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Investigation the potential role of some medicinal plants extracts in regulating serum lipid profile in female albino rats

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Abstract

Strong evidence showed that many medicinal plants have the potential to reduce hyperlipidemia disease. The aim of this study was to determine the hypolipidemic activity of aqueous extracts of *Fucus vesiculosus*, *Coleus forskohlii*, *Curcuma longa* L., *Rosmarinus officinalis* L., *Camellia sinensis* L. and *Melissa officinalis* L. on lipid profile in serum taken from the blood of rats. Fifty-seven female albino rats were divided into 19 groups, each with three rats, that were treated orally with an aqueous plant extract in three different doses, except the control group which was treated with normal saline only. The chemical compositions of these extracts were analyzed using High Performance Liquid Chromatography (HPLC).The results showed that the dose of 5 mg/kg of*Curcuma longa* was the powerful extract which reduced levels of cholesterol (CHO) and low-density lipoprotein (LDL) in serum rats' blood by 31 and 55%, respectively, compared with the control treatment. While, the effective extract to reduce triglycerides (TG) level was that of*Fucus vesiculosus*(50mg/kg) which reduced TG by 38% compared with the control. Also, *Melissa officinalis*(50 mg/kg) extract reduced 30% of very low-density lipoprotein (VLDL) level as compared to the control treatment. In addition, *Coleus forskohlii*(100 mg/kg) extract increased high-density lipoprotein (HDL) level by 115% after being orally given to rats for four weeks. The results of the study indicated significant differences among the concentrationsof the secondary compoundswithin their extracts, which maybe responsible for the observed variations of hypolipidemic activity for each extract. Based on these results, further investigation should target understanding the mechanismsby which these plants can be used as food additives and as dietary supplement.

Keywords: Hypolipidemic, aqueous extracts, Lipid profile, albino rats.

دراسة الدورالمحتمل لبعض مستخلصات النباتات الطبية في تنظيم مستوى الدهون في مصل اناث الجرذان البيضاء

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الخلاصة

أظهرت الدلائل القوية أن العديد من النباتات الطبية لديها القدرة على الحد من مرض زيادة الدهون في الدم. كان الهدف من هذه الدراسة هو تحديد الفعالية المثبطة للدهون للمستخلصات المائية في طحلب

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الفيوكس, نبات الكوليس , الكركم, المليسا , اكليل الجبل والشاي الاخضر في مصل دم الجرذان. تم تقسيم سبعة وخمسين من إناث الجرذان البيضاء في 19 مجموعة كل مجموعة تتالف من 3 جرذان تم تجريعها بثلاث جرع مختلفة عن طريق الفم بالمستخلصات المائية للنباتات المذكورة. عدا مجموعة السيطرة التي تم تجريعها بالنورمال سلاين فقط. .ايضا تم تحليل التراكيب الكيميائية لهذه المستخلصات باستخدام كروماتوغرافيا سائلة عالية الضغط (**HPLC**) . اظهرت النتائج ان الجرعة بتركيز 5ملغ/كيلو من نبات *Curcuma longa* كان المستخلص الاقوى في خفض الكوليسترول (CHO) والبروتين الدهني منخفض الكثافة (LDL) بمعدل 31 و55 % على التتابع مقارنة بمعاملة السيطرة ، في حين كان المستخلص الفعال لتقليل الدهون الثلاثية (TG) في نبات *Fucus vesiculosus* بتركيز 50 ملغم لكل كليوغرام اذ انخفض بمقدار 38% مقارنة بمعاملة السيطرة . اما عند اعطاء مستخلص نبات *Melissa officinalis* وبتركيز 50 ملغم لكل كيلو فان البروتين الدهني منخفض الكثافة للغاية (VLDL) قد سجل اكبر انخفاض30% مقارنة بمعاملة السيطرة. بالمقابل فقد سجل مستخلص نبات *Coleus forskohlii* وبتركيز 100 ملغم لكل كيلو اعلى ارتفاع في مستوى البروتين الدهني عالي الكثافة (HDL) 115% بعد إعطائه الجرذان لمدة اربعة اسابيع. أشارت نتائج الدراسة الى وجود فروق معنوية بين تراكيز المركبات الثانوية لهذه المستخلصات, والتي ربما تكون مسؤولة عن تباين نشاط نقص الدهون في الدم لكل مستخلص. بناءا على هذه النتائج يجب ان تهدف بحوث اضافية الى فهم الية استخدام هذه النباتات كمضافات ومكملات غذائية.

Introduction

Lipids are defined as biological substances which are generally hydrophobic in nature and in many cases soluble in organic solvents [1].The main biological functions of lipids include energy storage, signalling, and acting as structural components of cell membranes [2]. Lipids are absorbed from the small intestine and emulsified by bile salts,while they are synthesized from cholesterol in the liver, stored in the gallbladder and secreted following the ingestion of fat [3]. The conditions associated with the increase or decrease of levels of lipids in blood serum are known as hyperlipidemia and hypolipidemia, respectively. Hyperlipidemia is an increase in one or more of the plasma lipids, including triglycerides, cholesterol, cholesterol esters and phospholipids. It is also associated with increased levels of plasma very low-density lipoprotein and low-density lipoprotein, as well as reduced levels of high-density lipoprotein [4]. Hyperlipidemia is considered as one of the major risk factors causing cardiovascular diseases (CVDs) [5].

Hypolipidemia is a decrease in plasma lipoprotein caused by primary (genetic) or secondary (acquired) factors. It is usually asymptomatic and diagnosed incidentally on routine lipid screening [6]. Hypolipidemia is generally uncommon, but secondary causes are relatively common as compared to the rare primary hypolipidemic disorders. The frequency of hypolipidemia depends on which plasma cholesterol level is used to define the condition [7]. Moreover, many studies showed that elevated total or low density lipoprotein (LDL) cholesterol in the blood are powerful risk factors for coronary heart disease [8], whereas high HDL-cholesterol: LDL-cholesterol ratio may protect against this disease [9].

Herbal medicines are based on the premise that plants contain natural substances that can promote health and alleviate illness. Several herbs might help to reduce high blood lipids, among which*Fucus vesiculosus, Coleus forskohlii, Curcuma longa* L., *Rosmarinus officinalis* L., *Camellia sinensis* L. and *Melissa officinalis* L were tested in the present study. Therefore, this study was conducted to investigatethe effects of various extracts (aqueous) on increasing HDL and decreasingCHO, TG, LDL and VLDL levels in serum of laboratory rats.

Materials and methods

1-Collection of plant samples

Plant samples included dry leaves of *Rosmarinus officinalis*, *Camellia sinensis, Melissa officinalis*,rhizome of *Curcuma longa* and roots of *Coleus forskohlii*which were obtained from Baghdad, Iraq, while thallus of *Fucus vesiculosus* was obtained from Amman, Jordan. Each sample was air dried in shade and grinded by a blender to give small-size pieces (2 mm), then stored in a glass container at room temperature in a dry dark place before being used in the extraction step.

2-Preparation of plants aqueous extracts

An aqueous extract was prepared for each plant in different methods according to the plant parts [10].Then each extract was stored in a refrigerator until use. Different concentrations of each plant extract werepreparedby dissolving certain weight of each plant powderin D.W, according to the needed concentration. Then different concentrations (mg/ml) of plant extracts were prepared according the following equation [11]:

Concentration mg/ml = weight/ volume x 1000

3- Analysis of chemical composition of the plant extracts by HPLC

The analysis was carried out in the laboratories of the Ministry of Science and Technology **[**12]. Samples were analyzed by high performance liquid chromatography (HPLC;SYKAM, Germany).For calculating the concentration of each sample, the following formula was used:

$$\text{Conc. of sample } \mu g/ml = \frac{\text{Area of sample}}{\text{Area of standard}} \times \text{conc. of standard x dilution factor}$$

4-Laboratory animals

Fifty-seven female albino rats with an age range of8-10 weeks and a weight range of60-120 g were obtained from the National Center for Drug Control and Research. The animals were housed with a temperature range of 27±2Cº and the experimental protocol design was applied according to OCED [13]. The experimentswere conducted in the Research and Production Center for Veterinary Drug which provided the ethical approval ofall the experimental protocols. The rats were divided randomly into groups; each group was kept in a separate plastic cage. Rats were maintained under standard conditions of ventilation, temperature and humidity. Food and water were available; all animals were sacrificed at the end of the study.

5-Experimental design

This experiment was designed to evaluate the effects of some medicinal plants on lipid profiles in female albino rats. These parameters were examined after one month of the experiments. Rats received three different oral doses (mg/kg) and they were divided into 19 groups, each with 3 rats . The doses for each plant were designeddepending on the literatures(Table-1).

Table 1-Doses of plant aqueous extracts in mg/kg

Plants	Groups	Doses (mg/kg)	References
Fucus vesiculosus	1	50	[14]
	2	100	
	3	150	
Curcuma longa	4	5	[15]
	5	10	
	6	20	
Coleus forskohlii	7	100	[16]
	8	300	
	9	1000	
Melissa officinalis	10	50	[17]
	11	100	
	12	150	
Rosmarinus officinalis	13	170	[18]
	14	220	
	15	270	

Camellia sinensis	16	1.25	[19]
	17	2.5	
	18	5	
Control	Rats treated with normal saline only		

6-Collection of blood samples

Five milliliters (ml) of blood were directly withdrawn from the heart of the animals by cardiac puncture using a medical syringe. Each blood sample was placed in a tube containing ananticoagulant-free gel to obtain the serum,then centrifuged at 3000 rpm for 15 minutes to ensure a sufficient amount of serum that is free of red blood cells. The serum was then withdrawn and placed in a special plastic tube, which was kept clean and stored at -20 ° C until used [20].

7-Biochemical analysis

Spectrophotometer was used to measure different parameters in this study. Previously described methodswere used to determine total cholesterol[21]andTriglycerides[22]. Levels of HDL and LDL cholesterol were determined using methods reported by other studies [23, 24, respectively], while VLDL concentration was estimated using a previously described equation [25].

Statistical analysis

All data were presented as mean ±SD (standard deviation). The data were analyzed by one-way ANOVA followed by student t-test using SPSS software package version 17.0 (SPSS Inc., Chicago, IL, USA). The differences were considered as significant at $P<0.05$.

Results and discussion

Lipid profile assay of the studied groups

1-The effects of *Fucus vesiculosus* on the lipid profile

The results in Table-2 show the effects of *Fucus vesiculosus* extract on the levels of serumlipids.The results of the oral administration of *F. vesiculosus* for four weeks indicated that the levels of CHO, TG, LDL and VLDL were decreased, while the level of HDL was increased. The results also indicated that the lowest CHO and TG values were recorded usingthe 50 mg/kg treatment, showing reduction percentages of -21 and - 38 % as compared to the control (refer to the equation below). The lowest values for LDL and VLDL were observed with the 100 mg/kg and 150 mg/kg treatments, being reduced by -25 and -23% as compared to the control,respectively.In addition, the highest HDL value was recorded using the 50 mg/kg treatment, showing an increase of 73% compared with the control treatment.

*The percentages of differences were estimated according to apreviously described equation [26]:

C1 – C2/C1*100

Table 2-The effects of *F. vesiculosus* extractson CHO, TG, HDL, LDL and VLDL levels in rat's blood serum after four weeks of administration

Concentration (mg/kg)	Mean ± SE				
	CHO	TG	HDL	LDL	VLDL
50	123 .00 ± 0.57	106.67 ± 0.88	25.67 ± 0.88	83.67 ± 4.37	30.00 ± 4.58
100	125.00 ± 0.57	118.00 ± 4.61	22.67 ± 0.88	81.00 ± 2.30	28.00 ± 1.53
150	130.00 ± 6.55	129.33 ± 5.36	23.67 ± 1.45	86.33 ± 7.26	26.00 ± 1.15
Control	155.00 ± 9.64	171.33 ± 5.54	14.83 ± 0.60	108.33 ± 10.13	33.67 ± 1.20
LSD value (P<0.05)	19.062	14.736	3.277	21.877	8.332

Hypercholesterolemia, the most common risk factor associated with atherosclerosis, is characterized by the presence of high cholesterol levels in the blood. It has been previously reported [27] as one of the most important risk factors in the development and progression of atherosclerosis that leads to cardiovascular diseases (CVDs). Hypercholesterolemia poses a major problem to many societies and health professionals due to the close correlation between cardiovascular diseases and lipid abnormalities [28]. Lipids, represented by phospholipids, cholesterol, triglycerides (TG) and fatty acids, are considered essential to the human body, both by making up the basic structure of cell membranes (phospholipids) and by acting as precursors to steroid hormones, bile acids and vitamin D. The present results are possibly due to the effect of *Fucus*extractby decreasing trans-sialidase activity in the blood, an enzyme associated with cholesterol accumulation. Thus, this treatment may benefit patients with low thyroid function because slow metabolism is associated with excessive lipid and glucose accumulation [29]. Chemical analysis of *F. vesiculosus* indicated the presence of a wide range of compounds such as sodium alginate, which is a soluble algal polysaccharide found in many seaweeds, including *Fucus*, and may lower serum lipid levels [30].

2-The effects of *Curcuma longa* on the lipid profile

After four weeks of *C. longa* treatment, the results in Table-3 show that the levels of serum CHO, TG, LDL and VLDL were decreased, while the level of HDL was increased. The results indicated the lowest CHO, TG, LDL and VLDL levels using the 5 mg/kg treatment, showing reductions by-31, -18, -55 and -21%, respectively, as compared to the control. In addition,the highest HDL was increased was recorded using the 5 mg/kg treatment, which showed a reduction of 39% as compared with the control treatment.

Table 3-The effects of *C. longa* extractson CHO, TG, HDL, LDL and VLDL levels in rat's blood serum after four weeks of administration

Concentration (mg/kg)	Mean ± SE				
	CHO	TG	HDL	LDL	VLDL
5	107.67 ± 1.85	141.00 ± 23.64	20.67 ± 2.96	48.33 ± 2.33	26.67 ± 5.54
10	126.33 ± 7.21	148.33 ± 8.41	20.67 ± 1.20	75.67 ± 6.43	27.67 ± 2.18
20	130.00 ± 3.51	156.33 ± 4.84	19.00 ± 1.15	81.33 ± 3.48	31.67 ± 0.88
Control	155.00 ± 9.64	171.33 ± 5.54	14.83 ± 0.60	108.33 ± 10.13	33.67 ± 1.20
LSD value (P<0.05)	20.683	42.645	5.628	20.74	10.02

The 4- weeks oral administration of rats with*Curcuma longa*indicated that the levels of CHO, TG, LDL and VLDL were decreased, while the level of HDL was increased as compared with the control. These results are possibly due to the presence of curcumin, which is highly concentrated in the rhizomes of *C.longa*. Curcumin significantly reduces levels oflow density lipoprotein and very low density lipoproteinin the plasma and total cholesterol in the liver, whereas it increasesa-tocopherol level in rat plasma, suggesting an in vivo interaction between curcumin and a-tocopherol that may increase the bioavailability of vitamin E and decrease cholesterol levels [31].

3-The effects of *Coleus forskohlii* on the lipid profile

The results in Table-4 indicate that the serum levels of CHO, TG, LDL and VLDL were decreased, while the level of HDL was increased. The results indicated that the lowest CHO, LDL and VLDL values were observed with the 100 mg/kg treatment, showing reductionsby -15, -29 and -29%, respectively, as compared to the control. Also, the highest HDL level was recorded using thesame treatment and showed an increase by 115%as compared to the control treatment. The lowest TG level was observed with the 300mg/kg which was reduced by - 28%. According to these result, it seems that 100 mg/kg was the most effective concentration.

Table 4-The effects of *Coleus forskohlii* extractson CHO, TG, HDL, LDL and VLDL levels in rat's blood serum after four weeks of administration

Concentration (mg/kg)	Mean ± SE				
	Cholesterol	Triglyceride	HDL	LDL	VLDL
100	131.00 ± 4.16	127.00 ± 7.63	32.00 ± 4.93	77.00 ± 6.42	24.33 ± 1.45
300	135.33 ± 0.88	123.33 ± 1.85	21.00 ± 0.57	82.00 ± 8.08	24.00 ± 0.57
1000	142.67 ± 5.54	143.33 ± 5.89	20.33 ± 0.88	91.67 ± 6.35	28.67 ± 1.20
Control	155.00 ± 9.64	171.33 ± 5.54	14.83 ± 0.60	108.33 ± 10.13	33.67 ± 1.20
LSD value (P<0.05)	19.423	18.40	8.283	25.770	3.765

The oral administration of rats with*C. forskohlii*for four weeks reveals that the levels of CHO, TG, LDL and VLDL are decreased, while the level of HDL is increased as compared tothe control. These findings are in agreement with previously published results [32] which found that forskolin reduced cAMP production and acted as an anti-obesity agent. The above results arepossibly related to the presence of forskolin in the roots which increases cAMP accumulation and stimulates lipolysis. Enhanced lipolysis increases fat degradation and usage as a fuel in the body, which promotes fat and weight loss [33]. Cyclic AMP promotes the breakdown of stored fats in animal and human fat cells. Also, Han *et al.*, [34] proved that the administration of *C. forskohlii* extracts reduced body weight, food intake and fat accumulation in rats. Due to its cAMP stimulating properties, forskolins have been used as tonics for weight loss and body shape management.

4-The effects of *Melissa officinalis* on the lipid profile

The results shown in Table-5 demonstrate the effects of *Melissa officials* and demonstrate that the lowest CHO, TG, LDL and VLDL values were observed using the 50 mg/kg treatment, with reductions by -26, - 28, -41 and -30%, respectively, as compared to the control. Besides, the highest HDL level was recorded using the 50 mg/kg treatment, which showed an increase by 96% compared with the control treatment.

Table 5-The effects of *M. officinalis* on CHO, TG, HDL, LDL and VLDL levels in rat's blood serum after four weeks of administration

Concentration (mg/kg)	Mean ± SE				
	CHO	TG	HDL	LDL	VLDL
50	114.33 ± 5.20	122.67 ± 6.01	29.00 ± 1.52	63.67 ± 5.84	23.67 ± 1.20
100	129.33 ± 16.89	131.67 ± 2.84	23.00 ± 0.57	106.33 ± 4.09	26.00 ± 1.00
150	128.67 ± 8.56	127.33 ± 3.75	25.33 ± 2.33	88.67 ± 6.11	25.00 ± 0.57
Control	155.00 ± 9.64	171.33 ± 5.54	14.83 ± 0.60	108.33 ± 10.13	33.67 ± 1.20
LSD value (P<0.05)	35.687	15.303	4.746	22.542	3.350

After the administration of *M. officinalis* to rats, the results showed an agreement with the previous findings[35] that the supplementation of *M. officinalis* extract caused increased HDL and significantly decreased LDL-c, TC and TG levels. Changizi-Ashtiyani *et al.*,[36] reported that *M. officinalis* and barberry extracts can reduce serum levels of cholesterol, LDLand triglyceride. Jun *et al*. [37], in a study on the impact of *M. officinalis* extract on reducing plasma triglyceride levels, have noted the presence of quercetin compounds in the plant, which may have an inhibitory effect on lipid

peroxidation. In another study, Bolkent *et al*. [38] examined the effect of *M. officinalis* extract on hyperlipidemic rat's liver and reported reductions in liver cholesterol, total lipid, lipid peroxidation and liver enzymes, along with an increase in the glutathione levels.Besides, *M. officinalis* is rich in flavonoids that may have anti-inflammatory activities as well as antioxidant and lipid lowering effects [39].

5-The effects of *Rosmarinus officinalis* on the lipid profile

The obtained results in Table-6 show that *Rosmarinus officinalis* treatments affected CHO, TG, HDL, LDL and VLDL levels in rats blood serum. The lowest levels of CHO, TG, LDL and VLDL were recorded at 270 mg/kg treatment, showing decreasesby -25, - 25, - 41 and -28%, respectively, while HDL level was increased by 89% compared with the control treatment.

Table 6-The effect of *R. officinalis*extract on CHO, TG, HDL, LDL and VLDL levels in rat's blood serum after four weeks of administration

Concentration (mg/kg)	Mean ± SE				
	CHO	TG	HDL	LDL	VLDL
170	137.67 ± 7.17	131.33 ± 8.41	21.33 ± 1.76	133.33 ± 23.51	25.67 ± 1.76
220	138.33 ± 8.45	148.67 ± 23.84	17.67 ± 1.76	88.67 ± 12.41	29.33 ± 4.91
270	115.67 ± 2.60	129.33 ± 11.89	28.00 ± 6.55	64.33 ± 3.84	24.33 ± 2.84
Control	155.00 ± 9.64	171.33 ± 5.54	14.83 ± 0.60	108.33 ± 10.13	33.67 ± 1.20
LSD value (P<0.05)	24.332	46.449	11.482	46.819	9.887

These results are in agreement with the previous findings[40]that the oral administration of rosemary leaf extract caused significant declines in the blood levels of triglycerides, total cholesterol, LDL, but increased HDL. Rosemary leaf extract had a hypolipidemic potential, whichmight be an indication of progressive metabolic control of rosemary leaf extract on mechanisms involved in elimination of the lipids from the body. The most important constituents of rosemary are caffeic acid and its derivatives such as rosmarinic acid in addition to flavonoids. These compounds have antioxidant effects; Fuhrman *et al.* [41] reported that polyphenols, rosmarinic acid or carnosic acid (which contains a mixture of natural antioxidants) inhibited LDL oxidation in a dose-dependent manner. Gladine *et al*., [42] confirmed the ability of some polyphenols (e.g. flavonoids) to penetrate the lipid membranes constituted with phospholipids. Further, several authors also reported that flavonoids have hypolipidemic and hypocholesterolemic effects. Another study showed that flavonoids could reduce oxidized LDL in human and make LDL less susceptible to oxidative stress, and that flavonoids could recycle α-tocopherol by donating a hydrogen atom to the α-tocopherol radical, and thereby, delay the onset of lipid peroxidation. *Rosmarinus officinalis* water extract and its antioxidant compounds inhibit lipid peroxidation and free radicals generation in vitro and in vivo. Rosmarinic acid, diterpenoids and alpha-tocopherol were documented as the principal antioxidant constituents of rosemary extract [43].

6- The effects of *Camellia sinensis* on the lipid profile

Table-7 shows data on the different treatments of *Camellia sinensis*extractsthat affected CHO, TG, HDL, LDL and VLDL levels in rats blood serum. The levels of CHO, TG, LDL and VLDL were decreased, while the level of HDL was increased. In addition, the results indicated that CHO, TG, LDL and VLDL were reduced by -1.2, - 22, -4 and -25% respectively, while the HDL was increased by 48%, compared with the control treatment.

Table 7-The effects of *C. sinensis*extract on CHO, TG, HDL, LDL and VLDL levels in rat's blood serum after four weeks of administration

Concentration (mg/kg)	Mean ± SE				
	CHO	TG	HDL	LDL	VLDL
1.25	158.00 ± 8.54	142.67 ± 6.48	20.00 ± 1.20	108.67 ±7.85	28.00 ± 1.73
2.50	157.00 ± 4.72	135.33 ± 2.72	20.33 ± 0.88	107.33 ±5.36	26.00 ± 0.57
5.00	153.00 ± 6.02	133.67 ± 3.48	22.00 ± 1.15	104.33 ±7.35	25.33 ± 0.88
Control	155.00 ± 9.64	171.33 ± 5.54	14.83 ± 0.60	108.33 ±10.13	33.67 ± 1.20
LSD value (P<0.05)	24.441	15.678	3.227	25.650	3.843

These results agree with the findings of Shah *et al.,* [44] who found that the green tea has the capacity to reduce some of hyperlipidemia indices by a significant amount. These hypolipidimic activities of *C. sinensis*result from having catechin compounds which are strong stimulators of thermogenesis, hepatic β-oxidation, and hypolipidemic activity by lowering the intestinal absorption of lipids. Hence, the utilization of green tea can minimize the risk of atherosclerosis and cancer. Catechins, namely epigallocatechin (ECG) and epigallocatechin gallate (EGCG), were the more effective. EGCG has the ability to recycle vitamin E as an antioxidant; the recycling of antioxidants by their free radical electron transfer allows them to protect cells against lipid peroxidation in both membranes and LDL, because LDL oxidation increases the risk of atherogenic process.Antioxidant protection of LDL particles is fundamental for preventing cardiovascular disease.Besides, green tea polyphenol may exert an anti-atherosclerotic action by virtue of its antioxidant properties and increasing HDL-cholesterol levels [45].

Chemical constituents of the plants extracts

Results in Table-8 show the differences between the concentrations of each secondary metabolic compound among the plant extracts. The total concentrations of these compounds in the extracts of *Fucus vesiculosus*, *Coleus forskohlii*, *Curcuma longa*, *Melissaofficinalis*, *Rosmarinus officinalis* and *Camellia sinensis* were 226.55µg/ml, 1461.7µg/ml, 23.878 µg/ml, 540.8806µg/ml, 192.20588µg/ml and 710.82905µg/ml, respectively.

Measurement of the total content of these medicinal plant extracts, using the HPLC method, revealed that the highest total concentration of all tested compounds was present in *Camellia sinensis* (710.82905µg/ml). Also, rosmarinic acid (4.632.813µg/ml) was the major compound in *Rosmarinus officinalis*, which may be responsible for the clear hypolipidemic activity of *R. officinalis* species. Furthermore, *Fucus vesiculosus* extracthad the lowesttotal value of compounds' concentrations(226.55 µg/ml). Besides, kemferol (100.95µg/ml) was the major compound in *F. vesiculosus*.Forskolin (816.6 µg/ml) was the major compound in *Coleus forskohlii*, while Gallic acid (645.1µg/ml) was the minor compound in the same plant. Curcumin (23.878 µg/ml) was the major compound in *Curcuma longa*,kemferol (2.685.6µg/ml) was the major compound in *Melissa officinalis*, while Catechin (67.9 µg/ml) was the minor compound in their extracts. Finally, Catechin (8.839.6 µg/ml) was the major compound in *Camellia sinensis*extract, while Lutinene (380 µg/ml) was the minor compound.

The significant differences of secondary compound concentrations in these extractsmight be the reasonbehindthe variation in the hypolipidemic activity of each extract.

Table 8-Types and total concentrations of the chemical compounds in plant extracts

No.	Compounds µg/ml	*Fucus vesiculosus*	*Coleus forskohlii*	*Curcuma longa*	*Rosmarinus officinalis*	*Melissa officinalis*	*Camellia sinensis*
1	**Epigenen**	-		-	-	2.863.2	1.378.45
2	**Forskolin**	-	816.6	-	-	-	-
3	**Curcumin**	-	-	23.878	-	-	-
4	**Gallic acid**	42.45	645.1	-	4.301.090	464.35	4.174.55
5	**Rosmaric acid**	3.65	-	-	4.632.813	1.331.05	-
6	**Lutinene**	-	-	-	2.182.977	-	380
7	**Catechin**	-	-	-	181.089	67.9	8.839.6
8	**Caffic acid**	61.2	-	-	-	-	15.150
9	**Qurcetine**	11.3	-	-	-	1.750.75	288.55
10	**Kemferol**	100.95	-	-	-	2.685.6	9.992
11	**Tannic acid**	7	-	-	-	-	2.744.45
	Total concentration µg/ml	226.55	1461.7	23.878	192.20588	540.8806	710.82905

Conclusion

In the first step of this study on beneficial effects of orally-administered medicinal plants on serum lipids in rats, six medicinal plants were described to be effective on lipid profile,lowering serum triglyceride, total cholesterol, and LDL-C, whileincreasing serum HDL level. In this study, the dose of 5 mg/kg of*Curcuma longa* was the most powerful extract that reduced CHO and LDL levels in rat serum by 31 and 55%, respectively, compared with the control treatment. While, the effective extract to reduce TG level was that of 50mg/kg of*Fucus vesiculosus*which caused a reduction of 38% compared with the control. Also, *Melissa officinalis*(50 mg/kg) reducedthe VLDL level by 30% as compared to the control treatment. Moreover, *Coleus forskohlii*(100 mg/kg) extract increased HDL level by 115%. Finally, the hypolipidemic activities of the medicinal plants reported hereshow the potential of usage in reduction of hyperlipidemia disease.Based on these results, further investigation should target understanding the mechanisms of use of these plants as food additives and as dietary supplements.

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