Al-Baha University Journal of Basic and Applied Sciences 6(1) (2022) 1–5

Article available at Al-Baha University Journal of Basic and Applied Sciences

Journal of Basic and Applied Sciences

Journal homepage: https://portal.bu.edu.sa/web/jbas/

Therapeutic Effect of Cardamom Plant (*Elettaria cardamomum*) on Hypercholesterolemic Rats

Lobna Saad Mohammed Abd Elmeged*

Department of Home Economics-Nutrition, Al-Baha University, AlMakhwa, Saudi Arabia

ARTICLEINFO

Article history:
Received 2 February, 2021
Received in revised form
2 May, 2021
Accepted 6 May, 2021

Keywords:
Cardamom
Hypercholesterolemic patients

ABSTRACT

Medicinal herbs are plant parts that have many therapeutic benefits for many chronic diseases, and the cardamom plant is one of the most curative plants, which contains essential lipids such as sterol and phenolic acids. These lipids have antioxidative potential that might increase antioxidant enzyme activities such as superoxide dismutase, catalase, and glutathione peroxidase, so current study aims to know the effect of feeding different level of cardamom plant (Elettaria cardamomum) in on hypercholesterolemic rats. The experiment was performed in animal house. All rats were fed for one week on basal diet before starting the experiment, then divided into two main groups, the first group (n= 6 rats) was fed on the basal diet only as a control negative (C–ve) normal rats for 28 days. The rats of second main group (n= 18 rats) hypercholesterolemic rats. The second main group is divided into three sub-groups, including 2 groups fed with different concentrations of (10%, and 15 %) cardamom and one group control positive infected with the disease do not feed on the experimental diet. The result showed that in groups of 10% and 15% cardamom was significant (P<0.05) when compared with control negative, also results showed that U.acid in rats fed on 15 % cardamom was significant (P<0.05) when compared with control positive. The study recommends that adding cardamom in the diets of hypercholesterolemic patients at certain concentrations and under medical supervision. Also, different levels of cardamom powder, may be suggested for lowering LDL and atherogenic index levels.

1. Introduction

Medicinal herbs are plant parts that have many therapeutic benefits for many chronic diseases, and the cardamom plant is one of the most curative plants, which contains essential lipids such as sterol and phenolic acids. These lipids have antioxidative potential that might increase antioxidant enzyme activities such as superoxide dismutase, catalase, and glutathione peroxidase [1]. Cardamom seeds, from the ripe fruit of Elettaria Cardamomum, are widely used for flavoring purposes in food and carminative. In medicine, it is used to treat digestive disorders [2]. Despite its wide uses, little information has been reported about its pharmacological properties, which have shown to be antioxidant [3] and anti-inflammatory activity [4]. Antimicrobial activity of cardamom was attributed to its essential. Cardamom showed infectious effects against aspirin and ethanol-induced lesions in mice [5]. Cardamom is an herbal medicine that contains essential fats such as phenolic acids and sterols. These fats contain antioxidant potentials that may increase antioxidant enzyme activities such as superoxide dismutase, lactase and glutathione peroxidase [2].

* Corresponding author: Department of Home Economics-Nutrition, Al-Baha University, AlMakhwa, Saudi Arabia.

Tel.: +966 17 727 4111(ext. 11015).

E-mail address: lobna_lolo_2007@yahoo.com (Lobna S. Abd Elmeged).

1658-7537/

Studies show that cardamom exerts anti-inflammatory effects and can drastically reduce macrophage production of NO. However, there is only limited evidence of the biological role of cardamom components in human glucose and lipid metabolism [6].

Cholesterol is a fatty substance in your body. Cholesterol can be both helpful and harmful to your body. On the good side, it helps build the hormones and nerve cells your body needs. But when you have too much cholesterol, the walls of your blood vessels can thicken. This can cause heart attacks and strokes. Most of the time, we can take care of our cholesterol by eating right and getting the exercise we need. It's important to eat healthy foods to keep a healthy weight. High cholesterol may be a problem in your family. Know your family history. Talk about it with your health care provider [7].

This work aimed to know effect of different level of cardamom plant *(Elettaria cardamomum*) on hypercholesterolemic rats.

2. Materials and Methods

2.1. Materials

Preparation of cardamom plant. Dry plant of cardamom (*Elettaria cardamomum*) was purchased from the local market of Al Baha city, Saudi Arabia, cleaned thoroughly by washing, cut into small slice and dried in drying oven at temperature 50°C for 3 days, then crushed and milled as fine powder.

Experimental animals. Twenty-four male albino rats, Sprague Dawley strain, weighing 150±10g were used in the study.

Chemicals. Cholesterol was obtained as a pure white crystalline powder from Biojenistic company, Cairo, Egypt.

2.2. Methods

2.2.1. Biological experiment

Table 1 Composition of basal diet.

Ingredients	Amount
Protein (casein)	10%*
Corn oil	10%
Mineral mixture	4%
Vitamin mixture	1 %
Cellulose	5%
Choline chloride	0.2 %
Methionine	0.3 %
Corn starch	Up to 100%

Source: Reeves et al., (1993).

Table 2 The composition of salt mixture (/100 g).

Compounds	Amount
$CaCO_3$	600 mg
K_2HPO_4	645 mg
$Ca\ HPO_4.2H_2O$	150 mg
$MgSO_4.2H_2O$	204 mg
Nacl	334 mg
$Fe\ (C_6H_5O_7)_26H_2O$	55 mg
Kl	1.6 mg
$MnSO_4.4H_2O$	10 mg
$Zncl_2$	0.5 mg
$Cu\ SO_4.5H_2O$	0.06 mg

Source: Hegsted et al. (1941).

Table 3 The composition of vitamin mixture.

Vitamin	Amount
Vitamin E	10 Iu
Vitamin K	0.50 Iu
Vitamin A	200 Iu
Thiamin	0.50 mg
Pyridoxine	1.00 mg
Niacin	4.00 mg
Calcium panthothenic acid	0.40 mg
Vitamin D	100 Iu
Choline chloride	200 mg
Folic acid	0.02 mg
Inositol	24 mg
Para-amino – benzoic acid	0.02 mg
Vitamin B12	2.00 µg
Biotin	0.02 mg

Source: Campbell (1963)

2.2.2. Induced Disease for rats

Preparation of hypercholesterolemic rats. Hypercholesterolemia was in normal healthy adult male albino rats by feeding on hypercholesterolemic diet for 20 days, then fasting blood serum obtained and TC, VIDL, IDL, HDL, and TG, levels estimated. Rats were divided into 4 groups, 6 rats in each, and fed for 28 days.

2.2.3. Experimental Design and Animal Groups

Twenty-four Mature male albino rats of Sprague - Dawley strain weighing 150-160 g. B.Wt. at age of 14-16 weeks were obtained from Laboratory of Animal. The animals were allocated in plastic cages with metallic stainless covers and kept under strict hygienic measures. Rats were fed the basal diet for 7 days before the beginning of the experiment for adaptation. Diets were presented to rats in a special non-scattering feeding cups to avoid loss of food and contamination. Water was provided ad libitum via a narrow mouth bottle with a metallic tube tightly fixed at its mouth by a piece of rubber tube. Animals were subjected to a 12 hours light and 12 hours dark schedule and kept for 7 days before the start of the experiment for acclimatization. The rats were divided into 4 groups each of 6 rats. The groups of rats were as follows:

Group 1: six rats were fed basal diet (control negative).
Group 2: six hypercholesterolemic rats fed on basal diet (control positive)
Group 3: six hypercholesterolemic rats fed on basal diet containing 10% cardamom.
Group 4: six hypercholesterolemic rats fed on basal diet containing 15% cardamom.

2.2.4. Biological evaluation

During the experimental period (28 days), the consumed feed was recorded every day, and body weight recorded weekly. The body weight gain (B.W. G. %), food efficiency ratio (F.E.R) and also organs weight was determined according to Chapman et al. [8].

Blood sampling. At the end of the experiment period (28 days) rats were sacrificed by ether and anesthesia. Blood samples were obtained by retro-orbital method in a clean dry centrifuge tube. They were left to clot by standing at room temperature for 20 minutes, and then centrifuged at 1500 r.p.m for 15 minutes. Serum samples were collected by a dry clean syringe, poured in Wisserman tubes and then kept frozen in a refrigerator at -10ºC till biochemical analysis. Rats were thereafter opened, liver, spleen, heart, lungs and kidneys removed and washed in saline solution, then dried and weighted. according to methods described by Drury and Wallington [9].

Biological analysis. Food intake (consumption), body weight gain% (BWG %), food efficiency ratio (FER) according to Chapman et al. [8]. Using the following equations.

$$BWG\% = \frac{Finalweig\square t - Initialweig\square t}{Initialweig\square t} \times 100 \quad (1)$$

$$FER = \frac{Gaininbodyweig\square t(g/day)}{FoodIntake(g/day)} \quad (2)$$

$$\text{Relative weight of organs} = \frac{\text{Organ's weight}}{\text{Animal body weight}} \times 100 \quad (3)$$

2.2.5. Biochemical analysis

(a) Food intake
Food intake (consumption), body weight gain% (BWG %), food efficiency ratio (FER) according to Chapman et al. [8].

(b) Determination of serum glucose
Serum glucose was determined using chemical kits according ***(Trinder, 1969).***

(c) Determination of serum lipids
- **Triglycerides**. Enzymatic calorimetric determination of Triglycerides was carried out according to Fassati and Prencipe [10].
- **Total cholesterol.** The principle uses of total cholesterol determination according to Allain [11].
- **HDL-cholesterol.** Phosphotungstic acid and magnesium ions selectivity precipitating all lipoproteins except the HDL fraction-cholesterol present in the supernatant can be determined by the same method used for total cholesterol, according to Lopez [12].
- **V-LDL and LDL- cholesterol.** The determination of VLDL (very low density lipoprotins) and LDL were carried out according to the method of Lee and Nieman [13].
- **Total Lipids.** Total lipids were determined by colorimetric method according to Hustedt [14].
- **Total Lipids** [15].

(d) Determination of liver functions

- **Determination of Alanine transferase (ALT).** Determination of (ALT) was carried out according to the method of Tietz [16]. ALT catalyzes the transfer of the amino group from L-alanine to a-Ketoglutarate resulting in the formation of pyruvate and L-Glutamate.
- **Determination of Asartate Transferase (AST).** Determination of (AST) was carried out according to the method of Henry [17].

(e) Determination of e Kidney functions

- **Determination of Creatinine:** Creatinine was determined according to kinetic method of Henry [17].
- **Determination of urea:** Urea was determined according to the enzymatic method of Patton and Crouch [18].
- **Determination of Uric acid:** Uric acid was determined according to the method described by Patton and Crouch [18].

2.2.6. Statistical Analysis

Statistical analysis was calculated using one way classification. Analysis of variance (ANOVA), and least significant difference (LSD) according to Snedcor and Cochran [15].

3. Results and Discussion

This work aimed to know effect of different level of cardamom plant (Elettaria cardamomum) on hypercholesterolemic rats.

3.1. Biological results

3.1.1. Effect of feeding different level of cardamom on FI (Food intake), BWG% (Body weight gain) and FER (Food efficiency ratio) in hypercholesterolemic rats

Table 4 showed the effect of different levels of cardamom on Food intake value in normal rats group was (478.8 ± 31.86) gm/100gm. While in hypercholesterolemic rats groups with cardamom at different levels (positive control, 10 %, and 15 %) showed that (544.2 ±32.19, 516.6 ± 17.1, and 562.8 ± 38.9) gm/100gm, respectively the results showed high significant (P<0.05) between groups (10% and 15%) cardamom when compared with control negative.

Data in Table 4 indicated that the Body weight gain in both normal and hypercholesterolemic rats after 4 weeks. Body weight gain in normal rats group was (52.2 ± 11.43) gm/100gm. While hypercholesterolemic rats groups with cardamom at different levels (positive control, 10%, and 15%) showed, (21 ± 8, 55.6 ± 10.64 and 52.2 ± 7.05) gm/100gm, respectively. the results showed that significant differences between three groups.

Food efficiency ratio (FER) values in normal rats group was (0.194 ± 0.03). While in hypercholesterolemic rats groups with cardamom at different levels (positive control, 10%, and 15%) were (0.09 ± 0.04, 0.198 ±0.05, and 0.21 ± 0.04,). the results showed that non-significant differences between three groups. this result agreement with Albano.

3.1.2. Effect on (T. Lipids, ph. Lipids and Cholesterol)

Table 5 represents the effect of feeding different levels of cardamom on (T. Lipids, pH. Lipids and Cholesterol) in both normal and hypercholesterolemic rats after 4 weeks of feeding. T. Lipids in normal rats group was (237.6±10.5) mg/dl, while hypercholesterolemic groups at different levels of cardamom (positive control,5%, and 10 % cardamom) showed T-Lipids values (318.8±3.19, 260.2±1.79, and 243.8±2.88) mg/dl, respectively.

ph. Lipids values in normal rate group was (102.2±2.17) mg/dl, while in hypercholesterolemic groups at different levels of cardamom (positive control,10%, and 15 % cardamom) were (111±2.83, 102.2±2.49, and 101±1.41) mg/dl, respectively. Cholesterol values in normal rate group was (81.6±5.13) mg/dl, while in hypercholesterolemic groups at different levels of cardamom (positive control,10%, and 15 % cardamom) were (119.6±2.19, 90.4±6.49, and 84.8±3.03) mg/dl, respectively. This results agreement with Surendra [19]. Dietary supplementation of Greater cardamom favorably modifies lipid profile and significantly enhances fibrinolytic activity and total antioxidant status in patients with ischemic heart disease.

Table 4 Effect of feeding different level of cardamom on FI (Food intake), BWG% (Body weight gain) and FER (Feed efficiency ratio) in hypercholesterolemic rats (n = 6 rats).

Groups	FI(g)		BWG(g)		FER(g)	
	$\bar{x} \pm SE$	Change (%)	$\bar{x} \pm SE$	Change (%)	$\bar{x} \pm SE$	Change (%)
Control (-ve)	478.8 ±31.86 ^{b}	---	52.2 ±11.43 ^{a}	---	0.194 ±0.03 ^{a}	---
Control(+ve)	544.2 ±32.19 ^{a}	13.65	21 ±8 ^{b}	-57.85	0.09 ±0.04 ^{b}	-53.6
10% cardamom	516.6 ±17.1^{ab}	-5.07	55.6 ±10.64 ^{a}	164.76	0.198 ±0.05 ^{a}	120
15% cardamom	562.8 ±38.9 ^{a}	3.41	52.2 ±7.05 ^{a}	148.57	0.21 ±0.04 ^{a}	133.3

(U/L) means unit per liter*
Values denote arithmetic means ± Standard error of the mean.
Means with different letters (a, b, c, d) in the same column differ significantly at p ≤ 0.05 using one way ANOVA test, while those with similar letters are non-significant.

Table 5 Effect of feeding different level of cardamom on serum levels of (T. Lipids, ph. Lipids and Cholesterol) of hypercholesterolemic rats (n = 6 rats).

Groups	T. Lipids		ph. Lipids		Cholesterol	
	mg/dl $\bar{x} \pm SE$	Change (%)	mg/dl $\bar{x} \pm SE$	Change (%)	mg/dl $\bar{x} \pm SE$	Change (%)
Control (-ve)	237.6 ±10.5^{e}	--	102.2 ±2.17^{b}	--	81.6 ±5.13^{c}	--
Control(+ve)	318.8 ±3.19^{c}	34.17	111 ±2.83^{a}	8.61	119.6 ±2.19^{a}	46.56
10% cardamom	260.2 ±1.79^{b}	-18.38	102.2 ±2.49^{b}	-7.92	90.4 ±6.49^{b}	-24.41
15% cardamom	243.8 ±2.88^{c}	-23.52	101 ±1.41^{b}	-9	84.8 ±3.03^{bc}	-29.09

Values denote arithmetic means ± Standard error of the mean.
Means with different letters (a, b, c, d) in the same column differ significant at p ≤ 0.05 using one way ANOVA test, while those with similar letters are non-significant.

3.1.3. Effect on (T.G, LDL, HDL and VLDL)

Table 6 represents the effect of feeding different levels of cardamom on (T.G, HDL, LDL, and VLDL) in both normal and hypercholesterolemic rats after 4 weeks of feeding, T.g values in normal rate group was (53.2±5.85) mg/dl, while in hypercholesterolemic and in treatment groups fed on diet with different levels cardamom were (91.4±5.13, 60.4±3.13, and 56.2±2.68) mg/dl at levels (positive control, 10 %, and 15% cardamom) mg/dl, respectively.

HDL values in normal rate group were (46±1.41) mg/dl. While in hypercholesterolemic rats groups fed on diet with different levels cardamom were (41.6±0.59, 44.6±0.89, and 44.4±0.55) mg/dl at levels (positive control, 10 %, and 15% cardamom), respectively.

Table 6 Effect of feeding different level of cardamom on the serum levels of lipoprotein fractions (T.G, HDLc, LDLc and VLDLc) of hypercholesterolemic rats (n = 6 rats).

Groups	T.G.		HDLc.		LDLc.		VLDLc.	
	mg/dl $\bar{x} \pm SE$	Change (%)	mg/dl $\bar{x} \pm SE$	Change (%)	mg/dl $\bar{x} \pm SE$	Change (%)	mg/dl $\bar{x} \pm SE$	Change (%)
Control (-ve)	53.2±5.85^{b}	--	46±1.41^{a}	--	26.56±3.19^{c}		10.84±1.17^{b}	--
Control(+ve)	91.4±5.13^{a}	71.8	41.6±0.59^{b}	-9.56	61.4±3.88^{a}	140.21	18.28±1.03^{a}	68.63
10% cardamom	60.4±3.13^{b}	-33.9	44.6±0.89^{a}	7.21	36.28±3.8^{a}	-40.91	12.08±0.72^{b}	-33.9
15% cardamom	56.2±2.68^{b}	-38.5	44.4±0.55^{a}	6.73	25.28±3.8^{b}	-58.82	11.24±0.54^{b}	-38.5

Values denote arithmetic means ± Standard error of the mean.
Means with different letters (a, b, c, d) in the same column differ significantly at p≤0.05 using one way ANOVA test, while those with similar letters are non-significant.

Table 7 Effect of feeding different level of cardamom on serum levels of aspartate amino transaminase (AST), alanine amino transferase c) and alkaline phosphatase (ALP) enzymes of hypercholesterolemic rats (n = 6 rats).

Groups	AST		ALT		ALP	
	(U/L)* $\bar{x} \pm SE$	Change (%)	(U/L)* $\bar{x} \pm SE$	Change (%)	(U/L)* $\bar{x} \pm SE$	Change (%)
Control (-ve)	94.8±6.61^{b}	--	42.8±3.89^{bc}	--	104.6±7.9^{a}	--
Control(+ve)	102.8±1.79^{a}	8.4	48.2±1.3^{a}	12.6	111.4±7.4^{a}	6.5
10% cardamom	95.4±3.55^{b}	-7.1	44.4±1.52^{b}	-7.88	110.8±3.0^{a}	-0.53
15% cardamom	92.6±3.47^{b}	-9.9	4.04±0.89^{c}	-17.4	106.2±6.26^{a}	-8.25

(U/L) means unit per liter*
Values denote arithmetic means ± Standard error of the mean.
Means with different letters (a, b, c, d) in the same column differ significantly at p ≤ 0.05 using one way ANOVA test, while those with similar letters are non-significant.

LDL values in normal rate group was (26.56±3.19) mg/dl, while in hypercholesterolemic rats groups at different levels of cardamom (positive control, 10 %, and 15% cardamom) were (61.4±3.88a, 36.28 and 25.28±3.8) mg/dl, respectively. groups of 10% and 15% cardamom were significant (P<0.05) when compared with control negative.

VLDL values in normal group was (10.84±1.17) mg/dl, while in hypercholesterolemic groups at different levels of cardamom were (18.28±1.03, 12.08±0.72, and 11.24±0.54) mg/dl at levels (positive control, 10%, and 15%) respectively. The result showed non-significant differences(P<0.05) between all groups when compared with control negative. These results obtained in the present work agreed with Kazemi et al. [20], who showed that meta-analysis demonstrated that green cardamom intake significantly reduced triglycerides levels which may have played an indirect role in improved clinical symptoms in diseases with metabolic disorders.

3.1.4. Effect on liver enzymes (S.GOT, S.GOT, c and ALP)

Table (7) show the effect of feeding different level of cardamom on serum liver enzymes including (AST), (ALT) and (ALP) enzymes in hypercholesterolemic after 4 weeks of feeding. The (AST) in normal rats group was (94.8±6.61) U/L, while in hypercholesterolemic groups at different levels of cardamom (positive control, 10%, and 15 % cardamom) showed (102.8±1.79, 95.4±3.55, and 92.6±3.47) (U/L), respectively.
(ALT) values in normal rate group was (42.8±3.89) (U/L). While in hypercholesterolemic groups at different levels of cardamom (positive control, 10%, and 15 % cardamom) were (48.2±1.3, 44.4±1.52. and 4.04±0.89) (U/L), respectively. The results showed that all groups were significant (P<0.05) when compared with control positive.

(ALP) values in normal group was (104.6±7.9) (U/L), while in hypercholesterolemic rats groups fed a diet with different levels of cardamom (positive control,10%, and 15 % cardamom) were (111.4±7.4, 110.8±3.0, and 106.2±6.26) (U/L) respectively. the results showed that rats fed on 15 % cardamom was non-significant (P<0.05) when compared with control positive. This result agreed with Jamal et al. [2]. They concluded that cardamom aqueous extracts possessed hepatoprotective activity against gentamicin induced hepatotoxicity in rats.

Table 8 Effect of feeding different level of cardamom on kidney function (Urea, Creatinine and U. acid) of hypercholesterolemic rats (n = 6 rats).

Groups	Urea		Creatinine		U. acid	
	U/L* $\bar{x} \pm SE$	Change (%)	U/L* $\bar{x} \pm SE$	Change (%)	U/L* $\bar{x} \pm SE$	Change (%)
Control (-ve)	27.6 ±4.77^{a}	--	0.59 ±0.07^{b}	--	1.68 ±0.39^{a}	--
Control(+ve)	28.8 ±0.45^{a}	4.34	0.69 ±0.03^{a}	1.06	2.26 ±1.4^{a}	34.52
10% cardamom	23 ±1.41^{b}	-20.1	0.67 ±0.02^{a}	-2.89	1.56 ±0.09^{a}	-30.97
15% cardamom	22.4 ±0.55^{b}	-22.2	0.64 ±0.05^{ab}	-7.24	1.44 ±0.09^{a}	-36.28

(U/L) means unit per liter*
Values denote arithmetic means ± Standard error of the mean.
Means with different letters (a, b, c, d) in the same column differ significantly at p ≤ 0.05 using one way ANOVA test, while those with similar letters are non-significant.

4. Conclusion and Recommendations

The results showed that cardamom plant has a strong effect in decreasing the cholesterol of hypercholesterolemic rats and the improvement rate increased in the group containing 15% cardamom, because it contains sterol and phenolic acids which consider antioxidant that might increase antioxidant enzyme activities such as superoxide dismutase, catalase, and glutathione peroxidase which improves heart function very clearly. It could be recommended that:

- It is suggested to use cardamom powder for hypercholesterolemic patients.
- Different levels of cardamom powder, may be suggested for lowering LDL and atherogenic index levels.

References

1. Muthuraman A, Sood S, Singla SKJI. The antiinflammatory potential of phenolic compounds from Emblica officinalis L. in rat. 2011;19(6):327-334.
2. Jamal A, Javed K, Aslam M, et al. Gastroprotective effect of cardamom, Elettaria cardamomum Maton. fruits in rats. 2006;103(2):149-153.

3. Hinneburg I, Dorman HD, Hiltunen RJFc. Antioxidant activities of extracts from selected culinary herbs and spices. 2006;97(1):122-129.
4. Al-Zuhair H, El-Sayeh B, Ameen H, et al. Pharmacological studies of cardamom oil in animals. 1996;34(1-2):79-82.
5. Vasavada MN, Dwivedi S, Cornforth DJJoFS. Evaluation of garam masala spices and phosphates as antioxidants in cooked ground beef. 2006;71(5):C292-C297.
6. Majdalawieh AF, Carr RIJJoMF. In vitro investigation of the potential immunomodulatory and anti-cancer activities of black pepper (Piper nigrum) and cardamom (Elettaria cardamomum). 2010;13(2):371-381.
7. Angerosa F, Di Giacinto L, d'Alessandro NJJoHRC. Quantitation of some flavor components responsible for the "green" attributes in virgin olive oils. 1997;20(9):507-510.
8. Chapman D, Castillo R, Campbell JJCJoB, et al. Evaluation of protein in foods: 1. A method for the determination of protein efficiency ratios. 1959;37(5):679-686.
9. Drury R, Wallington E. Histological technique. Oxford University Press; 1967.
10. Fossati P, Prencipe LJCc. Serum triglycerides determined colorimetrically with an enzyme that produces hydrogen peroxide. 1982;28(10):2077-2080.
11. Allain CC, Poon LS, Chan CS, et al. Enzymatic determination of total serum cholesterol. 1974;20(4):470-475.
12. Lopez MJJoCC. HDL-cholesterol colorimetric method. 1977;23:882.
13. Lee R, Niemann D. Nutritional Assessment 2nd ed Mosby Missou USA. 1996.
14. Hustedt FJK-F. Die Kieselalgen Deutschlands, Osterreichs und der Schweiz unter Berucksichtigung der ubrigen Lander Europas sowie der angrenzenden Meeresgebiete. 1966;1:1-920.
15. Strandberg E, Tiltak D, Ehni S, et al. Lipid shape is a key factor for membrane interactions of amphipathic helical peptides. 2012;1818(7):1764-1776.
16. Tietz NJWSCP, Toronto, London. Biuret method for the determination of total protein in serum In: Fundamental of clinical chemistry. 1976;503.
17. Henry RJP, Techniqus nE, Hagerstown , Harcer, Row. Clinical Chemist. 1974;882.
18. Patton CJJoAC. Urea enzymatic method. 1977;49:464-546.
19. Verma SK, Jain V, Singh DPJAPJoTD. Effect of greater cardamom (Amomum subulatum Roxb.) on blood lipids, fibrinolysis and total antioxidant status in patients with ischemic heart disease. 2012;2:S739-S743.
20. Kazemi S, Yaghooblou F, Siassi F, et al. Cardamom supplementation improves inflammatory and oxidative stress biomarkers in hyperlipidemic, overweight, and obese pre□diabetic women: A randomized double□blind clinical trial. 2017;97(15):5296-5301.