AUSTRALIAN JOURNAL OF BASIC AND APPLIED SCIENCES

ISSN:1991-8178 EISSN: 2309-8414
Journal home page: www.ajbasweb.com

Artichoke as a tool to natural antioxidants for lowering diabetics and hypolipidemia parameters

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ARTICLE INFO

Article history:
Received 18 September 2016
Accepted 1 January 2017
Available online 16 January 2017

Keywords:
Artichoke, phenolic acids and flavonoids compounds, lowering diabetics and hypolipidemic pattern.

ABSTRACT

The present study was carried out to evaluate the different parts from the artichoke (leaves and head) and effect of their extracts (200, 400 and 600 mg/kg body weight rat) as natural antioxidants on hypercholesterolemia and hyper diabetic rats. Chemical composition, fatty acids analysis, free phenolic acids and flavonoids compounds were determined and their bound of them. The results showed that the higher amount of crude protein and lower in crude fiber were the artichoke head recorded 17.85 and 29.61% whereas, the leaves was recorded 9.54% in protein and the highest amount of crude fiber was 32.41%. The artichoke (head) showed a higher content of free total phenolic compounds (14.16 mg/g dry weight) followed by the artichoke (leaves) which contained only 9.06 mg/g dry weight. On the other hand both leaves and head parts of artichoke showed the lower content of the bound phenolic compounds. The main compounds in the identification of fatty acids were palmitic (16:0), oleic (18:1 n-9) and linoleic (18:2 n-6) acids respectively in the different parts of artichoke. At the end of biological experimental for four weeks the results showed that the artichoke head was significant lowering effect on lipid parameters and serum glucose in hypercholesterolemia and hyperdiabetic rats followed by leaves artichoke. These caused the artichoke head had contained high amounts from natural antioxidants and decreased in crude fiber whereas, the artichoke leaves was the highest in crude fiber and it was decreased in natural antioxidants. Therefore, it may be recommended that the fed with different parts of the artichoke are benefit healthy food, lowering diabetics and hypolipidemic pattern.

INTRODUCTION

Artichoke belonging to the family Asteraceae is an herbaceous perennial crop Bianco (2005). Recently, a renewed and growing interest in the artichoke with a focus on new uses as a functional food has been observed Lattanzio *et al*. (2009). Artichoke is widely cultivated for its large immature inflorescences, called capitula or heads. With edible fleshy leaves (bracts) and receptacle, which represent an important component of the Mediterranean diet, it is a rich source of bioactive phenolic compounds Lattanzio (1982). Artichoke can be eaten as a fresh, canned or frozen vegetable Efterpi *et al*. (2012). Since Roman times, this plant has been used in folk medicine for its health benefits which are mainly due to the high content of phenolic compounds and inulin Sonnante *et al*. (2007), Lattanzio *et al*. (2009) and Pandino *et al*. (2011).

Phenolic compounds are very important substances for human nutrition since they are involved in the prevention of cancer cardiovascular diseases; osteoporosis, diabetes mellitus and neurodegenerative diseases Clifford and Brown (2006). In addition, leaves, rich in phenolic compounds Fratianni *et al*. (2007), is used in herbal medicine and have been recognized since ancient times for their beneficial and therapeutic effects. Extracts from artichoke have been used for hepato-protection Adzet and Carlos (1987).

To Cite This Article: Fizah Mosaed Mohamad Al-Subhi., Artichoke as a tool to natural antioxidants for lowering diabetics and hypolipidemia parameters. ***Aust. J. Basic & Appl. Sci.,*** *11(1): 46-54, 2017*

Among the common edible plants, artichoke is a rich source of dietary anti-oxidants; therefore it could be used in phytopharmaceutical applications Ceccarelli *et al*. (2010). The edible parts of the artichoke plants are the large immature flowers, harvested in the early stages of their development, which represent about 30-40% of its fresh weight, depending on the variety and harvesting time. Since only the central portion of the capitula is consumed, the ratio of the edible fraction to the total biomass produced by the plant is very low, ranging from 15 to 20% of total biomass. This ratio further decreases, if the contribution to the total biomass represented by odd shoots that are often removed as part of common cultural procedures, is also considered Lattanzio (1982).

The pharmacological properties of artichoke flower heads are well documented in several in-vivo and in-vitro studies for the treatment of hepato-biliary dysfunction, dyspeptic syndromes, gastric diseases, as well as for inhibition of cholesterol biosynthesis and low density lipoproteins (LDL) oxidative agents responsible for arteriosclerosis and coronary heart disease Lattanzio *et al*. (2009) and Ceccarelli *et al*. (2010). Artichoke leaf extracts decreased serum lipids, as well as hepatic and cardiac oxidative stress in rats fed on high cholesterol diet Kucukgergin *et al*. (2010). Wild artichoke extracts fed to aged rats seemed to exert cardio protective effects Kucukgergin *et al*. (2010).

Medicinal plants especially artichoke (*Cynara scolymus* L.) leaves have long been used effectively for treating a variety of diseases in the world. Artichoke is full of natural antioxidants and contains caffeoylquinic acid derivatives (cynarin and chlorogenic acids) and flavonoids such as luteolin and apigenin (Llorach *et al*., 2002 and Wang *et al*., 2003). Artichoke has been reported to significantly reduce serum cholesterol in hypercholesterolemic subjects (Joy and Haber, 2007) and declined the production of reactive oxygen species (ROS), lipid peroxidation and the oxidation of low-density lipoproteins in vitro experiments (Zapolska-Downar *et al*., 2002).

Alterations in serum lipid and lipoprotein levels, especially hypercholesterolemia, result in a variety of chronic diseases such as coronary heart diseases and atherosclerosis (Gould *et al*., 2007and McKenney, 2001). Many studies have been conducted on plant flavonoids that might be beneficial in reducing the risk of obesity and its complications (Andersen *et al*., 2010 and Mulvihill and Huff, 2010). In this respect, artichoke (Cynara scolymus L.) is introduced as new lipid-lowering therapeutic agent (Joy and Haber, 2007 and Küskü-Kiraz *et al*., 2010). Artichoke leaves were used in traditional medicine for a variety of diseases especially, hyperlipidemia. Hypolipidemic effects of artichoke have been documented in experimental and clinical studies (Shimoda *et al*., 2003 and Joy and Haber, 2007). Also, artichoke is full of natural bioactive components, that is, caffeic acid, chlorogenic acid, cynarin, and luteolin. These components reduce the production of reactive oxygen species (ROS), lipid peroxidation and the oxidation of low density lipoproteins (LDL) in vitro experiments (Zapolska-Downar *et al*., 2002, Wang *et al*., 2003 and Juzyszyn *et al*., 2008). Therefore, these properties of artichoke warrant its application in traditional medicine.

The globe artichoke (Cynara cardunculus var. scolymus) is a variety of a species of thistle cultivated as a food. The edible portion of the plant consists of the flower buds before the flowers come into bloom. The budding artichoke flower-head is a cluster of many budding small flowers (an inflorescence) together with many bracts, on an edible base. Once the buds bloom, the structure changes to a coarse, barely edible form. Another variety of the same species is the cardoon, a perennial plant native to the Mediterranean region Rottenberg and Zohary (1996).

Therefore, the aim of this study was to evaluate of the different parts (leaves and head) of artichoke and it was determined the effects of the different parts of the artichoke extracts at 200, 400 and 600 mg/kg body weight ratios on the serum glucose, total lipids, total cholesterol and triglycerides, high and low density lipoprotein- cholesterol in serum.

MATERIALS AND METHODS

Materials:

Fresh artichoke (Cynara scolymus L.) was obtained from local market at Maka, Saudi Arabia. The leaves were separated from the plant and then the fresh samples of artichoke (leaves and head) were washed and dried in an oven at 50°C for two days, ground, sealed in polypropylene bags, and stored at 4°C until analysis.

The standards chemicals like phenolic acids and flavonoids compounds were purchased from Sigma Chemical Co. (St. Louis, MO, USA) and the HPLC-grade solvents such as chloroform, methanol and acetic acid were purchased from Merck (Germany).

Methods:

Determination of proximate composition of dried samples:

The analyses of ash, total carbohydrates, crude protein, crude fiber and fat were determined for the dried leaves and head of the artichoke as described by the AOAC (2010).

Sampling extraction of free and bound phenolic compounds:

Phenolic compounds were extracted into free and bound phenolics according to the methods of Sosulski *et al*. (1982), with a slight modification by Adom and Liu (2002). Free phenolic compounds of flours (1 g) were extracted with 10 ml of 80% chilled ethanol for 20 min with continuous shaking. After centrifugation at 2500g for 10 min, the residue was re-extracted twice and all supernatants were combined and evaporated to dryness under reduced pressure. The free phenolic compounds were then stored at – 40 °C until use. The residue from the extraction of free phenolic compound was hydrolyzed directly with 20 ml of 2 N NaOH for 90 min with continuous shaking at 60 °C (Yeh *et al*., 1980). The hydrolysate was acidified to pH 2 (6 N HCl) and centrifuged to separate cloudy precipitate. The liberated phenolic acids were extracted with ethyl acetate and evaporated to dryness and then bound phenolic compounds were dissolved and filled up to 10 ml of methanol and stored at – 4 °C until use. Total phenolic contents free and bound in samples were expressed as mg gallic acid equivalents (GAE)/g dry weight. Samples were analyzed in triplicates.

Free and bound of total flavonoids content in artichoke:

Total flavonoids content (TFC) of free and bond phenolic extracts of different parts (leaves and head) of artichoke was spectrophotometrically determined by the aluminium chloride method using quercetin as a standard (Zhishen *et al*., 1999). One ml of extract or standard solution (quercetin, 20–120 mg/l) was added to 10 ml volumetric flask, containing 4 ml of distilled water. To the flask 0.3 ml 5 % $NaNO_2$ was added and after 5 min 0.3 ml 10 % Al Cl_3 was added. At 6th min, 2 ml 1M NaOH were added and the total volume was made up to 10 ml with distilled water. The solutions were mixed well and the absorbance was measured against prepared reagent blank at 510 nm by using spectrophotometer (Unicum UV 300). Total flavonoids in sample were expressed as mg quercetin equivalents (QE)/ g fresh weight. Samples were analyzed in triplicates.

Fractionation and identification of phenolic compounds:

The polyphenolic compounds of artichoke extracts were fractionated and identified for phenolic compounds by HPLC, according to the method described by Pinto *et al*. (2008). Identification of individual phenolic compounds was performed on Hewlett- Packard HPLC (Model 1100), using a hypersil C18 reversed-phase column (25 × 4.6 mm) with 5µm particle size. Phenolic compounds were identified by comparing retention times and UV-VIS spectra with those of pure standards and the range of calibration curves.

Fatty acid composition in different parts of artichoke:

Fatty acid methyl esters were prepared by saponification of sample lipid contents with sodium hydroxide 0.5 mol/L (in methanol) followed by methylation with triboronfluoride (12.0 ml BF_3 in 100.0 ml methanol) according to Joseph and Ackman (1992) and separated by gas chromatography (GC) using a Thermo 3300 gas chromatograph equipped with a flame ionization detector (FID) and a fused-silica CP-7420 (SELECT FAME) capillary column (100 m × 0.25 mm cyanopropyl).

Fatty acids were identified by comparing retention times to those of standard methyl esters. Quantification of fatty acids (FAs) was performed using tricosanoic acid methyl ester as an internal standard according to Joseph and Ackman (1992).

Extraction of different parts of artichoke:

Artichoke fresh leaves and head were separated and cleaned, it mechanically blended with 2000 ml distilled water then filtered through two-layer of cheese cloth, and the resultant residue was re-dissolved in 1000 ml distilled water by using magnetic stirrer for 1h. The later aqueous extract was added to the first one. The combined aqueous extract was condensed in rotary evaporator under vacuum then lyophilized and stored at 4°C until further use. Lyophilization was conducted by using Freeze-Dryer Lyophilizer, Virtis, USA. The method of extraction was carried out according to Jimenez-Escrig *et al*. (2003).

Biological experiments:

Male albino rats Sprague Dawley strain (48 animals) weighing 170- 180 g were housed in individual cages with screen bottoms and fed on basal diet for one week. It consisted of casein 10%, corn oil 10%, cellulose 5%, salt mixture 4%, vitamin mixture 1% and corn starch 70%. The salt mixture and vitamin mixture used were that proposed by AOAC (2010).

After feeding on basal diet for eight days, rats were divided into two groups. The first group (6 rats) was fed on the basal diet for another four weeks (30 days) and considered as negative control. The second main group (42 rats) was fasted over night and injected with strepto zootocin (dissolved in 0.1M citric acid buffer and adjusted at pH 4.5) into the leg muscle (5mg /100g body weight) to induce hyperdiabetic and hypercholesterolemia rats according to Madar (1983). After 48 hr. of injection the second main group was divided into seven sub groups (6 rats for each). The first one (6 rats) was continued to be fed on basal diet and considered as positive control. From the second to four subgroups (6 rats for each) were fed on basal diet and it

was received 2 ml orally per day from artichoke leaves extract at three ml doses (200, 400 and 600 mg/kg b.wt.) and also, from the five to seven subgroups (6 rats for each) were fed on basal diet and it was received 2 ml orally per day from artichoke head extract at three doses (200, 400 and 600 mg/kg b.wt.). Each rat was weighted every two days and the food consumption was calculated.

At the end of experimental period (four weeks), the blood samples were taken with drawn from the orbital plexus and centrifuged at 3000 rpm to obtain the sera. After that, the sera were kept on a deep-freezer at -20°C until their analyses. Serum glucose, total lipids, total cholesterol and triglycerides were determined according to Tietz (1986), knight *et al*. (1972), Allain *et al*. (1974) and Fossati and Prencipe (1982), respectively. High and low density lipoprotein- cholesterol in serum was determined according to Burstein (1970) and Fruchart (1982).

Statistical analysis:

The data obtained in the present study was analyzed by ANOVA. For all analyses, when a significant difference (p b 0.05) was detected in some variable, the data means test was applied to evaluate the difference between the samples. The results were analyzed with the aid of the software SAS System for Windows SAS (2008).

RESULTS AND DISCUSSION

Chemical compositions of different part in artichoke:

Results in Table (1) showed that the protein content of the artichoke leaves and heads the highest amount of crude protein was for the heads recorded 17.85% followed by the leaves recorded 9.54% successively. These results are in agreement with the results of Hosseinzadeh *et al*. (2013) who found that, the protein content of artichoke leaves was in the ranged from 8.05 to 12.35%. However, Lutz *et al*. (2011) who found that the protein content of artichoke heads was ranged from 15.96 to 18.25%.

The fat content of the different parts of artichoke is also shown in the same Table and the resultant reported that significant difference for the fat content between leaves and head. These results are in accordance with the results of Hosseinzadeh *et al*. (2013) who found that, the fat content of artichoke leaves was in the range of 1.6 to 2.3% on dry wt. basis. Meanwhile, Jimenez-Escrig *et al*. (2003) reported that the fat content of artichoke heads was only 1.69%.

Concerning that the crude fiber content for artichoke significant difference could be shown among all the samples. The highest amount of fiber was for the leaves (32.41%). The lowest amount was recorded for the heads (29.61%).

Results of the ash content of the leaves and head of artichoke significant difference was recorded 9.52 and 7.48%, respectively. These results are in accordance with the results of Lutz *et al*. (2011) who reported that, the content of artichoke heads was 7.04%. In addition, Hosseinzadeh *et al*. (2013) reported that the ash content of artichoke leaves was 9.01%. Percentage of total carbohydrates (d.w) of artichoke was significant difference amounted of total carbohydrates and it was recorded for the leaves and head 46.09 and 42.70%, respectively.

Table 1: Proximate composition in artichoke parts (g/100g dry weight basis).

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

Total phenolic and total flavonoids content of free and bound of artichoke:

Data presented in Table (2) indicated that the artichoke (head) showed a higher content of free total phenolic compounds FTPC (14.16 mg/g DW) followed by the artichoke (leaves) which contained only 9.06 mg/g DW. On the other hand both leaves and head parts of artichoke showed the lower content of the bound phenolic compounds (5.35 and 4.20 mg/g DW, respectively).

Previous studies showed that the artichoke (head) contained higher amount of phenolic compounds along with higher amount of minerals and dietary fibers. As a role of phenolics, the artichoke (head) should posses higher free radicals scavenging activity than the artichoke (leaves), These results were supported by the results of Perez- Garcia *et al*. (2000) who found that nutritional and pharmaceutical properties of both leaves and head are linked to their special chemical composition which includes high levels of polyphenolic and inulin which possess potential antioxidant activity. Lattanzio *et al*. (2009) found that by-product of artichoke are very rich in phenolic compounds and hence can regarded as a functional food.

In addition, the total flavonoids contents (TFC) of free and bound phenolic extracts of artichoke leaves and head are shown in Table (2). The total flavonoids content of the free phenolic extracts was higher than that the bound phenolic extracts. The total flavonoids concentrations of free and bound phenolic in artichoke head

extracts were significantly higher (9.85 and 4.06 mg/g DW) when compared to artichoke leaves (5.91 and 2.17 mg/g DW).

Table 2: Total phenolic and total flavonoids content of free and bound methanolic extracts of different parts of artichoke.

Analysis	Leaves mg/g	Head mg/g
Free phenolics	9.06 ± 0.06[b]	14.16+0.08[a]
Bound phenolics	5.35 ± 0.08 [a]	4.20 ± 0.07
Free total flavonoids	5.91 ± 0.12 [b]	9.85 ± 0.12 [a]
Bound total flavonoids	2.17 ± 0.15 [b]	4.06 ± 0.11 [a]

Identification of phenolic compounds for the dried artichoke parts:

The phenolic compounds of the artichoke parts extracts were identified by HPLC, results are shown in Table (3). Phenolic compound 5-o-Caffeoylquinic acid (Chlorogenic acid) was found to be in high concentration (mg/100g dried sample) for the head was recorded 5.1021 mg/100g; meanwhile it was in low percentage for leaves that recorded 0.7145 mg/100g.

The phenolic compound 1, 3-di-o-caffeoylquinic acid (cynarin) was found in little amounts than that chlorogenic acid, but still in higher amount than 1,5-di-o-caffeoylquinic acid into the samples of artichoke under investigation. Shen *et al*. (2010) reported that, the three compounds; (5-o-caffeoylquinic acid (chlorogenic acid), 1, 3-di-o-caffeoylquinic acid (cynarin) and 1,5-di-o-caffeoylquinic acid are the major active compounds in artichoke, they are considered to be responsible for their antiatherogenic action. The caffeoylquinic acids are natural antioxidant with potential health benefits in the context of inhibiting the development of cancers, exacerbated by the presence of reactive oxygen species Fukumoto and Mazza (2000). The phenolic compound apignin was found in small amount for the two varieties of artichoke either leaves or heads. Justesen and Knuthsen (2001) and Pandino *et al*. (2013) reported that, apignin is a compound which is seldom encountered in the plant kingdom, being found only in some herbs and vegetable.

Luteolin phenolic compound was also found in leaves and heads for two varieties of artichoke. Pandino *et al*. (2013) and Kukic *et al*. (2008) reported that, luteolin are of interest since they show antimicrobial activity and inhibit cholesterol synthesis.

Table 3: Phenolic compounds (mg/100 g) for dried artichoke parts.

Phenolic compounds	Artichoke parts	
	Leaves	Head
5-o-Caffeoylquinic acid (Chlorogenic)	0.7145	5.1021
1,3-di-o-Caffeoylquinic acid (Cynarin)	1.2823	0.4792
1,5-di-o-Caffeoylquinic acid	0.1136	0.1516
Apignin	0.1046	0.1101
Luteolin	0.0224	0.1384
Caffeic acid	0.1086	0.1102
Salicylic acid	0.1202	0.1297
Gallic acid	0.1015	0.1157
Coumarin	0.1018	0.1128
Ferulic acid	0.0534	0.1151
Narirutin	0.0215	0.1175

Fatty acid composition in dried artichoke parts:

Table (4) shows the ten main fatty acids which were detected in dried artichoke parts, four sum of saturated fatty acids (SFAs), two sum of monounsaturated fatty acids (MUFAs) and four sum of polyunsaturated fatty acids (PUFAs) (two n-6; two n-3). The main compounds in the SFA, MUFA and PUFA groups were palmitic (16:0), oleic (18:1 n-9) and linoleic (18:2 n-6) acids respectively. Alpha-linolenic acid (18:3 n-3) was also a significant proportion of PUFA content.

Biological experiments:

Effect of different parts of artichoke extract on initial, final body weight and feed efficiency ratio in diabetic and cholesterolemic rats:

The results from Table (5) indicated that the effect of different artichoke on initial, final body weight and feed efficiency ratio in diabetic and cholesterolemic rats. From the resultant it could be observed that the normal negative control group was fed on basal diet had the highest in final body weight (194.5 g, increased in gain body weight 27.0 g) and feed efficiency ratio (5.84%) at the end experimental period (four weeks). While, the positive control group was fed on basal diet slightly significantly increased in final body weight (177.0 g increased 6.7g about initial body weight) and feed efficiency ratio was 1.92%. Meanwhile, the rat groups fed on leaves and head artichoke extract orally per day at levels 600 mg/ kg was observed that no significantly changes in final body weight and total food intake between them. It is mean that the rats fed on different parts from artichoke at ratio 600 mg/kg did not affect on food intake and body weight.

Table 4: Fatty acid quantification (mg/100 g) for dried artichoke parts.

Fatty acids composition	Artichoke parts	
	Leaves	Head
16:0 (Palmitic acid)	229.95 ± 20.94[b]	2303.58± 146.02[a]
18:0 (Stearic acid)	13.37 ± 2.27[b]	297.20± 15.08 [a]
18:1n-9 (Oleic acid)	17.80 ± 2.75 [b]	99.87± 8.60 [a]
18:1n-7 (cis-Vaccenic acid)	6.74 ± 1.06 [b]	51.84± 6.31 [a]
18:2n-6 (Linoleic acid)	518.92 ± 39.93 [b]	3462.87± 189.8 [a] 7
18:3n-3 (alpha-Linolenic acid)	242.60 ± 19.04 [b]	987.74± 34.42 [a]
20:0 (Arachidic acid)	7.51 ± 0.69 [b]	180.52± 21.45 [a]
22:0 (Behenic acid)	5.66 ± 0.67 [b]	52.91± 5.89 [a]
20:4n-6 (Arachodonic acid)	9.00 ± 0.94 [b]	127.94± 8.80 [a]
20:5n-3 (Eicosa-pentaenoic acid)	20.49 ± 1.75 [b]	175.60± 11.32 [a]
Sum of saturated fatty acids	256.49 ± 21.08 [b]	2600.78± 148.47 [a]
Sum of monounsaturated fatty acids	24.54 ± 2.95 [b]	151.71± 10.67 [a]
Sum of polyunsaturated fatty acids	796.41 ± 44.2 [b]	4754.15± 193.50 [a]

Table 5: Initial, final body weight and feed efficiency ratio in rats fed orally of different parts in artichoke extract

Groups	Initial body weight	Final body weight	Gain body weight	Total food intake	Feed efficiency ratio
Control negative	167.5 ±7.6 [b]	194.5 ±6.6 [a]	27.0	462.7 ±26.0 [a]	5.84 ±0.2 [a]
Control positive	170.3 ±8.0 [ab]	177.0 ±7.0 [b]	6.7	348.6 ±28.3 [b]	1.92 ±0.6 [d]
Group1	181.7 ±8.6 [a]	191.8 ±7.9 [a]	10.1	450.4 ±31.3 [a]	2.42 ±0.2 [c]
Group 2	182.3 ±9.1 [a]	197.8 ±8.2 [a]	15.5	445.6 ±31.1 [a]	3.47 ±4.7 [b]
Group 3	171.8 ±7.8 [b]	193.8 ±8.1 [a]	22.0	420.0 31.2 [a]	5.24 ±0.2 [d]
Group 4	180.5 ±8.6 [a]	192.3 ±7.9 [a]	12.8	455.9 ±30.8 [a]	2.81 ±0.6 [c]
Group 5	175.3 ±6.7 [b]	192.1 ±8.4 [a]	16.8	450.5 ±22.3 [a]	3.73 ±0.2[b]
Group 6	173.2 ±7.6 [b]	198.3 ±9.5 [a]	25.1	430.4 ±15.4 [a]	5.83 ±0.4 [a]

Group 1 fed on basal diet and 2 ml orally/ day 200mg/kg body weight from artichoke leaves
Group 2 fed on basal diet and 2 ml orally/ day 400mg/kg body weight from artichoke leaves
Group 3 fed on basal diet and 2 ml orally/ day 600mg/kg body weight from artichoke leaves
Group 4 fed on basal diet and 2 ml orally/ day 200mg/kg body weight from artichoke head
Group 5 fed on basal diet and 2 ml orally/ day 400mg/kg body weight from artichoke head
Group 6 fed on basal diet and 2 ml orally/ day 600mg/kg body weight from artichoke head

Effect of different part in the artichoke extract on glucose level and lipid parameter in diabetic and cholesterolemic rats:

Table (6) showed that the effect of different parts (leaves and head) in the artichoke extracts at 200, 400 and 600 mg/kg b.wt ratios on glucose level, total lipids, triglyceride, total cholesterol, high density lipoprotein and low density lipoprotein in hyperlipidemic and diabetic rats groups during four weeks. The results showed that the decreases significant of serum total lipid when the hyperlipidemic rats fed on 600 mg/kg b.wt from leaves and head (390.2 and 350.5 mg/dl, respectively) after 4 weeks. On the same parallel, when rats fed on diets contain 600 mg/kg orally from leaves and head artichoke, the serum total cholesterol and triglycerides were significant decreased to 135.2 and 130.0 mg/dl for cholesterol and 145.3 and 136.8 mg/dl for triglycerides, respectively than control positive was 238.8 and 235.8 mg/dl. Results showed that the part (head) in the artichoke extracts was more effective than the part (leaves) artichoke from serum lipids patterns which due to the head artichoke was rich in polyphenols and flavonoids content. Also, the effectiveness of head artichoke was clear in triglycerides then total cholesterol.

Artichoke extracts and some of their pure phenolic constituents were assessed for their protective role in the control of oxidative damage to biological molecules (proteins, lipids and DNA), caused by free radicals such as RCOO• and/or OH•, and the mechanism of their action using the β-carotene/linoleate assay, the deoxyribose assay and the metmyoglobin assay (Lattanzio *et al*., 2005).

The results from HDL- cholesterol and LDL- cholesterol in hyperlipidemic and diabetic rats fed orally on different parts (leaves and head) in the artichoke extracts at 200, 400 and 600 mg/kg b.wt ratios are reported that in the same table. From the resultant it could be observed that the HDL- cholesterol was significantly increased in hyperlipidemic and diabetic rats fed orally on leaves and head artichoke at 400 and 600 mg/dl ratios. However, the hyperlipidemic and diabetic rats fed orally on different parts (leaves and head) in the artichoke

extracts at 400 and 600mg/kg b. wt ratios significantly lowered in LDL- cholesterol from 168.3 mg/dl in control positive to 67.3 and 62.7 mg/dl in leaves and head artichoke at 600mg/kg b. wt ratio.

Although the most important active compound of Cynara scolymus L., cynarin, is present in the whole plant, the major concentration is found in the artichoke. For this reason, most of the natural medicines obtained from this plant are prepared from leaves and head. Cynarin is found in the whole plant and besides is considered one of the main active chemical compounds. Technically, cynarin is a caffeolquinic acid and concentrates in major degree in the artichoke (Speroni, 2003).

From the results it could be noticed that the hyperlipidemic and diabetic rats fed orally on 400 and 600 mg/kg b. wt ratios head artichoke significantly decreased in serum glucose blood level (166.0 and 140.3 mg/dl), followed by hyperlipidemic and diabetic rats fed orally on 400 and 600 mg/kg b. wt ratios leaves artichoke (171.5 and 145.2 mg/dl). It is clear that feeding orally of the different parts (leaves and head) in the artichoke extracts at600 mg/kg b. wt ratios reducing serum glucose level. Artichokes are very high in fiber, which is crucial for numerous functions in the body. These decrease may be caused the high amount of fiber found in artichokes has the ability to help keep blood sugar levels stable, avoiding spikes and dips in insulin that can lead to serious problems for diabetics. The fiber in artichokes allows glucose to be absorbed in the blood more slowly, and because fiber is a substance that can be digested and does not require insulin, fiber does not count towards the amount of carbohydrates or glucose you consume.

From the obviously results it could be noticed that the different parts (leaves and head) in the artichoke extracts are riche in the phenolic acids and flavonoids compounds. These contained it could may be prevention of diabetics level and lipid parameters and lowering of them.

Table 6: Effect of different part in artichoke extract on glucose level and lipid parameter in diabetic and cholesterolemic rats (mg/dl).

Groups	Total lipids	Triglycerides	Total cholesterol	HDL cholesterol	LDL cholesterol	Total glucose
Control negative	326.3 ±17.3 [d]	103.8 ±8.6 [d]	120.8 ±8.3 [d]	49.5 ±5.8 [a]	60.5 ±3.0 [d]	128.0 ±8.0 [d]
Control positive	605.0 ±25.7 [a]	235.8 ±15.4 [a]	238.8 ±14.3 [a]	23.0 ±1.9 [b]	168.3 ±8.5 [a]	250.0 ±16.5 [a]
Group1	566.0 ±23.9 [b]	212.0 ±8.3 [b]	172.5 ±8.1 [b]	27.3 ±1.9 [b]	102.9 ±5.3 [b]	222.3 ±12.2 [b]
Group 2	471.3 ±22.5 [c]	194.8 ±8.9 [c]	163.0 ±8.2 [c]	37.5 ±1.8 [c]	86.6 ±5.4 [c]	171.5 ±11.7 [c]
Group 3	390.2 ±19.2 [d]	145.3 ±7.5 [d]	135.2 ±5.9 [d]	40.2 ±2.1 [a]	67.3 ±4.3 [d]	145.2 ±8.3 [d]
Group 4	511.6 ±15.7 [b]	200.1 ±5.4 [b]	168.3 ±4.6 [b]	30.0 ±21.9 [b]	95.4 ±3.8 [b]	190.5 ±9.2 [b]
Group 5	440.5 ±22.4 [c]	182.0 ±8.9 [c]	160.0 ±8.1 [c]	39.75 ±2.1 [c]	83.9 ±5.2 [c]	166.0 ±12.2 [c]
Group 6	350.5 ±21.9 [d]	136.8 ±8.6 [d]	130.0 ±8.0 [d]	42.0 ±2.6 [a]	62.7 ±4.3 [d]	140.3 ±12.3 [d]

In conclusion, among the two fractions of artichoke the (leaves and head) was found to contain the highest contented of flavonoids and phenolic of free phenolic extract. Significantly different was observed in the total flavonoids of the different parts of artichoke. These compounds in artichoke helps to lower blood cholesterol level by lowering low density lipoprotein or bad cholesterol levels. Artichoke is also beneficial for other heart health benefits like reducing inflammation and blood glucose.

REFERENCES

Adom, K.K and R.H. Liu, 2002. "Antioxidant activity of grains", Journal of Agriculture and Food Chemistry, 50: 6182-6187.

Adzet, C.J and L.J. Carlos, 1987. Hepatoprotective activity of polyphenolic compounds from *Cynara scolymus* against CCl4 toxicity in isolated rat hepatocytes. J Nat Prod., 50: 612-7.

Allain, C.C., L.S. Poon, C.S. Chan, W. Richamand and P.C. Fu, 1974. Enzymatic determination of total serum cholesterol.Clin. Chem., 20(4): 470.

Andersen, C., S. Rayalam, M.A. Della-Fera and C.A. Baile, 2010. Phytochemicals and adipogenesis. Biofactors, 36: 415-422.

AOAC, 2010. Official Methods of Analysis of Association of Official Chemists. 18th Ed., Washington, D.C., USA.

Bianco, V., 2005. Present situation and future potential of artichoke in the Mediterranean basin. Acta Hort, 681: 39-55.

Burstein, M., 1970. HDL Cholesterol determination after separation of high density lipoprotein. Lipids Res., 11: 583-589.

Ceccarelli, N., M. Curadi, P. Picciarelli, L. Martelloni, C. Sbrana and M. Giovannetti, 2010. Globe artichoke as functional food. Mediterranean J Nutr Metab, 3: 197-201.

Clifford, M and J. Brown, 2006. Dietary flavonoids and health, broadening the perspective. In: Andersen O & Markham K Eds. Flavonoids: Chemistry, biochemistry and applications. CRC Press, Boca Raton: USA.

Efterpi, C., B. Eleftherios and F. Panagiota, 2012. Nutritional and Functional Properties of Cynara Crops (Globe Artichoke and Cardoon) and Their Potential Applications: A Review. Int J App Sci Technol., 2: 64-70.

Fossati, P. and L. Prencipe, 1982. The determination of triglyceride using enzymatic methods. Clin. Chem., 28: 2077.

Fratianni, F., M. Tucci, M. De Palma, R. Pepe and F. Nazzaro, 2007. Polyphenolic composition in different parts of some cultivars of globe artichoke (*Cynara cardunculus* L. var. *scolymus* (L.) Fiori). Food Chem., 104: 1282-86.

Fruchart, J.C., 1982. LDL Cholesterol determination after separation of low density lipoprotein. Rev. Fr. Des Lab., 103: 7-17.

Fukumoto, L.R. and G. Mazza, 2000. Assessing antioxidant and proxidant activities of phenolic compounds. Journal of Agricultural and Food Chemistry, 48: 3597-3604.

Gould, A.L., G.M. Davies, E. Alemao, D.D. Yin and J.R. Cook, 2007. Cholesterol reduction yields clinical benefits: meta-analysis including recent trials. Clin. Ther., 29: 778-794.

Hosseinzadeh, M., F. Shekari, M. Janmohammadi and N. Sabaghnia, 2013. Effect of sowing date and fliar application of salicylia acid on forage yields and quality of globe artichoke (cynara scolymus L.) Annales 8: 50-59.

Jimenez-Escrig, A., L. Dragsted, B. Daneshvar, R. Pulido and F. Saura-Calixto, 2003. In vitro antioxidant of edible artichoke (cynara scolymus L.) and effect of biomarkers of antioxidant in rats. Journal of Agriculture and Food Chemistry, 51: 5540-5545.

Joseph, J.D. and R.G. Ackman, 1992. Capillary column gas-chromatographic method for analysis of encapsulated fish oils and fish oil ethyl-esters e collaborative study. Journal of AOAC International, 75: 488-506.

Joy, J.F. and S.L. Haber, 2007. Clinical uses of artichoke leaf extract. Am. J. Health Syst. Pharm., 64: 1906-1909.

Justesen, U. and P. Knuthsen, 2001. Composition of flavonoids in frsh herbs and calculation of flavonoid intake by use of herbs in traditional Danish dishes. Food Chemistry, 73: 245-250.

Juzyszyn, Z., B. Czerny, A. Pawlik and M. Drozdzik, 2008. The effect of artichoke (*Cynara scolymus* L.) extract on ROS generation in HUVEC cells. Phytother. Res., 22: 1159-1161.

Knight, J.A., S. Anderson and J.M. Rowle, 1972. Chemical bases of the sulpfo-phospho vanillin reaction for estimating total serum lipids. J. Clin. Chem., 18 : 199-204.

Kucukgergin, C., A.F. Aydin, G.O. Ozdemirler, G. Mehmetcik, N. Kocar-Toker and M. Uysal, 2010. Effect of artichoke leaf extract on hepatic and cardiac oxidative stress in rats fed on high cholesterol diet. Biol Trace Elem Res., 135: 264-74.

Kukic, J., V. Popovic, S. Petrovic, P. Mucaji, A. Ciric, D. Stojkovic and M. Sokovic, 2008. Antioxidant and antimicrobial activity of Cynara cardunculus extracts. Food Chemistry, 107: 861-868.

Küskü-Kiraz, Z., G. Mehmetçik, S. Dogru-Abbasoglu, M. Uysal, 2010. Artichoke leaf extract reduces oxidative stress and lipoprotein dyshomeostasis in rats fed on high cholesterol diet. Phytother. Res., 24: 565-570.

Lattanzio, V., 1982. Composizione valore nutritivo e terapeutico del carciofo, Informatore Agrario XXXVIII, 1*:* 18727-31.

Lattanzio, V., N. Cicco and V. Linsalata, 2005. Antioxidantactivities of artichoke phenolics. *Acta Horticulturae*, 681: 421-428.

Lattanzio, V., A.K. Paul, L. Vito and C. Angela, 2009. Globe artichoke: a functional food and source of nutraceutical ingredients. J Funct Foods, 1: 131-44.

Llorach, R., J. Espin, B.F. Tomas and F. Ferreres, 2002. Artichoke (*Cynara scolymus* L.) byproducts as a potential source of health-promoting antioxidant phenolics. J. Agric. Food Chem., 50: 3458-3464.

Lutz, M., C. Henriquez and M. Escobar, 2011. Chemical composition and antioxidant properties of mature and baby artichokes (cynara scolymus L.) raw and cooked. Journal of Food Composition and Analysis, 24: 49-54.

Mader, Z., 1983. Effect of brown rice and soybean dietary fiber on the control, glucose and lipid metabolism in diabetic rats. Am. M. J. Clin. Nutr., pp: 388-393.

McKenney, J.M., 2001. Pharmacotherapy of dyslipidemia. Cardiovasc. Drugs Ther., 15: 413-422.

Mulvihill, E.E. and M.W. Huff, 2010. Antiatherogenic properties of flavonoids: implications for cardiovascular health. Can. J. Cardiol., 26: 17A-21A.

Pandino, G., S. Lombardo, G. Mauromicale and G. Williamson, 2011. Profile of polyphenols and phenolic acids in bracts and receptacles of globe artichoke (Cynara cardunculus var. scolymus) germplasm. J Food Compos Anal., 24: 148-53.

Pandino, G., S. Lombardo and G. Mauromicale, 2013. Globe artichoke leaves and floral stems as a source of bioactive compounds. Industrial Crops and Products, 44: 44-49.

Perez Garcia, F., T. Adzet and S. Canigueral, 2000. "Activity of artichoke leaf extract on reactive oxygen species in human leukocytes", Free Radical Research, 33: 661-665.

Pinto, M.S., F.M. Lajalo and M.I. Genovese, 2008. Bioactive compounds and quantification of total ellagic acid in strawberries (Fragaria×ananassa Duch) Food Chemistry, 107: 1629-1635.

Rottenberg, A. and D. Zohary, 1996. "The wild ancestry of the cultivated artichoke." Genet. Res. Crop Evol., 43: 53-58.

SAS System for Windows (Statistical Analysis System), 2008. Version 9.2. Cary, USA: SAS Institute Inc. S.

Shen, Q., Z. Dai and L. Yanbin, 2010. Rapid determination of caffeoylquinic acid derivatives in cynara scolymus L by ultrafast liquid chromatography/ tandem mass spectrometry based on a fused core C18 column. Journal of separation science, 33: 3152-3158.

Shimoda, H., K. Ninomiya, N. Nishida, T. Yoshino, T. Morikawa, H. Matsuda, M. Yoshikawa, 2003. Anti-hyperlipidemic sesquiterpenes and new sesquiterpene glycosides from the leaves of artichoke (*Cynara scolymus* L.): structure requirement and mode of action. Bioorg. Med. Chem. Lett., 13: 223-228.

Sonnante, G., D. Pignone and K. Hammer, 2007. The domestication of artichoke and cardoon: from Roman times to the genomic age. Ann Bot., 100: 1095-1100.

Sosulski, F., K. Krygier and L. Hogge, 1982. "Free esterified and insoluble-bound phenolic acids. 3. Composition of phenolic acids in cereal and potato flours", Journal of Agricultural and Food Chemistry, 30: 337-340.

Speroni, E., R. Cervellati, P. Govoni, S. Guizzardi, C. Renzulli and M.C. Guerra, 2003. Efficacy of different Cynara scolymus preparations on liver complaints. Journal of Ethnopharmacol., 86(2-3): 203-11.

Tietz, N.W., 1986. Text Book of Clinical Chemistry. P.796.Saunders, W. B. Co., London-Pheladelphia.

Wang, M., J.E. Simon, I.F. Aviles, K. He, Q.Y. Zheng and Y. Tadmor, 2003. Analysis of antioxidative phenolic compounds in artichoke (*Cynara scolymus* L.). J. Agric. Food Chem., 51: 601-608.

Yeh, Y.F., R.C. Hoseney and D.R. Lineback, 1980. "Changes in wheat flour pentosans as a result of doughmixing and oxidation", Cereal Chemistry, 57: 144-148.

Zapolska, D.D., D.A. Zapolski, M. Naruszewicz, A. Siennicka, B. Krasnodebska and B. Koldziej, 2002. Protective properties of artichoke (*Cynara scolymus*) against oxidative stress induced in cultured endothelial cells and monocytes. Life Sci., 71: 2897-2908.

Zhishen, J., T. Mengcheng and W. Jianming, 1999. "The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals", Food Chemistry, 64: 555-559