ANNALS OF THE
UNIVERSITY OF CRAIOVA

Series: ✓*Biology*
✓*Horticulture*
✓*Food products processing technology*
✓*Environmental engineering*

Vol. XXX (LXVI) - 2025

CHICORY (*CICHORIUM INTYBUS*): BIOACTIVE COMPOUNDS, BIOLOGICAL ACTIVITIES AND AGRONOMIC POTENTIAL

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Keywords: *Cichorium intybus, antioxidant activity, bioactive compounds, agronomic use, inulin*

ABSTRACT

Cichorium intybus L., known as chicory, is a perennial species with a long history of use in traditional medicine, agriculture and the food industry. The plantain root is an important source of inulin, a prebiotic compound, and the leaves and other organs contain various compounds such as phenolic acids, sesquiterpene lactones and flavonoids that confer anti-inflammatory, hepatoprotective and antioxidant properties. Furthermore, chicory has a valuable agronomic potential, as it is an adaptable, rustic species that can be used in sustainable agricultural systems. This paper synthesizes recent data on the biological effects, chemical composition and agroindustrial valorization opportunities of chicory, with an emphasis on its functional and sustainable uses.

INTRODUCTION

Cichorium intybus L. is commonly known as chicory, a perennial plant belonging to the Asteraceae family, genus *Cichorium*, native to Europe and currently widely cultivated in subtropical and temperate regions of the world. *C. intybus L.* is valued for both its medicinal properties and nutritional value, and is often used in traditional medicine to treat various conditions, such as dyspepsia, liver disorders, constipation and inflammation (Street et al. 2013) (Sharma et al. 2021).

Botanically, the plant has an erect stem, basal leaves arranged in a rosette and characteristic light blue flowers. In agriculture and industry, the most valuable part of the plant is the root, as it is rich in inulin, a prebiotic soluble fiber that has numerous important applications in the pharmaceutical and food industries (Nagy et al. 2023). Chicory also contains a diverse complex of bioactive compounds, such as flavonoids (apigenin, luteolin), phenolic acids (ferulic acid, chlorogenic acid), tannins and sesquiterone lactones (lactucopicrin), all of which contribute to its therapeutic effects (Birsa & Sarbu 2023).

Recent studies have highlighted important pharmacological properties of *C. intybus L.* extracts, including antimicrobial, hepatoprotective, antioxidant, anti-inflammatory and hypoglycemic actions (Nowrouzi et al. 2017) (Singh & Chahal 2018).

Thus, chicory represents an important source of bioactive compounds, with numerous promising applications in both the biotechnological, food and therapeutic fields. By integrating modern processing technologies and sustainable utilization of by-products, chicory is outlined as a strategic resource in the context of circular bioeconomy and the development of functional products (Street et al. 2013).

MATERIAL AND METHODS

In this study, all data were obtained through a comprehensive review of specialized articles, available in the following databases: Google Scholar, ResearchGate, Elsevier, PubMed and ScienceDirect. The following keywords were used in combination:

"*C. intybus L.*", "biological activities", "hepatoprotector", "anti-inflammatory" and "herbal medicine" to search these databases. Also, chapters and books were checked. The most representative references used were written in English. The following steps were followed:

(i) developing the article outline and formulating the questions; (ii) recognizing relevant works; (iii) selecting and grouping the works; (iv) collecting data, summarizing, organizing and interpreting the available research; (v) writing the manuscript and final editing.

RESULTS AND DISCUSSIONS

1. Anatomy and morphology of C. intybus L.

C. intybus L. (Figure 1.) is a perennial herbaceous plant of the Asteraceae family, the plant presenting anatomical and morphological features adapted to temperate conditions and well-drained soils. The external morphology is characterized by the thick, pivoting, elongated root, rich in inulin. The stem is branched, erect, presents a rigid appearance. The leaves are oblong-lanceolate, and the upper ones are sessile and basally rosette. The flowers are capitulum-type inflorescences, hermaphrodite, light blue to purple in color. The fruits are small achenes, with a rough surface, without pappus.

Figure 1. General appearance of the *C. intybus L.* plant in its natural environment (original image).

The internal anatomy is represented by the epidermis which is formed by single-layered cells, covered by the cuticle.

The cortical parenchyma serves as a storage site for inulin.

The conducting fascicles are of the collateral type in the stem and are well highlighted in cross-section.

Lactocells (laticifers) are present in the stem and leaves and are responsible for the bitter latex.

2. Phytochemical composition

The richest part of the plant in inulin is the underground part, inulin is a long-chain fructan that constitutes the main storage carbohydrate. This compound is present in a proportion of over 60 % of the dry weight of the root (Roberfroid 2004), it is a significant prebiotic compound, it is able to stimulate the development of beneficial intestinal microbiota. In addition, the plant also contains in addition to inulin, chlorogenic acid, chicoric acid, as well as various flavonoids, such as apigenin or luteolin, all of which are known for their anti-inflammatory and antioxidant activity (Street et al. 2013).

Another important group of active compounds is represented by sesquiterpene lactones, especially lactucopicrin, it contributes to the bitter flavor of the plant and has immunomodulatory and antimicrobial properties (Zhou et al. 2005). The phytochemical composition may vary depending on genotype, climatic factors, plant development stage and post-harvest processing methods (Table 1.) (Papetti et al. 2002).

Table 1.

The main biochemical components identified in the organs of the C. intybus plant and their functional importance (Street et al. 2013) (Mulabagal & Tsay 2004).

Constituents	Organs –*C. intybus* (content in %)	Components / Observations
Inulin	Root (40–70 % of dry matter)	Important prebiotic, stimulates the development of intestinal flora
Chicoric acid, chlorogenic acid	Leaves, roots (variable, 0.1–2 %)	Antioxidant, anti-inflammatory, liver protection
Flavonoids (luteolin, apigenin)	Leaves (traces–0.5 %)	Antioxidant and anti-inflammatory properties
Sesquiterpene lactones	Leaves, latex (bitter taste, 0.2–1 %)	Antimicrobial activity, immunomodulatory
Minerals (K, Ca, Mg, Fe)	Roots and leaves (K: up to 1.5 %, Ca: 0.8 %)	Nutritional value, contributes to general metabolism
Vitamin C, carotenoids	Leaves (vit. C: 20–35 mg/100g fresh; β-carotene: up to 1 mg/100g)	Antioxidant activity; sensitive to heat processing

3. Biological activities

3.1. Antioxidant capacity

Over time, chicory extracts have demonstrated an impressive antioxidant capacity, evaluated by various methods such as ABTS, DPPH and FRAP. The antioxidant capacity is due to the high content of polyphenols, which act as electron donors and neutralize free radicals that are responsible for oxidative stress and cellular aging (Jančić et al. 2017).

3.2. Hepatoprotective and anti-inflammatory effect

Numerous preclinical studies have demonstrated the hepatoprotective effect of *C. intybus L.* extracts, especially on the liver affected by toxic agents such as ethanol or carbon tetrachloride. By administering the extracts, a reduction in serum

levels of hepatic transaminases (AST, ALT) as well as inflammatory biomarkers was observed. All these effects are correlated with the ability of the extracts to inhibit hepatic inflammation and oxidative stress (Gilani & Janbaz 1994).

3.3. Antimicrobial effects

The antimicrobial action of chicory against pathogenic bacteria such as *Staphylococcus aureus*, *Escherichia coli* and fungi such as *Candida albicans* is due to phytochemical components such as chlorogenic acid and sesquiterpene lactones. In vitro studies have demonstrated inhibition of bacterial colony development and reduction of biofilm formation (Petrovic et al. 2024).

3.4. Antidiabetic and prebiotic activity

Inulin plays a significant role in regulating carbohydrate metabolism by contributing to lowering blood glucose and increasing insulin sensitivity. A randomized study conducted on patients with type 2 diabetes demonstrated that inulin obtained from chicory caused a significant decrease in blood glucose. In addition, *C. intybus L.* has an indirect effect on the metabolic state and immunity of the body through the probiotic action of inulin that contributes to the balance of the intestinal microbiota (Marzban et al. 2022).

4. Agri-food applications

C. intybus L. plays a special role in the food industry due to its rich content in soluble fibers, especially inulin, which is used as a prebiotic ingredient, but also as a substitute for sugar and is found in various dietary products. Also, the dried roots are used as a coffee substitute, having similar properties but being caffeine-free (Neyrinck et al. 2025).

At the agro-industrial level, chicory is valued by obtaining functional extracts, organic fertilizers and biofuels. At the same time, the plant is used to obtain animal feed as a natural feed additive, it has an antiparasitic role and beneficial effects on digestion. Adaptability to poor soils and resistance to poor conditions such as drought, recommend this valuable species in the context of sustainable agronomy (Chandra et al. 2016).

CONCLUSIONS

C. intybus L. is a valuable source of bioactive compounds, especially inulin, sesquiterpene lactones and polyphenols, which confer antioxidant, prebiotic, anti-inflammatory and hepatoprotective properties. Modern scientific evidence supports its traditional use, and the diversity of biological applications recommends it as a plant with significant potential in the phytotherapeutic, agronomic and food fields. This plant can contribute to the development of sustainable and functional chains in the bioeconomy through the integral valorization, including by-products.

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