

Hypolipidemic Effect of Sumac (*Rhus Coriaria L*) Fruit Powder and Extract on Rats Fed High Cholesterol Diet

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ABSTRACT

Fruits of sumac (*Rhus coriaria*) are widely used spice which has several properties such as antioxidant, anti-inflammatory and antimicrobial. The present study was conducted to test the hypolipidemic effect of sumac fruit powder and extract under various concentrations against hyperlipidemia. Chemical composition, minerals content, total phenolic, flavonoid and antioxidant activity were determined. Forty two male albino rats were used in the study, they were distributed into six groups, (n=7 rats). Group 1 was fed on standard diet as a negative control (-ve). The other five groups were fed on basal diet containing 4% cholesterol and 1% cholic acid (HCD) for 8 weeks to induce hypercholesterolemia. Group 2 (positive control group) was fed on HCD only. Groups 3 and 4 were fed on HCD + sumac powder at 5 and 10% per kg diet. Groups 5 and 6 were fed on HCD + sumac extract at 0.5 and 1.0 g/kg b.w/day orally respectively. Results recorded that sumac is a source of dietary fibers, minerals, flavonoid, phenolic and antioxidants activity. The results indicated that positive group (+ve) showed significantly higher level of serum TC, TG, LDL-c, VLDL-c, urea, uric acid, creatinine, ALT, AST, ALP, TNF α , MDA and acetyl cholinesterase (AChE) and decrease in serum HDL-c and SOD, while the groups treated with sumac powder at 5% and 10% and sumac extract at 0.5 and 1.0 g can reduce blood cholesterol and other lipids and improve liver and kidney function especially the level of 10% powder and 1.0g extract compared to positive group (+ve). It could be concluded that, fortified diets with 10% sumac powder and those which received sumac extract at 1.0 g had the best effect on hypercholesterolemic rats.

Key words: Sumac, hypercholesterolemia, serum lipids, DPPH, kidney and liver function.

INTRODUCTION

Sumac (*Rhus coriaria L.*, family *Anacardiaceae*) is one of the most popular spices in Mediterranean and Arabic countries, which is obtained by crushing the dried fruits. Sumac is used in traditional medicine for its antibacterial and antioxidant effect (Aliakbarlu *et al.*, 2013 ; Ali-Shtayeh *et al.*, 2013 and Kossah *et al.*, 2013), antifungal (Onkar *et al.*, 2011), anti-inflammatory (Panico *et al.*, 2009), DNA protective (Chakraborty *et al.*, 2009), hypoglycemic (Golzadeh *et al.*, 2012 and Anwer *et al.*, 2013), and hypolipidemic activities (Madihi *et al.*, 2013).

Sumac is a rich source of tannins, phenolic compounds, oleic and linoleic acids, vitamins, minerals, anthocyanins and organic acids (Zargham and Zargham, 2008; Kossah, *et al.*, 2009 and Kossah, *et al.*, 2010).

Water extracts of sumac have marked antioxidant activity against

lipid peroxidation and free radicals, it protect humans against oxidative DNA-damage (Chakraborty *et al.*, 2009 and Bursal and Koksal, 2011).

Hypercholesterolemia is a disturbance of lipid metabolism caused by an increase of plasma concentrations of the various lipid and lipoprotein fractions, and considered as a major risk factor for hyperlipidemia disease and hypercholesterolemia.

Hyperlipidemia have been classified as one of the largest risk factors caused to the expansion, and riskiness of coronary heart diseases (Kolovou *et al.*, 2005; Reiner and Tedeschi, 2006; Roberts *et al.*, 2006 and Zainab Sajid *et al.*, 2016).

The aim of the present work was to study the hypolipidemic effect of sumac fruit powder and extract on rats fed high cholesterol diet.

MATERIALS & METHODS

Materials

Plant: Sumac (*Rhus coriaria L.*) fruits were obtained from Medical Herbs Center, Cairo, Egypt.

Chemicals:

Cholesterol, cholic acid, casein, cellulose, all vitamins and minerals ingredients were purchased from El-Gomhoryia Company for chemicals, El-Mansoura City, Egypt. Kits were obtained from Biodiagnostic Company, Giza, Egypt.

Experimental animals:

Forty two male Sprague Dawely rats weighing $180 \pm 10g$ were obtained from Agricultural Research Center, Giza, Egypt.

Methods

Preparation of raw material

Sumac fruits were ground into powder then stored in polyethylene bags at 4°C until used.

Preparation of sumac Aqueous Extract:

30 g of sumac powdered were extracted with hot distilled water and cooled for 30 min, and filtrated twice. Extract was concentrated to dryness in vacuum, and stored in refrigerator according to (Ghaleb *et al.*, 2006).

Chemical analysis of raw materials:

Moisture, protein, crude fibers, fat content and ash contents were analyzed as described in the A.O.A.C (2000). Total carbohydrates were calculated by the difference. Minerals content included (Ca, P, K, Mg ,Fe & Zn) were determined according to Chapman & Pratt (1978). After complete digestion the minerals were determined using Unicam atomic absorption Spectrophotometer. Total phenole and flavonoid were determined according to Singleton *et al.*, (1999) and Zhishen *et al.*, (1999). Antioxidant activity assayed by the 1, 1-diphenyl-2-picryl-hydrazyl (DPPH) method of Brand-Wiliams *et al.*, (1995) with some

modification. The extract (0.5 and 1.0 g) in methanol (1 ml) was blended with 4 ml of 0.004% methanolic solution of DPPH. The blend was shaken strongly and left to stand for 30 min in dark and the absorbance was then measured at 517 nm.

The percent of DPPH decrease according to the equation:

Antiradical activity = $\frac{\text{Absorbance of control} - \text{Absorbance of sample}}{\text{Absorbance of control}}$

Biological Experiment:

Standard Diet: ordinary diet was prepared according to AIN-93 guidelines (Reeves *et al.*, 1993).

Induction of Hypercholesterolemia:

Hypercholesterolemia was induced in rats by feeding high cholesterol diet (4% cholesterol and 1% cholic acid) in normal diet for 8 weeks (Kamesh and Sumathi, 2012). Serum cholesterol level was monitored after two weeks

from each rat to make sure the induction of hypercholesterolemia.

Experimental design:

Animals were reserved in the laboratory in plastic cages under stable temperature ($24 \pm 2^\circ\text{C}$), and fed on standard diet for seven days for adaptation period, water was supplied ad-libitum, then rats were distributed into six groups (n=7 rats) as follow :

Group 1: Control normal group: Rats were fed on basal diet only without any treatment during the experimental period.

Group 2: Control positive group: Rats were fed on high cholesterol diet (HCD) only without any treatment.

Group 3: Rats were fed with HCD + 5% sumac powder per kg diet /daily after two weeks from the onset of induction of hypercholesterolemia.

Group 4: Rats were fed with HCD + 10% sumac powder per kg diet /daily after two weeks from the

onset of induction of hypercholesterolemia.

Group 5: Rats were fed with HCD + 0.5 g/kg, b.w /day sumac extract given orally by stomach tube after two weeks from the onset of induction of hypercholesterolemia.

Group 6: Rats were fed with HCD + 1.0 g /kg, b.w /day sumac extract given orally by stomach tube after two weeks from the onset of induction of hypercholesterolemia.

During the experimental period (8 weeks), feed intake, body weight gain and Feed efficiency ratio (FER) were determined according to **Chapman *et al.* (1950)**.

Biochemical analysis:

Serum total cholesterol, triacylglycerol, high density lipoprotein, low density lipoprotein and very low density lipoprotein were determined by the methods of **Richmond (1973); Fassati and Principe (1982); Gordon, (1977) and Friedewald *et al.* (1972)**

respectively. An atherogenic index was calculated by dividing TC / HDLc according to **Castelli and levitear (197)**. (ALT), (AST) and alkaline phosphates (ALP) were assayed by **Reitman and Frankel (1957) and Kind and King (1954)**. Serum uric acid, urea nitrogen and creatinine were determined by the methods of **Fossati *et al.* (1980), Patton and Crouch, (1977) and Bohmer (1971)**. Determine tumor necrosis factor (TNF- α), according to **Lin *et al.* (1998)**. Superoxide dismutase enzymes (SOD) and malondialdehyde (MDA) were estimated by **Beuchamp and Fridovich, (1971) and Ohkawa *et al.*, (1979)**. Acetylcholinesterase (AChE) activity was determined by **Knedel and Boottger, (1967)**.

Statistical analysis:

Data were statistically analyzed of variance “ANOVA” test at (P \leq 0.05) according to **Snedecor and Cochran (1967)**.

RESULTS & DISCUSSION

The chemical composition of sumac are illustrated in table (1).The moisture, protein, fat , ash, carbohydrate and fiber , ratios were (13.65, 4.93, 16.88, 5.09, 59.45 and 19.61 g/100g) respectively. The results in this study are similar to that obtained by **Özcan and Hacisefaerogullari, (2004) and Kizil and Turk, (2010)**. Furthermore sumac is rich in proteins, essential oils, fatty acids, and fiber (**Shabir, 2012**).

The minerals composition of sumac was presented in table (2). The results of calcium, phosphorus, potassium, magnesium, iron and zinc were (398.9, 123.7, 812.5, 85.67, 15.32 and 2.03 mg/100g) respectively. These data are confirmed with **Kossah et al., (2009)** who reported that sumac fruits could be used in the human diet to supply the required mineral elements. Many other studies indicated that K , Ca, Mg, and Ph were

found in sumac fruit (**Barakat et al., 2003; Özcan and Hacisefaerogullari, 2004; Özcan and Akbulut, 2007; Kizil and Turk, 2010**).

Data in table (3), showed that total phenol , flavonoid and scavenging effect of sumac extract on DPPH, the ratios of total phenol and flavonoid were (4836 and 769 mg/100g) respectively, while the DPPH radical-scavenging activity of sumac extract was (11.56 mmol/ml). The results in this study are similar to that obtained by **Mavlyanov et al., (1997)** who revealed that sumac's fruit rich in flavones, phenolic acids, hydrolysable tannins, anthocyanin and fatty acids. Sumac water extracts showed the strongest antioxidant activity (**Pourahmad, 2010 ; Bursal and Köksal, 2011 and Aliakbarlu et al.,2013**).

Data in Table (4) could be observed that there were significant increases in FI and BWG for control positive group in comparison

to the negative control (-ve). Groups fed on the hypercholesterolemic diet (HCD) containing sumac fruits powder at 5 and 10 % and those which received the extract at concentrations 0.5 and 1.0 g/kg showed improvement in FI and BWG compared to the negative control (-ve). The results recorded that FER of positive group (+ve) (hypercholesterolemic rats) was decreased compared with the negative control group, while groups treated with sumac powder and extract showed increase in FER comparable with the positive control. These data are in accordance with **Kosar *et al.*, (2006)** who demonstrated that sumac is rich in tannins; tannins present in sumac are hydrolysable, susceptible to cleavage by hydrolysis and have small molecular size. Their small size has made them to be easier to digest and absorb and have many health benefits. Also **Kossah *et al.*, (2009)** who indicated that sumac species can be

considered as potential sources of dietary fiber which is helpful in alleviating gastro-intestinal disorders.

The obtained data in Table (5) indicated that positive group (+ve) showed a marked significant increase in TC, TG, LDL-c, VLDL-c and Atherogenic indices. However it showed marked reduction in HDL-c compared with the negative control (-ve). Our results indicated that reduction of TC, TG, LDL-c, VLDL-c and Cholesterol/HDLc, associated with elevation of HDL-c in rats fed on HCD fortified with sumac powder at 5 and 10 % and the orally treated with extract at concentrations 0.5 and 1.0 g/kg compared with the positive control. Furthermore all treated groups with sumac powder and extract showed no significant difference in cholesterol/HDL-c compared with the negative control group (-ve). These results are confirmed with **Mansoob, (2012)** mentioned that the

hypocholesterolemic action of sumac may be owing to its polyphenolic components. Polyphenols have been shown to lower the inverse cholesterol transport, minimize the intestinal cholesterol absorption and elevated bile acid excretion. Sumac fruit extract decreased the high serum lipid levels (Mohammadi *et al.*, 2010 and Shafiei, *et al.*, 2011).

Results presented in Table (6) summarize the effect of sumac powder and extract at different ratios on serum uric acid, urea and creatinine in rats fed HCD. The positive control group recorded significant high level in serum uric acid, urea and creatinine in comparison to a negative control (-ve). Results revealed that there was non-significant difference in creatinine among negative control group and other treated groups. While the rats fed on supplemented diet with sumac powder and received extract showed significant decrease values of serum

uric acid, urea and creatinine compared with positive group (+ve). The best improvement of all parameters was observed in groups treated with sumac powder at 10 % and sumac extract at 1.0 g. These results are in parallel with those obtained by Mahidi *et al.*, (2013) showed that sumac extract decreased uric acid level. Sumac is rich in strong antioxidants called tannins, flavonoids, anthocyanins and phenolic acids (Al-Jassabi & Azirun, 2010; Pourahmad *et al.*, 2010 and Abu-Reidah *et al.*, 2015).

Results in Table (7) indicated that the positive control showed a significantly higher in AST, ALT and ALP in comparison to a negative control (-ve). Our results indicated that the high levels of AST and ALT in serum are indicators for liver dysfunction. These findings are in agreement with Al-Dosari, (2011) who revealed that rats fed on HCD for 70 day showed significantly higher levels in serum liver enzymes. In this

study all groups treated with sumac powder and extract showed significantly lower of AST, ALT and ALP comparable with positive group (+ve). Phenolic compounds and anthocyanins, present in the sumac have anti-oxidant effect against free radicals caused by HCD. The results in this study are similar to that obtained by **Attaby *et al.*, (2013)** and **Madihi *et al.*, (2013)** revealed that sumac lowered significantly the levels of AST and ALT. In this respect, the aqueous extract of sumac fruit showed hepatoprotective activity against cytotoxicity of oxidative stress (**Abbass *et al.*, 2012**).

Results in Table (8) revealed that positive group (+ve) showed a significantly lower level of SOD activity while it recorded significantly higher level of TNF- α , MDA and Acetylcholinesterase (AChE) as compared to the negative control (-ve). These results are agree with **Derosa *et al.*, (2015)** who reported that

mice fed on high fat diet exhibited increase in TNF- α plasma level . All treated groups with sumac fruits powder at 5 and 10 % and groups that received extract at concentrations 0.5 and 1.0 g/kg showed improvement in SOD while it showed a significantly lower levels of TNF- α , MDA and Acetylcholinesterase (AChE) compared with the positive group (+ve). These results matches with that of **Pourahmad *et al.* (2010)**, who demonstrated that the Malondialdehyde formation was significantly higher following reactive oxygen species (ROS) formation and aqueous extracts of sumac fruit inhibit both malondialdehyde formation and cytotoxicity. Furthermore **Mohammadi *et al.*, (2010)** and **Bursal and Koksai, (2011)** indicated that sumac extract increased superoxide dismutase and catalase activities. Others demonstrated that sumac extract (300 mg/ kg per animal) could act on the oxidative stress by

decreasing MDA and significantly increased the level of GSH and CAT activity (Beretta *et al.*, 2009; Darwish., 2011 and Aliakbarlu *et al.*, 2013). Also Singh *et al.*,(2014) indicated that (AChE) was significantly higher in animals fed on high fat diet, hence reduction acetylcholine needed for memory and learning.

CONCLUSION

In conclusion, sumac powder and extract at different ratios resulted in significant improvement in lipids profile, liver and kidney functions and antioxidant parameters in hypercholesterolemic rats.

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Table (1): Chemical composition of sumac (g/100g)

Nutrients	Moisture (%)	Crude Protein (%)	Fat (%)	Ash (%)	Carbohydrates (%)	Crude Fiber (%)
Sumac	13.65	4.93	16.88	5.09	59.45	19.61

Data are means of three determinations

Table (2): Minerals content of sumac (mg/100g)

Minerals	Calcium (mg/100g)	Phosphorus (mg/100g)	Potassium (mg/100g)	Magnesium (mg/100g)	Iron (mg/100g)	Zinc (mg/100g)
Sumac	398.9	123.7	812.5	85.67	15.32	2.03

Data are means of three determinations

Table (3): Total phenol and flavonoids and Scavenging effect of sumac extract on DPPH

Variables	T. phenol mg/100g	T. flavonoid mg/100g	DPPH mmol/ml
Sumac	4836	769	11.56

Data are means of three determinations

Table (4): Effect of sumac powder and extract on body weight gain, feed intake and feed efficiency ratio of hypercholesterolemic rats

Parameters Groups	Feed intake g/day/rat	Body weight gain (g)	FER
G1: Negative Control	13.19 ± 1.00 ^c	43.56 ± 2.21 ^c	0.059± 0.03 ^a
G 2: Positive Control	20.30 ± 0.88 ^a	48.95 ± 4.89 ^a	0.043± 0.04 ^d
G3: HCD + sumac powder 5%	16.34 ± 0.95 ^b	45.56 ± 3.21 ^b	0.050± 0.0 ^b
G4: HCD + sumac powder 10%	15.86 ± 1.02 ^b	44.19 ± 3.28 ^b	0.050± 0.0 ^b
G5: HCD + sumac extract 0.5 g	18.87 ± 2.5 ^b	46.22± 3.14 ^b	0.044± 0.03 ^c
G6: HCD + sumac extract 1.0 g	17.60 ± 1.80 ^b	45.01 ± 3.26 ^b	0.046± 0.02 ^c

Means ± standard deviations in the same column with different letters are significantly different (P ≤ 0.05)

Table (5): Effect of sumac powder and extract on lipids profile of hypercholesterolemic rats

Parameters Groups	T. Ch mg/dl	T.G. mg/dl	HDL-c mg/dl	LDL-c mg/dl	VLDL- c mg/dl	Atherogenic Index Cholesterol/ HDLc
G1: Negative Control	77.30 ±3.66 ^c	81.84 ±3.65 ^c	41.75 ± 1.13 ^b	19.18 ±1.23 ^c	16.37 ±1.08 ^b	1.85 ±0.098 ^b
G2: Positive Control	156.69 ±4.98 ^a	166.58 ±3.69 ^a	31.48 ±1.87 ^c	91.89 ±5.67 ^a	33.32 ±1.82 ^a	4.98 ±0.076 ^a
G3: HCD + sumac powder 5%	84.12 ±4.45 ^b	82.46 ±4.54 ^b	41.55 ±1.54 ^b	26.08 ±2.44 ^b	16.49 ±1.33 ^b	2.02 ±0.052 ^b
G4: HCD + sumac powder 10%	80.28 ±4.11 ^b	81.90 ±4.43 ^c	42.47 ±1.32 ^a	21.43 ±1.34 ^c	16.38 ±1.12 ^b	1.89 ±0.023 ^b
G5: HCD + sumac extract 0.5 g	79.67 ±1.99 ^c	83.36 ±2.55 ^b	39.12 ±2.11 ^b	23.88 ±2.01 ^b	16.67 ±1.64 ^b	2.04 ±0.056 ^b
G6: HCD + sumac extract 1.0 g	77.19 ±2.19 ^c	80.52 ±1.96 ^c	43.61 ±2.03 ^a	17.48 ±3.22 ^c	16.10 ±1.11 ^b	1.77 ±0.054 ^b

Means ± standard deviations in the same column with different letters are significantly different ($P \leq 0.05$)

Table (6): Effect of sumac powder and extract on kidney functions of hypercholesterolemic rats

Parameters Groups	Uric acid mg/dl	Urea mg/dl	Creatinine mg/dl
G1: Negative Control	1.73± 0.26 ^c	18.75± 1.13 ^c	1.27± 0.01 ^b
G2: Positive Control	3.87± 0.81 ^a	28.48± 1.87 ^a	2.75± 0.11 ^a
G3: HCD + sumac powder 5%	2.46± 0.15 ^b	23.95± 1.54 ^b	1.75± 0.13 ^b
G4: HCD + sumac powder 10%	1.97± 0.17 ^c	21.41± 1.08 ^b	1.45± 0.12 ^b
G5: HCD + sumac extract 0.5 g	2.01± 0.62 ^b	20.51± 2.03 ^b	1.49± 0.02 ^b
G6: HCD + sumac extract 1.0 g	1.81± 0.27 ^c	19.62± 2.11 ^c	1.38± 0.12 ^b

Means ± standard deviations in the same column with different letters are significantly different ($P \leq 0.05$)

Table (7): Effect of sumac powder and extract on liver functions of hypercholesterolemic rats

Parameters Groups	ALT μ /ml	AST μ /ml	ALP μ /ml
G1: Negative Control	29.35± 1.12 ^d	51.17± 5.81 ^d	44.17± 5.66 ^d
G2: Positive Control	46.55± 3.35 ^a	79.39± 9.61 ^a	60.38± 5.81 ^a
G3: HCD + sumac powder 5%	35.17± 2.01 ^b	57.25± 6.15 ^b	50.73± 4.37 ^b
G4: HCD + sumac powder 10%	33.84± 0.74 ^b	55.64± 4.25 ^c	47.34± 5.01 ^c
G5: HCD + sumac extract 0.5 g	34.23± 2.61 ^b	59.14± 8.10 ^b	48.54± 3.11 ^c
G6: HCD + sumac extract 1.0 g	31.11± 3.65 ^c	55.11± 4.13 ^c	46.91± 3.20 ^c

Means ± standard deviations in the same column with different letters are significantly different ($P \leq 0.05$)

Hypolipidemic Effect of Sumac (*Rhus Coriaria L*) Fruit Powder and Extract on Rats Fed High Cholesterol Diet

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Table (8): Effect of sumac powder and extract on TNF α , MDA, SOD and Acetylcholine esterase (AChE) of hypercholesterolemic rats

Parameters Groups	TNF α pg/ml	MDA $\mu\text{mol/l}$	SOD (μ /ml)	Acetylcholine esterase (AChE) $\mu\text{mol/ml}$
G1: Negative Control	1.12 $\pm 0.35^d$	1.54 \pm 0.54 ^c	30.97 \pm 0.54 ^a	3.54 \pm 0.2 ^c
G2: Positive Control	3.99 \pm 0.58 ^a	4.79 \pm 0.65 ^a	20.54 \pm 0.71 ^c	7.15 \pm 0.4 ^a
G3: HCD + sumac powder 5%	2.34 \pm 0.66 ^b	2.64 \pm 0.37 ^b	25.49 \pm 0.54 ^b	5.12 \pm 0.6 ^b
G4: HCD + sumac powder 10%	2.02 \pm 0.36 ^b	2.38 \pm 0.32 ^b	27.85 \pm 0.25 ^b	4.82 \pm 0.7 ^b
G5: HCD + sumac extract 0.5 g	1.89 \pm 0.68 ^c	2.93 \pm 0.35 ^b	26.98 \pm 0.84 ^b	4.89 \pm 0.4 ^b
G6: HCD + sumac extract 1.0 g	1.72 \pm 0.57 ^c	2.11 \pm 0.58 ^b	29.52 \pm 0.28 ^{ab}	3.96 \pm 0.7 ^c

Means \pm standard deviations in the same column with different letters are significantly different ($P \leq 0.05$)

تأثير مسحوق و مستخلص السماق الخافض لدهون الدم في الفئران المغذاة على وجبة مرتفعة الكوليستيرول

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أجريت الدراسة الحالية لدراسة التأثير الخافض لدهون الدم لكل من مسحوق و مستخلص السماق بإستخدام تركيزات مختلفة في الفئران المغذاة على وجبة مرتفعة الكوليستيرول ، وقد تم تقدير التركيب الكيميائي وبعض المعادن والفينولات والفلافونيدات والتأثير المضاد للاكسدة للسماق. قد أجريت الدراسة على 42 من ذكور فئران التجارب تتراوح أوزانهم 10 ± 180 جرام والتي قسمت عشوائيا الى ستة مجموعات تحتوى كل منها على 7 فئران كالاتى : المجموعة الاولى والتي تغذت على الوجبة القياسية وهى المجموعة الضابطة السالبة وبقى المجموعات الخمس تم تغذيتها على الوجبة القياسية المضاف لها 4%كوليستيرول + 1% كوليستيرول اسيد لاجداث الاصابة بارتفاع دهون الدم ثم قسمت الى المجموعة الثانية والتي تغذت على الوجبة مرتفعة الكوليستيرول فقط وهى المجموعة الموجبة والمجموعة الثالثة والرابعة وقد تم تغذيتهم على الوجبة مرتفعة الكوليستيرول المضاف لها مسحوق السماق بنسب 5 و 10 % و المجموعة الخامسة والسادسة وقد تم تغذيتهم على الوجبة مرتفعة الكوليستيرول بالاضافة الى اعطائهم مستخلص السماق بنسب 0.5 و 1.0 جرام / كجم من وزن الجسم عن طريق الانبوبة المعدية يوميا حتى نهاية التجربة 8 أسابيع . قد أشارت النتائج الى ان السماق مصدر جيد للالياف و المعادن والفينولات والفلافونيدات كما ان له تأثير على الشقوق الحرة ، كما سجلت النتائج ارتفاع فى دهون الدم ووظائف الكبد والكلى والمالونالدهيد والاستيل كولين ومؤشر الاورام فى المجموعة الضابطة الموجبة فى حين اشارت النتائج الى انخفاض دهون الدم والمالونالدهيد والاستيل كولين ومؤشر الاورام وتحسن فى وظائف الكبد والكلى وارتفاع فى الليبوبروتينات مرتفعة الكثافة وسوبراكسيد ديسموتيز فى المجموعات التى تغذت على وجبة مرتفعة الكوليستيرول والتي عولجت بمسحوق ومستخلص السماق خاصا عند استخدام نسب 10% مسحوق و 1.0 جرام مستخلص السماق بالمقارنة بالمجموعة الضابطة الموجبة. لذلك توصى الدراسة بتدعيم الوجبات بكلا من مسحوق و مستخلص السماق لما لهم من تأثير على خفض دهون الدم فى الفئران .

الكلمات المفتاحية: السماق ، ارتفاع الكوليستيرول ، دهون الدم ، وظائف الكبد والكلى ، الشقوق الحرة