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Artichoke and health (food and medicine): A review

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Abstract

Globe artichoke (*Cynara scolymus*), which belongs to Asteraceae, is one of the perennial herbaceous plants that combined food and medicinal properties, especially immature flower heads (edible) and leaves, due to the diversity in the plant's metabolic compounds content. From the food side, it is a rich source of inulin that is harmless to diabetics, also important fibers and nutrients. Medically, the plant contains many important phenolic compounds as antioxidants and liver stimulants, the most important of which are Cynarin and other compounds that belong to the caffeoylquinic acids group, in addition to the presence The presence of luteolin is important in lowering triglycerides and low-density lipoprotein (LDL). So the immature flower heads can be eaten directly as food and achieve the medical benefit, the most important is liver stimulants, while the other parts of the plant, including the leaves and pomace, can use as food supplements to reduce fat, cholesterol and as a good source of antioxidants important in scavenging free radicals and strengthening the immune system, prevention of atherosclerotic diseases and hypertension associated with heart disease.

Keywords: Artichoke, Cynarin, Inulin, Antioxidants, Food, Medicine

Introduction

The ancient artichoke (*Cynara scolymus*) or (*Cynara cardunculus* L. var. *scolymus*) recently. An perennial herbaceous plant belonging to the Asteraceae family, its cultivation is spread in many Mediterranean countries, especially Italy, Algeria, Tunisia, Egypt and Spain as well as in France and America, and its original home is probably the Mediterranean basin (Abu Zeid, 2000). Climate: It needs mild winters and hot summers (Bekheet and Sota, 2019).

The important part that is eaten (edible) is the immature flower heads, which are one of the richest food sources of polyplenols because of their flavonoids and hydroxcinanmates as well as the plant's inulin and high-quality minerals (Ceccarelli et al., 2010).

The plant varies in its content of medicinal compounds according to different species, varieties, plant parts and stage of physiological development (Nergro et al., 2012).

Through the qualitative detection of phenolic compounds in the flower heads by HPLC, MS and DAD.ESI/MS, 22 main compounds were identified, 11 of which are caffeoylquinic acids and 8 are flavonoids, while 1,5-di -o-caffeoylquinic acid is the predominant compound in the flower heads, and it is found in a good percentage also in pomace, while in juice the predominant compound was 1,3-di-o-caffeoylquinic acid (cynarin) due to isomerization processes during the extraction process.

The total amount of phenols reaches 12 $g.kg^{-1}$ in the dry matter of pomace (Schutz et al., 2004) and the total phenol content varies according to the cultivars, ranging from about 7-13 mg. g^{-1} in the methanolic extract of flower heads at maturity (Curadi et al., 2005), which indicates that artichoke is a promising source of antioxidants among food components.

One of the most important compounds with medicinal effects in artichokes is cynarin, which is found in high levels in the leaves and has an action similar to the liver protecting and cell regeneration effect of silymarin, found in *Silybum marianum* (Aksu and Altinterim, 2013). The therapeutic properties are often attributed to this compound (Lattanzio et al. 2009).

In addition to the artichoke content of antioxidants important in protecting against diseases that cause liver damage, it was found that it contains a good

percentage of nutritionally important minerals (Biel et al., 2020).

Several studies have confirmed the role of artichoke in increasing bile secretion and reducing LDL and cholesterol and its relationship with the prevention of heart disease as well as its role as an anti-cancer (Behara, 2011 and Lattanzio et al., 2009., Bekheet and Sota, 2019 and Zyed et al., 2020 and Ceccarelli et al. , 2010).

As well as the importance of the plant in the treatment of digestive disorders, especially indigestion (Williamson et al., 2009). The reason for this is due to the role of artichoke in increasing bile secretion (Kraft, 1997). Artichoke can be used to fortify bakery products, as it mixes a percentage of the powder to be suitable for people with diabetes and high fat, as it has been proven to reduce fasting sugar and triglycerides (Nazni et al., 2006).

While artichoke alone has a protective effect from many diseases, a synergistic effect can occur between traditional medicines and the artichoke extract. A study showed that artichoke extracts have anti-breast cancer properties through a synergistic effect with the drug used for treatment (paclitaxel or adriamycin), the combined treatment can be able to reduce the dose of chemotherapy, reduce toxicity and side effects.The study indicated role of polyphenols in artichoke extract against free radicals and inhibiting cancer cells as a natural treatment, promising within the strategies of oncology (Maria et al., 2020), but in other cases some negative interactions with other drugs may or may not occur, so in order to avoid that, specialists in the field of medication should be consulted when using. Gelatti et al. (2016) reported the possibility of interactions between herbal drugs and chemical drugs (manufactured) .

In the nutritional and preventive field, the benefit is not limited to the flower heads only, but all parts of the plant, such as factory waste, can be used as a source rich in inulin and use it to support the beneficial intestinal bacteria (Zeaiter et al., 2019) and the importance of this in regulating digestion and metabolism and the prevention of digestive disorders .In addition to the nutritional and health benefits of the parts that are eaten (flower heads) confirmed Bekheet and Sota, (2019) a group of industrial, nutritional and medical benefits for other parts of the plant (leaves, stems and roots) being used in:

(a) as livestock feed
(b) source of inulin
(c) source of secondary metabolites
(d) The seed oil can be used to make biodiesel

Based on the foregoing, it became clear the extent of the nutritional, health and preventive importance of the plant and all its parts, which reveals the role of the promising plant in the prevention of many diseases by activating the liver and lowering cholesterol and the importance of this in protecting the heart and arteries from diseases as well as the nutritional importance as a good source of inulin suitable for diabetics and other The many benefits, Therefore, the study aimed to collect information about these benefits, discuss them and their relationship to human health and food.

Nutritional importance: The important part that is eaten from the plant is the flower heads immature and eaten fresh or canned or Frozen (Elsohaimy, 2014). The flower heads and leaves are characterized by their high content of inulin (which consists of a chain of fructose molecules) (Al-amrani, 2010) and it is also found in the roots (Hellwege et al., 2000).

Inulin is safe for diabetics, as it is degraded by the inulase enzyme , this enzyme is not present in the human gut (Al-Daoudi, 1990), so it is useful as a nutritional supplement and is suitable for obese, diabetic and hyperlipidemic individuals (Kwon et al., 2018 and Al-Subhi, 2017). Agro-Industrial discards can be used from the remnants of the plant parts (the stem and outer parts), in addition to the antioxidants contained in these parts, which indicates the possibility of using them as nutritional supplements and as a preventive against dangerous diseases such as cancer (Rodriguez et al., 2020). Zeaiter et al. (2019) showed the residue content of inulin in different parts of the plant (Table 1):

Table (1) Inulin content of artichoke residue in different plant parts as dry matter (g.100 g-1).

The parts	Reducing sugars content	Inulin content
Bract	10.40 ± 0.91	15.96 ± 1.75
Leaves	23.09 ± 0.84	4.70 ± 1.21
Stem	20.68 ± 2.30	27.97 ± 4.58

Mellilia et al. (2014) indicated that the contents of artichokes, including inulin, differed according to different cultivars and plant parts, the percentage of inulin (g. kg^{-1} d.m) was measured in receptacle and Bracts of Syracuse variety (294 and 162 respectively) compared with Caltagirone variety

(237 and 130 respectively). Al-Subhi (2017) made a general analysis of heads (capitula) and leaves (bracts) and determined the percentage of protein , fat, fiber, Ash content and total carbohydrate (Table 2).

Table (2) Chemical analysis of some nutritional components of artichoke (g. g100 $^{-1}$ d. w).

Chemical analysis	Head (capitula)	Leaves (bracts)
Crude protein	17.85±0.22a	9.54±0.21b
Crude fat	1.56±0.05b	2.34±0.06a
Crude fiber	29.61±0.11b	32.41±0.24a
Ash content	7.48±0.14b	9.52±0.18a
Total carbohydrates	42.70±0.13b	46.09±0.44a

Based on the inulin content of artichoke and other components such as fiber and others, some studies were conducted related to human food and health. Nazni et al. (2006) mixed artichoke powder (6 g) with five types of bakery products for biscuits and wheat bread, four types of these products were selected, Then 15 patients (diabetic type 2) were given these products compared with 15 placebo(healthy) , after 90 days it was observed significant decrease ($p < 0.05$) in level in fasting sugar and a decrease in LDL(low-density lipoprotein), total cholesterol and triglycerides in exchange for an increase in HDL level for the treated group (patients) compared with the non-treatment group (Placebo). In an attempt to use artichoke as a source of inulin and a fat replacer in the manufacture of ice cream and its effect on the sensory and chemical properties of ice cream by supporting it with artichoke and reducing levels of fat (milk source) by 6, 9 and 12% compared to control (15% fat). The results showed that the product (ice cream) enriched with artichoke was close in its sensory properties to the control despite its lower fat content. Accordingly it can be recommended to add artichoke as a source of inulin as an alternative to fat to produce low calorie ice cream (Abo El-Enien et al., 2015).

Costablie et al. (2010) demonstrated the role of artichoke as a source of inulin in supporting the growth of beneficial gut micro biota through a clinical trial carried out on 16 healthy adults who were supplemented with VLCI (Very long Chain Inulin) derived from artichoke and compared with 16 volunteers who took maltodextrin (10 g.d^{-1}) and for two periods, each period of 3 weeks separated by a period of 3 weeks (washout). The results concluded that the numbers of biofidobacterio and Lactobacilli were significantly higher when the treatment (VLCI) compared with placebo. In addition, the levels of *Atopobium group* bacteria increased significantly, while the number of bacteria *Bacteroide-prevotella* decreased significantly and there were no negative damages in the digestive system, regardless of simple and medium flatulence, by measuring the production of gas in the laboratory. This study indicates the importance of consuming artichokes as a source of inulin, which exerts a vital effect by increasing the number of intestinal organisms .

These results were corroborated by Zeaiter et al. (2019) by the possibiy of utilizing plant stem bracts as a source of inulin, extracted with ethanol using ultrasound. The extract has the ability to increase the growth of beneficial bacteria (Five types of Lactobacillus and four types of Bifidobacterium) and the importance of this in getting rid of digestive disorders and improving digestion.In addition to the inulin content of the flower heads, they are distinguished by their content of minerals, fibers and phenolic compounds, which increases their nutritional and health importance (Lattanzio et al., 2009 and Ceccarelli et al., 2010 and Zayed et al., 2020).

The importance of the plant has transcended to the inedible parts, as we explained earlier, such as the leaves, which are a good source of inulin, minerals and fibers. Thus, it can be used as nutritional supplements to achieve many nutritional and health benefits in reducing fat, glucose level at diabetes, obesity and other benefits. The plant contains a group of major beneficial minerals in varying proportions(K > P > Ca > Mg > Na) and the minor elements (Mn> Cr > Fe > Zn) which were measured in the leaf extract (Biel et al., 2020). In this context, Pandino et al., 2010 indicated that the plant was distinguished by the ratio of potassium to sodium K/Na compared to some vegetables, revealing the importance of the plant in the prevention of blood pressure and cardiovascular diseases.

Hepatoprotective: Several studies were carried out in this field to test the role of artichoke and its extracts in protecting the liver from disorders and diseases that cause liver damage or poor performance and functions.

In an experiment by Kaymas et al. (2016) they tested the effect of aqueous extract of artichoke leaf (ALE) on hepatic damage from poisoning with Alpha-Amanitine (the toxic compound from *Amanita phalloids*). 28 rats were divided into 4

groups (Control, Alpha-Amanitine alone (3mg/kg), ALE (1.5gm/kg), Alpha-Amanitine + ALE for 14 days.The results showed that Alpha-Amanitine treatment increased (MDA) hepatic-malondialdehyde and a decrease (SOD) superoxide dismutase, glutathione peroxidase (GSH+PX), catalase and glutathione (GSH). In contrast, there was a decrease in the level of MDA and an improvement in the indicators of antioxidants when treated with ALE, so it can be said that artichoke juice (Juice) is suitable in the case of Poisoning caused by Amanita phalloids **.** The researcher showed that the biological effect on the characteristics of the study is due to the phenolic compound Cynarin (derived from caffeoylquinic acid), as it works to protect the liver by secreting bile, expelling toxins from the liver and generating new cells. In the field of drug poisoning, a study was conducted by El Morsy and Kamel (2015) on the evaluation of artichoke leaf extract, from which it was concluded that artichoke may provide protection from paracetamol hepatotoxicity through its anti-oxidant and apoptotic properties in rat liver (at a dose of 2 g paracetamol. kg-1) when using artichoke extract 1.5 g. kg^{-1} orally for 14 days. One of the most important liver diseases that lead to cirrhosis is hepatic-alcohol caused by drinking alcohol, especially with the increase in quantities and the period of consumption, which leads to many cases of death. Therefore, many attempts have been made to reduce these harms by using medicinal herbs. Tang et al. (2017) carried out a laboratory experiment. A group of mice induced by alcoholic liver disease were treated by alcoholic artichoke extract (edible) at a concentration of 0.4, 0.8 and 1.6 g.kg b.w for 10 days. The results indicated that the artichoke extract prevented the elevated levels of aspartate, aminotransferase, alanineaminotransferase, malondialdeyde, triclyceride and total cholesterol. On the other hand, an increase in the level of superoxide dismutase and glutathione was observed at treated by ethanolic extract of artichoke.

Histopathological tests were observed to reduce the deterioration of the liver, inflammation and necrosis of hepatocyte. Immunological examination showed that the artichoke treatment significantly suppressed expression level TLR4 toll-like receptor and nuclear factor-kappa (NF×B) in liver tissue, which indicates the high ability of edible extract to achieve more than one thing, which is an increase in the levels of important enzymes, reducing inflammation damage and strengthening the immune system by reducing TLR4, NF-Kb (necrosis factor-kappa).

One of the studies was carried out to evaluate the effect of artichoke leaf extract (ALE) and vitamin C (VC) against lead (Pb) poisoning on rats by four treatments(500mg lead/kg, 500mg lead/kg +300mg/kg Artichoke, 500mg lead/kg +VC 1mg/kg) with control for a week. In the results of the study, a significant decrease in enzymes was observed alanine transamimase, alkaline phosphatase, aspartate transaminase, malondialdehyde, serum lead, triglyceride, LDL (21.9, 26.86, 12.9, 46.91, 35.85, 38.26, 38.38 % respectively).when treated with artichoke compared to poisoned rats only (without treatment), there were no significant differences between artichoke and VC (vitamin C) treatment in reducing serum lead, alanine transamimase and alkaline phosphatase, and the anatomical detection showed lymphocyte infiltration in artichoke treatment compared with control and VC treatments. derivatives, and apigeninluteolin) had a role in reducing the level of lead for the ability of these compounds to chelate heavy elements such as lead because of the ability its toxicity in addition to being a scavenger of free radicals (Heidarian. and Rafieian- Kopaei, 2013).

Lipid and hypercholesterolemia: Many studies have been conducted on reducing Lipid and cholesterol. The artichoke plant is one of the important plants that lead to reduce cholesterol and regulate its proportion in the blood. Therefore, many experiments were conducted to evaluate the role of artichoke in regulating the lipid ratio in the blood and its relationship to the prevention of blood pressure and cardiovascular disease. Among the important studies, what was found Englischa et al. (2000) when evaluating the efficacy of dry artichoke extract (hydro extract 25-35:1) in the form of film-coated tablets containing 450 mg extract (trade name: Valverde Artischockebei Verdauungsbeschwerden) in treating hyperlipoproteinemia and comparing it with placebo. The artichoke extract was significantly superior in reducing total cholesterol, LDL, and LDL/HDL ratio (18.5, 22.3 and 20.2% respectively), compared with the placebo group, which amounted to 8.6, 6.3 and 7.2% respectively, and no side effects were recorded, so this study can be included as a guide for recommending dry artichoke extract for the treatment of Prevention of atherosclerosis and coronary heart disease.

In a clinical trial by Rondanelli et al. (2012) conducted on 92 overweight patients with

moderate hypercholesterolemia, they were divided into two groups: the first 46 (age 54.2 ± 6.6 years) and weight (25.8 ± 3.9 kg /m2) Supplied with artichoke leaf extract (ALE) at a ratio (250 gm, 2 bid). Placebo group 46 (age 53.8±9.0 years) and weight (24.8 ± 1.6 kg/m2) for 8 weeks. Showed a significant decrease in total cholesterol, low-density lipoprotein (LDL), and LDL/HDL ratio, and total cholesterol/HDL (high-density lipoprotein) with a significant increase in HDL in patients given ALE compared to the placebo group. So, artichoke can play an important role for those with mild hypercholesterolemia by raising HDL and lowering LDL.The role of artichoke extract in increasing HDL was explained due to its polyphenols, especially chlorogenic acid, by improving the activity of paraoxonase-1 (PON-1), an enzyme that binds with HDL-C and prevents its oxidation (by preventing oxidative stress and inflammatory effects). The decrease in triglycerides and LDL is due to the action of Luteolin (also a polyphenol found in artichoke extract) that inhibits the coenzyme 3-hydroxy-3-methylglutaryl (HMG-CoA), a key enzyme in the manufacture of cholesterol in the liver.

Artichokes are an important source of luteolin (which belongs to a group of flavonoids), which plays a role in preventing obesity and metabolic disorders such as dyslipidemia, hepatic steatosis, and insulin resistance. Kwon et al (2018) test the power of artichoke leaves in mice (C57BL/6N) fed an obesity-induced high-fat diet for 16 weeks. The results of the test showed that adding artichoke to the diet reduced obesity and decreased dyslipidemia by decreasing lipogenesis with increase in fatty acid oxidation, which led to an improvement in hepatic steatosisbatter. The role of artichoke in reducing obesity and hepatotoxicity by suppressing lipogenesis and increasing bile secretion, as well as the ability of luteolin and artichoke to prevent insulin sensitivity .

Artichoke's anti-obesity efficacy: A diet accompanied by a high percentage of fat often leads to an increase in body weight that is associated with metabolic disorder and body abnormalities. Artichoke plays an effective role in weight loss due to its effect on improving liver function , gut microbiota, inhibiting digestive enzymes (such as pancreas lipase, α-glucosidase and α-amylase), increasing bile secretion, lipolysis and reducing blood glucose (Mahboubi, 2018). Several studies have pointed to the role of artichoke anti-obesity, we mention some of them.

An experiment was carried out by Abdulkhaleq et al. (2019) aimed at investigating the effect of artichoke as a dietary supplement with low and high doses of aqueous extract of artichoke leaf (ALE) in mice fed on HFD (600 and 1500 mg. kg body weight. day^{-1}), it was found that lower doses of ALE were more pronounced in mitigating the side effects of the high-fat diet (HFD).

Another experiment evaluated the effect of artichoke against the hypolipidemic relationship with obesity by feeding the rats with hypercholesterolemia (0.5% cholic acid + 1% cholesterol for 15 days at 0.5 ml/200g) using aqueous extract of artichoke leaf (ALE) with a ratio of 150 and 300 and 600 mg. kg-1 A group of rats were treated with simvastatin (4 mg. kg-1) and the control group was provided with water (0.5 $ml.200g^{-1}$) for 30 days with maintaining a high-cholesterol diet. The results of the experiment showed that rats treated with artichoke extracts and simvastatin significantly reduced the levels of cholesterol (46.9%, 51.9%, 44%, 41.9% respectively) and LDL (52.1%, 54.8%, 51.9%, 46.7% respectively) compared with the control. Biochemical analyzes revealed a significant decrease in the concentration of IL-1, IFN-Ɣ, TNF-α, IL-1 - and IL-6 treated with artichoke extract at different concentrations, and the results of this experiment indicated the reason for the anti-hypolipidemic effect of artichoke could be related to the presence of polar substances in the aqueous extract of artichoke leaves. (Mocelin et al, 2016)

Anti-hypoglycemic: Diabetes has spread recently, with its two types, type1 and type 2, due to many reasons, the most important of which are: diet and the genetic factor. Artichoke is one of the plants that can improve blood glucose levels.

In an experiment on male rats (Wistar rats) induced with diabetes (by streptozotocin), two groups of them were provided: 100 and 300 mg. 1 kg of alcoholic extract of artichoke and group untreated with artichoke and control group. The results showed that the treatment with artichoke reduced blood glucose, as the artichoke extract lowered the level of glucagon, glucose, AST(aspartate amino transferase), ALT(alanine amino transferase) and ALP(alkaline phosphatase) with an increase in the level of insulin compared to the diabetes group without the extract, due to the fact that eating artichoke increases the antioxidants and enzyme activity of superoxide dismutase activity, thus reduce oxidative stress. This is beneficial for diabetic patients who suffer

from increased oxidative stress**,** On the other hand, the regeneration of damaged pancreatic cells, as well as the presence of chlorogenic acid, synaryn and luteolin compounds, may be related to the protection of β-cells damaged by oxidative stress and drugs that induce diabetes, as well as the role of chlorogenic acid, synaryn and luteolin in increasing the intracellular glucose (insulin-like action) and decreasing glucose uptake from through the intestine (Hosseini et al., 2014).

Hypercholesterolemia and hyperdiabetes were induced in rats and treated with two types of artichoke parts (heads and leaves) after determining the components of each of them from protein, fiber and free phenolic acids. The results showed a significant decrease in lipid and serum glucose when treated with flower heads followed by leaves due to the high content of antioxidants and fiber, which confirms the value of artichoke and its nutritional and health benefit in reducing sugar and fat in diabetic patients. In general, the presence of fiber stabilizes the level of glucose in the blood by allowing glucose to be absorbed slowly in the blood, while the presence of phenolic acids (antioxidants) protects against diabetes and works to reduce fat and sugar at the same time (Al-subhi, 2017).

On the other hand, Abdel Magied et al. (2016) indicated that the results differed according to the cultivar when they tested the effect of two artichoke cultivars (Green globe and Violet) for leaves and heads on lowering blood glucose and hyperlipidemia in rats (albino), they found that treatment with leaf extract of green globe by 1.5 $mg.kg^{-1}$ is distinguished in lowering glucose in diabetic rats, as well as recording the best results in reducing hypercholesterolemic. We find in this study that the leaves were distinguished in reducing fats and sugar, while the study before that, we find that the heads were distinguished in reducing fats, this may be attributed to the different varieties.

Antioxidants properties: Artichoke contains many phenolic compounds, as it is one of the rich sources of polyphenols, especially in the immature flower heads (Ceccarelli et al., 2010). Some of the compounds belong to Caffeoylquinic acid and some of them belong to the flavonoids group (Schütz et al., 2004). Cynarin is the most important phenolic compound, found in the leaves and flower heads (Al-amrani, 2010 and Aksu and Altinterim, 2013) and is often attributed to its therapeutic properties (Lattanzio, 2009).

The percentage of total phenols varies according to the varieties, plant parts and physiological age (the stage of physiological development) of the plant part, as it ranges (2.580-3.106% of the dry matter) in young heads and ranges (1.600 - 2.238% of the dry matter) in the mature heads of different varieties. In leaves, it ranges (6.806 - 9.806% of dry matter) according to the in different varietiesas also (Wang et al., 2003). In general Al-Subhi (2017) confirmed the difference in the percentage of phenols and flavonoids (free and linked) with the difference in the plant part (Table 3).

Table (3) percentage of free and linked phenols and flavonoids in artichoke (g. g100 $^{-1}$ d. w)

Analysis	Head ($mg.g^{-1}$)	Leaves($mg.g^{-1}$)
Free phenolics	14.16+0.08a	9.06 ± 0.06b
Bound phenolics	4.20 ± 0.07	5.35 ± 0.08 a
Free total flavonoids	9.85 ± 0.12 a	5.91 ± 0.12 b
Bound total flavonoids	4.06 ± 0.11 a	2.17 ± 0.15 b

Table (4): Showed the difference in the percentage of the types of phenolic compounds according to the plant variety of the artichoke plant (mg kg-1 d.m) according to Lombardo et al. (2009)

Compound	Violetto di Provenza	Violetto di Sicilia	Romanesco clone C3
Lut rut	7.8 ± 0.1	63.1 ± 9.0	10.0 ± 0.6
Lutglc	8.3 ± 1.2	14.0 ± 3.0	21.4 ± 1.3
Lutglr	46.5 ± 5.2	169.6 ± 11.9	570.0 ± 11.5
Nar	29.7 ± 1.1	34.1 ± 4.9	23.7 ± 0.4
Nar glc	18.2 ± 0.02	10.2 ± 1.4	18.4 ± 1.0
1 CQ ac	nd(1)	259.4 ± 14.4	19.6 ± 1.0
3 CQ ac	nd	121.3 ± 8.9	28.7 ± 0.5
4 CQ ac	30.0 ± 0.6	265.3 ± 10.1	51.7 ± 1.5
5 CQ ac	316.3 ± 2.0(2)	6565.7 ± 12.7	131.2 ± 11.5
Caf ac	nd	nd	0.4 ± 0.02

1,3 di CQ ac	36.7 ± 2.7	50.6 ± 4.6	32.1 ± 1.6
Apiglr	841.0 ± 0.6	1073.3 ± 28.4	2599.0 ± 62.1
Api rut	119.0 ± 4.8	77.6 ± 14.3	157.6 ± 7.2
Apiglc	53.9 ± 2.6	100.9 ± 23.6	604 ± 3.4
4,5 di CQ ac	18.9 ± 3.9	5.3 ± 0.1	nd
di CQ	nd	70.2 ± 5.4	nd
3,4 di CQ ac	12.9 ± 6.7	152.3 ± 27.9	nd
3,5 di CQ ac	123.1 ± 4.2	1699.8 ± 238.0	76.9 ± 15.6
1,5 di CQ ac	129.7 ± 23.9	2884.4 ± 341.6	93.0 ± 18.0

1) nd = not detected. (2) Mean values ± standard deviation

Note: Lut rut: luteolin 7-*O*-rutinoside , Lutglc: luteolin 7-*O*-glucoside , Lutglr: luteolin 7-*O*-glucuronide , Nar: narirutin , Nar glc: naringenin 7-*O*-glucoside 1 CQ ac: 1-*O*-caffeoylquinic acid , 3 CQ ac: 3-*O*- caffeoylquinic acid , 4 CQ ac: 4-*O*-caffeoylquinic acid , 5 CQ ac: 5-*O*-caffeoylquinic acid (or chlorogenic acid) , Caf ac: caffeic acid , 1,3 di CQ ac: 1,3-di-*O*-caffeoylquinic acid (or cynarin) , Apiglr: apigenin 7-*O*glucuronide ,Api rut: apingenin 7-*O*-rutinoside, Apiglc: apigenin 7-*O*-glucoside , 4,5 di CQ ac: 4,5-di-*O*-caffeoylquinic acid, di CQ: dicaffeoylquinic acids , 3,4 di CQ ac: 3,4-di-*O*-caffeoylquinic acid ,3,5 di CQ ac: 3,5-di-*O*-caffeoylquinic acid, 1,5 di CQ ac: 1,5-di-*O*-caffeoylquinic acid .

The presence of the high level of phenolic compounds in plants known for their antioxidant activity is the reason for the plant's antioxidant activity (Emanuel et al., 2011). In a comparison between the phenol content of leaves and roots, Ibrahim et al. (2013) found that the leaves' content of phenols was higher than the roots, especially the methanolic extract, as it reached in the leaves (30.28 mg.gm^{-1}) almost twice as much as what is found in the roots (16.42 mg.gm^{-1}) Which indicates the possibility of employing this content of phenols to promote health by reducing the negative effect of lipid peroxidation. Alassadi (2017) indicated a remarkable ability of the plant against oxidation. This was not limited to the aerial parts of the plant, but even the parts below the surface of the soil. Alghazeer et al. (2012) confirmed the antioxidant activity of artichoke rhizomes, indicating that the isolated flavonoids have a high efficiency in scavenging free radicals.

By comparing immature with mature artichokes, Lutza et al. (2011) found that immature artichokes are more capable of removing and scavenging free radicals according to the DPPH test, as their content is high of polyphenols, caffeic acid, chlorogenic acid and cynarin, which gives more attention as an antioxidant. The study conducted by Schütz et al. (2004) revealed that the total phenolic contents (12 g. kg^{-1}) based on dry matter of artichoke pomace is a promising source of phenolic compounds that can be recovered and used as natural antioxidants.

Immunomodulatory properties: Some studies revealed the role of artichoke in increasing the body's immunity, as the strengthening immune system means increasing the body's resistance to diseases and the speed of its recovery when suffering from a disease.

In an experiment on quail birds (Japanese quails poisoned) treated with CCl4(carbon tetrachloride), Khorramshahi and Samedi (2015) tested the effect of artichoke powder on the immune performance of birds, the experiment included treatments: Artichoke alone control, Artichoke + CCl4 and CCl4) . The results did not show a significant effect of artichoke and CCl4 on feed conversation, feed intake and body weight of the bird. But when adding 2% of artichoke to the feed led to a significant increase in the number of hymphocyte count and a decrease in the percentage of Heterophils/Lymphocytes(H/L). Finally, in the treatment of artichoke and CCl4, either alone or together, no effect was observed on the relative weight of the spleen and liver.

In the same context, In an experiment on 300 birds, Fallah et al (2013) tested the effect of artichoke supplement meal (AL) and Mentha piperita extract on immune cells and biochemical indicators, the results after 42 days showed significant differences between control and treatment 1.5% Artichoke leaves + 200 mg.kg^{-1} mint extract (in drinking water) in the amount of triglyceride and cholesterol, which recorded the lowest values. The highest values in this treatment were recorded in lymphocytes and no significant differences were observed in the antibody titer against.

The relationship of artichokes with cardiovascular disease: One of the benefits of artichoke associated with increasing bile secretion and decreasing LDL and cholesterol is the prevention of cardiovascular diseases due to its association with blood lipids and the efficiency of heart work, as the increase in fat percentage works on atherosclerosis and over time high blood pressure and cardiovascular disease as a result, as well as the importance of artichoke in reducing fasting sugar and triglycerides (Nasni et al. (2006). This is related to the prevention of different heart disease, the reason is due to the reduction of metabolic disorders for people who suffer from high fat and blood glucose, this is extremely important for health care professionals, Alternative medicine and proper nutrition (Rondanelli et al. 2012).

The results of the trial conducted by Ben Salem et al. (2019) demonstrated the presence of the protective effect of artichoke in protecting the heart through its antioxidant activity on the one hand, and on the other hand its effect in reducing Obesity associated with hyperlipidemia and hypertension and thus protecting the heart from damage in mice, as it was found that Oral administration of artichoke extract (200 and 400 $mg.kg^{-1}$ for 60 days) led to a significant decrease in body weight, total cholesterol and triglycerides accompanied by an increase in antioxidant enzymes superoxide dismutase (SOD), glutathione peroxidase (GPx) and catalase (CAT) compared with the high-fat diet (HFD). All of the foregoing review of studies on the role of artichoke in lowering triglycerides, LDL, cholesterol and reducing obesity is associated with preventing atherosclerosis and cardiovascular disease. The ratio between potassium and sodium has a direct relationship between blood pressure and different heart diseases, in this aspect, Pandino et al., 2011 pointed out the distinction of the artichoke plant in the ratio of potassium to sodium K/Na compared with some vegetables, which reveals the importance of the plant in the prevention of blood pressure and cardiovascular diseases.

Conclusions

Based on the foregoing, It has been observed that artichoke has many medicinal properties in different parts of the plant, especially the flower heads and leaves, because of the phenolic compounds they contain that have a clear role against oxidative stress (antioxidants), which means increasing the body's immunity and preventing ravages that cause many diseases. Including chronic ones such as hepatitis and lowering cholesterol associated with the prevention of arterial and heart diseases as well as nutritional benefits as a source of minerals and fiber useful for the digestive system and others, so we recommend eating that the plant as a salad to achieve the preventive benefits of diseases and nutritional benefits at the same time.

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