



Review Article

Chemical review on *Cynara scolymus* L.

Abdelaziz F. S. Farrag^{1*}, Reda F.A. Abdelhameed², Jihan M. Badr², Amgad I. M. Khedr¹

¹ Department of Pharmacognosy, Faculty of Pharmacy, Port Said University, Port Said, 42526.

² Department of Pharmacognosy, Faculty of Pharmacy, Suez Canal University, Ismailia, 41522.

*Correspondence: Abdelaziz Farrag zezofraj28@gmail.com Abdel_Aziz.farag@pharm.psu.edu.eg, Tel. 01021077222

ARTICLE INFO

Article history :

Received 2 March 2023

Received in revised form

2 April 2023

Accepted 2 April 2023

Available online 2 April 2023

Keywords: *Cynara scolymus* L., phenolic compounds, flavonoids, sesquiterpene glycosides.

© 2023 by the authors; licensee Port Said University,



Egypt. This article is an open access article distributed under the terms and conditions of the Creative Commons by Attribution (CC-BY) license

(<http://creativecommons.org/licenses/by/4.0/>).

ABSTRACT

Nature has always contained a plenty of biologically active substances in nature. The Asteraceae family is diverse, with 1900 genera and 32,000 species of plants, including trees, shrubs, and herbs. Asteraceae plants are commonly used as treatments in traditional medicine. They have been used to treat a range of illnesses as antibacterial, anticholesterolemic, anti-cancer, antioxidant, and anti-inflammatory medicines. The artichoke, or *Cynara scolymus* L., is a classic vegetable in many cultures. This plant has recently been successfully grown in Egypt. The purpose of this research is to fully understand the phytochemical composition of *C. scolymus* L. The finding shows that plant parts include bioactive components such as flavonoids, total phenolic compounds, saponins, sesquiterpene glycosides and fatty acids. These phytochemicals' existence is connected to this plant's potential as a medicine. Such review affords plenary inspection of the total secondary metabolites isolated from the *Cynara scolymus* L. until now, besides their parts of the plant.

1. Introduction:

A perennial member of the Compositae family, *Cynara scolymus* L. can reach heights of 1.5 to 2 meters. An edible bud with many triangular scales and a diameter of 8 to 15 cm gives rise to a substantial head of blooms. For their choleric and hepatoprotective properties, *C. scolymus* head and leaf extracts have been used in folk medicine for a long time. They are primarily used to improve liver function and treat chronic liver and gall bladder diseases, jaundice, hepatitis, arteriosclerosis,

and symptoms of diabetes, which are frequently linked to the cynarin content [1-2]. They are also used as functional food preparations. Mono- and dicaffeoylquinic acids are also said to possess these medicinal qualities [1-3]. The leaves of *C. scolymus* contain up to 2% phenolic acids, primarily chlorogenic acid, cynarin, and caffeic acid; 0.4% bitter sesquiterpene lactones, of which 47-83% is cynaropicrin; grosheimin; and 0.1-1% flavonoids like luteolin, including the glycosides known as luteolin-7-O-rutinoside

(scolymoside), luteolin-7-O- Studies on the effects of *C. scoly mus* leaf extract have demonstrated its capacity to decrease cholesterol production and LDL oxidation as well as have antioxidative, antibacterial, anti-HIV, bile expelling, hepatoprotective, urinate, and choleric action [2, 4]. Even though the extract has been used for medical purposes for a long time, little research has been done on it as an antibacterial agent. Fresh, canned, or frozen vegetables may all be made from *C. scoly mus* [5]. Due to its high number of polyphenols and inulin, this plant has historically been employed in folk medicine since the time of the Romans [5, 6]. Due to their role in cancer prevention, these chemicals are crucial for human nutrition [7]. It is the most abundant source of dietary antioxidants among commonly grown food plants [8], making it a potential candidate for use 4. in phytopharmaceutical products [5, 9]. The current review concentrates on the chemical structures of the isolated compounds from *Cynara scoly mus* L., beside their parts of the plant.

2. Chemical composition reported in *Cynara scoly mus* L.

Results of contents of stem, bract, flower and root of artichoke (cultivar balady) growing in Egypt. Components detected in artichoke extracts (roots, stem, flower head and bracts) using HPLC-DAD-ESI-MS. As mentioned in **Table 1**.

2.1. Phenolic acids

3. 2.2. Flavonoids

Components detected in artichoke extracts (roots, bracts, flowers, and leaves) using HPLC-DAD-ESI-MS. As mentioned in **Table 2**.

2.3. Sesquiterpene glycosides

Components detected in artichoke extracts (roots, bracts, flowers and leaves) using HPLC-DAD-ESI-MS. As mentioned in Error! Reference source not found.3.

2.4. Sesquiterpene lactones

Components detected in artichoke extracts (roots, bracts, flowers and leaves) using HPLC-DAD-ESI-MS. As mentioned in **Table 4**.

2.5. Triterpene saponins

Components detected in artichoke extracts (roots, bracts, flowers, and leaves) using HPLC-DAD-ESI-MS. As mentioned in **Table 5**.

2.6. Fatty acids

Components detected in artichoke extracts (roots, bracts, flowers, and leaves) using HPLC-DAD-ESI-MS. As mentioned in Error! Reference source not found.6.

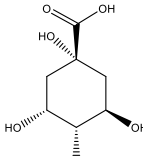
Conclusion

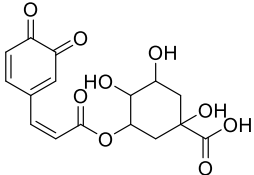
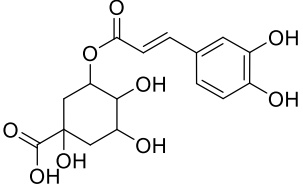
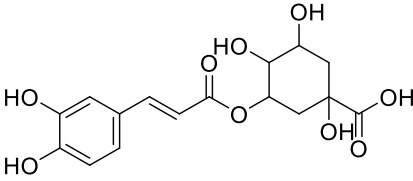
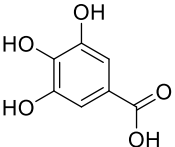
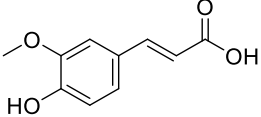
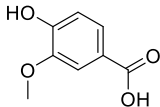
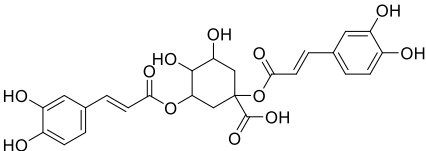
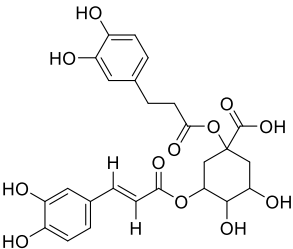
According to the results of the current study, *C. scoly mus* plant parts contain significant amounts of total phenols, saponins, flavonoids, proteins, and vitamin C, along with other phytochemicals. These phytochemicals can be utilized as an external medicinal supplement and have a variety of bioactive qualities. The various phytochemicals found in the leaf of *C. scoly mus* are now being identified and isolated, and their antioxidant and anti-cancer properties are being investigated. To better *C. scoly mus* cultivation and future commercialization in Egypt, it is crucial to characterize it.

Conflict of Interest

The authors declare and state that this research was conducted in the absence of any potential or source for conflict of interest.

Table 1: List of phenolic compounds isolated and identified in *C. scoly mus*

Name	Structure	Source	References
Quinic acid		Flower head, bracts, stem and roots	[9-10]

Chlorogenoquinone		Flower head, bracts, stem and roots	[9-10]
Chlorogenic acid		Flower head, bracts, stem and roots	[9-10-11]
Neochlorogenic acids		Flower head, bracts, stem and roots	[10-12]
Gallic acid		Flower head, bracts, stem and roots	[10-11]
Ferulic acid		Flower head, bracts and floral stem	[13]
Vanillic acid		Flower head, bracts and floral stem	[13]
1,3-Di-O-caffeoylquinic acid (cynarin)		Flower head, bracts, stem and roots	[10-11]
1,5-Dicaffeoylquinic acid		Flower head and leaves	[10-14]

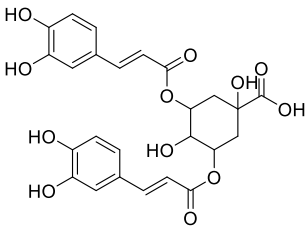
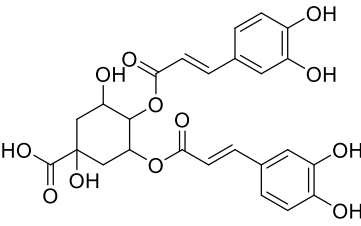
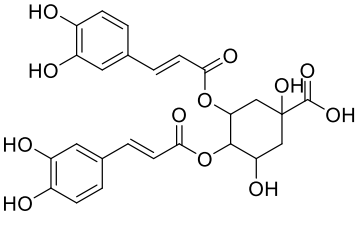
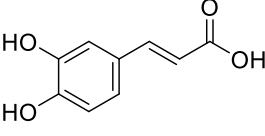
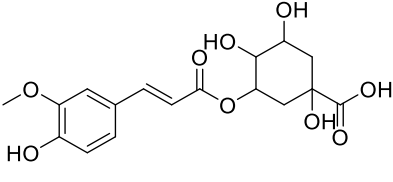
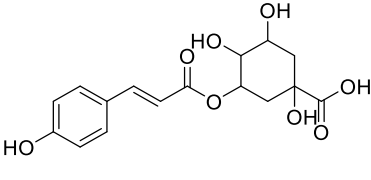
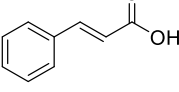
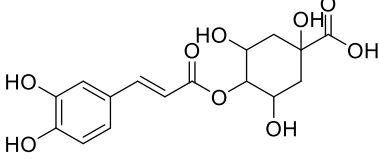
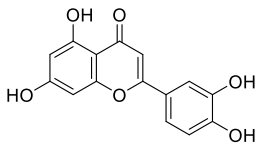
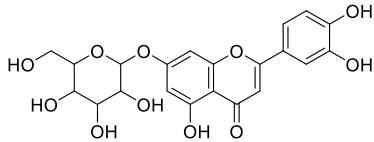
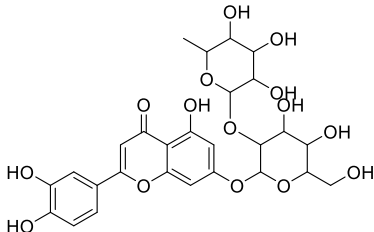
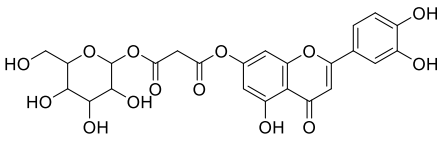
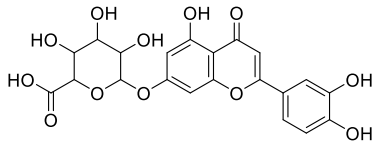
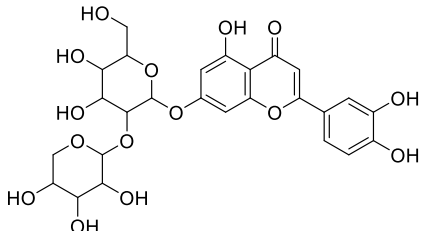
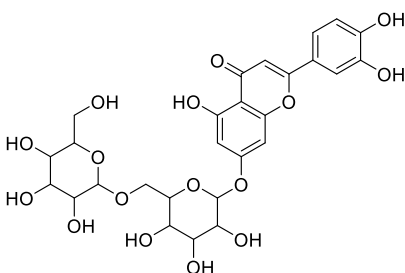
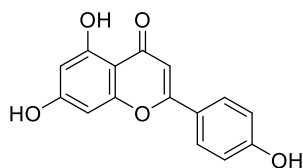
3,5-Di-O-caffeoylquinic Acid		Bracts and stem	[10-15]
4,5-Di-O-caffeoylquinic acid		Bracts and stem	[15]
3,4-Dicafeoylquinic acid		Bracts, flower head and floral stem	[16-17]
Caffeic acid		Flower head, bracts, floral stem	[9-13]
3-O-Feruloylquinic acid		Bracts	[10]
<i>p</i> -Coumaroylquinic acid		Bracts	[10]
Cinnamic acid		Flower head, bracts, stem and roots	[9]
4-O-Caffeoylquinic acid		Bracts, floral stem	[10-17]

Table 2: List of flavanoids isolated and identified in *C. scolymus*

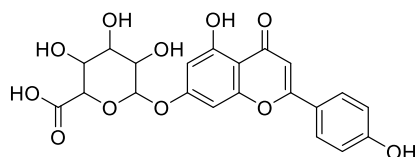
Name	Structure	Source	References
Luteolin		Flower head, bracts, stem and roots	[9-18]
Luteolin-7-O-glycoside (cynaroside)		Flower head, bracts, stem and roots	[10-18]
Luteolin-7-O-rutinoside (scolymoside)		Flower head, bracts, stem and roo	[9-10-18]
Luteolin 7-O-malonyl- glucoside		Bracts	[19]
Luteolin-7-O- glucuronide		Bracts, flower head and floral stem	[19]
Luteolin- neohesperido-side		Floral stem	[19]
Luteolin-7- gentiobioside		Bracts	[20]

Apigenin



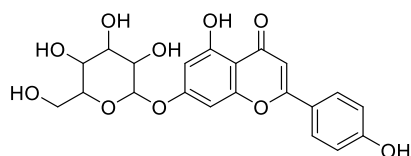
Flower head, bracts,
stem and roots [9-10-18]

Apigenin-7-O-glucuronide



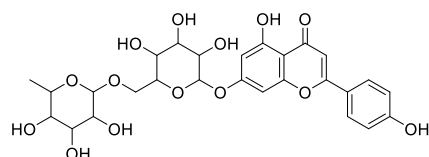
Bracts, floral stem [19]

Apigenin-7-O-glucoside



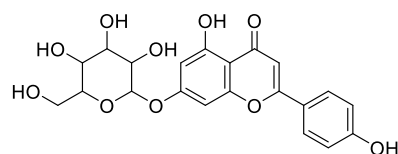
Flower head, bracts,
floral stem and roots [21]

Apigenin-7-O-rutinoside



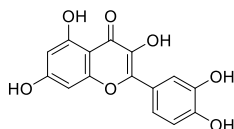
Bracts [15-22]

Apigenin-7-O-D-glucopyranoside



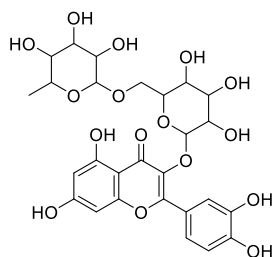
Bracts [15]

Quercetin



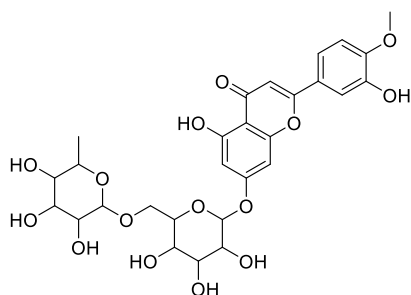
Bracts [20-23]

Rutin



Bracts [20-21]

Hesperidin



Bracts [20-24]

Table 3: List of sesquiterpene glycosides isolated and identified in *C. scolymus*

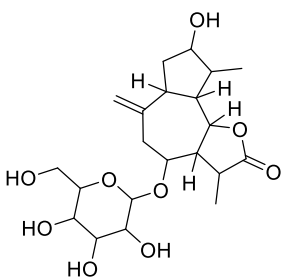
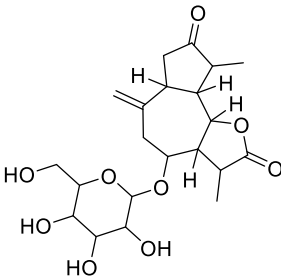
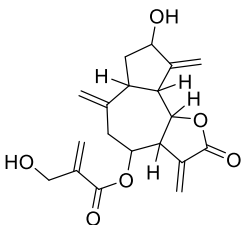
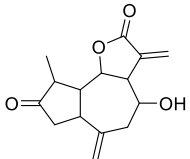
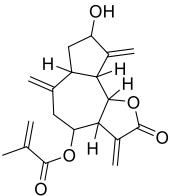
Name	Structure	Source	References
Cynarascoloside A		Flower head, bracts, floral stem and roots	[9-14]
Cynarascoloside C		Flower head, bracts, floral stem and roots	[14-18]

Table 4: List of sesquiterpene lactones isolated and identified in *C. scolymus*

Name	Structure	Source	References
Cynaropicrin		Bracts	[9-10]
Grossheimin		Flower head, bracts, floral stem and roots	[9-10-14]
Aguerin B		Bracts	[14]

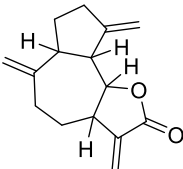
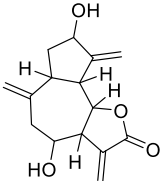
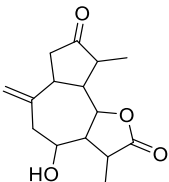
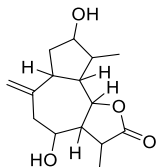
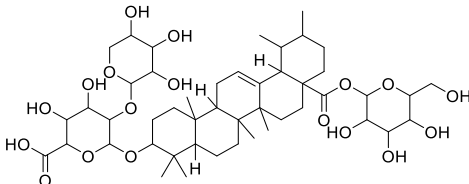
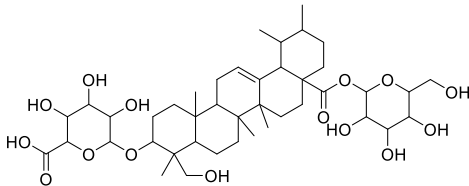
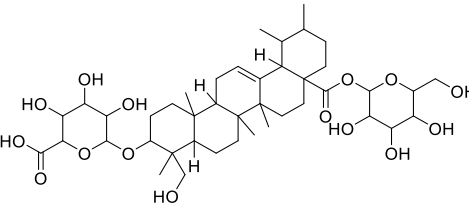
Dehydrocostus lactone		Bracts	[14]
11,13-Dihydrodesacylcynaropicrin		Bracts	[14]
Isoamberboin		Bracts	[14]
Isolipidiol		Bracts	[14]

Table 5: List of triterpene saponins isolated and identified in *C. scolymus*.

Name	Structure	Source	References
Cynarasaponin A		Bracts	[9-10]
Cynarasaponin E		Bracts	[9-10]
Cynarasaponin C		Bracts	[9-10]

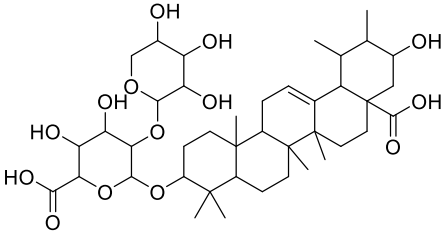
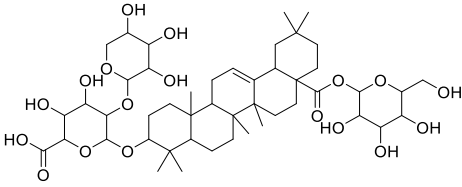
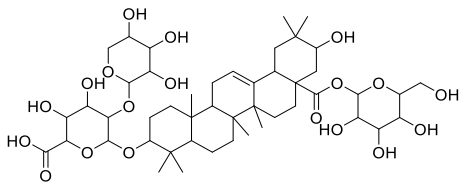
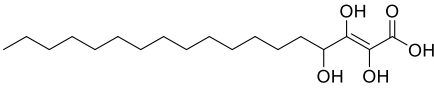
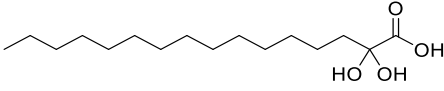
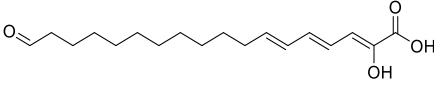
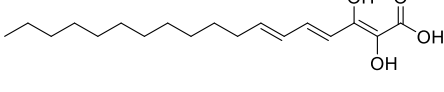
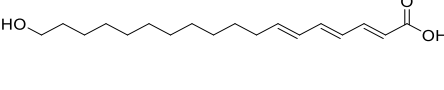
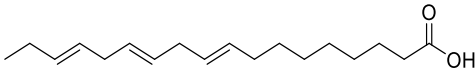
Cynarasaponin F		Bracts	[9-10]
Cynarasaponin H		Bracts	[9-10]
Cynarasaponin J		Bracts	[9-10]

Table 6: List of amino and fatty acids isolated and identified in *C. scolymus*

Name	Structure	Source	References
Trihydroxy-octadecenoic acid		In all but the highest conc. In roots	[9-10]
Dihydroxy hexadecanoic acid		In all but the highest conc. In roots	[9-10]
Hydroxy-oxo-octadecatrienoic acid		In all but the highest conc. In roots	[9-10]
Dihydroxy-octadecatrienoic acid		In all but the highest conc. In roots	[9-10]
Hydroxy-octadecatrienoic acid		In all but the highest conc. In roots	[9-10]
9,12,15-Octadecatrienoic acid (linolenic acid)		In all parts	[9-10]

References

- [1] Speroni E, Cervellati R, Govoni P, Guizzardi S, Renzulli C, Guerra MC. Efficacy of different *Cynara scolymus* preparations on liver complaints. Journal of ethnopharmacology. 2003 Jun 1;86(2-3):203-11.

- [2] Wang M, Simon JE, Aviles IF, He K, Zheng QY, Tadmor Y. Analysis of antioxidative phenolic compounds in artichoke (*Cynara scolymus* L.). Journal of agricultural and Food Chemistry. 2003 Jan 29;51(3):601-8.
- [3] Nateghi R, Samadi F, Ganji F, Zerehdaran S. Hepatoprotective effects of *Cynara scolymus* L. extract on CCl₄ induced liver injury in broiler chickens. International Journal of AgriScience. 2013;3(9):678-88.
- [4] Llorach R, Espin JC, Tomas-Barberan FA, Ferreres F. Artichoke (*Cynara scolymus* L.) byproducts as a potential source of health-promoting antioxidant phenolics. Journal of agricultural and food chemistry. 2002 Jun 5;50(12):3458-64.
- [5] Lattanzio V, Kroon PA, Linsalata V, Cardinali A. Globe artichoke: A functional food and source of nutraceutical ingredients. Journal of functional foods. 2009 Apr 1;1(2):131-44.
- [6] Pandino G, Lombardo S, Mauromicale G, Williamson G. Profile of polyphenols and phenolic acids in bracts and receptacles of globe artichoke (*Cynara cardunculus* var. *scolymus*) germplasm. Journal of food composition and analysis. 2011 Mar 1;24(2):148-53.
- [7] Clifford M, Brown JE. Dietary flavonoids and health-broadening the perspective. Flavonoids: Chemistry, biochemistry and applications. 2006:319-70.
- [8] Brown JE, Rice-Evans CA. Luteolin-rich artichoke extract protects low density lipoprotein from oxidation in vitro. Free radical research. 1998 Jan 1;29(3):247-55.
- [9] El Sayed AM, Hussein R, Motaal AA, Fouad MA, Aziz MA, El-Sayed A. Artichoke edible parts are hepatoprotective as commercial leaf preparation. Revista Brasileira de Farmacognosia. 2018 Apr; 28:165-78.
- [10] Farag MA, El-Ahmady SH, Elian FS, Wessjohann LA. Metabolomics driven analysis of artichoke leaf and its commercial products via UHPLC-q-TOF-MS and chemometrics. Phytochemistry. 2013 Nov 1;95:177-87.
- [11] Khedr AI, Farrag AF, Nasr AM, Swidan SA, Nafie MS, Abdel-Kader MS, Goda MS, Badr JM, Abdelhameed RF. Comparative Estimation of the Cytotoxic Activity of Different Parts of *Cynara scolymus* L.: Crude Extracts versus Green Synthesized Silver Nanoparticles with Apoptotic Investigation. Pharmaceutics. 2022 Oct 13;14(10):2185.
- [12] Sánchez-Rabaneda F, Jauregui O, Lamuela-Raventos RM, Bastida J, Viladomat F, Codina C. Identification of phenolic compounds in artichoke waste by high-performance liquid chromatography-tandem mass spectrometry. Journal of Chromatography A. 2003 Aug 1;1008(1):57-72.
- [13] Lattanzio V, van Sumere CF. Changes in phenolic compounds during the development and cold storage of artichoke (*Cynara scolymus* L.) heads. Food Chemistry. 1987 Jan 1;24(1):37-50.
- [14] Shimoda H, Ninomiya K, Nishida N, Yoshino T, Morikawa T, Matsuda H, Yoshikawa M. Anti-hyperlipidemic sesquiterpenes and new sesquiterpene glycosides from the leaves of artichoke (*Cynara scolymus* L.): structure requirement and mode of action. Bioorganic & medicinal chemistry letters. 2003 Jan 20;13(2):223-8.
- [15] Zhu X, Zhang H, Lo R. Phenolic compounds from the leaf extract of artichoke (*Cynara scolymus* L.) and their antimicrobial activities. Journal of agricultural and food chemistry. 2004 Dec 1;52(24):7272-8.
- [16] Shen Q, Dai Z, Lu Y. Rapid determination of caffeoylquinic acid derivatives in *Cynara scolymus* L. by ultra-fast liquid chromatography/tandem mass spectrometry based on a fused core C18 column. Journal of separation science. 2010 Oct;33(20):3152-8.
- [17] Mejri F, Baati T, Martins A, Selmi S, Serralheiro ML, Falé PL, Rauter A, Casabianca H, Hosni K. Phytochemical analysis and in vitro and in vivo evaluation of biological activities of artichoke (*Cynara scolymus* L.) floral stems: Towards the valorization of food by-products. Food Chemistry. 2020 Dec 15;333:127506.
- [18] Schütz K, Persike M, Carle R, Schieber A. Characterization and quantification of anthocyanins in selected artichoke (*Cynara scolymus* L.) cultivars by HPLC-DAD-ESI-MS n. Analytical and bioanalytical chemistry. 2006 Apr;384:1511-7.
- [19] Romani A, Pinelli P, Cantini C, Cimato A, Heimler D. Characterization of Violetto di Toscana, a typical Italian variety of artichoke (*Cynara scolymus* L.). Food Chemistry. 2006 Mar 1;95(2):221-5.
- [20] Hinou J, Harvala C, Philianos S. Polyphenolic substances of *Cynara scolymus* L. leaves. In Annales Pharmaceutiques Francaises 1989 Jan 1 (Vol. 47, No. 2, pp. 95-98).
- [21] Hammouda FM, Seif El-Nasr MM, Shahat AA. Flavonoids of *Cynara scolymus* L. cultivated in Egypt. Plant foods for human nutrition. 1993 Sep;44:163-9.
- [22] Abdel-Moneim A, Ahmed OM, Abd El-Twab SM, Zaky MY, Bakry LN. Prophylactic effects of *Cynara scolymus* L. leaf and flower hydroethanolic extracts against diethylnitrosamine/acetylaminoflourene-induced lung cancer in Wistar rats. Environmental Science and Pollution Research. 2021 Aug;28:43515-27.
- [23] Frutos, M.J.; Ruiz-Cano, D.; Valero-Cases, E.; Zamora, S.; Pérez-Llamas, F. Artichoke (*Cynara scolymus* L.). In Nonvitamin and Nonmineral Nutritional Supplements, 1st ed.; Nabavi, S.M.; Silva, A.S., Eds; Academic Press: London, United Kingdom, 2018; Volume 3, pp. 135-138. DOI:10.1016/b978-0-12-812491-8.00018-7
- [24] Palermo M, Colla G, Barbieri G, Fogliano V. Polyphenol metabolite profile of artichoke is modulated by agronomical practices and cooking method. Journal of agricultural and food chemistry. 2013 Aug 21;61(33):7960-8.