Therapeutic effect of purslane, coriander and celery seeds on hypercholesterolemic rats

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Abstract:

A significant risk factor for cardiovascular illnesses is hypercholesterolemia. In traditional medicine, seeds like celery, coriander, and purslane are well-known for their medicinal properties. This research sought to determine how celery, coriander, and purslane affected hypercholesterolemic rats. 42 male albino rats were divided into seven groups with six animals each for 60 days: negative control fed on a basal diet, positive control hypercholesterolemic rats were fed on a basal diet +1% cholesterol. Four group fed as positive control with 20% of celery, coriander, purslane and mixture of seeds. The last group demonstration oral drug rosuvastatin (10 mg/kg/day). The present study showed that hypercholesterolemia caused significantly increases in body weight gain, food intake and FER as well as total cholesterol (TC), total triglycerides (TG), low density lipoprotein (LDL-c), very low density lipoprotein (VLDL-c), total lipid, phospholipid, urea, creatinine, total protein, albumin, globulin and MDA and decrease in and high density lipoprotein (HDL-c), GSH and SOD in positive control. Supplemented diet of hypercholesterolemic rats with seeds, especially (20% mixture of seeds) lead to significant ($p<0.05$) decrease in body weight gain, food intake and FER as well as total cholesterol (TC), total triglycerides (TG), low density lipoprotein (LDL-c), very low density lipoprotein (VLDL-c), total lipid, phospholipid, urea, creatinine, total protein, albumin, globulin and MDA and significant increase of HDL, GSH and SOD comparing with negative control. Our findings suggested that the supplementation diet with celery, coriander and purslane seeds caused obvious reduction in lipid levels in a hypercholesterolemia disease which prevent from the development the cardiovascular diseases.

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Key words: Celery, Coriander, Purslane, Lipid profile and Hypercholesterolemia

INTRODUCTION

Hypercholesterolemia and hyperlipidemia relate to high levels of cholesterol, low-density lipoproteins (LDL), triglycerides, and very low-density lipoproteins (VLDL). Excessive fat deposition in circulatory vessels results in plaque formation, artery wall obstruction, and, eventually, a stroke or heart attack (**Stapleton *et al.*, 2010).** Cardiovascular disease, diabetes, and hypertension are all consequences of hyperlipidemia and hypercholesterolemia (**Hopkins *et al.*, 2003; Stapleton *et al.*, 2010**). Controlling the kind and amount of lipids in the diet, exercising, and using a lipid-lowering diet can help to manage hyperlipidemia and hypercholesterolemia. The medical establishment is up against a hurdle in curing hypercholesterolemia without causing any negative side effects (**Islam *et al.*, 2011**). One of the main risk factors producing CVDs is hyperlipidemia. It is characterised by a rise in one or more plasma lipids, proteins, phospholipids, and plasma lipoproteins, including triglycerides and cholesterol (**Shattat, 2014**). Cardiovascular risks rise with the development of hyperlipidemia because the buildup of plasma lipids in the artery wall causes widespread vascular remodelling, localised inflammation, and the development of atherosclerotic plaques (**Porez *et al.*, 2012**). Recently, numerous attempts have been made to use specific common plants that are already well-known in conventional medicine for containing biological components that can be used to lower lipid levels in the body to help lower cholesterol (**Rhee *et al.*, 2005 and Kim *et al.*, 2007**). The diet of choice should include functional foods like spices and herbs because they contain antioxidants with a great group of bioactive compounds that includes phenolic compounds, flavonoids, sulphur-containing compounds, alkaloids, tannins, phenolic diterpenes, and vitamins. It is preferable to prevent dietary problems rather than treat them and it is preferable to change one's diet rather than taking medicine (**McCormick, 2017**).

Celery (*Apium graveolens* L.) is a plant that belongs to the Apiaceae family (**Dolati *et al.*, 2018**). It is a typical fragrant vegetable that is eaten every day around the world (**Tashakori-Sabzevar *et al.*, 2016**). Both the whole plant and its seeds have been used as food and medicine (**Hassanen *et al.*, 2015**). Celery seeds yield volatile or essential oils in amounts ranging from 1.8 to 3.4 percent; this oil comprises 20% selinene and 60% limonene (**Powanda *et al.*, 2015**). The phytochemical components of celery, such as bergapten, flavonoids, glycosides, furanocoumarins, furocoumarin, limonene, psoralen, xanthotoxin, and selinene, aid in the prevention of coronary and vascular diseases. Just a few of their pharmacological properties include spermatogenesis induction, anti-dysmenorrhea, anti-hypertension, and cardiovascular disease prevention (**Salehi *et al.*, 2019**). In the same vein, celery oil contains one of the most essential bioactive components known as phthalide, which has a positive impact on health by protecting against cholesterol, cancer, and high blood pressure. Sedanolide is the most active phthalide molecule, which reduces tumours in cancer patients (**Dąbrowska *et al.*, 2020**).

Coriander, also known as *Coriandrum sativum*, is a member of the Apiaceae or Umbelliferae family (**Abdelkader *et al.*, 2018).** 0.8% percent of yellow oil with a nice aroma and oxygenated monoterpenes (80.47%) and monoterpene hydrocarbon (6.45%) were produced from coriander seeds. (**Pande *et al.*, 2010**). The main element of coriander essential oil is linalool, which is colourless and has a distinctive odour, sweet, soft, warm, and aromatic flavour (**Msaada *et al.*, 2007**). Coriander has a wide range of bioactivities. Coriander seed aqueous extract has diuretic qualities, and seed and root extracts have antioxidative characteristics (**Tang *et al.*, 2013**). In obese-hyperglycemic hyperlipidemic rats, oral administration of coriander extract regulated glycemia and reduced high levels of insulin, total cholesterol, LDL-cholesterol, and triglycerides (**Aissaoui *et al.*, 2011**).

Purslane (*Portulaca oleracea* L.) is a widely distributed weed in the *Portulacaceae* family, with extensive distribution throughout the world (**Petropoulos *et al.*, 2016**) and is commonly called “Rejlah” in Egypt (**Shehata and Soltan, 2012**). Purslane is one of the most widely used medicinal herbs, and it has been dubbed a "Global Panacea" by the World Health Organization (**Alam *et al.*, 2014**). It is widely valued for the high nutritional value of its edible plant parts, which are abundant in omega-3 fatty acids, particularly -linolenic acid (**Oliveira *et al*., 2009**). Minerals like Ca, K, and P, as well as proteins and carbohydrates, also, tocopherols, carotenoids, and ascorbic acid, are all valuable components of purslane edible sections (**Szalai *et al.,* 2010**). Furthermore, antioxidant capabilities have been linked to phenolic components and oleracein derivatives of purslane leaf extracts (**Sicari *et al*., 2018**). The high content of a range of phytoconstituents in this plant was thought to be responsible for the plant's biological actions, such as antibacterial and antifungal (**Oh *et al*., 2000**). Purslane also has the potential to defend against oxidative stress induced by vitamin A deficiency (**Arruda *et al*., 2004**). Purslane also includes active compounds that can be used to treat parasitic infections including leishmaniasis and trypanosomiasis (**Costa *et al*., 2007**).

Since it is critical to find a nutraceutical that can prevent oxidative stress in hypercholesterolemia, the goal of this study was to investigate the protective effect of purslane, coriander and celery seeds and their combination to induce hypercholesterolemia in rats by monitoring lipid and lipoprotien statuse, liver, kidny funcations and antioxidant statuse.

MATERIALS AND METHODS

Materials:

1. **Seeds** of celery (*Apium graveolens* L.), coriander (*Coriandrum sativum*) and purslane (*Portulaca oleracea* L.) were obtained from Agriculture Research Center, Giza, Egypt.
2. **Cholesterol powder** were purchased from El Gomhoria Company, Egypt. Rosuvast (Rosuvastatin) was purchased from Chemipharm Pharmaceutical Industries S.A.E. – Egypt. Each tablet contains 20 mg of (Rosuvastatin).
3. **Animals**: 42 healthy adult male albino rats (*Sprague dawely*) weighing (150 ± 10g) were purchased from the Agricultural Research Center, Giza, Egypt. International standards for the handling and use of laboratory animals were followed in all biological experimentation.

When handling animals, ethical standards were upheld, and authorization was requested from the relevant department.

4. **Basal Diet:** The basal diet was prepared according to modification of **NRC (1992)** as shown in Table A.

Table (A): Chemical ingredients of basal diet:

Ingredients	g/kg Basal diet	% Basal diet
Casein	200	20
Corn starch	497	49.7
Sugar (Sucrose)	100	10
Cellulose	30	3
Corn oil	50	5
mineral admixtures	100	10
Vitamin admixtures	20	2
DL-methionine	3	0.3

Chemical analysis of seeds:

- Total ash contents, fat, fiber, protein and moisture were carried out according to the methods of **(AOAC, 2000).** Percentage carbohydrate was given by the flooweing equation: 100 – (ash% + moisture %+ fat %+ protein%)
- Determination of total phenols was determined according to (**Slinkard and Singleton, 1977),** while flavonoid according to (**Zhishen *et al*., 1999).**

Biological experiments:

Experimental animal design:

42 male albino rats were adapted for one week before the experiment, the animals were kept separately in stainless steel cages under controlled conditions, with a constant temperature of 22°C and lighting that runs on a 12-hour cycle. They also always have full access to food and water. After acclimatization periods, animals were randomly divided into seven groups with six animals each and given the following:

- The first group (-ve): 6 rats were fed on a basal diet and kept as a negative control group.
- Second group (+ve): 6 hypercholesterolemic rats were fed on a basal diet +1% cholesterol and kept as a positive control group (+ve control) according to **Shehata and Soltan (2012**).
- The third group: 6 hypercholesterolemic rats were fed on a basal diet +1% cholesterol+20% celery seeds.
- The fourth group: 6 hypercholesterolemic rats were fed on a basal diet +1% cholesterol+20% coriander seeds
- The fifth group: 6 hypercholesterolemic rats were fed on a basal diet +1% cholesterol+20% purslane seeds
- The sixth group: 6 hypercholesterolemic rats were fed on a basal diet +1% cholesterol+20% mixture of celery, coriander and purslane seeds.
- The seventh group: 6 hypercholesterolemic rats were fed on a basal diet +1% cholesterol+ oral drug rosuvastatin (10 mg/kg/day) according to **Fassini *et al.*, (2011),** drugs were dissolved in saline and given intravenously every day at various times.

Over the course of the 60 days, weekly change in body weight and food intake were monitored. Feed intake (gm.) was determined every two days according to **Chapman *et al.*, (1959).** Body weight gain was calculated by using the following equations:

$$\text{Body weight gain BWG(\%)} = \frac{\text{final weight(g)} - \text{intial weight(g)}}{\text{intial weight(g)}} \text{x100}$$

Feed efficiency ratio (FED) = weight gain (g) / Feed intake (g)

Blood sample collection:

Rats were scarified under ether an aesthesia at the end of the experiment's 60-day run, blood samples were taken from the inner canthus of the rats' eyes, after 12 hours of fasting. According to **Drury and Wallington (1980**), blood samples were received into clean, dry centrifuge tubes, allowed to clot at room temperature, and then spun at 5000 rpm for

10 min to extract serum. The samples were kept in a deep freezer at -18°C until they were used for biochemical analyses.

Biochemical analysis of serum:

Lipid profile were estimated as:

- Triglycerides and total cholesterol were determined according to (**Fassati and Prencipe 1982**) and (**Allain *et al*., 1974**), respectively.
- HDL$_{-C}$ was determined according to (**Lopes *et al.*, 1977**).
- LDL$_{-C}$ and VLDL$_{-C}$ were calculated by using the method of (**Friedewald *et al*., 1972).**
- Serum total Lipids was calculated accordance to (**Tietz, 1976).**

LDLc = Total cholesterol - (HDL$_C$ + VLDL$_C$)

VLDLc = TG / 5

Phospholipids = total lipid – (TG-TC).

Liver function was determined as following:

- Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were measured according to the method described by **Burtis *et al*., (1999**).
- The activity of serum total protein (TP) concentrations was evaluated chemically using the Folin-phenol reagent and bovine serum as a standard, as described by **Henry (1964).**
- Serum albumin was evaluation utilization the method of **Doumas and Biggs (1971).**
- Serum globulin value was decorator by subtracting the albumin from total proteins accordance to **Coles (1974).**

Kidny function was obtained as following analysis:

- Serum uric acid and creatinine were determined according to the methods described by **Fassati *et al*. (1980), and Young (2001).**

Antioxidant activity:

- The activity of tissue antioxidant enzyme superoxide dismutase (SOD) was estimated according to the method described by **Oyanagui, (1984).**
- Malondialdehyde (MDA) is a lipid peroxidation product, have been determined using the procedure described by **Mistura and Midora (1987)**.
- Glutathionee peroxidase activity (GPA) was determined spectrophotometrically according to the method described by **Weinhold *et al*. (1990).**

Statistical analysis:

The collected data were presented as means with standard deviations. All tests were completed using the computer programme of the statistical analysis programme (SPSS, version 24) according to **McCormick and Salcedo (2017).**

RESULTS AND DISCUSSION

Proximate chemical composition of celery seeds, coriander seeds and purslane seeds:

Data presented at Table (1) revealed the chemical composition, moisture, protein, ash, fat, fiber and carbohydrates of celery seeds, coriander seeds and purslane seeds.

Results showed that celery seeds recorded 8.09±0.09, 16.35±0.11, 4.11±0.02, 12.52±0.04, 22.13±0.05 and 49.30±0.19 g/100g for moisture, protein, ash, fat, fiber and carbohydrates, respectively.

While, coriander seeds recorded 9.19±0.07, 12.97±0.09, 14.83±0.04, 29.63±0.07, 8.11±0.07 and 54.88±0.19 g/100g for moisture, protein, ash, fat, fiber and carbohydrates, respectively.

On the other hand, purslane seeds scored 6.42±0.25, 26.24±0.07, 10.04±0.091, 15.17±0.04, 14.94±0.08 and 42.44±0.13 g/100g for moisture, protein, ash, fat, fiber and carbohydrates, respectively.

From previous data, it could be observed that coriander seeds were higher in moisture, fat, fiber and carbohydrates content than celery or purslane, while celery seeds were higher in ash content than coriander and purslane, when, purslane seeds were higher in protein than other seeds. These results are in harmony with those obtained by **Shahwar *et al.* (2012**) who found that coriander seeds have a low moisture content (6.20%), while were rich in protein (12.58 %) and crude fat (9.12 %), while crude fiber was (37.14%). Also, **Abou raya *et al.* (2013**) showed that coriander seeds recorded 8.8%, 15.1%, 13.4%, 6.3% and 31.6% for moisture content, crude protein, ash, crude fiber and carbohydrates, respectively.

El Gindy, (2017) reported that purslane is rich with nutritional value, especially protein, ash and fiber contents. Purslane leaves contains 22.8% protein, 6.8% fat, 26.21 ash, 2.54% fiber and 2.54 carbohydrates. Moreover, **Shehata and Soltan (2012**) found that purslane seed contain 5.93, 22.34, 9.10, 13.37, 15.39 and 33.87% for moisture, protein, fat, crude fiber, ash and carbohydrate. While, Celery seeds contains 6.39, 18.19, 3.25, 12.12, 20.83 and 39.22% for moisture, protein, fat, crude fiber, ash and carbohydrate. **Syed and Rajeev (2012**) reported that the moisture content of purslane powder was 5.14% and celery (5.1-11%). While, crude protein levels in celery seed were 18.19%.

Table (1): Chemical composition (%) of celery, coriander and purslane seeds

Groups / Variables	Celery seeds	Coriander seeds	Purslane seeds
Moisture	**8.09±0.09 b**	**9.19±0.07 a**	**6.42±0.25 c**
Protein	**16.35±0.11 b**	**12.97±0.09 c**	**26.24±0.07 a**
Total fat	**4.11±0.02 c**	**14.83±0.04 a**	**10.04±0.091 b**
Crude fiber	**12.52±0.04 c**	**29.63±0.07 a**	**15.17±0.04 b**
Ash	**22.13±0.05 a**	**8.11±0.07 c**	**14.94±0.08 b**
T.Carbohydrates	**49.30±0.19 b**	**54.88±0.19 a**	**42.44±0.13 c**

Each value is the mean ± SD

The values in each column with different superscript are significantly different at (p < 0.05).

Total phenols and flavonoid of celery, coriander and purslane seeds:

Bio-active compound as (total phenol and flavonoid mg/100g) for celery, coriander and parsley seeds are represented in Table (2).

Form observed data, it was found that celery seeds contain (397.84±1.51 mg/100g total phenol) and (281.33±3.51 mg/100g total flavonoid), from the same table, coriander seeds contain total phenol as (351.16±2.26 mg/100g) and total flavonoid (621.33±3.51 mg/100g), while purslane contain (539.91±1.32 and 484.33±10.06 mg/100 g) for total phenol and flavonoid, respectively.

Generally, data indicated that coriander was the highest in total flavonoid content followed by purslane then celery, while purslane seeds were higher in total phenol followed by celery then coriander.

Because of its high antioxidant activity, coriander is a good source of polyphenols and phytochemicals. Coriander leaves and seeds both contain antioxidants, although leaves have more antioxidants than seeds (**Wangensteen *et al*., 2004**). Its high pigment content, particularly carotenoids, is credited with its antioxidant properties. Its extract's carotenoids were discovered to have a stronger hydroxyl radical scavenging capacity, protecting cells from oxidative damage (**Peethambaran *et al.*, 2012**). Phenolic molecules are one of the most important and widespread groups of secondary metabolites. Based on the amount of phenol rings and the structural components that bond these rings, phenolic groups can be divided into four categories. Flavonoids (anthocyanins, flavones, and isoflavones), tannins, stilbenes, and lignans are among these groups (**Balasundram *et al*., 2006**).

Table (2): Total phenols and total flavonoids in celery, coriander and purslane seeds

Groups / Variables	Celery seeds	Coriander seeds	Purslane seeds
Total phenols mg/100 g	**397.84±1.51 b**	**351.16±2.26 c**	**539.91±1.32 a**
Total flavonoids mg/100 g	**281.33±3.51 c**	**621.33±3.51 a**	**484.33±10.06 b**
Each value is the mean ± SD **The values in each column with different superscript are significantly different at (p < 0.05).**			

Flavonoids, phenolic acids, and tansiopropanoids, which are distinctive phytochemicals found in celery and have good antioxidant effects, bind to free radicals (**Nickavar *et al.*, 2007**). Polyphenols have biological benefits that include antioxidant activity, inducers for controlling free radicals and peroxidation, and more. Due to the chemical similarities among polyphenols, free radicals can be neutralised via interactions between one or more phenolic groups and hydrogen donors (**De Almeida *et al.*, 2005**). **Jung *et al.*, (2011)** showed that phytochemical contents in celery were 28.17 - 34.6 mg/g for total phenolics and 16.4 – 19.6 mg/g for flavonoids. **Ashoush *et al.* (2017**) resulted that the values were 30.3 mg/g and 18.5 mg/g total phenolics and total flavonoids respectively in celery leaves.

Lim and Quahf (2007) reported that purslane phenols content was ranged between 157 and 304 mg/100g. Also, **Almasoud and Salem (2014**) stated that purslane has a high content of total phenol (179.89 mg/100g). Moreover, **El Gindy, (2017)** found that purslane has a high content of phenols and flavonoids (950 mg GAE /100g and 4953 mg QE /100g).

Nutritive and biological value of seeds on experimental rats:

Body weight gain, food intake and feed efficiency ratio (FER) of hyper cholesterolemia rat groups:

As shown in Table (3), the averages of all rat groups' initial body weights after seven days of adaption (feeding on basal diet) ranged between

144 and 151 g, then after 60 days from the experiments at the end the final body weight ranged between 217 and 355 g.

Table (3): Change in body weight, food intake and FER in hyper cholesterolemic rat groups fed on celery, coriander and purslane seeds.

Rat Groups	Initial weight (gm)	Final weight (gm)	Wight gain (gm)	Wight gain%	Food intake (gm)	FER
Control (-ve)	144.50a± 4.20	290.00b± 11.23	145.50b± 10.25	100.69b± 11.96	24.17b± 0.14	0.069b± 0.02
Control (+ve)	146.25a± 5.18	355.25a± 20.26	209.00a± 21.65	142.91a± 16.29	29.60a± 0.05	0.080a± 0.02
Celery seed	145.50a± 7.76	278.25bc± 10.26	132.75c± 21.32	91.23c± 15.02	23.19c± 0.06	0.066d ±0.02
Coriander seed	148.00a± 5.59	276.25bc± 15.21	128.25bc± 16.57	86.66bc± 14.18	23.02c± 0.12	0.063c± 0.01
Purslane seed	150.00a± 8.90	260.00c± 15.75	110.00bc± 10.35	73.33bc± 18.87	21.67d± 0.09	0.056c± 0.02
Seed mixture	151.00a± 7.34	258.50c± 20.84	107.50c± 10.86	71.19c± 13.07	21.54d± 0.07	0.055d± 0.03
Rosuvastatin drug	149.00a± 6.68	217.25d± 29.44	68.25d± 26.25	45.81d± 13.09	18.10e± 0.09	0.042e± 0.02

Each value is the mean ± SD
The values in each column with different superscript are significantly different at (p < 0.05).

Data presented in Table (3) show that an induced hypercholesterolemia caused a significant increase (P<0.05) in body weight gain, food intake and FER in positive control comparing to the healthy group (negative control).

Administration of different seeds (celery, coriander, purslane and mix) comparing to rosuvastatin drug and hypercholesterolemic rats caused a significant decrease (P<0.05) in body gain, food intake and FER comparing to the negative control.

Body weight can be seen of as a marker for food consumption, but total food intake is a sign of the rats' acceptance and enjoyment of the diet (**Al-Amery and Takruri, 2021**).

According to, **Barakat (2011**), an induced hypercholesterolemia significantly increased (P<0.05) body weight growth. **El-Kherbawy *et al.*, (2011**) exhibited significantly (P<0.05) lower body weights and feed efficiency ratios when parsley or coriander was added at 10, 15, and 20% compared to the equivalent values in normal or hypercholesterolemic rats. In addition, **Shehata and Soltan (2012)** revealed significant increases in body weight, food intake, and FER in rats fed a high-cholesterol diet. **Beltagy *et al*., (2018)** reported that high fat diet replaced with different levels of celery powder helped to increase food intake / day comparing to high fat diet control group.

The result of the decreasing in body weight gain due to feeding on seed mix may be attributed to the high present fiber in coriander, purslane and celery as mentioned in chemical composition (29.63, 15.17 and 12.52%, respectively).

According to **Torsdottir *et al.* (1991),** the dietary fiber slows down the stomach emptying rate, allowing rats to feel fuller for longer while delaying nutrient absorption and digestion. This results in decreased food intake and a reduction in body weight increase. Results are in line with **Shehata and Soltan (2012)** who observed that purslane and celery (fresh and seeds) supplementation of hypercholestroemic mice's diet caused a decrease in body weight, food intake and FER. **Niharika and Sukumar (2016**) reported that purslane decreased body weight.

Effect of feeding on celery, coriander and purslane seeds on serum alanine aminotransferase (ALT) and aspartate aminotransferase (AST) enzymes in hyper cholesterolemic rats.

The obtained data in Table (4) indicated that the both of ALT and AST level of control positive group recorded the highest value (437.42 and 492.94 U/L) compared with control negative group (47.45 and 109.95 U/L) with significant differences at (P<0.05). Data illustrated that the activities of

ALT and AST of hyperchloesterolemic rats fed on celery, coriander and purslane seeds and their mixture, increased significantly (P<0.05) in hyperchloesterolemic rats group and ranged between (71.45 to 103.00 U/L) for ALT and (227.11 and 311.30 U/L) for AST in comparison with the negative control (47.45 and 109.95 U/L). This mean that, due to the accelerated lipid peroxidation brought from the elevated cholesterol, there were significant (P<0.05) anomalies in the concentration of these enzymes. However, due to their powerful antioxidant capability, the seeds-based intervention significantly reduced (P<0.05) the abnormal levels of AST & ALT in all investigations.

The oral administration of rosuvastatin drug to hyperchloesterolemic rats recorded the lowest mean values of ALT and AST (71.45 and 227.11 U/L) followed by the group fed on seed mixture (77.85 and 247.03 U/L).

Generally, data show that the hyperchloesterolemic rats fed on seed mixture in diets could improve the liver function parameters (ALT and AST) in the same level with the oral rosuvastatin drug.

From the above results, ALT and AST, one of the most common liver function tests measures the levels of intracellular hepatic enzymes that have seeped into the circulation and function as a producer of hepatocytes. Additionally, ALT and AST levels serve as markers of liver function, and their return to normal values denote normal liver function. As a result, the hepatotoxic effect of rats is indicated by the rise in ALT activity in serum, which is primarily caused by the leakage of enzymes from the liver cytosol into the blood stream (**Dauqan *et al.*, 2012**).

Table (4): Effect of feeding on celery, coriander and purslane on serum ALT and aspartate aminotransferase AST enzymes in hyper cholesterolemia rats.

Rats group	ALT (U/L)	AST (U/L)
Control (-ve)	47.45 e ± 4.13	109.95 d ± 10.05
Control (+ve)	437.42 a ± 63.01	492.94 a ± 68.31
Celery seed	103.00 b ± 7.57	311.30 b ± 30.60
Coriander seed	79.06 d ± 9.85	262.65 c ± 34.09

Purslane seed	**82.71 c ± 10.54**	**295.05 b ± 29.65**
Seed mixture	**77.85 d ± 8.62**	**247.03 c ± 20.22**
Rosuvastatin drug	**71.45 d ± 7.65**	**227.11 c ± 15.30**
Each value is the mean ± SD **The values in each column with different superscript are significantly different at ($p < 0.05$).**		

According to **Kim *et al.*, (2010**), the exogenous cholesterol content from diet tends to raise the activities of AST and ALT. Also, **Ajdari *et al.*, (2014)** observed that feeding on hyperchlosterolamic substantially increased the ALT and AST activity in serum. These results agree with those of **Beltagy *et al.*, (2018)** who resulted that rat fed a diet containing powdered celery leaves and seeds showed an improvement in the activity of the ALT enzyme because their levels of alanime amine transforose (ALT) were lower than their levels of asparate amine transferase (AST) in the same groups of rats. The phytonutrients in coriander, celery and purslane, such as omega-3 fatty acids, polyunsaturated fatty acids, and flavonoids, which have antioxidant effects against oxidative stress, may be the cause of the decreased activity of the liver enzymes ALT, AST, and ALP in the purslane-treated group, indicating its protective role against liver damage (**Dkhil *et al.*, 2011**).

Moreover, **Ali *et al*. (2011)** observed that administering purslane dramatically decreased the serum levels of liver enzymes. **Shehata and Soltan (2012**) predicted that including celery and purslane (fresh and seed) in a hypercholesterolemic diet will help restore hepatic function by improving lipid metabolism or postponing the development of hepatic disorders. Additionally, **Lee *et al*., (2011)** stated that hypercholesterolemic rat groups administered purslane powder had lower ALT and AST activity than the hyperchlosterolamic group.

Effect of feeding on celery, coriander and purslane on serum total protein, albumin and globulin in experimental rats.

Data in Table 8, show total protein, albumin and globulin of control and hyperchlosterolamic rat groups examined celery, coriander and purslane seeds and their mixture comparing to oral rosuvastatin drug. The healthy group (negative control) recorded the lowest value of total protein, albumin and globulin (5.73, 2.96 and 2.76 mg/dL), respectively comparing to the positive control which recorded the highest value (8.12, 4.83 and 4.83 mg/dL).

Table (5): Effect of feeding on celery, coriander and purslane seeds on serum total protein, albumin and globulin in experimental rats.

Rats group	T. protein (mg/dL)	Albumin (mg/dL)	Globulin (mg/dL)
Control (-ve)	5.73 c ± 0.39	2.96 c ± 0.26	2.76 c ± 0.17
Control (+ve)	8.12 a ± 0.51	4.83 a ± 0.13	4.83 a ± 0.43
Celery seed	7.03 b ± 0.25	3.54 b ± 0.07	3.45 b ± 0.29
Coriander seed	6.68 b ± 0.24	3.50 b ± 0.07	3.21 b ± 0.32
Purslane seed	6.92 b ± 0.33	3.52 b ± 0.08	3.36 b ± 0.22
Seed mixture	6.67 b ± 0.44	3.46 b ± 0.04	3.29 b ± 0.31
Rosuvastatin drug	6.66 b ± 0.67	3.42 b ± 0.06	2.98 b ± 0.77

Each value is the mean ± SD

The values in each column with different superscript are significantly different at (p < 0.05).

Moreover, there was a significant decrease (P<0.05) in total protein albumin and globulin in hyperchlosterolamic rat groups compared to the positive control group, meanwhile, administration of celery, coriander and purslane seeds and their mixture showed significant (P<0.05) improvement in total protein, albumin and globulin compared with positive group. While there were no significant differences (P<0.05) between hyperchlosterolamic rat groups fed on celery, coriander and purslane seeds and their mixture.

Feeding on seed mixture was nearly in values of oral rosuvastatin drug with no significant differences (P<0.05) for total protein, albumin and globulin.

Total protein, bilirubin, and albumin concentrations can help determine the health of the liver and the extent of any damage (**Yakubu *et al.*, 2005**). Given that the liver is the primary organ involved in the synthesis of the majority of proteins, this could be the result of liver damage. Frequently, liver cirrhosis and chronic hepatitis are associated with hyperchlosterolamic. Low feed intake may also result in decreased protein absorption.

Effect of feeding on celery, coriander and purslane seeds on serum lipid profile in experimental rats:

The results of lipid profiles (total cholesterol (TC), total triglycerides (TG), high density lipoprotein (HDL-c), low density lipoprotein (LDL-c), very low density lipoprotein (VLDL-c), total lipid and phospholipid) are shown in Table (6).

Hypercholesterolemic group (positive control) exhibit significant increase ($p<0.05$) in TC, TG, LDL-c, VLDL-c, total lipid and phospholipid, and decrease in high density lipoprotein (HDL-c) compared to the healthy group (negative control).

Supplemented diet of hypercholesterolemic rats with different seeds (celery, coriander and purslane) and their mixture as well as oral rosuvastatin drug lead to significant decrease ($p<0.05$) in total cholesterol, total triglycerides, LDL-c, VLDL-c, total lipid and phospholipid, and increase in HDL-c comparing to positive control.

The hypercholesterolemic rats group feed on diet supplemented with mixture seeds recorded the lowest values of mentioned parameters (58.9, 81.54, 3.10, 16.30, 367.16 and 344.53 mg/dl) , respectively which were near with the values scored with oral rosuvastatin drug (56.63, 76.88, 1.21, 15.38, 372.33 and 352.08 mg/dl)., while the highest increase in HDL (40.13 mg/dl) after oral rosuvastatin drug (40.13 mg/dl).

Table (6): Effect of feeding on celery, coriander and purslane seeds on serum lipid profile in experimental rats

Rats group	TC	TG	HDL	LDL	VLDL	Total lipid	phospholipid
Control (-ve)	43.43 d ± 3.12	44.85 d ± 8.63	30.45 d ± 2.61	4.48 c ± 1.05	8.97 d ± 1.67	252.16 c ± 50.97	250.74 e ± 5.91
Control (+ve)	88.33 a ± 9.72	193.71 a ± 29	29.98 d ± 3.01	13.13 a ± 1.86	38.74 a ± 5.85	778.00 a ± 87.72	672.62 a ± 2.03
Celery seed	60.64 c ± 1.05	107.35 b ± 17.66	35.65 b ± 1.41	6.97 b ± 1.98	21.47 b ± 3.53	433.33 b ± 49.57	386.62 b ± 3.98
Coriander seed	59.36 b ± 8.06	98.67 b ± 11.86	34.29 c ± 1.71	3.12 c ± 0.98	19.73 b ± 7.35	398.50 b ± 29.96	358.79 c ± 7.14
Purslane seed	64.60 b ± 3.36	103.94 b ± 15.63	37.52 b ± 2.01	4.13 c ± 1.02	20.79 b ± 5.23	421.33 b ± 48.50	381.99 b ± 3.55
Seed mixture	58.90 b ± 9.35	81.54 b ± 19.6	40.13 a ± 1.48	3.10 d ± 0.51	16.30 c ± 3.93	367.16 b ± 50.82	344.52 d ± 4.98
Rosuvastatin drug	56.63 b ± 7.29	76.88 c ± 9.41	41.24 a ± 1.48	1.21 e ± 0.34	15.38 c ± 1.88	372.33 b ± 59.02	352.08 cd ± 6.13

Each value is the mean ± SD
The values in each column with different superscript are significantly different at ($p < 0.05$).

Understanding cholesterol metabolism has facilitated the development of medications and dietary approaches to lower risk for cardiovascular events. Plasma cholesterol plays a significant role in the pathophysiology of atherosclerosis. Investigating dietary influences on plasma lipids and cholesterol is crucial (**Al-Amery and Takruri, 2021)**. The increase in lipid profile in Hypercholesterolemic rats are agreement with **Harnafi *et al*., (2009)** and **Kumar *et al*., (2011**) reported that TC, TG and LDL-c levels in hypercholesterolemic control rats were significantly higher than the normal control group.

Purslane's ability to lower cholesterol could be attributed to the presence of polyphenols, flavonoids, alkaloids, and crude fibre, all of which have been proven to be effective hypolipidemic agents **(El- Newary 2016**).

This outcome was consistent with **Huang *et al.*, (2011)** earlier study, which found that purslane could dramatically lower serum levels of total cholesterol (TC), triglycerides (TG), and low-density lipoprotein (LDL-C), while raising HDL-C levels (**Abdalla Junior, 2010**). By blocking pancreatic cholesterol esterase, interacting with bile acids, and reducing cholesterol solubility in micelles, polyphenolic compounds, according to **Gallo and Naviglio (2017**), demonstrated cholesterol-lowering effect by purslane. This could delay the absorption of cholesterol. This theory is in line with the findings of **Heidrich *et al.* (2004)** suggested that cholesterol esterase inhibitors would be effective treatments for lowering blood cholesterol levels.

Coriander seeds contain a substance called petroselinic acid that reduces inflammation by blocking the Cox-1 and Cox-2 enzymes (**Zhang *et al.*, 2015**). Docosahexanoic acid (DHA) and alpha-linolenic acid (ALA) are omega-3 fatty acids that encourage the release of anti-inflammatory compounds. They are also known to lower TG levels, raise HDL levels, ameliorate endothelial dysfunction, and other things (**Bradberry *et al.*, 2013**). It is clear that coriander seeds play a function in enhancing lipid metabolism because oral administration of various doses of coriander seeds dramatically lowered the changed level of lipids.

Because it increases bile acid secretion and inhibits lipase, celery is advantageous for decreasing blood cholesterol levels (**Tsi and Tsi, 2000**). **Perumalraja and Sharief (2014)** reported that administration of celery extract resulted in a rise in HDL cholesterol and a decrease in total cholesterol, triglycerides, LDL, and VLDL. Also, **Mustafa *et al.*, (2019)** resulted that the celery seed aqueous extract decreased triglyceride (TG) and low-density lipoprotein (LDL), while increased high density lipoprotein (HDL).

Effect of feeding on celery, coriander and purslane seeds on blood urea and creatinine levels of experimental rats:

As explained in Table (7), blood urea and creatinine levels of healthy rats (negative control rats and hypercholesterolemic rats which fed on celery, coriander and purslane seeds and their mixture decreased compared to the positive control group.

The lowest value of both urea and creatinine was for the negative control rat group, followed by rosuvastatin drug group, however positive control group recorded the highest urea and creatinine values (5.58 *mg/dl* and 0.54 *mg/dl*, respectively).

Data indicated that no significant difference ($P<0.05$) was recorded for hypercholesterolemic rats fed on diet with celery, coriander and purslane seeds and its mixture as well as oral rosuvastatin drug during the experimental period. Apparent also from the same table that gradual decrease was recorded in urea content and creatinine level of hypercholesterolemic rats fed on diet replaced with mixture seeds as a function of prolonging experimental period.

Table (7): Effect of feeding on celery, coriander and purslane seeds on blood urea and creatinine levels of experimental rats.

Rats group	Creatinine (mg/dL)	Urea (mg/dL)
Control (-ve)	0.32 c ± 0.02	2.48 c ± 0.12
Control (+ve)	0.54 a ± 0.01	5.58 a ± 0.65
Celery seed	0.49 b ± 0.01	3.93 b ± 0.58
Coriander seed	0.46 b ± 0.02	3.14 b ± 0.46
Purslane seed	0.45 b ± 0.03	3.60 b ± 0.64
Seed mixture	0.43 b ± 0.06	3.47 b ± 0.58
Rosuvastatin drug	0.42 b ± 0.07	3.45 b ± 0.51

Each value is the mean ± SD

The values in each column with different superscript are significantly different at ($p < 0.05$).

Creatinine is actively discharged by the tubules and filtered by the glomerulus in the kidney. Additionally, free creatinine might be seen in blood serum (**Stevenes *et al.*, 2006**). In addition to having higher blood glucose levels, hyperchlosterolamic rats experienced renal changes including fat cell growth, weight gain in the kidneys, glomerular sclerosis, and inflammatory infiltrates (**Palanisamy *et al.*, 2008 and De Castro *et al.*,**

2013). However, rats fed on diets substituted with various amounts of celery found that celery's polyphenol content prevented renal failure (**Suleria *et al.,* 2013**). These findings are in line with those of **Karimi *et al.,* (2010)** who claimed that purslane's aqueous extract has pronounced nephroprotective effect and shows promise in treating acute renal injury brought on by nephrotoxins. **Helal *et al.,* (2018)** resulted that 5 % purslane leaves and 2.5 % purslane leaves had the lowest uric acid, urea, and creatinine levels, with significant differences.

Effect of feeding celery, coriander and purslane seeds on liver lipid peroxide malondialdehyde (MDA), reduced glutathione (GSH) and superoxide dismutase (SOD) contents of rats:

Results recorded in Table (8) indicated that there was a significant decrease ($P<0.05$) in MDA and a significant increase ($P<0.05$) in GSH and SOD in all rats groups fed on celery, coriander and purslane seeds and their mixture as well as oral rosuvastatin drug compared to positive control group. Normal control rats recorded the lowest MDA level (16.02 *nmol/g protein*), followed by rats group with hyperchlosterolamia and oral rosuvastatin drug, then the hyperchlosterolamic rats fed on seed mixture, coriander, purslane and celery (25.25, 27.53, 30.25, 36.75 and 43.25) *nmol/g protein*, respectively.

Rats with hyperchlosterolamia (control+ve group) had the highest MDA level 16.02 *nmol/g protein*). It could be noticed that hyperchlosterolamic rats which treated with celery, coriander and purslane seeds showed significant decrease ($P<0.05$) of MDA levels as compared to positive control group.

Data also show that glutathione (GSH) and superoxide dismutase (SOD) recorded the highest levels in the negative control group (1.92 and 362.75), where the lowest GSH and SOD levels were for positive control group (0.58 and 50.50). On the other hand, there was a significant increase ($P<0.05$) in GSH and SOD levels for hyperchlosterolamic groups fed on celery, coriander and purslane seeds compared to the positive control group.

Data in Table 8 revealed that there was a significant increase in GSH and SOD but showed a significant decrease (P<0.05) in MDA in all rat groups which treated with celery, coriander and purslane seeds and their mixture as well as oral rosuvastatin drug as compared to the hyperchlosterolamic rat group (positive).

As a marker for lipid peroxidation in cancer, MDA level has been employed (**Sabitha and Shyamaladevi 1998**). According to research by **Szatrowski and Nathan (1991)**, the weakening of antioxidant defense may have contributed to the high levels of MDA in malignant conditions. Malondialdehyde (MDA), a byproduct of polyunsaturated fatty acid peroxidation in cells, is one of the ultimate products of blood peroxidation. A rise in free radicals leads to an excess of MDA generation. Malondialdehyde levels are frequently used as indicators of antioxidant status and oxidative stress.

Table (8): Effect of feeding celery, coriander and purslane seeds on liver lipid peroxide malondialdehyde (MDA), reduced glutathione (GSH) and superoxide dismutase (SOD) contents of rats

Rats group	MDA	GSH	SOD
Control (-ve)	16.02 d ± 1.60	1.92 a ± 0.20	362.75 a ± 50.56
Control (+ve)	106.21 a ± 10.09	0.58 c ± 0.02	50.50 d ± 6.25
Celery seed	43.25 b ± 4.93	0.72 b ± 0.20	62.75 c ± 7.54
Coriander seed	30.25 c ± 4.76	0.77 b ± 0.03	71.25 c ± 7.52
Purslane seed	36.75 b ± 6.85	0.75 b ± 0.33	62.79 c ± 6.82
Seed mixture	27.53 c ± 2.82	1.02 a ± 0.90	98.03 b ± 9.98
Rosuvastatin drug	25.25 c ± 3.26	1.05 a ± 0.79	119.25 b ± 12.56

Each value is the mean ± SD

The values in each column with different superscript are significantly different at (p < 0.05).

A dry powder celery leaf diet decreased the hypercholesterolemia, liver enzymes and blood lipids in rats. Additionally, the liver lesions in rats have decreased. According to this study, patients with hepatic illness and hypercholesterolemia may benefit from a celery diet (**Belal, 2011**).

Shehata and Soltan (2012) showed that mice with high cholesterol who were fed purslane, purslane seeds, celery, and celery seeds had lower liver glutathione (GSH) levels.

The hypercholesterolemic group's GSH content dramatically dropped when compared to the normal group, whereas the groups given purslane, purslane seeds, celery, and celery seeds significantly increased ($P<0.05$) when compared to the hypercholesterolemic group. Results are accordance with data reported by **Mohamed *et al.*, (2011**) who indicated that animals who ingested purslane juice significantly increased the glutathione content in their livers, when compared to control rats. Moreover, **Al-Amery and Takruri (2021)** found that the blood peroxidation (MDA) values in the wild and cultivated purslane groups (10.9 ±1.6 and 10.9 ±2.8 nmol/ml, respectively) were considerably lower than the control group's MDA level (14.3 ±3.0 and 15.8 ±5.0 nmol/l. Results also approved with **Hijazi and Mouminah (2017)** who reported that oral pretreatments with celery leaves extracts for 6 weeks caused significant reduced tissue malondialdehyde (MDA) levels and boosted antioxidant enzyme activity. Additionally, **Kajal and Singh (2019)** observed that administration of coriander extract increase in level of SOD, GSH, and decrease in lipid peroxidation in terms of TBARS.

CONCLUSION

Based on the findings and our interpretations, we came to the conclusion that using celery, coriander and purslane seeds on rats with high cholesterol levels, had proved its efficiency on hypercholesterolemia, kidney and liver function in rats

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التأثير العلاجي لبذور الرجلة والكزبرة والكرفس على الفئران المصابة بإرتفاع كوليسترول الدم

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الملخص العربي:

يعتبر إرتفاع الكولسيترول فى الدم مؤشر لخطر الإصابه بأمراض القلب و الأوعيه الدموية. تعتبر بذور كل من الكرفس و الكسبره و الرجله من البذور المعروفة بفوائدها العلاجيه المتنوعة. كان الهدف من هذه الدراسة معرفة تأثير بذور الكرفس و الكسبره و الرجله على الفئران المصابه بإرتفاع نسبة الكوليسترول فى الدم. تم إجراء التجربه على ٤٢ فأراً من ذكور الفئران البيضاء و تقسيمهم إلى سبع مجموعات كل منها تحتوى على ٦ فئران لمده ٦٠يوم كالتالى : المجموعه الضابطه السالبه تتغذى على الوجبة القياسيه، المجموعه الضابطه الموجبه (مصابة بفرط الكوليسترول) تتغذى على الوجبه القياسيه+ ١٪ كوليسترول و أربع مجموعات تتغذى على الوجبه القياسيه + ١٪ كوليسترول + ٢٠٪ من الوجبه بذور كرفس او كسبره او رجله او خليط بينهم بنسبة (١:١:١)و المجموعه الاخيره تتناول عقار روسوفاستاتين بمعدل (١٠مجم/كجم/يوم). أظهرت الدراسه أن إرتفاع كوليسترول الدم أدى الى زياده كبيره فى وزن الجسم و الكوليسترول الكلى، الدهون الثلاثيه، البروتين الدهنى منخفض الكثافه و منخفض الكثافه جدا و الدهون الكليه و الفوسفوليبيدات، اليوريا و الكرياتنين، البروتين الكلى، الالبيومين، الجلوبيولين، إنزيم المانولدايالدهيد و نقص كل من البروتين الدهنى عالى الكثافه و الجلوتاثيون و إنزيم السوبر أكسيدويسميوتيز فى المجموعه الضابطه الموجبه. بينما وجد أن النظام الغذائى الذى يحتوى على البذور خاصة (٢٠٪ خليط بينهم) أدى الى إنخفاض كبيره فى وزن الجسم و الكوليسترول الكلى، الدهون الثلاثيه، البروتين الدهنى منخفض الكثافه و منخفض الكثافه جدا و الدهون الكليه و الفوسفوليبيدات، اليوريا و الكرياتنين، البروتين الكلى، الالبيومين، الجلوبيولين، إنزيم المانولدايالدهيد و زياده كل من البروتين الدهنى عالى الكثافه و الجلوتاثيون و إنزيم السوبر أكسيدويسميوتيز مقارنه بالمجموعه الضابطه السالبه. و بالتالى تشير الدراسه إلى أن النظام الغذائى المكمل ببذور الكرفس و الكسبره و الرجله تؤدى إلى إنخفاض واضح فى مستوى الدهون فى الدم للفئران المصابه بإرتفاع الكوليستروول و بالتالى تقليل الاصابه بأمراض القلب و الأوعيه الدمويه.

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