Rec. Pharm. Biomed. Sci. 7 (2), 1-7, 2023

REVIEW ARTICLE

RECORDS OF PHARMACEUTICAL AND BIOMEDICAL SCIENCES

A Review on Biological Activities of Different Parts of *Cynara scolymus* L.

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Received on: 05. 11. 2022

Revised on: 27. 11. 2022

Accepted on: 03. 12. 2022

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Abstract

Biologically active materials have always been abundant in nature. The discovery of natural remedies can come from a variety of sources, including microorganisms, terrestrial plants, terrestrial invertebrates and vertebrates, and saltwater macro- and microorganisms. Historically, investigations on drug development have identified medicinal plants as a valuable source of bioactive chemicals. With 1900 genera and 32,000 species, including trees, shrubs, and herbs, the Asteraceae family is varied. Plants from the Asteraceae family are frequently utilized in traditional medicine as remedies. As antibacterial, anticholesterolemic, anti-cancer, antioxidant, and anti-inflammatory agents, they have been utilized to treat a variety of ailments. Therefore, several phytochemical studies were conducted to screen these genus plants, and this research identified several chemical compounds from diverse chemical classes, including fatty acids, flavonoids, triterpenes, sesquiterpene glycosides, phenolic acids, and sesquiterpene lactones. The most relevant prior biological research of several species in the genus *Cynara scolymus* L. are included in this study.

Keywords: *Cynara scolymus L.*, biological activities

1. Introduction:

Globally, medicinal plants are widely used for prevention or treatment of many illnesses with minimal or no side effects. Curing with herbal medicine is back to prehistoric times (**Farràs, 2021**) and it is expressed about 90% of traditional therapies (**Sofowora et al., 2013**). So, many scientific papers were oriented to illustrate how these plants undergo their pharmacological effects. Previous studies involved the green medicine as a crude extract of whole plant (**Elhady et al., 2022, Eltamany et al., 2022**), an extract of certain parts (**Goda et al., 2022, Duan et al., 2020**), purified natural compounds (**Elhady et al., 2022, Habib et al., 2022**) or isolated certain bioactive fractions such as polyphenols, essential oils, saponins, alkaloids & polysaccharides (**Micale et al., 2020, Selim et al., 2022**). Previous study reported the ability of C. scolymus L. to reduce fasting blood glucose level, A1C-derived average glucose (ADAG), and homeostatic model assessment (HOMA), that assess β-cell function and insulin resistance, in prediabetic patients (**Rondanelli et al., 2013**). Fallah Huseini and his coworkers proved the antihyperlipidemic effect of *C. scolymus* L. via reduction in total cholesterol level, and low-density lipoprotein (LDL) (**Fallah et al., 2012**). All these findings were pertained to the existed polyphenolic compounds. Polyphenolic compounds exhibited a crucial impact in treatment of cancer (**Farrag et al., 2022**). This review will include the most significant previous biological studies of different parts of *C. scolymus* L.

2. Biological activities reported for *Cynara scolymus L.*

Table 1: Biological activities reported for *Cynara scolymus* L.

Part used and/or extract	Method	Dose/Conc. and duration	Results and pharmacological effect	References
I- Antioxidant activity				
Fully matured leaves	DPPH free radical scavenging activity.	-	Results of the analysis indicated that overall, the leaves contained the highest concentration of total phenols. The antioxidant action was correlated to total phenolic content.	**(Randhir et al., 2004)**
The edible artichoke heads	DPPH free radical scavenging activity.	-	The edible artichoke heads contained a significantly lower amount of phenols inside for dried mature heads. Different drying methods (oven-drying at 70 °C vs freeze-drying) were found to have no significant effect on the total phenol contents of the artichoke samples harvested on two different dates.	**(Wang et al. 2003)**
Leaves, receptacles, bracts and roots	DPPH (RSA) free radical scavenging activity.	-	Indi-cates that all samples tested have noticeable effect on DPPH radical. The demonstrated high antioxidant activity in the edible receptacles and bracts are attributed to higher contents of phenolic constituents since a direct proportional association was observed between total phenolic content and activity.	**(El Sayed et al. 2018)**
The artichoke flower	DDPH ABTS Radical Scavenging Activity. Iron (II) Chelating Activity	-	Hydrolysis time significantly affected the antioxidant activity of ovalbumin hydrolysates with *C. scolymus* L. against the ABTS radical (p 0.01), producing a decline in the IC50 value and, concurrently, a rise in the TEAC, indicating a higher antioxidant power of the hydrolysates. Regarding the effect of the hydrolysis time in the iron chelating activity of the TH, no significant differences were	**(Bueno-Gavilá et al. 2021)**

			observed.	
Floral stem	DPPH, ABTS, and FRAP in vitro assays	-	showed strong free radical scavenging activity against DPPH and ABTS radicals. Methanol extract was the most effective radical scavengers	**(Mejri et al. 2020)**
II- Antimicrobial activity				
The artichoke flower	The bacterial species studied were Enterococcus faecalis (NCIMB 775), Escherichia coli (NCIMB 9484), Listeria innocua (CCUG 15531), and Pseudomonas fluorescens (NCIMB 9046).	-	Only a statistically significant inhibitory effect was observed ($p \leq 0.05$) for the growth rate of E. faecalis. There was no antimicrobial effect of the hydrolysates against the Gram-positive microorganisms tested.	**(Bueno-Gavilá et al. 2021)**
Floral stem	The disc diffusion method	Dispensing 100 µL of inoculum suspension 108 CFU/mL**.** Sterile filter paper discs (6 mm in diameter) were soaked with 15 µL of sample extract (1 mg/mL)	Methanol extract was the most effective against all test microorganisms with the effect being more pronounced against gram+ bacteria. The strains S. aureus and E. faecum were the most sensitive. The gram− bacterial strains E. coli and S. typhimurium**,** and the yeast C. albicans were resistant to all AFS extracts.	**(Mejri et al. 2020)**
Leaves	The disk diffusion method	Disks (6.0 mm in diameter) impregnated with 0.025ml of each extract at a concentration of 10.0 mg/ mL were placed on the inoculated plates.	The n-butanol fraction exhibited the most significant antimicrobial activities against all of the tested microorganisms, followed by chloroform and ethyl acetate fractions.	**(Zhu et al. 2004)**
Floral stem	alloxan-diabetic mice	AFS extract (250 mg/kg b.w)	These observations indicate that AFSE ameliorated diabetes, presumably through enhanced insulin production and/or secretion, and its cellular sensitivity as well as	**(Mejri et al. 2020)**

			improved glucose tolerance.	
Artichoke leaves, bracts, flower and floral stem	Thirty type 2 diabetic individuals of both sexes in the age group of 35-45 years, who were not on insulin therapy	4 globe artichoke wheat biscuits containing 6grams of globe artichoke powder and distributed for each individual daily [morning (2) and evening (2)]	A positive impact of globe artichoke in the reduction of fasting and post prandial blood glucose level.	**(Nazni et al. 2006)**
Leaves aqueous extracts	Stz-induced diabetic Male Wistar rats	200 to 400 mg/kg/day, p.o.) 5 days after STZ treatment for 21 days.	Aqueous extract showed a significant antidiabetic effect and improved the lipid profile of diabetic mice.	**(Heidarian and Soofiniya 2011)**
Flowering head	Adult male Wistar with a regimen of unlimited access to regular rodent chow	By a metal gavage at an infusion volume of 4 mL/kg, 30 min, Intragastrical	*Cynara scolymus L.* flowering head extract produced a marked decrease in glycemia	**(Fantini et al. 2011)**
IV- anti-inflammatory activity				
Floral stem	inhibition of protein (Albumin) denaturation assay	1 mL of sample extract (1 mg/mL)	Results showed that EtoAc extract displayed the highest (98%) inhibitory effect, whereas methanol extract exhibited the lowest (69.5%) effect. The capacity of AFS extract to inhibit heat-induced albumin denaturation reflects its possible anti-inflammatory effect in vitro.	**(Mejri et al. 2020).**
VI- Hepatoprotective, hypocholesterolimic and hypolipidemic activities				
leaves, receptacles, bracts and roots	CCl4 induced hepatotoxicity in Wistar albino rats	500, 900 mg/kg/day were compared with silymarin at a dose of 500 mg/kg/day.	Activities At a dose of 500 mg/kg/day, the receptacle extract is the most effective extract as hepatoprotective and hypolipidemic agent, comparable to silymarin at the same dose.	**(El Sayed et al. 2018).**
Floral stem	alloxan-treated mice	Mice treated with AFS extract (250 mg/kg b.w)	AFSE has potential to lower lipid profile and prevent the development of atherosclerosis and cardiovascular complications in diabetic animals.	**(Mejri et al. 2020).**

VII- Anti-spasmodic activity				
Fully matured leaves	Guinea-Pig Ileum	dichloromethane and ethyl acetate extract (0.1—2.0 mg/ml)	A significant inhibitory effect for the contractile response elicited by acetylcholine on guinea-pig ileum.	**(Emendörfer et al. 2005).**
VIII- Cytotoxic activity				
The edible part (head) of fresh artichoke	breast cancer cell line, MDA-MB231	concentrations of AEs (from200 to 800 μM for 24h)	High doses of polyphenolic extracts (AEs) are able to activate an apoptotic program in MDA-MB231 to halt tumor progression.	**(Mileo et al. 2015).**
The edible parts (receptacles with inner and intermediate bracts) and leaves	Cell cytotoxicity assay on human carcinoma cells MSTO-211H, MPP-89 and NCI-H28 mesothelioma cell lines	Concentrations (ranging from 3 to 200 µg/ml)	*Cynara scolymus* L. affects malignant pleural mesothelioma by promoting apoptosis and restraining invasion	**(Pulito et al. 2015).**
The flower	Prostate cancer cell line, PC-3	concentrations of AE (0.1, 1, 10, and 100 µg/ml)	large doses of *Cynara scolymus L.* extracts can promote an apoptotic program in PC-3 to stop tumor progression.	**(Khedr et al., 2022)**

3. Conclusion

In this review we have discussed the biological activities reported in various parts belonging to *Cynara scolymus* L. It is obvious that this genus is a rich source of compounds with wide range of biological activities.

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