Pharmacogn. Res., 2023; 15(3):405-409.
https://www.phcogres.com

Review Article

Insight on Phytochemical and Pharmacognostic Review of *Cichorium intybus*

Nimmathota Madhavi[1,*], B. Lohith Chandu[2], G. Rithika[2], B. Niharika[2], T. Rama Rao[1]

[1]Department of Pharmaceutics, CMR College of Pharmacy, Affiliated to JNTUH, Hyderabad, Telangana, INDIA.
[2]CMR College of Pharmacy, Affiliated to JNTUH, Hyderabad, Telangana, INDIA.

ABSTRACT

In today's growing world herbs are gaining a lot of importance because of their ability to improve human health. One such herb is *Cichorium intybus*. It is also called as chicory/kasni representing Asteraceae family and cultivated across various parts of the globe. *Cichorium intybus* grows up to a height of 150 cm having thick, strong, irregularly branched twig like stem, long robust thick brown tapio root, lobed and unlobed leaves, seed like fruits and flowers of various colours. Chicory contains various chemical constituents like cichoric acid, sesquiterpenes, lactones, caffeic acid derivatives, inulin, sugars, proteins, sugars, volatile compounds and many more. The phytochemical composition of chicory exhibits not only various pharmacological activities such as nematicidal, hypotensive, analgesic and hepatoprotective but also used in the treatment of several diseases like diabetes, cancer, viral infections, bacterial infections, allergic reactions and antioxidant property respectively. It also has great importance in the field of Ayurveda, it had various medicinal properties and used as a flavouring agent in different food preparations like soups and salads. Current review aimed to emphasize the botanical characteristics, chemical composition, pharmacological activities and culinary applications of *Cichorium intybus*.

Keywords: *Cichorium intybus*, Pharmacological activity, Chemical composition, Culinary applications.

Correspondence:
Dr. Nimmathota Madhavi
Associate Professor, Department of Pharmaceutics, CMR College of Pharmacy, Affiliated to JNTUH, Hyderabad-501401, Telangana, INDIA.
Email: nimmathota.madhavi@gmail.com
ORCID: https://orcid.org/0000-0002-0458-7406

Received: 24-01-2023;
Revised: 12-02-2023;
Accepted: 31-03-2023.

INTRODUCTION

Cichorium intybus L. (Chicory) is a perennial plant belonging to the family Asteraceae, generally called as Kasni or chicory.[1] The name *Cichorium intybus* L. is derived from both Latin and Greek words. *Cichorium* is the Latin word for field, while *intybus* is derived from the Greek verb "to cut," due to the presence of leaves, and in part from the Latin tubus, which indicates the presence of hollow stem.[2] Despite being a native of Europe it is cultivated globally (Australia, Mid-Asia, Eastern USA, Northern Africa, and South Africa).[1] In the northern Himalayas and plains of India, chicory is cultivated alongside winter crops and is frequently used as a food and medicine source during the lean months.[3] In ancient times, the Egyptians cultivated chicory for its medicinal properties, as a replacement for coffee, as a vegetable crop, and even as feed for animals. Some parts of Italy, such as Latium and Tuscany, utilize the leaves as green vegetables in salads and soups.[4,5] In countries like India and South Africa, where coffee consumption is exceptionally high, chicory roots are roasted and crushed and used as a coffee alternative or addition or supplement.[6]

A wide range of ailments, from minor cuts to diabetes, have been treated with chicory in the past.[7] The leaves, roots, and seeds of the plant are farmed on a commercial scale and their usage in traditional medicine has spread over the world.[4] It is an important note that both the fructans and inulin may be obtained commercially from chicory roots.[3] Few of the therapeutic phytochemicals are also found in chicory such as carbohydrates, alkaloids, tannins, flavonoids, fatty acids and volatile oils respectively.[4]

In Ayurvedic medicine, the seeds serve as a medicinal raw substance, when compared to extracts from the leaf and root, the seed shows the greatest levels of antioxidant activity. The roots and leaves are used in the treatment of several diseases like liver, urinary tract, gall bladder and arteriosclerosis.[3] Current review aimed to emphasize the botanical characteristics, chemical composition, pharmacological activities and culinary applications of *Cichorium intybus*.

BOTANICAL CLASSIFICATION

Kingdom: Plantae

Sub kingdom: Tracheobionta

DOI: 10.5530/pres.15.3.044

Super division: Spermatophyta

Division: Magnoliophyta

Order: Asterales

Family: Asteraceae

Sub family: Asteradeae

Genus: Cichorium

Species: Indica *C. intybus*

BOTANICAL CHARACTERISTICS

Cichorium intybus L. is an annual plant obtained from the family of Asteraceae (formerly: Compositae).[1] It grows to a height of 20 to 150 cm. It grows a long, robust, spindly, thick root.[2] Stems are thick, strong, glabrous to bristly and about 2 to 6 feet tall. The stems having in order branches which contains twig-like milky sap. *Cichorium intybus* can grow from tall-ribbed stems and produces risen. The plants appear like short, thick hairs near to the stem bottom and most branches are appeared at the top.[8] Leaves are of lobed and unlobed and the edge of the leaf blade has lobes and the base of the leaf blade is cuneate or narrow.[2]

The fruit is like a seed with tiny scales at the tip. The flowers contain several components and can grow up to 1.5 inches broad. They are generally in light blue but sometimes be in white or pink. The ray's lips are toothed. Every day the flowers bloom and close, they are especially high in nectar and pollen. *Cichorium intybus* grows in the temperate climate zones of various countries such as Europe, southwest Asia, north Africa, Australia, New Zealand respectively.[8] The plant can live in both lowlands and lowers mountain regions.[2]

CHEMICAL COMPOSITION

There are many different chemical compounds present in the morphological components of chicory, including the roots, herbs, flowers and leaves respectively.[8] Apart from those parts of plant, the major component was found as cichoric acid which is a methanolic extract of *C. intybus* L.[8] Majority of the plant constituents are aliphatic chemicals and their derivatives, with less terpenoids. According to phytochemical analysis, the plant various parts consisting of sesquiterpene lactones (particularly lactucin and lactucopicrin), caffeic acid derivatives (chiroric acid, chlorogenic acid and dicaffeoyl tartaric acid), proteins, hydroxycoumarins, flavonoids, alkaloids, steroids, terpenoids, oils, volatile compounds, vitamins and polyenes respectively.[8]

Fresh chicory root comprised of about 68%, 14%, 5%, 6%, 4% and 3% chemicals as inulin, sucrose, cellulose, protein, ash and miscellaneous chemicals. Chicory roots include sesquiterpene lactones such as germacranolides (lactucin, lactucopicrin and 8-deoxylactucin), and guajanolides (cycriozides B and C, sonchuzide C) which produces bitter taste.[9]

The seeds of chicory contain various amino acids namely histidine, arginine, leucine, isoleucine, lysine, methionine, serine, glutamic acid, glycine, aspartic acid, proline, etc, fatty acids and minerals (Ca, K, P, Na, Mg, Zn, Cu, Fe, Se and Mn) respectively.[11] The root contains 0.01-0.02% of the bitter intybin glycoside, 9-15% reducing sugars and 40-60% inulin. Chicory leaves contain inulin, vitamins A, B1, B2, and C, calcium, potassium, magnesium, sodium, iron, copper, manganese, and zinc etc. Chicory flowers include saccharides, flavonoids, fatty acids, steroids, terpenoids, essential oils and anthocyanins etc.[9]

PHARMACOLOGICAL ACTIVITIES

Fresh and dried materials are most frequently used for medicinal purposes and *C. intybus* is one of the important therapeutic plant from the Asteraceae family.[4] Chicory contains inulin, which may aid in weight loss and weight control in people by promoting satiety, preventing constipation, enhancing bowel function and improving general health.[10] Several *C. intybus* extracts have shown a variety of biological and pharmacological properties such as hepatoprotective, anti-hyperuricemia, anti-inflammatory, antidiabetic, antinematodal, antioxidant, antiproliferative antibacterial and antiprotozoal.[2]

Anti-diabetic Activity

Dietary inulin-type fructans found in chicory root which regulate the production of peptides like incretins by endocrine cells found in the intestinal mucosa. Though its capacity limited to encourage the secretion of endogenous gastrointestinal peptides involved in appetite regulation, this effect may bevilop obesity and diabetes.[10]

In one study, using streptozotocin induced diabetic rats, the application of whole plant ethanolic extract at a dose of 125 mg/kg body mass resulted in lower serum levels of glucose, cholesterol and triglycerides respectively.[4] Additionally, it was discovered that the chicory extract reduced glucose-6-phosphatase levels as compared to the control group. When applied during either the early or late stages of diabetes, the aqueous seed extract produce similar hypoglycemic effect.[2]

Anti-cancer Activity

C. intybus extracts have demonstrated their antitumor potential in recent years through cytotoxicity studies. A raw ethanolic root extract application significantly slowed the progression of tumors, according to a study using Ehrlich ascites carcinoma mouse models. When 700 mg/kg body mass of the tested extract was administered intraperitoneally every day, an average lifespan increase of up to 70%.[4] The aqueous-ethanolic macerate of the leaves in turn reduce the growth of C32 amelanotic melanoma cells. *C. intybus* extracts havea cytotoxic effect on prostate cancer, amelanotic melanoma, breast cancer, renal adenocarcinoma and leukemia cells respectively.[2]

Anti-inflammatory Activity

In the treatment of pyorrhea or gingival inflammation, alcohol-based extracts of the *C. intybus* root demonstrated an anti-inflammatory effect.[11] In the human colon carcinoma (HT 29) cell line, chicory root extracts were tested for their ability to reduce TNF-*α*mediated Cyclooxygenase (COX) induction. Prostaglandin E2 (PGE2) production was dose-dependently inhibited by the ethyl acetate extract. The chicory extract also inhibited the TNF-mediated induction of COX-2 expression. The levels of TNF-α, IL-6, and IL-1 in the serum were reduced by chicory roots.[4]

Anti-bacterial Activity

The chicory plant was effective against yeast, gram-positive and gram-negative bacteria. *Escherichia coli, Staphylococcus aureus, Staphylococcus epidermidis, Bacillus subtilis, Bacillus thuringiensis, Bacillus subtilis, Salmonella typhi, Micrococcus luteus, Candida albicans, Klebsiella pneumoniae, Enterobacter cloacae*, and *Streptococcus pyogenes* are among the bacteria that are inhibited by *C. intybus*.[8]

Petrovic *et al.* investigated the antibacterial activity of *C. intybus* water, ethanol, and ethyl acetate extracts. All the tested extracts showed antibacterial activity, with the ethyl acetate extract being the most active. A water extract inhibits *Agrobacterium radiobacter* sp. *tumefaciens, Erwinia carotovora, Pseudomonas fluorescens*, and *Pseudomonas aeruginosa*. The ethanol and ethyl acetate extracts inhibits *S. aureus, P. aeruginosa, E. coli* and *C. albican*.[2]

Hepatoprotective Activity

Extracts from different morphological parts of *C. intybus* have been shown to have hepatoprotective properties. In studies on animals, the roots and seeds of chicory have shown antihepatotoxic potential. One study found that administering an aqueous and methanolic chicory seed extract to mice with liver damage caused by acetaminophen and carbon tetrachloride decreased mortality as well as serum levels of Alkaline Phosphatase (AP), Aspartate Aminotransferase (AST), and Alanine Aminotransferase (ALT).[8] Similar outcomes were observed for alcoholic seed extracts, aqueous root extracts, and root callus extracts. Biochemical parameters, such as elevated bilirubin levels, showed an improvement in the health of treated animals, and histological tests demonstrated a significant reduction in liver damage.[8]

The plant diet reduced several liver damage indicators, such as high levels of liver enzymes and low levels of superoxide dismutase, glutathione peroxidase, and catalase. With the help of methotrexate, Asadi *et al.* induced oxidative stress in rat liver. As a result, there was a sharp drop in the levels of enzymes like Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT), Alkaline Phosphatase (ALP), Glutathione (GSH), Catalase (CAT), Superoxide Dismutase (SOD), and Glutathione Peroxidase (GPx), and a sharp rise in the levels of Total Bilirubin (TB) and Malondialdehyde (MDA).[8]

Anti-Neurotoxic Activity

Glycosides and triterpenoids found in *Cichorium intybus* promote GABAergic transmission while inhibiting glutamatergic transmission. Glutamatergic and GABAergic systems, the current study aimed to investigate the impact of chicory extract on pyridoxine-induced peripheral neuropathy.[2] In an experiment, male rats were given a high dose of pyridoxine (800 mg/kg, i.p.) for 14 days to cause neuropathy. The results indicated that chicory extract had positive effects on pyridoxine-induced peripheral neuropathy.[2]

Antiviral Activity

At higher concentrations, the extracts of *Cichorium intybus* L. demonstrated excellent antiviral activity against HSV1[2] In one study by Zhang *et al.* studied the D-galactosamine (D-GalN)-induced normal human HL-7702 hepatocyte, the duck fetal hepatocytes infected with Duck Hepatitis B Virus (DHBV) as a result this study confirmed cichoric acid's ability to fight against hepatitis B.[8]

A molecular docking method was used to investigate the potentiality of medicinal plants in alleviating the novel SARS-CoV-2 infection.[8] Hence, there will be a vaccine or specific antiviral medication for the treatment of infection since the infection outbreak, supportive care and preventing complications is the current management strategy. The possible inhibitors are 3-Chymotypsin protease (3CLpro), Papain-like protease (PLpro), and RNA-dependent RNA polymerase (RdRp) respectively. Chicory used fight against SARS-CoV-2.[4]

Analgesic Activity

Three distinct chicory active ingredients-lactucin, lactucopicrin and 11,13-dihydrolactucin-were tested for their analgesic effects on mice using the tail-flick and hot plate tests, with lactucopicrin showing to be the most effective. It is interesting that any of these substances employed in the tail-flick test at 30 mg/kg exhibited effects that were equivalent to ibuprofen at 60 mg/kg. Additionally, lactucin and lactucopicrin contributed to some degree of animal tranquilization as seen by a decrease in the animals' spontaneous motor activity.[2]

Nematicidal Activity

The toxicity of chicory against internal parasites is widely established. The addition of dry powder made from chicory rhizome to foods elongates food preservation time. Ether-soluble phenolics from the chicory rhizome have nematicidal action.[10] Chicory is commonly used as a fodder supplement since studies show that feeding it to farm animals reduced their worm loads.[10]

Effect on the Immune System

As a result of its advantages in treating immune-related illnesses, *C. intybus* is a common medicinal plant used in conventional medicine. *C. intybus* can alter immunological responses, according to a number of evidences.[2] By focusing on mice dendritic cells, Karimi *et al.* investigated how the immune system was affected by an ethanolic extract of chicory root. Higher concentrations of *C. intybus* prevented allogenic T cells from proliferating while lower quantities caused cytokines like IL-4 and IFN-γ to shift levels, with IFN-γ rising and IL-4 falling.[12]

Antiallergic Activity

According to Kim *et al.* the aqueous extract of *C. intybus* suppressed mast cell immediate-type responses to compound 48/80 in mice at a dosage of 1000 mg/kg in a dose-dependent manner.[13] When given at dosages between 1 and 1000 mg/kg, anti-dinitrophenol lowered plasma histamine levels in a way that was dose-related. Mast cell-mediated immediate-type allergy responses are inhibited by *C. intybus* aqueous extract both *in vivo* and *in vitro*.[4]

Hypotensive Effect

Sedighi *et al.* claim that the ethanol leaf extract of *C. intybus* protects against hypertension. 32 male wistar rats were separated into four groups of eight for the purpose of this study. Animals were given normal saline in the control group and extract at 25, 50, and 100 mg/kg for two weeks in the *C. intybus* groups.[14] Median (MAP), Systolic (SAP) and Diastolic Arterial Pressure (DAP) significantly decreased in the 50 mg/kg extract-treated group compared to the control and 200 mg/kg extract-treated treated groups.[14]

Antioxidant Activity

Chicory demonstrated promising potential to be taken into consideration as a natural remedy for reducing oxidative stress and liver damage brought on by nitrosamine chemicals.[15] The DPPH radical scavenging ability of the *Cichorium intybus* seed extract/fractions was good, with an IC_{50} range of 21.28-72.14 g/mL.[1] The strongest antioxidant activity was seen in the 100% methanolic extract and ethylacetate fraction. However, the outcomes demonstrated that *Cichorium intybus* seeds solvent extract/fractions had substantial (p0.01) differences in antioxidant activity.[1] *C. intybus* water extract showed an antioxidant effect on Low-density Lipoprotein (LDL) and inhibits the synthesis of thio-barbituric acid reactive material and the breakdown of fatty acids in LDL.[13] A high quantity of anthocyanins found in *C. intybus* seeds may have a direct scavenging impact on the generation of Reactive Oxygen Species (ROS) owing to antioxidant activity.[16]

CULINARY APPLICATIONS OF THE COMMON CHICORY

The main utilized portions of chicory for industrial and culinary purposes are the roots, leaves, and flowers.

Culinary uses of chicory roots

Young chicory roots can be boiled and served with sour cream or herbal sauce. Leaves cut into pieces and served to enhance the flavouring of various soups. Mature roots, once the bitter core is removed an excellent complement to soups and meat dishes was prepared. Chicory roots are also used to prepare drinks. The most popular one is chicory coffee.[2] Another extremely intriguing example is a functional beverage made primarily from burdock root, with 10% chicory root and added ginger juice. Diabetic patients can use such a functional beverage to help with their treatment since it has a distinctive organoleptic profile.[2]

Culinary uses of chicory leaves

Chicory leaves are bitter greens that are packed with minerals like magnesium and potassium. They can be incorporated into different salads, soups, and pasta dishes for added nutrition. The combination of these leaves goes well with chicken, ham, and shrimp.[17]

Culinary uses of chicory flowers

Fresh vibrant colour flowers make them garnish for meat meals, seafood, and salads. Anthodia may be stored in vinegar and the buds can be marinated and served similarly to capparis.[2]

ALLERGIES TO THE COMMON CHICORY

There may be a chance to cause allergic reaction in those are sensitive to the Asteraceae/Compositae family. Members of this family include ragweed, chrysanthemums, marigolds, daisies, and many others. If allergic to chicory, consuming or handling it results in itching, hives, shortness of breath, wheezing, facial swelling, dizziness, pale skin, and loss of consciousness. It is absolutely critical to seek medical attention if displaying such symptoms, as an allergic reaction to chicory root extract may be life-threatening.[2] Depending on the individual, allergic symptoms can be systemic and/or local, ranging from rhino-conjunctivitis to asthma and anaphylactic reactions, to contact dermatitis. Only two cases of allergic reactions to raw chicory roots have been documented. The majority of reactions occurred in response to leaves (raw and cooked) showing skin contact or inhalation.[2]

CONCLUSION

Since *cichorium intybus* L. is a safe and effective herbal medication, this review discusses its botanical features, chemical components, pharmacological effects, and culinary applications.

The multifunctional properties of chicory extracts may be a promising alternative source for the pharmaceutical industry.

ACKNOWLEDGEMENT

The authors Lohith Chandu, Rithika and Niharika are thankful to Madhavi mam and Rama Rao sir for support and encouragement to write the article.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

PGE2: Prostaglandin E2; **COX:** Cyclooxygenase; **AP:** Alkaline phosphatase; **AST:** Aspartate aminotransferase; **ALT:** Alanine aminotransferase; **LDL:** Low-density lipoprotein; **AST:** Aspartate aminotransferase; **ALT:** Alanine aminotransferase; **ALP:** Alkaline phosphatase; **GSH:** Glutathione; **GPx:** Glutathione peroxidase; **TB:** Total bilirubin; **DHBV:** Duck hepatitis B virus.

REFERENCES

1. Al-snafi AE. The medical importance of *Cicer arietinum*-A review. IOSR J Pharm. 2017:29-40.
2. Janda K, Gutowska I, Geszke-Moritz M, Jakubczyk K. The common cichory (*Cichorium intybus* L.) as a source of extracts with health-promoting properties-a review. Molecules. 2021;26(6):1-14. doi: 10.3390/molecules26061814, PMID 33807029.
3. Kumar CNP, Shruthi R, Kannan R, Babu UV. Botanical pharmacognosy of *Cichorium intybus* seeds. 2020;4-10.
4. Street RA, Sidana J, Prinsloo G. *Cichorium intybus*: Traditional uses, phytochemistry, pharmacology, and toxicology. Evid based Complement Altern Med. 2013. doi: 10.1155/2013/579319, PMID 24379887.
5. Pieroni A, Nebel S, Santoro RF, Heinrich M. Food for two seasons: Culinary uses of non-cultivated local vegetables and mushrooms in a south Italian village. Int J Food Sci Nutr. 2005;56(4):245-72. doi:10.1155/2013/579319, PMID 24379887.
6. Sastri BN. The Wealth of India. A dictionary of Indian raw materials and industrial products. Council of Scientific and Industrial Research;1950;556-61.
7. Kowal RR. KEYS TO The Asteraceae of Wisconsin; 2007.
8. Devi J, Sharma RB, Kumar A, Kumar A. Medicinal Importance of *Chichorium intybus*-a review. 2022;9(5):114-23.
9. Singh R, Kaur CK. *Cichorium intybus* L.: a review on phytochemistry and pharmacology. Int J Chem Stud. 2018;6(3):1272-80.
10. Das S, Vasudeva N, Sharma S. *Cichorium intybus*: a concise report on its ethnomedicinal, botanical, and phytopharmacological aspects. Drug Dev Ther. 2016;7(1):1. doi: 10.4103/2394-6555.180157.
11. Papetti A, Mascherpa D, Carazzone C, Stauder M, Spratt D, Wilson M, *et al*. Identification of organic acids in *Cichorium intybus* inhibiting virulence-related properties of oral pathogenic bacteria. Food Chem. 2013;138(2-3):1706-12. doi: 10.1016/j .foodchem.2012.10.148, PMID 23411301.
12. Karimi MH, Ebrahimnezhad S, Namayandeh M, Amirghofran Z. The Effects of *Cichorium intybus* extract on the maturation and activity of dendritic Cells. Daru. 2014;22(1):28. doi: 10.1186/2008-2231-22-28, PMID 24564889.
13. Kim M. The water soluble extract of chicory affects rat intestinal morphology similarly to other non-starch polysaccharide. Nutr Res. 2002;22(11):1299-307. doi: 10.1 016/S0271-5317(02)00423-2.
14. Sedighi M, Cheraghi M, Faghihi M, Rahimi-Madiseh M, Kiani A, Dehghani M, *et al*. Hypotensive effect of *Cichorium intybus* extract in rats. J Herb Med Pharmacol. 2021;10(2):257-61. doi: 10.34172/jhp.2021.29.
15. Hassan HA, Yousef MI. Ameliorating effect of chicory (*C. intybus*) supplemented diet against nitrosamine precursors-induced liver injury and oxidative stress in male rats. Food Chem Toxicol. 2010;48(8-9):2163-9. doi: 10.1016/j.fct.2010.05.023, PMID 20478349.
16. Laura D, Morroni F, Lombardi-boccia G, Lucarini M, Hrelia P, Cantelli-forti G, *et al*. Red Chicory (*Cichorium intybus* L. cultivar) as a potential source of antioxidant anthocyanins for intestinal health. Vol. 2013.
17. Chicory AN: A plant with multiple uses. [Recette magazine]; 2021.

Cite this article: Madhavi N, Chandu BL, Rithika G, Niharika B, Rao TR. Insight on Phytochemical and Pharmacognostic Review of *Cichorium intybus*. Pharmacog Res. 2023;15(3):405-9.