REVIEW ARTICLE

Potential of *Lactuca* and *Gyrocarpus* Species: A Comprehensive Review

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ABSTRACT

Lactuca, a genus within the Asteraceae family, comprises a diverse group of herbaceous plants commonly known as lettuces. This review seeks to offer an extensive summary of *Lactuca* species, exploring their taxonomy, morphological diversity, nutritional content, medicinal properties, and potential agricultural and environmental applications. *Lactuca runcinata*, a species within the *Lactuca* genus, has been a subject of increasing interest in the field of pharmacology due to its potential medicinal properties. Based on recent studies, this review comprehensively examines the pharmacological activities associated with *L. runcinata*. The focus encompasses various aspects, including anti-inflammatory, antioxidant, analgesic, antimicrobial, and other relevant pharmacological activities, shedding light on the therapeutic potential of this plant. *Gyrocarpus*, a distinctive genus within the family Hernandiaceae, comprises a group of intriguing flowering plants with a global distribution. Despite its relatively lesser-known status, botanists and researchers have been drawn to *Gyrocarpus* because of its distinctive traits and possible uses. This review strives to thoroughly examine *Gyrocarpus*, encompassing its taxonomy, morphology, ecological significance, phytochemistry, and potential uses in various fields. This plant species has a significant traditional usage history and is increasingly capturing the attention of the scientific community. This review seeks to offer a thorough examination of the therapeutic effects associated with *Gyrocarpus asiaticus*, relying on recent studies. The review encompasses diverse aspects, including anti-inflammatory, antioxidant, antimicrobial, anticancer, and other relevant pharmacological activities, shedding light on the potential therapeutic applications of this plant. This study's primary objective is to comprehensively examine the chemical composition and medicinal properties associated with *G. asiaticus* Willd and *L.R* DC. These plants demonstrate significant antibacterial, anthelmintic, cardiotonic, antioxidant, anticancer, antidiabetic, hypolipidemic, and hepatoprotective properties. The evaluation of the toxicity of the plant extracts suggests their safety for animal consumption. *G. asiaticus* and *L. runcinata* contain diverse phytoconstituents that may contribute to their various pharmacological activities. This literature review serves as a foundational resource for phytochemical and pharmacological screening, affirming the safety of these plants for medicinal development. Researchers can leverage this information for further investigation and development of pharmaceutical interventions.

Keywords: *Gyrocarpus*, *Lactuca*, Antioxidant, Anticancer, Hepatoprotective.

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INTRODUCTION

The genus *Lactuca* is an integral component of human diets, primarily owing to the widespread consumption of lettuce. Beyond *Lactuca sativa* exists a rich assortment of *Lactuca* species, each with unique attributes and potential applications. Wild lettuce, scientifically identified as *Lactuca runcinata*, has an extensive traditional usage history in the context of medicinal applications. This section introduces the plant and its traditional applications, setting the stage for a detailed exploration of its pharmacological activities.[1] Its enigmatic botanical features characterize the genus *Gyrocarpus* and holds importance within the broader context of plant diversity. This section provides an introduction to *Gyrocarpus*, highlighting its taxonomic position, distribution, and general characteristics. *Gyrocarpus asiaticus* Willd, commonly known as the helicopter tree, holds significance in traditional medicine. This section introduces the plant, highlighting its traditional uses and setting the stage for a detailed exploration of its pharmacological activities.[2] The application of plants or their constituents in medical practices has been a tradition dating back to ancient times. The incorporation of phytomedicine to address diverse diseases is a vital component of the healthcare system. *G. asiaticus* Willd, belongs to the *Gyrocarpus* genus within the Magnoliopside class. *G.*

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Table 1: Medicinal properties of various *Lactuca* species

Species	*References*	*Activity*
L. sativa	Sayyah *et al*., (2004), Pepe *et al*., (2015), Adesso *et al*., (2016),	Anti-inflammatory
L. sativa var. *crispa*	Zekkori *et al*., (2018).	Antiinflammatory
L. sativa	Caldwell 2003, Altunkaya *et al*., (2009), Oh *et al*., (2011),	Antioxidant activity
L. tuberose	Stojakowska *et al*., (2013).	Antioxidant activity
L. indica	Choi *et al*., 2016.	Antioxidant activity
L. runcinata	Devi and Muthu 2014.	Antioxidant activity
L. serriola	Urmila *et al*., 2013.	Antioxidant activity
L. orientalis	Jaradat *et al*., 2017.	Antioxidant activity
L. sativa var *longifolia*	Edziri *et al*., 2011.	Antioxidant activity
L. sativa	Harsha and Anilakumar 2012.	Antianxiety
L. sativa	Ruiz-Lozano *et al*., (1996).	Superoxide dismutase activity
L. sativa	Gui *et al*., (2015).	Phytotoxic property
L. sativa	Harsha and Anilakumar 2012.	Anxiolytic property
L. indica	Lüthje *et al*., 2011.	Uroepithelial infection
L. indica	Kim *et al*., 2007.	Hepatoprotective activity
L. indica	Kim *et al*., 2007.	Anti-diabetic
L. scariola	Chadchan *et al*., 2016.	Anti-diabetic
L. scariola	Elsharkawy and Alshathly 2013.	Anticancer activity
L. sativa	Qin *et al*., 2018.	Anti-Tumor Potential
L. sativa	Gridling *et al*., 2010.	Anti-leukaemic effects
L. sativa var *longifolia*	Edziri *et al*., 2011.	Antiviral activity
L. sativa	Matvieieva *et al*., 2012.	Antiviral activity
L. scariola	Al-Marzoqi *et al*., 2015, Yadava and Jharbade 2007.	Anti-baAntibacterialty
L. orientalis	Jaradat *et al*., 2017	Anti-baAntibacterialty
L. sativa var *longifolia*	Edziri*et al*., 2011.	Anti-baAntibacterialty
L. sativa	Zdravkovic *et al*., 2012.	Anti-baAntibacterialty
L. indica	Olivia BK *et al*., 2021	Anti-baAntibacterialty
L. sativa	Edziri HA *et al*., 2011	Anti-baAntibacterialty
Ulva lactuca	KIM IH *et al*., 2007	Anti-baAntibacterialty
L. serriola	Al-Marzoqi AH *et al*., 2015	Antibacterial activity
L. runcinata DC	Kanthal LK *et al*., 2013	Anthelmintic activity
L. serriola	Awan AF *et al*., 2020	Hepatoprotective activity
L. sativa	Hefnawy HT *et al*., 2013	Hepatoprotective activity
L. sativa	Gopal SS *et al*.,2017	Anti-diabetic
L. indica	Hou CC *et al*., 2003	Anti-diabetic
L. sativa	Naseem S*et al*., 2022	Anti-diabetic
L. serriola	Chadchan KS *et al*., 2016	Antidiabetic activity
L. indica	Rosanto T *et al*., 2020	Anti-diabetic
L. steriolla	Elsharkawy E *et al*., 2013	Anticancer activity
U. lactuca	Arsianti A *et al*., 2009	Anticancer activity
L. virosa	Gharpure S *et al*.	Anticancer activity
U. lactuca	Khalil Mohamed AA *et al*., 2023	Anticancer activity
L. indica	Kim JN *et al*., 2012	Antioxidant activity
L. sativa	Adesso S *et al*., 2016	Antioxidant activity
L. indica	Wang SY *et al*. 2003	Antioxidant activity

asiaticus displays a range of pharmacological characteristics, encompassing antioxidant, anthelmintic, and anticancer effects[3]. *L. runcinata* DC, plant is extensively employed as a diuretic and for the treatment of persistent liver and intestinal blockages. *L. runcinata* DC is acknowledged for its nutritional content, comprising vital elements such as carbohydrates, proteins, fats, along with micronutrients like calcium, iron, and phosphorous. Chewing *L. runcinata* and betel leaf is an efficacious remedy for mouth and tongue blisters. The foundation of this investigation lies in a review of the literature, emphasizing the phytochemical composition and pharmacological properties of *G. asiaticus* Willd and *L.R* DC.[4]

Taxonomy and Morphological Diversity

Lactuca species exhibit diverse morphological features, including leaf shape, color, and growth habit. This section delves into the taxonomy of the genus, highlighting the key characteristics that differentiate various *Lactuca*s pecies.[5] Discussions on the evolution and genetic diversity within the genus shed light on the intricate relationships among different members. An in-depth examination of *Gyrocarpus* taxonomy and morphology is crucial for understanding the genus's evolutionary relationships and unique traits. This section explores the classification of *Gyrocarpus* species, emphasizing their distinctive leaf and flower structures, growth habits, and reproductive mechanisms.[6]

Medicinal Properties

Traditional medicine has often utilized certain *Lactuca* species for their medicinal properties. In this segment, the pharmacological features of *Lactuca* are examined, exploring the existence of bioactive substances like lactucin and lactucopicrin, along with their potential therapeutic benefits. The exploration of anti-inflammatory, analgesic, and sedative properties offers a glimpse into the pharmaceutical potential of *Lactuca* species. Lettuce is renowned for its low-calorie content and high levels of essential nutrients, making it a staple in salads and various culinary preparations. However, this section expands the discussion to encompass other *Lactuca* species, exploring their nutritional profiles and potential contributions to a balanced diet.[7] Comparative analyses of nutrient content among different species provide valuable insights into their potential health benefits. Certain *Gyrocarpus* species have been traditionally used in folk medicine, and this section provides an overview of their medicinal properties. The discussion may include anti-inflammatory, antimicrobial, or other therapeutic effects attributed to *Gyrocarpus* extracts. Insights into ongoing research and potential future developments in medicinal applications are also explored.[8] The medicinal properties of various *Lactuca* species are shown in Table 1, and the medicinal properties of various *Gyrocarpus* species are shown in Table 2.

Anti-inflammatory Activity

One of the prominent pharmacological activities associated with *L. runcinata* is its anti-inflammatory potential. This section reviews studies investigating the plant's efficacy in modulating inflammatory responses, including the exploration of bioactive compounds responsible for these effects. One of the key pharmacological activities associated with *G. asiaticus* is its anti-inflammatory potential. This section reviews studies investigating the plant's ability to modulate inflammatory responses, including the identification of bioactive compounds responsible for these effects.[9,10]

Antibacterial Activity

Lactuca potential as a source of antimicrobial agents is explored, considering studies that investigate its efficacy against bacteria, fungi, and other microorganisms. In 2021, Olivia BK and colleagues documented the antimicrobial efficacy of *Lactuca indica* against *Pseudomonas fuscovaginae* and *Escherichia coli*. The authors attributed the antimicrobial properties of *L. indica* to the existence of lactucin, a type of sesquiterpene lactone. They further established a direct correlation between the antimicrobial effectiveness of *L. indica* and the quantity of lactucin present in the plant.[11] In 2011, Edziri HA and collaborators documented the antimicrobial

Table 2: Medicinal properties of various *Gyrocarpus* species

Species	*References*	*Activity*
Gyrocarpus asiaticus Willd	Kanthal LK *et al*., 2013	Anthelmintic activity
G. asiaticus Willd	Yelchuri P *et al*., 2010	Anti-diabetic
G. americanus Jacq.	RI Sarkar *et al*., 2022	Analgesic activity
G. asiaticus Willd	Kanthal LA *et al*., 2014	Antibacterial
G. americanus	Bradacs G *et al*., 2010	Antimicrobial and antiprotozoal activities
G. jacquinii	Klausmeyer P *et al*., 2012	induction of C/EBPα activity
G. asiaticus Willd	Vithya T *et al*., 2013	Anticancer activity
G. asiaticus Willd	Vithya T *et al*.., 2012	Antioxidant activity
G. asiaticus Willd	Kanthal LK *et al*., 2017	Hepatoprotective activity
G. asiaticus Willd	Kanthal LK *et al*., 2014	Cytotoxic activity
G. jathrophifolius	Ruiz-Terán F *et al*., 2008	Antioxidant activity
G. asiaticus Willd	Satayanarayana S *et al*., 2020	Antioxidant activity
G. americanus	Sarkar RI *et al*., 2022	Analgesic activity

capabilities of *L. sativa*. They observed that methanolic and aqueous extracts demonstrated antimicrobial properties against gram-positive and gram-negative bacteria, displaying a MIC as low as 2.5 mg/mL. The methanolic and aqueous extracts also demonstrated significant antiviral efficacy, with 200 µg/mL IC_{50} value.[12] In 2007, KIM IH and colleagues documented the antimicrobial properties of *U. lactuca*. The author noted potent activity specifically targeting the bacterium methicillin-resistant *Staphylococcus aureus.*[13] In 2015, Al-Marzoqi AH and co-authors documented the antimicrobial efficacy of *L. serriola*. The author observed that terpenoids, alkaloids, and phenolic compounds exhibited antimicrobial activity against *S. aureus* and *S. saprophyticus*, with gram-positive bacteria proving susceptible to these bioactive constituents.[14] This section evaluates the plant's antimicrobial spectrum and mechanisms of action. *G. asiaticus* has shown promise as a source of antimicrobial and antifungal agents. This section examines studies evaluating the efficacy of the plant against bacteria, fungi, and other microorganisms, discussing potential applications in infectious disease management. In 2014, Kanthal LK and collaborators reported that the methanolic extract from GA Willd showed favorable results against *E. coli*, presenting the maximum zone of inhibition at 18.5 mm. The observed MIC was 0.039 mg/mL, and the MBC was measured at 0.16 mg/mL.[15] In 2010, Bradacs G and co-authors reported GA Jacq's effectiveness leaves against *Trypanosoma brucei* was noteworthy.[16]

Anthelmintic Activity

Specific and extensively documented information regarding the anthelmintic activity of *Lactuca* species is currently limited. Nevertheless, *Lactuca* species, commonly referred to as lettuce, have been the subject of studies exploring various bioactive compounds and potential health advantages. Certain plant compounds, including specific secondary metabolites, may demonstrate anthelmintic properties. Similarly, for *Gyrocarpus*, a genus of plants, specific research on its anthelmintic characteristics may not be as broadly documented as for more thoroughly researched plants. In 2013, Kanthal LK and colleagues documented the anthelmintic activity of the methanolic extract of *LR* DC and *GA* Willd. The results demonstrated noteworthy anthelmintic activity, substantiating the traditional use of both plants in comparison to the standard. The findings also suggested that *LR* DC demonstrated higher effectiveness when compared to *GA* Willd.[17]

Antioxidant Activity

The antioxidant capacity of *L. runcinata* is another critical aspect of its pharmacological profile. The review explores the plant's capacity to neutralize free radicals and provide protection against stress produced by oxidation, discussing implications for potential therapeutic applications in conditions associated with oxidative damage. The antioxidant capacity of *G. asiaticus* is another essential aspect of its pharmacological profile. The review explores the plant's ability to counteract oxidative stress, examining studies on free radical scavenging, lipid peroxidation, and other parameters associated with antioxidant activity.[17] In 2012, Kim JN and colleagues documented the antioxidant properties of *L. indica*. The authors noted that the leaf extract of *L. indica* contained elevated levels of antioxidant compounds, exhibiting superior antioxidant activity compared to the root extract. Specifically, the leaf extract demonstrated a polyphenol content of 42.8 mg/gm and a flavonoid content of 23.09 mg/gm, while the root extract showed lower levels with polyphenols at 7.66 mg/gm and flavonoids at 0.77 mg/gm.

Furthermore, the leaf extract displayed heightened DPPH and ABTS radical scavenging abilities across all extract concentrations compared to the root extract.[18] In 2016, Adesso S and collaborators documented the *L. sativa* shows antioxidative potential. The author observed that these extracts exhibited significant effectiveness in scavenging free radicals, showcasing noteworthy results.[19] In 2003, researcher Wang SY *et al*. documented the antioxidant properties of *L. indica*. The extract derived from *L. indica* demonstrated significant activity in scavenging free radicals.[20] In 2009, researcher Altunkaya A. *et al*. recorded that the lettuce extract shows synergistic antioxidative effects when combined with α-tocopherol, quercetin, or ascorbic acid. The lettuce extract distinctly demonstrated antioxidative effects, evident in the lag phase observed in the formation of conjugated dienes.[21] In 2020, Satayanarayana S documented the antioxidant properties of *G. asiaticus* Willd extract. The author noted that the presence of phytoconstituents such as saponins and flavonoids in the *G. asiaticus* Willd extract contributes to its antioxidant activity. Additionally, the author mentioned that the extract is associated with a relatively low range of side effects.[22]

Anticancer Activity

Research on the potential anticancer properties of *G. asiaticus* is explored in this section. The review covers studies investigating its effects on cancer cell lines, mechanisms of action, and implications for future cancer therapeutics. In 2013, Elsharkawy E *et al*. documented the anticancer properties of *L. steriolla*. The author substantiated the anticancer effects of a terpenoid compound isolated from terrestrial Saudi plants. The methanol extract of *L. steriolla*, was investigated for cytotoxic effects. A notably high cytotoxic activity against breast cancer is indicated for the methanolic extract of L. *steriolla.*[23] In 2009, Arsianti A *et al*. documented the anticancer properties of the seaweed *U. lactuca*. Concentrated extracts from *U. lactuca* exhibited positive outcomes for the presence of steroid metabolites, glycosides, flavonoids, and tannins. The researcher concluded that *U. lactuca* a potential agents for developing new agents against breast and colorectal cancers.[24] In 2022, Gharpure S *et al*. documented the anticancer properties of *L. virosa*. The author noted that ZnO nanoparticles derived from *L. virosa* demonstrated a lack of cytotoxicity when evaluated on HCT-116 cancer cells.[25] In 2023, Khalil Mohamed AA *et al*. recorded the anticancer effects of an ethanolic extract from *U. lactuca* on colorectal cancer cells. The *U. lactuca* extract exhibited anticancer activity. The author highlighted *U. lactuca* as a natural reservoir of polyunsaturated fatty acids, suggesting its potential to impede the proliferation of cancer cells through processes like apoptosis.[26] As of now, there is no recorded evidence of *Gyrocarpus* demonstrating anticancer activity.

Antidiabetic Activity

Numerous research has explored the potential of plants for their antidiabetic properties, and some have shown promising results in various studies. It's important to note that while some plants may exhibit antidiabetic activity, they should not be considered as a replacement for conventional medical treatments. Always consult a healthcare professional before incorporating new plant-based remedies into your diabetes management plan. The antidiabetic properties of *G. asiaticus* are attributed to certain bioactive compounds found in the plant. However, it's important to note that research on *G. asiaticus* and its effects on diabetes is still in its early stages, and additional research is required to ascertain its effectiveness and safety for this intent. *Lactuca* is a genus of plants that includes lettuce, and some species within this genus have been studied for potential antidiabetic effects. However, it's essential to note that research on the antidiabetic properties of *Lactuca* is limited, and further investigations are necessary to confirm its effectiveness and safety for this particular objective. Some studies have explored the potential hypoglycemic (blood sugar-lowering) activity of certain *Lactuca* species. These studies often involve laboratory experiments and animal models to assess the impact of plant extracts on glucose metabolism. In 2017, Gopal SS and colleagues conducted research revealing the antidiabetics of *L. sativa*. The study highlighted lactucaxanthin, a compound in *L. sativa*, as responsible for antidiabetic. The research also involved an *in-silico* analysis of the interaction between lactucaxanthin and these enzymes, and its inhibitory effects were further investigated using both *in-vitro* assays and diabetic rat models induced by streptozotocin (STZ).[27] Hou CC and colleagues at the year 2003 documented the antidiabetic properties of *L. indica*. The study highlighted that, among these compounds, both lactucain C and lactucaside demonstrated notable effects in managing diabetes.[28] Naseem S and colleagues at the year 2022 state that *L. sativa* is a consumable plant frequently employed by local communities for the purpose of diabetes management.[29] In 2016, Chadchan KS and colleagues proposed that the leaves of *L. serriola* could serve as an alternative to synthetic drugs for treating individuals with diabetes. The author noted that the extract prepared by aqueous media of these leaves substantially lowered glucose concentration. Whether administered acutely or over an extended period, supplementation with *L. serriola* leaves demonstrated improved in antidiabetic activity[30].In 2020, Rosanto T and colleagues conducted a study examining the antidiabetic activity of *L. indica* (L.). The author presented findings indicating the antidiabetic efficacy of *L. indica* leaves, supported by the presence of various chemical constituents. The most notable effect observed was the significant reduction in blood glucose levels in mice induced with streptozotocin.[31] However, in the case of *Gyrocarpus*, only a limited number of instances have been documented regarding its antidiabetic properties. In 2014, Yelchuri P and colleagues reported on the antidiabetic activity of ethanolic extracts derived from using *G. asiaticus* Willd bark to address diabetes induced by streptozotocin in rats. The author emphasized that *G. asiaticus* Willd contains notable quantities of alkaloids, flavonoids, saponins, carbohydrates, and phytosterols. The study revealed a substantial decrease in heightened blood glucose levels was observed within 30 minutes following the application of ethanolic extracts from *G. asiaticus* Willd.[32]

Hepatoprotective Activity

Detailed information on the hepatoprotective activity of *Lactuca* and *Gyrocarpus* species is scarce. However, certain studies have investigated the possible hepatoprotective effects of specific compounds found in plants, including those present in *Lactuca* and *Gyrocarpus*. Hepatoprotective activity is a substance's ability to protect the liver from damage and support its normal functioning. In 2020, Awan AF and colleagues documented the hepatoprotective properties of *L. serriola* in cases of hepatotoxicity induced by paracetamol.[33] In 2013, Hefnawy HT and colleagues recorded the hepatoprotective effects of an extract prepared from methanol of *L. sativa* against oxidative damage induced by carbon tetrachloride in rats. The researchers concluded that the application of lettuce extract improves the antioxidant defense mechanism against toxicity induced by CCl_4. The findings provide evidence suggesting a potential therapeutic role for lettuce extract in conditions associated with free radical-mediated diseases.[34,35] In 2019, Baisakhi Moharana and colleagues documented the hepatoprotective action of the aqueous extract of *G. asiaticus*. The researchers observed a significant increase in ALT levels in the induced group, and in comparison to the group with paracetamol-induced toxicity, the group treated with *G. asiaticus* exhibited a notable decrease in ALT levels, a result further confirmed through histopathological analysis.[35-41]

CONCLUSION

This comprehensive review underscores the importance of *Lactuca* species beyond the familiar lettuce found in salads. By exploring their taxonomy, nutritional content, medicinal properties, and potential applications in agriculture and the environment, we gain a deeper appreciation for the diversity and versatility of this plant genus. As we continue to unlock the secrets of *Lactuca*, the possibilities for its utilization in various domains are vast and promising. *L. runcinata* emerges as a promising candidate in the realm of pharmacology, exhibiting a spectrum of activities with potential therapeutic implications. As research on this plant advances, a deeper understanding of its pharmacological profile will contribute to the development of novel therapeutics and wellness interventions. In conclusion, *Gyrocarpus* stands as a fascinating genus with unique botanical features and diverse potential applications. By unraveling the mysteries surrounding its taxonomy, morphology, ecological roles, and phytochemical composition, we pave the way for a deeper understanding of *Gyrocarpus* and its contributions to various scientific disciplines. As research continues, the future holds exciting possibilities for harnessing the untapped potential of *Gyrocarpus* for the benefit of humanity and the environment. *G. asiaticus* Willd emerges as a botanical species with diverse pharmacological activities, holding promise for various therapeutic applications. This review acts as an exhaustive reference for researchers and healthcare professionals keen on exploring the pharmacological potential of *G. asiaticus* Willd. Upon reviewing the present work, it can be deduced that the study provides a comprehensive overview of the chemical composition and pharmacological attributes of *G. asiaticus* Willd and *L. runcinata* DC. Both plants have been traditionally utilized in treating various ailments and have demonstrated diverse therapeutic properties. However, it is noteworthy that the antidiabetic of *L. runcinata* and the hypolipidaemic activity of *G. asiaticus* have not been thoroughly explored. Future research endeavors should prioritize investigating other pharmacological activities, utilizing various plant parts and solvents, to broaden the understanding of the therapeutic potential of *L. runcinata* DC and *G. asiaticus* Willd for the treatment of different diseases.

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