quantities of anti-apoptotic proteins such p21, Bcl-2, and Mcl1, which demonstrated increased resistance to apoptosis. In PTTG1-knockdown cells, the expression of twenty genes linked to cell proliferation—including CXCL10, VEGFA, TNF, TP63, and FGFR1—was significantly reduced. The authors' findings show that the variable expression of PTTG1 modulates leukemic cell apoptosis mediated by luteolin. Reactive oxygen species buildup brought on by luteolin is essential for inhibiting NF-kappaB and enhancing JNK's ability to cause lung cancer cells to become more susceptible to TNF-induced apoptosis.

Heat processing, however, dramatically decreased luteolin's capacity to prevent endothelial cell angiogenesis, cell invasion, and migration. (98) Moreover, by changing p-IGF1R/PI3K/AKT/mTOR activation, the flavonoid inhibited the migration of glioblastoma cells and may have uses in clinical settings for chemoprevention. A other study's findings suggested that luteolin might stop the proliferation of breast cancer cells by going after human telomerase reverse transcriptase (hTERT). However, the authors propose

that additional research on luteolin's method of hTERT regulation may be warranted in light of its potential use as a therapeutic target for the treatment of breast cancer. (100) According to Ma L et al.'s research from 2015, luteolin inhibited cell migration and facilitated Sirt1-driven apoptosis in NCI-H460 cells, hence exerting an anticancer impact.

Antioxidant effects: -

Research has demonstrated that luteolin attenuates the oxidative stress and inflammatory phenotype that high glucose induces in H9C2 cardiomyocytes. By activating the antioxidant nuclear factor-erythroid 2 related factor 2 (Nrf2) signaling pathway, it inhibited the nuclear factor-kappa B (NF-κB) pathway. Consequently, luteolin shields heart tissues in diabetic mice induced by streptozotocin by regulating oxidative stress mediated by Nrf2 and inflammatory responses mediated by NF-κB.

But by boosting eNOS, luteolin shields the diabetic heart from ischemia/reperfusion damage.- Lanan Wassy Soromou Himalayan Journal of Health Sciences, Volume 7, Issue 2, pages 1–12, e-ISSN: 2582-0737, 2022 [7] mediated S-nitrosylation of Keap1, with consequent activation of Nrf2 and the Nrf2-related antioxidative signaling pathway. Numerous analyses were conducted to assess the impact of the 3-OH group and 1,4-pyrone moiety on its antioxidant activity. During sprint activity, both high and low doses of mangiferin and luteolin supplementation improve performance, muscle O₂ extraction, and brain oxygenation. Following pre-treatment with luteolin and hydrogen peroxide induction (H₂O₂), human umbilical vein endothelial cells demonstrated protection against H₂O₂-induced oxidative stress as well as amelioration of ROS and superoxide production.

NADPH oxidase subunits' H₂O₂-induced membrane assembly was hindered by its treatment, and this was further verified by blocking NADPH oxidase specifically. The purpose of the study was to evaluate luteolin's antioxidant capacity against benzo(a)pyrene-induced lung carcinogenesis in Swiss albino mice. The study's findings indicate that mice given benzo(a)pyrene orally (50 mg/kg body weight) experienced an increase in lipid peroxides, as well as a decrease in both enzymatic and non-enzymatic antioxidants, including reduced glutathione, vitamin E, and vitamin C. Additionally, tumor markers specific to the lung, such as carcinoembryonic antigen and neuron specific enolase, were also elevated. By encouraging signaling through the natural antioxidant enzyme peroxiredoxin II, luteolin also guards against myocardial ischemia/reperfusion injury, highlighting the significant advantageous function of this antioxidant system in the heart.

Antiviral effects: -

One of the main viruses that causes viral encephalitis in humans is the Japanese encephalitis virus. The illness has a high death rate. Researchers looking for efficient antiviral treatments for the illness discovered that luteolin has strong antiviral action against the replication of the Japanese encephalitis virus in A549 cells. On the virus, it demonstrated extracellular virucidal action. The extremely contagious disease dengue, which is indigenous to tropical regions, is quickly spreading around the world. Any one of the four dengue virus serotypes can cause it, and female Aedes mosquitoes carry the virus into human bodies. The illness ranges in severity from a low-grade fever to shock syndrome and dengue hemorrhagic fever. The

researchers discovered that luteolin prevents four different dengue virus serotypes from replicating. It was discovered to lessen the production of infectious viral particles. Lutein shown in vivo antiviral efficacy in mice infected with dengue virus and suppressed the enzyme activity, according to biochemical analysis of human furin.

Researchers showed that luteolin inhibited influenza A virus replication by infecting multiple cell lines with two different subtypes of the virus. According to their assay, this chemical inhibited coat protein I complex production, which was connected to the endocytic pathway and entry of influenza viruses, and interfered with viral replication in the early stages of infection.

Heart protective effects: -

Zhang X et al. (2017) found that luteolin had a significant positive cardioprotective effect on myocardial ischemia/reperfusion injury. This result may be attributed to the in vitro and in vivo down-regulation of the TLR4-mediated NF- κ B/NLRP3 inflammasome. Furthermore, Yan Q et al. 2019 shown that luteolin enhances heart preservation by preventing cardiomyocytes' hypoxia-dependent L-type calcium channels from opening.

In summary, it has been shown that the flavonoid possesses a variety of cardio-protective properties. After examining luteolin's protective effects on isolated rat hearts during hypothermic preservation, researchers came to the conclusion that adding luteolin to cardiac preservation solutions can greatly enhance the benefits of hypothermic preservation on rat hearts while also having a myocardial protection effect. In the clinic, heart transplantation has been used as the best course of action for individuals with end-stage heart failure.

Nevertheless, the heart can only be preserved in a hypothermic state for 4-6 hours, and calcium buildup over time is a significant contributing cause to cell death. It has been shown in earlier research that luteolin, which is used to treat cardiovascular illnesses, decreases cell death and L-type calcium currents during hypothermic preservation, allowing donor hearts to be stored for longer and in a safer manner. Investigations into the protective function of luteolin in regulating cardiomyocyte calcium cycling revealed that, over a 6-hour preservation period, luteolin administration reduced calcium excess.

Additionally, it inhibited the build-up of crucial regulatory proteins and enzymes for the calcium circulation in cardiomyocytes, including the mitochondria Ca²⁺ uniporter and calmodulin. Chamber dilatation and left ventricular dysfunction are the hallmarks of myocardial infarction, and they are linked to significantly increased mortality. Research on luteolin's impact on post-infarction cardiac dysfunction and assays revealed that in cardiomyocytes that were simulatedly injured in a myocardial infarction, luteolin increased autophagy.

Additionally, in the cardiomyocytes exposed to simulated myocardial infarction injury, it raised the potential of the mitochondrial membrane, the amount of adenosine triphosphate, the activity of citrate synthase, and the activities of complexes I, II, III, IV, and V. Its protective benefits are linked to improved mitochondrial biogenesis through Mst1 inhibition and up-regulation of autophagy. One hazardous element that is of global concern is inorganic mercury, which can seriously harm the heart. .. In response to the insult, luteolin dramatically reduced oxidative stress, apoptosis, and cardiac histopathology damage in the

rat heart caused by HgCl₂. Additionally, it was observed that luteolin blocked NF-κB activation in the heart of rats treated with HgCl₂ and elevated levels of protein kinase B (AKT), phosphatidylinositol 3-kinase (PI3K), and nuclear factor-erythroid-2-related factor 2 (Nrf2) and its downstream proteins.

Neurological impairments protection: -

Long-term potentiation is one of the synaptic plasticity processes that has been identified as a biological correlate of learning and memory. Abnormal synaptic function is also present in many neurological illnesses that are associated with cognitive deficiencies. In the oral gyrus of the rat hippocampal region, it has been discovered that the flavonoid luteolin improves basal synaptic transmission and facilitates the induction of long-term potentiation by high frequency stimulation. Ultimately, the authors show that luteolin both modifies and shields synapses from the deleterious effects of chronic cerebral hypoperfusion on the development of long-term potentiation.

The neuroprotective potential of luteolin and co-ultra micronized palmitoylethanolamide in the treatment of cerebral ischemia was investigated in another study. At the end of the trial, there were notable improvements in neurological state, cognitive impairment, pain, degree of spasticity, and independence in daily living activities compared to baseline and 30 days following therapy. Luteolin, however, has also been demonstrated to exhibit neuroprotection in a range of neurological conditions by enhancing neuron survival and reducing the intracellular reactive oxygen species level.

1. Phytochemistry

1.1. Chemical Structure

2. Lutein, a member of the flavone group of flavonoids, is a compound with the formula C₆-C₃-C₆, two benzene rings (A, B), a third ring (C) that contains oxygen, and a double bond consisting of two and three carbons [Figure 1]. Additionally, hydroxyl groups are present in luteolin at carbon positions 5, 7, 3', and 4'. It is 3', 4', 5-, and 7-tetrahydroxyflavone chemically. (11)

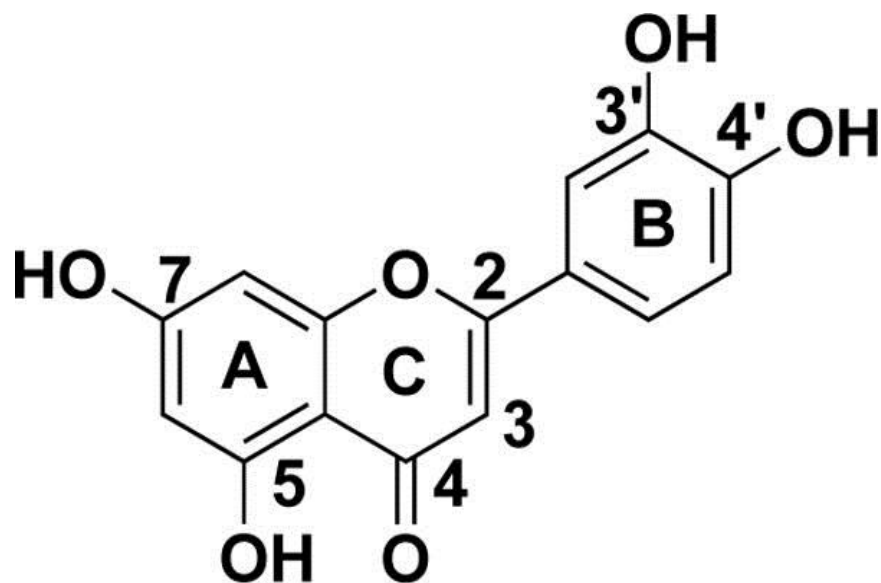


Figure 1. Chemical structure of Luteolin the extraction and isolation of luteolin from *V. negundo*

All the prepared extracts viz. methanol, ethanol, chloroform and dichloromethane showed the presence of flavonoids by Shinoda test.

2.3. Structure activity relationship

- 3 Important structural elements of luteolin linked to its biological and biochemical activity are its 2–3 double bond and hydroxyl moiety. (13) Lutein is frequently glycosylated in plants, just as other flavonoids. During absorption, the glycoside is digested to release luteolin, and some of the luteolin is changed into glucuronides when it passes through the intestinal mucosa. Luteolin does not degrade when heated, and cooking-related losses are minimal.

3.3. Extraction of luteolin

The four extraction techniques used by the authors to separate LTL from *Vitex negundo* L. leaves were maceration, soxhlet, reflux, and ultrasound assisted extraction. Their results demonstrate that different extraction techniques and solvent combinations resulted in a range of extract yields. The greatest and minimum yields for ethanol extract were found to be 14.5% and 5.2%, respectively, utilizing the soxhlet and UAE techniques, whereas the UAE method produced the highest yield for methanol extract. They concluded that the reflux approach is the best and should be utilized for leaf extract in industrial or research facilities. This method uses methanol instead of other extraction procedures.





2.3. Quantitative estimation of luteolin by HPLC method






The most effective solvent for luteolin extraction is methanol, according to HPLC measurements of many *V. negundo* L. extracts. It was discovered that the luteolin content of the methanol extracts produced by the maceration, soxhlation, reflux, and UAE processes was 1.020%, 1.075%, 6.340%, and 0.640%, respectively. Furthermore, it was discovered that the reflux approach was the most effective.





3 Pharmacognosy



3.1. Natural sources

Luteolin, as a common flavonoid is abundantly present in many fruits, vegetables, and medicinal herbs

Botanical name of the plant	Illustrating image of the plant	Common name	Biological activities
<i>Apium graveolens</i>		Celery	Antioxidant Neuroprotection Hypolipidemic, Hypoglycemic, Anti-platelet aggregation Antiadhesive activity Anti-depression Larvicidal and mosquito repellent activity Hepatoprotective activity Anticancer activity Antidiabetic activity Anti-inflammatory activity Antimicrobial activity Analgesic Antiulcer Anti-spasmolytic Anti-infertility Antiplatelet Hypocholesterolemic Cardiotonic
<i>Brassica oleracea</i>		Broccoli	Antioxidant Anti-inflammatory Cancer chemopreventive agent
<i>Piper nigrum</i>		Pepper	Antioxidant Anticancer Antidiabetic Anti-inflammatory, Immunomodulatory, analgesic, anticonvulsant, neuroprotective, anti-asthmatic, anti-carcinogenic, anti- ulcer, and anti-amoebic properties
<i>Thymus vulgaris</i>		Thyme	Antiseptic

<p><i>Allium cepa</i></p>		<p>Onion</p>	<p>Antioxidant Immunological biomarker Antidiabetic Macrophage activation inhibitor</p>
<p><i>Daucus carota subsp. sativus</i></p>		<p>Carrots</p>	<p>Nephroprotective Antioxidant and hepatoprotective Glucose uptake improver cytoprotective Anti-angiogenic Antifungal</p>
<p><i>Chrysanthemum indicum</i></p>		<p>Mums or chrysanthus</p>	<p>Anti-inflammatory Antiobesity NLRP3 and AIM2 inflammasome activation inhibitor Antibacterial, antiviral, anti-oxidant and immunomodulatory Anti-adipogenic Natural skin-whitening agent Apoptotic</p>
<p><i>Malus domestica</i></p>		<p>Apple</p>	<p>Antibacterial α-Glucosidase Inhibitor Antioxidant Antimicrobial</p>
<p><i>Brassica napobrassica</i></p>		<p>Kohlrabi</p>	<p>Antioxidant Proapoptotic potential</p>

<p><i>Cynara scolymus</i></p>		<p>Artichoke</p>	<p>Antioxidant Hypolipidemic Anti-hyperglycemic Liver protective effect</p>
<p><i>Lactuca sativa</i></p>		<p>Red leaf lettuce</p>	<p>Phytogenic acaricide Antioxidant Anti-inflammatory</p>
<p><i>Cichorium intybus</i> var. <i>intybus</i></p>		<p>Chicory greens</p>	<p>Antioxidant Antifungal</p>
<p><i>Cucurbita maxima</i></p>		<p>Pumpkin</p>	<p>Urinary Disorder improver Antidiabetic Anti-obese potential</p>
<p><i>Capsicum annuum</i></p>		<p>Green hot chili pepper</p>	<p>Cardio protective, antilithogenic, antiinflammatory, analgesia, thermogenic</p>

		Serrano pepper	Antioxidant
<p><i>Cichorium intybus</i> var. <i>foliosum</i> <i>Endive</i></p>		Radicchio	Antiinflammator

Natural occurrences:

The most common source of luteolin is leaves, however it can also be found in rinds, barks, clover blossoms, and pollen from ragweed. Additionally, it has been isolated from *Salvia tomentosa*, an aromatic flowering plant belonging to the Lamiaceae family of mints.[5]

Effects:

It has been demonstrated that plant components like flavonoids offer health advantages. One type of flavonoid that has anti-oxidative, anti-tumor, and anti-inflammatory qualities is luteolin, or Lut. The heart-protective benefits of Lut have been documented in recent scientific literature both in vitro and in vivo.[6]

Fruit:

Green peppers, celery, thyme, and chamomile tea all contain luteolin. Quercetin-rich foods include onions, apples, and capers. Chrysin comes from the fruit of the tropical plant known as blue passionflower. Citrus fruits such as oranges, grapefruits, lemons, and others are rich in naringenin, hesperetin, and eriodicytol.

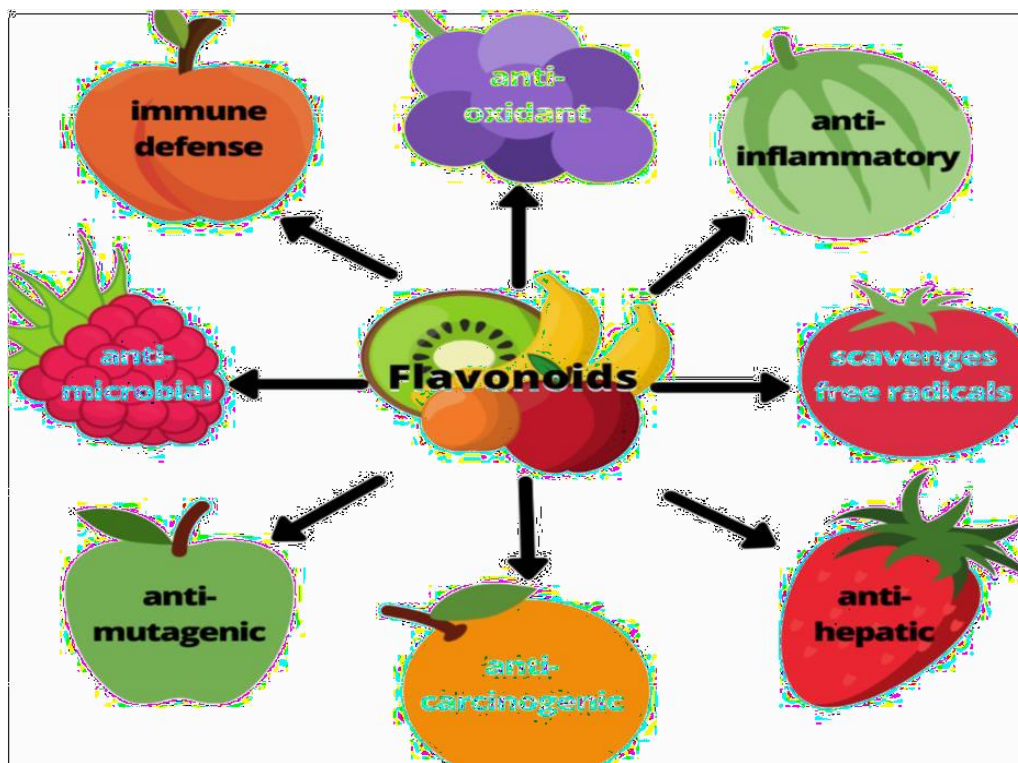


Figure 2 : source of Luteolin

Literature Review :

S. Nabavi et al. (2015): Numerous in vitro and in vivo investigations have shown these phytochemicals to have great efficacy and few side effects. Dietary flavonoids, which are present in a variety of fruits and vegetables, are a significant and widespread class of phytochemicals that are bioactive substances. Broccoli, pepper, thyme, and celery are among the plant products that contain luteolin, a significant flavonoid.

Aziz N., et al (2018): It has been determined that luteolin (3', 4', 5,7-tetrahydroxyflavone) is frequently found in plants. Ethnopharmacologically, luteolin-rich plants have been utilized to treat inflammation-related symptoms. In numerous model studies, isolated luteolin as well as extracts from plants high in luteolin have both shown anti-inflammatory properties.

López-Lázaro M., et al (2009); According to epidemiological data, flavonoids may be a significant factor in the lower risk of chronic illnesses linked to a diet high in foods produced from plants. In traditional medicine, flavonoids are frequently found in plants and are used to cure a variety of illnesses.

Hostetler G. L. et al (2017): A subclass of flavonoids known as flavones is gaining attention due to their biological activity both in vivo and in vitro. The main sources of flavones and their widely varying amounts in food and drink are reviewed in this article. It also discusses the functions of flavones in plants, how growth circumstances affect their concentrations, and how stable they are when processed into food.

Schomberg Jet al.(2010) : Prior research on luteolin showed growth inhibition of multiple cancer cells in vitro; however, there is a paucity of in vivo studies and a lack of a thorough knowledge of the molecular

mechanisms at the genomic level. This study found that luteolin effectively inhibits both in vitro and in vivo melanoma cell proliferation. The mode of action of luteolin in melanoma cells was determined by means of molecular investigations and genomic profiling.

M.-Y. Hung and colleagues (2020): Common flavonoid luteolin is found in large amounts in many food plants and has been shown to have positive effects on the cardiovascular system. Nevertheless, the processes underlying luteolin endothelial cell protection.

Plan of work:

- Literature survey
- Effect of luteolin on body
- Luteolin use for treatment of disease
- Sources of Luteolin
- Mechanism of action

Benefits damage caused by oxidative stress remains unclear.

TIME LINE

Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Task 1								
Task 2								
Task 3								
Task 4								
Task 5								
Task 6								

Methodology:

Introduction, Material and method

- Equipment
- Reference compound and chemicals
- Plant
- Preparation of standard luteolin solution
- Preparation of standard Apigenin solution
- Chromatographic conditions
- Calibration curve for standard Luteolin
- Calibration curve for standard Apigenin
- Validation of the method
- Statistical Analysis3 .

Conclusion

It has long been known that a healthy diet and consumption of bioactive chemicals from fruits and vegetables, which are natural sources, can help prevent cancer and other human diseases. The literature has a wealth of information about the phytochemicals found in plants and their ability to suppress the development of major diseases. These phytochemicals can also be used as supplemental therapy to prevent and slow the spread of many malignancies in humans. These food-based products are thought to be safer and more effective against the spread of cancer because they are chemo-preventive agents. In this regard, luteolin, a flavonoid present in a variety of fruits and vegetables, has been identified as an anticancer agent due to its ability to induce cell cycle arrest and apoptosis as well as to effectively inhibit metastasis and angiogenesis in a number of cancer cell lines, including those from the breast, colon, pancreas, and lung. In conclusion, this research has demonstrated that luteolin, due to its natural origin, safety, and affordability in comparison to synthetic cancer medications, can be a valuable supplemental therapy for the prevention and treatment of several cancer types. However, before this substance is prescribed, more research on various pharmacokinetic parameters—which may involve human subjects—is required, as the majority of the findings cited in the current work are based on in vitro and in vivo studies, which may not accurately represent the effect on humans. Furthermore, clinical trials could be used to investigate the development of standardized dosage. According to the information compiled for this review, luteolin (LTL) has several advantageous effects, such

as anti-inflammatory and anti-cancer effects. This claim might yet create new opportunities for therapeutic approaches. However, further in vitro and in vivo studies are needed to investigate basic questions regarding luteolin (LTL) in the health sciences theory, research, and practice.

Proposed Outcome:

One type of flavonoid that has anti-oxidative, anti-tumor, and anti-inflammatory qualities is luteolin Or Lut. The heart-protective benefits of Lut have been documented in recent scientific literature both in vitro and in vivo. The majority of flavonoids including luteolin—are thought to be antioxidants. Several investigations have demonstrated the positive neuroprotective benefits of luteolin in both vitro and invivo setting.

Reference:

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