

# Supplementation of garlic and coriander seed powder: Impact on body mass index, lipid profile and blood pressure of hyperlipidemic patients

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**Abstract:** Garlic and coriander play an obligatory role in the metabolism of lipids leading to the reduction of CVD development. We hypothesized that garlic, coriander and their mixture improves the lipid profile, BMI and blood pressure of CVD patients. Eighty patients were partitioned into 4 groups, each group consisting of twenty patients. The groups were randomly assigned to three supplements i.e. garlic powder (GP), coriander seed powder (CSP) and mixture (1:1 dry weight basis) of GP and CSP at a dose rate of 2 g/day. The fourth group was kept as placebo. The patients were examined for serum lipid profile, BMI and blood pressure at the start (0 day), 20, 40 and 60<sup>th</sup> day of supplementation. The initial 40 days were the intervention period whereas the last 20 days were the follow up period. The results indicated that all the supplements significantly ( $p < 0.05$ ) influenced the BMI, HDL, total cholesterol, triglycerides, LDL and systolic blood pressure of the patients. Among the supplements, GP had the highest influence on BMI, TC, LDL and HDL whereas the impact of GP-CSP and CSP was more pronounced on TGL and blood pressure of the patients, respectively. All the parameters decreased with supplementation except HDL, which increased with the consumption of supplements. It was concluded that consumption of garlic, coriander and their mixture at a dose rate of 2 g/day is improving the lipid parameters of the patients.

**Keywords:** BMI, hyperlipidemia, lipid profile, garlic, coriander.

## INTRODUCTION

Hyperlipidemia is one of the major causes of cardiovascular diseases. It refers to an increased level of lipid substances including cholesterol, triglycerides and low density lipoprotein and decreased level of high density lipoprotein in the blood (Ahmed *et al.*, 1998). It may be primary or secondary and contributes to various abnormal events, including coronary heart disease, rheumatic heart disease, atherosclerosis, heart attack, myocardial infarction and deep venous thrombosis (DVT) (WHO/FAO, 2002). The underlying mechanism of CVD comprises the deposition and retention of lipid containing compound such as LDL in the coronary arteries, resulting in decreased blood flow to heart muscles leading to the development of CVD related conditions (Rudling, 2006). Chylomicrons and chylomicron fragments are triglyceride rich particles that carry dietary derivative fats and may play a role in the early stages of developing CVD (Wilhelm and Cooper, 2003).

The consumption of high-energy diets, which are low in omega-3 and omega-6 fatty acids, and lack of physical activities have been attributed to the increased risk of CVD (Johnson *et al.*, 2011 and Simopoulos, 2002). A number of plant based nutraceuticals has been recognized that prevents and reduces the progression of

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cardiovascular diseases and associated risk factors (Omeish *et al.*, 2011). For example, spices offer a cheap and easily accessible source of micronutrients and other phytochemicals having antioxidant and hypocholesterolemic properties to help prevent the advancement of CVD (Mahmood *et al.*, 2010; Tasawar *et al.*, 2011).

Garlic and coriander have been reported to have several medicinal and nutritional implications such as they are used to lower the blood lipids and improve CVD symptoms (Dhanapakiam *et al.*, 2007). The daily consumption of a garlic clove can lower the LDL cholesterol and triglycerides by 15 and 17%, respectively (Kojuri *et al.*, 2007). Garlic indirectly improves CVD by reducing extra weight, hyperlipidemia, hypertension and prevent thrombus formation. The beneficial effect of garlic powder is due to the presence of organosulphur compounds that lower lipid materials in arterial wall (El-Sabban and Abouazra, 2008). The sulphur containing compound "alliin" is converted to its active form "allicin" by the enzyme alliinase when the garlic clove is crushed. Allicin blocks the HMG-CoA reductase enzyme involved in biosynthesis of cholesterol in the liver (Choudhary, 2008). In a study conducted by Liu and Yeh, it was observed that garlic extract decreased cholesterol production by up to 75% without causing any cellular toxicity.

The consumption of coriander seeds powder has intense influence on the metabolism of lipid substances in animals fed on high cholesterol containing diet (Dhanapakiam *et al.*, 2007). A considerable antioxidant action is exhibited by aqueous extract of coriander containing phenolic and carotenoids (De-Almeida *et al.*, 2003). The coriander causes a significant increase in BMG-CoA reductase and plasma lecithin cholesterol acyl transferase (LCAT) enzymes activity. This mechanism has been shown to decrease the level of LDL and VLDL cholesterol while increasing HDL cholesterol (Dhanapakiam *et al.*, 2007; Fawzy *et al.*, 2008).

Many attempts have been made to assess the individual effect of garlic (Rilvin 2001; Steiner and Li, 2001; Qidwai and Ashfaq, 2013) and coriander seed powder (Dhanapakiam *et al.*, 2007; Aissaoui *et al.*, 2011; Parsaeyan, 2012) on cardiovascular diseases and its associated risk factors. However, there is lack of knowledge on the combined influence of garlic and coriander seed powder on the body mass index, lipid profile and blood pressure of hyperlipidemic human individuals. Since garlic is a rich source of sulphur containing compounds and coriander provides an abundant supply of antioxidants, their combine application may synergistically enhance their potentials against cardiovascular diseases. Therefore, this study aimed to investigate the individual as well as the combined effect of garlic and coriander seed powder on lipid profile, body mass index and blood pressure of hyperlipidemic patients. We hypothesized that supplementation of garlic and coriander seed powder would prove a useful therapeutic intervention to combat cardiovascular diseases in hyperlipidemic people.

## MATERIALS AND METHODS

### Recruitment and study design

A single-blind, randomized, placebo-controlled intervention clinical trial was conducted at Cardiac Rehabilitation Center of Hayatabad Medical Complex Hospital Peshawar, Khyber Pakhtunkhwa-Pakistan. Eighty human individuals of both sexes and aged 40-80 years were enrolled in the study on the basis of consecutive sampling basis. The inclusion criteria was based on the presence of hyperlipidemia with CVDs, total cholesterol > 200mg/dl and serum triglycerides >150 mg/dl whereas the subjects suffering from gastro-intestinal problems and pregnant and lactating women were excluded from the study. The patients were partitioned randomly into 4 groups, each group consisting of 20 patients. The 1<sup>st</sup> group was given garlic powder (GP), the 2<sup>nd</sup> group coriander seed powder (CSP) and the 3<sup>rd</sup> group GP and CSP mixture (1:1) at a dose rate of 2 g per subject per day. The control or Placebo group was not fed any supplement. The total study duration was 60 days with 40 days of dose duration followed by 20 days follow-up period.

First hydrolyzed to cholesterol and fatty acids by cholesterol esterase enzyme and then to hydrogen peroxide by cholesterol oxidase. Peroxidase enzyme converted hydrogen peroxide to red quinine. The intensity of the color was checked at 505nm and correlated with the concentration of cholesterol in the sample.

### Triglycerides

The triglycerides concentration in serum was measured by enzymatic and colorimetric method using DIALAB kits. The method was based upon the principle that triglyceride incubated with lipoprotein lipase liberated glycerol and free fatty acids. Glycerol was converted to glycerol-3-phosphate and adenosine-5-diphosphate by glycerol kinase and adenosine triphosphate. Glycerol-3-phosphate was then converted by glycerol phosphate dehydrogenase to dihydroxyacetone phosphate and hydrogen peroxide. The hydrogen peroxide reacted with 4-aminophenazone and p-chlorophenol in the presence of per oxidase to give red color; the intensity of the color was measured at 505 nm.

### HDL cholesterol

In the DIALAB HDL cholesterol-AUTO reagent, separation of the lipoprotein fractions was achieved by adding antibodies, which was absorb into the surface of chylomicrons, VLDL and LDL. In a second step, the added detergent broke up the HDL lipoproteins and therefore made HDL cholesterol available for quantitation by an enzymatic system.

### LDL cholesterol

LDL Cholesterol was calculated by the Feridewald formula (Friedewald *et al.*, 1972). LDL cholesterol (mg/dl) = (Total cholesterol – HDL cholesterol) - (TGL/5)

### Body mass index

Clients' weights and heights were measured by using standard procedure. Standard digital scale was used for weight determination and height was measured by using an elastic height tap. BMI was calculated from weight and height values using the following formula (WHO, 2004). BMI= weight in kg/ height in m<sup>2</sup> Blood pressure Blood pressure was measured by using sphygmomanometer.

## STATISTICAL ANALYSIS

The data were subjected to analysis of variance (ANOVA) using statistical software package Minitab 16. Significance was declared at p<0.05. When significant results were obtained, post-hoc analyses were carried out to compare the differences among the means using Least Significant Difference (LSD) test. Each mean was calculated from triplicate values.

## RESULTS

### Baseline characteristics of individuals

Baseline information regarding the study participants

**Table 1:** Baseline characteristics of individuals at registration

Parameters	Groups			
	GP	CSP	GP-CSP	Control
Male: Female ratio	2:5	4:3	5:2	5:2
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
Age (years)	53.57 $\pm$ 8.5	46.42 $\pm$ 6.7	65.28 $\pm$ 9.7	50.57 $\pm$ 7.8
BMI (kg/m <sup>2</sup> )	28.01 $\pm$ 3.1	27.3 $\pm$ 4.6	26.21 $\pm$ 5.2	30.39 $\pm$ 4.4
TC (mg/dl)	241 $\pm$ 14.4	229.57 $\pm$ 26	217 $\pm$ 12.6	227 $\pm$ 24.7
TGL (mg/dl)	258.42 $\pm$ 17.7	194.28 $\pm$ 14.3	251.28 $\pm$ 11.7	292.14 $\pm$ 12.3
HDL (mg/dl)	42.28 $\pm$ 5.2	41.85 $\pm$ 5.4	43.57 $\pm$ 4.0	41 $\pm$ 6.4
LDL (mg/dl)	147.02 $\pm$ 28.9	148.85 $\pm$ 45.9	123.17 $\pm$ 109.7	127.57 $\pm$ 31.1
Systolic (mmHg)	140 $\pm$ 25.2	140 $\pm$ 20.8	141.42 $\pm$ 21.2	137.14 $\pm$ 12.5
Diastolic (mmHg)	85.71 $\pm$ 14.0	88.57 $\pm$ 9.0	83.57 $\pm$ 11.1	85.71 $\pm$ 7.9
Glucose (mg/dl)	240 $\pm$ 123.3	126 $\pm$ 31.9	162 $\pm$ 46.1	135.85 $\pm$ 33.4

**Table 2:** Effect of garlic and/or coriander on BMI and lipid profile of patients with hyperlipidemia

Biochemical Parameter	Groups	Days			
		0	20	40	60
BMI	GP	28.01 $\pm$ 3.1 <sup>b</sup>	27.47 $\pm$ 4.2 <sup>bcd</sup>	27.24 $\pm$ 4.3 <sup>cde</sup>	27.63 $\pm$ 4.1 <sup>bc</sup>
	CSP	27.30 $\pm$ 4.6 <sup>b-e</sup>	26.89 $\pm$ 4.7 <sup>def</sup>	26.74 $\pm$ 4.6 <sup>efg</sup>	27.11 $\pm$ 4.7 <sup>cde</sup>
	GP-CSP	26.21 $\pm$ 5.2 <sup>fg</sup>	26.27 $\pm$ 5.6 <sup>fg</sup>	26.11 $\pm$ 5.7 <sup>g</sup>	26.34 $\pm$ 5.3 <sup>fg</sup>
	Control	30.39 $\pm$ 4.4 <sup>a</sup>	30.36 $\pm$ 4.4 <sup>a</sup>	30.57 $\pm$ 4.4 <sup>a</sup>	30.64 $\pm$ 4.6 <sup>a</sup>
TC (mg/dl)	GP	241 $\pm$ 14.4 <sup>bcd</sup>	218.57 $\pm$ 30.1 <sup>defg</sup>	195.28 $\pm$ 20.4 <sup>ghi</sup>	223 $\pm$ 11.0 <sup>c-f</sup>
	CSP	229.57 $\pm$ 26.0 <sup>cde</sup>	215.57 $\pm$ 10.2 <sup>efg</sup>	191.57 $\pm$ 27.2 <sup>hi</sup>	201.28 $\pm$ 23.6 <sup>fgh</sup>
	GP-CSP	217 $\pm$ 12.6 <sup>efg</sup>	184.85 $\pm$ 28.4 <sup>hi</sup>	176.71 $\pm$ 19.5 <sup>i</sup>	177.28 $\pm$ 10.6 <sup>i</sup>
	Control	227 $\pm$ 24.7 <sup>cde</sup>	245.71 $\pm$ 31.8 <sup>bc</sup>	263.42 $\pm$ 37.9 <sup>ab</sup>	278.42 $\pm$ 29.0 <sup>a</sup>
TGL (mg/dl)	GP	258.42 $\pm$ 117.7 <sup>ab</sup>	227.71 $\pm$ 61.4 <sup>bc</sup>	206.14 $\pm$ 52.4 <sup>bcd</sup>	188.28 $\pm$ 82.9 <sup>c-f</sup>
	CSP	194.28 $\pm$ 44.3 <sup>cde</sup>	190.28 $\pm$ 70.8 <sup>c-f</sup>	151.28 $\pm$ 38.2 <sup>def</sup>	159.57 $\pm$ 18.1 <sup>def</sup>
	GP-CSP	251.28 $\pm$ 110.7 <sup>ab</sup>	190.28 $\pm$ 41.1 <sup>ef</sup>	136.28 $\pm$ 32.2 <sup>f</sup>	149.85 $\pm$ 51.7 <sup>def</sup>
	Control	292.14 $\pm$ 128.3 <sup>a</sup>	185.71 $\pm$ 28.4 <sup>c-i</sup>	204.42 $\pm$ 29.5 <sup>bcd</sup>	187 $\pm$ 40.9 <sup>c-i</sup>
HDL (mg/dl)	GP	42.28 $\pm$ 5.2 <sup>def</sup>	48.85 $\pm$ 9.2 <sup>a-e</sup>	55.14 $\pm$ 11.8 <sup>a</sup>	44.42 $\pm$ 11.4 <sup>c-f</sup>
	CSP	41.85 $\pm$ 5.4 <sup>ef</sup>	50 $\pm$ 10.1 <sup>a-d</sup>	46 $\pm$ 9.5 <sup>b-f</sup>	44.14 $\pm$ 7.2 <sup>c-f</sup>
	GP-CSP	43.57 $\pm$ 4.0 <sup>cd<sup>ef</sup></sup>	50.42 $\pm$ 7.5 <sup>abc</sup>	53 $\pm$ 10.5 <sup>ab</sup>	46.57 $\pm$ 10.1 <sup>b-f</sup>
	Control	41 $\pm$ 6.4 <sup>ef</sup>	50.14 $\pm$ 13.0 <sup>a-d</sup>	45.85 $\pm$ 9.5 <sup>b-f</sup>	40.28 $\pm$ 5.3 <sup>f</sup>
LDL (mg/dl)	GP	147.02 $\pm$ 114.3 <sup>cd</sup>	124.17 $\pm$ 59.6 <sup>d-h</sup>	98.91 $\pm$ 59.2 <sup>hi</sup>	140.91 $\pm$ 80.4 <sup>cde</sup>
	CSP	148.85 $\pm$ 45.9 <sup>cd</sup>	127.51 $\pm$ 69.4 <sup>def</sup>	115.31 $\pm$ 40.6 <sup>c-i</sup>	125.22 $\pm$ 22.5 <sup>d-g</sup>
	GP-CSP	123.17 $\pm$ 109.7 <sup>d-h</sup>	105.11 $\pm$ 44.0 <sup>f-i</sup>	96.45 $\pm$ 41.0 <sup>i</sup>	100.74 $\pm$ 50.8 <sup>ghi</sup>
	Control	127.57 $\pm$ 31.1 <sup>def</sup>	158.42 $\pm$ 23.3 <sup>bc</sup>	176.68 $\pm$ 24.4 <sup>ab</sup>	200.74 $\pm$ 41.3 <sup>a</sup>

BMI: Body Mass Index, TC: Total Cholesterol, TGL: Triglycerides, HDL: High Density Lipoprotein, LDL: Low Density Lipoprotein, GP: Garlic Powder, CSP: Coriander Seed Powder, GP-CSP: Garlic Powder-Coriander Seed Powder

showed male to female ratios of 2:5, 4:3, 5:2, 5:2 for GP, CSP, GP-CSP and control groups, respectively (table 1). The average age of the individuals across the groups ranged from 46.42 to 65.28 years. Average BMI of the individuals ranged from 26.21 to 30.39 kg/m<sup>2</sup> whereas the concentrations of TC, TGL, HDL and LDL ranged from 217 to 241, 194.28 to 292.14, 41 to 43.57, 123.17 to 148.85 mg/dl, respectively. The systolic blood pressure of subject individuals varied from 137.14 to 140 mmHg whereas the diastolic blood pressure from 83.57 to 88.57 mmHg. Similarly, the blood glucose levels of the four groups ranged from 126 to 240 mg/dl.

Effect of GP and CSP supplementation on lipid profile The BMI of subject individuals was significantly ( $p < 0.05$ ) affected by both supplement types and supplementation time (table 2). The highest average BMI (30.64kg/m<sup>2</sup>) was recorded for control group at day 60 whereas the lowest (26.11kg/m<sup>2</sup>) for individuals provided with GP-CSP mixture at day 40 of the experimental period. The average BMI showed a decreasing trend in treatment groups with the length of supplementation time, however, at follow-up period i.e. after day 40, a non-significant increase in BMI was observed.

**Table 3:** Effect of garlic and/or coriander on blood pressure of patients with hyperlipidemia

Biochemical Parameter	Group	Days			
		0	20	40	60
SBP (mm Hg)	GP	140±25.2 <sup>ab</sup>	137.14±19.8 <sup>ab</sup>	134.28±14.0 <sup>ab</sup>	134.28±16.2 <sup>ab</sup>
	CSP	140±20.8 <sup>ab</sup>	120±12.9 <sup>d</sup>	117.14±13.8 <sup>d</sup>	121.42±13.5 <sup>cd</sup>
	GP-CSP	141.42±21.2 <sup>a</sup>	133.57±14.9 <sup>ab</sup>	140.71±11.0 <sup>a</sup>	138.57±10.7 <sup>ab</sup>
	Control	137.14±12.5 <sup>ab</sup>	128.57±9.0 <sup>bcd</sup>	135.71±18.1 <sup>ab</sup>	132.85±17.0 <sup>abc</sup>
DBP (mm Hg)	GP	85.71±14.0	85.71±12.1	82.85±11.1	82.85±11.1
	CSP	88.57±9.0	84.28±12.7	81.42±14.6	85.71±11.3
	GP-CSP	83.57±11.1	82.14±7.0	82.14±7.0	84.28±5.3
	Control	85.71±7.9	84.28±7.9	85.71±9.8	87.14±11.1

SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, GP: Garlic Powder, CSP: Coriander Seed Powder, GP-CSP: Garlic Powder-Coriander Seed Powder

Total cholesterol significantly reduced with the supplementation of garlic and coriander (table 2). The highest decrease was noted in GP group (45.72mg/dl) followed by GP-CSP group (40.29mg/dl) during the intervention period of 40 days. In contrast, TC increased from 227 to 278.42mg/dl in control group during the 60 days of experimental period. However, the mean values of TC in intervention groups again increased during follow up period. The increase was significant for GP and non-significant for CSP and GP-CSP groups.

Triglycerides showed a decreasing trend with supplementation process. The maximum reduction was noted for GP-CSP group, where the TGL decreased from 251.28 to 136.28mg/dl during the intervention period. The lowest decrease (43mg/dl) was recorded for CSP group. The level of TGL slight increased during the follow up period in all intervention groups but the increase was non-significant ( $p < 0.05$ ). The control group also exhibited a progressive reduction in the mean values of TGL. The HDL level of intervention groups significantly ( $p < 0.05$ ) improved with supplementation. The highest impact was noted for garlic powder, which increased the HDL level of subject individuals from 42.44 to 55.14 mg/dl during the intervention period. The lowest increase (4.15mg/dl) was noted for individuals provided with coriander seed powder. During the follow-up period a reversal of the increasing trend was examined for HDL. In control group the HDL decreased from 41 to 40.28mg/dl during the entire period of the experiment.

The LDL levels reduced significantly after 40 days of intervention but the mean values again started increase during the follow up period in treatment groups, while in control group there was a steady increase in the mean values of LDL during the 60 days of experimental period. Among the supplements, GP was found most effective in decreasing the level of LDL in hyperlipidemic people.

Effect of GP and CSP supplementation on blood pressure  
The supplement types and supplementation period individually as well as interactively significantly ( $p < 0.05$ )

affected the SBP of the patients whereas non-significant effect was examined for DBP (table 3). The greatest influence on SBP was examined for CSP, which reduced SBP from 140 to 117.14 mmHg in subject individuals during the intervention period. The lowest reduction in SBP was noted for GP-CSP group. A slight increase in SBP was recorded during follow up period in intervention groups. In control group there was a non-significant change in SBP during the entire experimental period.

## DISCUSSION

### *Effect of GP and CSP on BMI and lipid profile*

The present study demonstrated that a regimented garlic and coriander seed powder supplementation program significantly improved the BMI and lipid profile of hyperlipidemic individuals. Among the supplement treatments, garlic powder (alone) showed highest efficacy against BMI, total cholesterol, HDL and LDL whereas the garlic and coriander seed mixture was found more effective in reducing the triglyceride level of subject individuals. The present results are consistent with those reported in previous literature. Superko and Ronald (2000) and Bashiri (2014) reported a non-significant decrease in BMI by providing 900 and 1000mg garlic powder per day, respectively to subjects with sedentary physical activity. Similarly, Kim *et al.*, (2011) reported a significant decrease in body weight by providing garlic extract for 5 weeks to obese and hypercholesterolemic rats. The consumption of 2g each of garlic, coriander seed powder and their mixture for 40 days, in our case, significantly reduced the BMI of hyperlipidemic individuals. The higher efficacy of garlic in reducing the BMI of hyperlipidemic people may be attributed to sulfur containing compounds that reduced the production of fatty substances. In addition, coriander is a rich source of dietary fiber that plays a key role in reducing the body weight (Matos *et al.*, 2005; EI-Kherbawy *et al.*, 2011; Anfenan, 2014).

The garlic and coriander seed powder alone and in combination caused a significant reduction in total

cholesterol level of the participants. The present results are in line with the findings of Rajeshwari *et al.* (2011), Parsaeyan (2012) and Afenan (2014) who reported a significant decrease in total cholesterol with consumption of garlic and or coriander seed powder. The hypocholesterolemic action of garlic and coriander was attributed to the presence of allicin, flavonoids and phenolic compounds in them that enhanced lipid metabolism Wangenstein *et al.*, 2004). In addition to allicin, garlic contains diallyl disulfide and dipropyl disulfides that are known for their hypocholesterolemic action (Al-Numair *et al.*, 2009). Garlic powder also contains appreciable quantity of non-digestible carbohydrates that has been reported to be associated with lowering the cholesterol (Simons *et al.*, 1995).

Triglycerides levels of the subjects were also significantly influenced by the supplements. The highest impact was examined for garlic and coriander seed powder mixture. Similar results were previously reported by Parsaeyan, (2012) and Anfenan *et al.* (2014). However, contradictory results exist that do not allow a conclusion on the beneficial role of garlic and coriander in the improvement of CVD risk via normalization of blood lipids (Ziaei *et al.*, 2001; Parastouei *et al.*, 2006). These discrepancies may be explained by the interference of several factors, such as lack of consistency among studies, variation in dosage, standardization of garlic and coriander preparations and duration of treatment. The TGL lowering effect in the current study may be due to inhibited fatty acids synthesis (Bopanna *et al.*, 1997), increased lipolytic activity by tissue lipases, suppression of lipogenic enzymes (Pari and Venkateswaran, 2003) and activation of LCAT (Aissaoui *et al.*, 2011). Flavonoids and polyphenols in coriander and allicin and sulfur-containing compounds in garlic are responsible for the hypolipidemic effect (Jia *et al.*, 2009; Udayakumar *et al.*, 2009).

The supplementation of garlic powder, coriander seed powder and their mixture to hyperlipidemic subjects significantly improved their HDL level. Among the supplements, garlic exerted the strongest influence on the enhancement of HDL level of the participants. The present results are consistent with those reported by Kojuri *et al.*, (2007) who reported that a dose of 800 mg/day enteric-coated garlic powder significantly increased the HDL level of hyperlipidemic patients. Similar results were also reported by Qinna *et al.*, (2012) and Hussien *et al.*, (2013). The effectiveness of garlic in enhancing the HDL level might be due to inhibited absorption of intestinal cholesterol and enhanced cholesterol turnover to bile acids by allicin. Allicin inhibits HMG-CoA reductase and thus reduces hepatic cholesterol biosynthesis (Ashraf *et al.*, 2005; McRae, 2005).

Patients with garlic and coriander seed powder supplementation. Although all the supplements showed

significant results, the reducing power of garlic powder was more pronounced. The present results complimented the findings of Sebonin *et al.*, (2008) who reported 13.8% reduction in the LDL level of 42 hypercholesterolemic human subjects by providing them with 600 mg/day garlic powder. Hussein *et al.*, (2013) reported a marked decrease in LDL level of hyperlipidemic patients by feeding them with 1000 mg garlic per day for a period of 12 weeks. Similarly, Rajeshwari *et al.*, (2011) observed a significant

#### ***Effect of GP and CSP on blood pressure***

The supplementation of GP and CSP significantly affected the SBP whereas no influence was recorded on DBP was non-significantly noticed. These results are consistent with Bashiri (2014) who reported significant reduction in systolic blood pressure by feeding the patients with 1000mg garlic powder per day along with regular exercise for 4 weeks. Similarly, Ashraf *et al.*, (2013) showed significant reduction in systolic and diastolic blood pressure in both dose and duration dependent manner in patients with essential hypertension.

The possible mechanism by which garlic might induce its hypotensive effect could be through the production of nitric oxide, which promotes vasodilation (Al-Qattan *et al.*, 2001). Similarly, the functions of both endothelium-derived relaxing factor and constricting factors like endothelin-1 is found to be altered with garlic consumption (Tripathi, 2009), that ultimately affect the blood pressure. The gamma glutaryl cysteines, present in garlic, may also be involved in lowering blood pressure, as these compounds inhibit angiotensin-converting enzyme (Omar *et al.*, 2007). In an *in vitro* study Benavides *et al.*, (2007) demonstrated that garlic-derived compounds could be converted to hydrogen sulfide by red blood cells that act as vasodilator and thus may have cardio protective properties (Lefer, 2008). Likewise, the use of coriander as a traditional hypotensive agent has been reported in many cultures (Eddouks *et al.*, 2002). The antihypertensive property of coriander may be attributed to its ability to increase urine output, excretion of electrolytes and glomerular filtration rate (Aissaoui *et al.*, 2008). In addition, coriander is reported to exhibit gut stimulatory, inhibitory and hypotensive effects by mediating the cholinergic, Ca<sup>2+</sup> antagonist and the combination of these mechanisms.

#### **CONCLUSION**

Garlic powder caused a statistically significant reduction in BMI, TC and LDL, however a significant increase in HDL, while a non-significant reduction in TGL and VLDL. Coriander powder decreased TC and LDL significantly while TGL, VLDL and BMI non-significantly, however HDL increased but it was non-significant. Mixture of both reduced TC, TGL, LDL and VLDL significantly while HDL increased significantly but BMI reduced non-significantly.

## REFERENCES

- Ahmed SM, Clasen ME and Donnelly J (1998). Management of dyslipidemia in adults. *Amr. Family Physician*, **57**: 2192-2204.
- Aissaoui A, El-Hilaly J, Israilli ZH and Lyoussi BB (2008). Acute diuretic effect of continuous intravenous infusion of an aqueous extract of *Coriandrum sativum* L. in anaesthetized rats. *J. Ethnopharmacol.*, **115**: 89-95.
- Aissaoui A, Zizi S, Israilli ZH and Lyoussi B (2011). Hypoglycemic and hypolipidemic effects of *Coriandrum sativum* L. in Merionesshawi rats. *J. Ethnopharmacol.*, **137**: 652-661.
- Al-Numair KS (2009). Hypocholesteremic and antioxidant effects of garlic (*Allium sativum* L.) extract in rats fed high cholesterol diet. *Pak. J. Nutr.*, **8**: 161-166.
- Al-Qattan KK, Khan I, Alnaqeeb MA and Ali M (2001). Thromboxane-B2, prostaglandin-E2 and hypertension in the rat 2-kidney 1-clip model: A possible mechanism of the garlic induced hypotension. *Prostaglandins, Leukotriene Essential Fatty Acids*, **64**: 5-10.
- Anfenan MLK (2014). Study the effect of consumption of coriander and Vit-B6 on rats suffering from hyperlipidemia. *World Appl. Sci. J.*, **30**: 1504-1509.
- Ashraf R, Amir K, Shaik AR and Ahmad T (2005). Effect of garlic on dyslipidemia in patients with type 2 diabetes mellitus. *J. Ayub. Med. Coll. Abbottabad.*
- Ashraf R, Rafeeq AK, Imran A and Absar AQ (2013). Effects of *Allium sativum* (Garlic) on systolic and diastolic blood pressure in patients with essential hypertension. *Pak. J. Pharm. Sci.*, **26**: 859-863.
- Bashiri J (2014). The effect of regular aerobic exercise and garlic supplementation on lipid profile and blood pressure in inactive subjects. *Zaheedan J. Res. Med. Sci.*, **10**: 20.
- Benavides GA, Squadrito GL, Mills RW, Patel HD, Isbell TS, Patel RP, Darley-Usmar VM, Doeller JE and Kraus DW (2007). Hydrogen sulfide mediates the vasoactivity of garlic. *Proc. Natl. Acad. Sci.*, **104**: 17977-17982.
- Bopanna KN, Kannan J, Sushma G, Balaraman R and Rathod SP (1997). Antidiabetic and antihyperlipidemic effects of neem seed kernel powder on alloxan diabetic rabbits. *In. J. Phar.*, **29**: 162-167.
- Choudhary R (2008). Beneficial effect of *Allium sativum* and *Allium tuberosum* on experimental hyperlipidemia and atherosclerosis. *Pak. J. Physiol.*, **4**: 7-9.
- De Almeida EM, Bion FM, Filho JM and Guerra NB (2003). In vivo antioxidant effect of aqueous and etheric coriander (*Coriandrum sativum* L.) extracts. *Eur. J. Lipid Sci. Technol.*, **105**: 483-487.
- Dhanapakiam P, Joseph JM, Ramaswamy V, Moorthi M and Kumar AS (2007). The cholesterol lowering property of coriander seeds (*Coriandrum sativum*): Mechanism of action. *J. Environ Biol.*, **29**: 53-56.
- Eddouks M, Maghrani A, Lemhadri ML, Ouahidi L and Jouad H (2002). Ethnopharmacological survey of medicinal plants used for the treatment of diabetes mellitus, hypertension and cardiac diseases in the southeast region of Morocco (Tafilalet). *J. Ethnopharmacol.*, **82**: 97-111.
- El-Kherbawy GM, Ibrahimand ES and Zaki SA (2011). Effect of Parsley and Coriander leaves on hypercholesterolemic rats. Home Economic Division, Food Technology Dept., Faculty of Agric., Cairo University Agricultural Research Center-Giza. El-Sabban F and Abouazra H (2008). Effect of garlic on atherosclerosis and its factors. *East Mediterr. Health J*, **14**: 195-205.
- Fawzy M, Ramadan MAA and El-Ahmed SA (2008). Coriander (*Coriandrum sativum* L.) seed oil improves plasma lipid profile in rats fed a diet containing cholesterol. *Europ. Food Res. Tech.*, **227**: 1173-1182.
- Friedewald WT, Robert IL and Donald SF (1972). Estimation of the Concentration of Low-Density Lipoprotein Cholesterol in Plasma, Without Use of the Preparative Ultracentrifuge. The American Association of Clinical Chemists, Inc. Biometrics Research Branch (W.T.F.) and the Molecular Disease Branch (R.I.L. and D.S.F.), National Heart and Lung Institute, 9000 Rockville Pike, Bethesda, Md. 20014.
- Heiner K and Rahbani M (1998). Evaluation of the effect of garlic oil preparation on serum lipoproteins and cholesterol metabolism. *JAMA*, **279**: 1900-1904.
- Hussien ZM, Luma TA and Qutuba GH (2013). Effect of atorvastatin and garlic on lipid profile in hyperlipidemic patients. *DJM*, **5**.
- Jia Q, Liu Y, Wu X, Wang R, Hu X and Li Y (2009). Hypoglycemic activity of a polyphenolic oligomer-rich extract of cinnamomparthenoxylon bark in normal and streptozocin-induced diabetic rats. *Phytomedicine*, **16**: 744-750.
- Johnson F, Mavrogianni A, Ucci M, Vidal-Puig A and Wardle J (2011). Could increase time in a thermal comfort zone contribute to population increases in obesity? *Obes. Rev.*, **12**: 1-9.
- Kim I, Jin YK, Yu JH, Kyung AH, Ae SO, Jae HK and Kang JC (2011). The beneficial effects of aged black garlic extract on obesity and hyperlipidemia in rats fed a high fat diet. *J. Med. Plants Res.*, **5**: 3159-3168.
- Kojuri J, Amir RV and Majid A (2007). Effects of *Anethum graveolens* and garlic on lipid profile in hyperlipidemic patients. *Lipids Health Disease*, **6**: 5.
- Lefer DJ (2008). Potential importance of alterations in hydrogen sulphide (H<sub>2</sub>S) bioavailability in diabetes. *Brit. J. Pharmacol.*, **155**: 617-619.
- Liu L and Yeh YY (2002). S-alk(en)yl cysteine of garlic inhibits cholesterol synthesis by deactivating HMG-CoA reductase in cultured rat hepatocytes. *J. Nutr.*, **132**: 1129-1134.
- Mahmood ZA, Sualeh M, Mahmood SBZ and Karim MA (2010). Herbal treatment for cardiovascular disease:

- The evidence-based therapy. *Pak. J. Pharm. Sci.*, **23**: 119-124.
- Matos SL, Paula H, Pedrosa ML, Santos RC, Oliveira EL, Chianca JR and Silva ME (2005). Dietary models for including hypercholesterolemia in rats. *Braz. Arch. Biol. Technol.*, **48**: 203-209.
- McRae MPA (2005). Review of studies of garlic (*Allium sativum*) on serum lipids and blood pressure before and after 1994. Does the amount of allicin released from garlic powder tablets play a role? *J. Chiropractic Med.*, **4**: 182-190.
- Moulas AN, Zervos IA, Tsantarliotou MP and Botsoglou NA (2003). Simultaneous determination of retinoic acid, retinol and retinyl palmitate in ram plasma by HPLC. *J. Liquid Chrom. Related Technol.*, **26**: 559-572.
- Omar SH, Hasan A, Hunjul N, Ali J and Aqil MI (2007). Historical, chemical and cardiovascular perspectives on garlic- A review. *Pharmacog. Rev.*, **1**: 80-87.
- Omeish AF, Abbadi W, Ghanma IM, Drabaa Z, Botoosh FA, Seif A and Massadeh M (2011). Hospital-based study on the use of herbal medicine in patients with coronary artery disease in Jordan. *J. Pak. Med. Assoc.*, **61**: 683-687.
- Parastouei K, Ravanshad SH, Mostafavi HA and Setoudehmaram E (2006). Effects of garlic tablet on blood sugar, plasma lipids and blood pressure in type 2 diabetic patients with hyperlipidemia. *KAUMS. J. (FEYZ)*, **5**: 9-16.
- Pari L and Venkateswaran S (2003). Effect of an aqueous extract of *Phaseolus vulgaris* on plasma insulin and hepatic key enzymes of glucose metabolism in experimental diabetes. *Pharmazie*, **58**: 916-919.
- Parsaeayan N (2012). The effect of coriander seed powder consumption on atherosclerotic and cardioprotective indices of type 2 diabetic patients. *Iran J. Diabetes Obesity*, pp.4-2.
- Qidwai W and Ashfaq T (2013). Role of garlic usage in cardiovascular disease prevention: An evidence-based approach. *Evidence-Based Complement Alter Med.*, pp.1-9.
- Qinna NA, Kamona BS, Al-Hussainy TM, Taha H, Badwan AA and Matalka KZ (2012). Effects of prickly pear dried leaves, Artichoke leaves, Turmeric and garlic extracts and their combinations on network. *ISRN Pharmacol.*, pp.1-7.
- Rajeshwari U, Shobha I and Andallu B (2011). Comparison of aniseeds and coriander seeds for antidiabetic, hypolipidemic and antioxidant activities. *Spatula DD.*, **1**: 9-16.
- Rivlin R (2001). Historical perspective on the use of garlic. *J. Nutr.*, **131**: 951S-954S.
- Rudling M (2006). Lowering of LDL cholesterol prevents cardiovascular diseases. Normal values are too high-treatment time is a crucial factor. *Lakartidningen*, **103**: 3278-3282.
- Sebonin IA, Andrianova IV, Demidova ON, Gorchakova TV and Orekhov AN (2008). Lipid lowering effects of time-released garlic powder tablets in double blinded placebo controlled randomized study. *J. Atherosclerosis Thomb.*, **15**: 334-338.
- Simon LA, Balasubramaniam S, Konigsmark MV, Parfitt A, Simon J and Peters W (1995). The effect of garlic on plasma lipids and lipoproteins in mild hypercholesterolemia. *Atherosclerosis*, **113**: 219-225.
- Simopoulos AP (2002). The importance of the ratio of omega-6 / omega-3 essential fatty acids. *Biomed. Pharmacother.*, **56**: 365-379.
- Steiner M and Li W (2001). Aged garlic extract, a modulator of cardiovascular risk factors: A dose-finding study on the effects of age on platelet function. *J. Nutr.*, **131**: 980-984.
- Superko HR and Ronald MK (2000). Garlic powder effect on plasma lipids, postprandial Lipemia, Low Density Lipoprotein particle size, High density lipoprotein subclass distribution and lipoprotein. *J. Am. Coll. Cardio*, **35**: 1097-1099.
- Tasawar Z, Siraj Z, Ahmad N and Lashari ML (2011). The effects of *Nigella sativa* (Kalonji) on lipid profile in patients with stable coronary artery disease in Multan, Pakistan. *Pak. J. Nutr.*, **10**: 162-167.
- Tripathi K (2009). A Review-Garlic: The Spice of Life- (Part-I). *Asian J. Res. Chem.*, **2**: 8-13.
- Udayakumar R, Kasthuriengan S, Mariashibu TS, Rajesh M, Anbazhagan VR and Kim SC (2009). Hypoglycaemic and hypolipidaemic effects of *Withania somnifera* root and leaf extracts on alloxan-induced diabetic rats. *Int. J. Mol. Sci.*, **10**: 2367-2382.
- Wangesteen H, Samuelsen A and Malterud K (2004). Antioxidant activity in extracts from coriander. *Food Chem.*, **88**: 293-297.
- WHO (World Health Organization). 2004. Reducing risks, promoting healthy life. Geneva, World Health Organization.
- WHO/FAO(World Health Organization/Food and Agricultural Organization) (2002). Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases. Report No. 916.
- Wilhelm MG and Cooper AD (2003). Induction of atherosclerosis by human chylomicron remnants: A hypothesis. *J. Atherosclerosis Thromb.*, **10**: 132-13.
- Ziaei S, Hantoshzadeh S, Rezasoltani P and Lamyian M (2001). The effect of garlic tablet on plasma lipids and platelet aggregation in nulliparous pregnant at a high risk of preeclampsia. *Eu. J. Obs. Gynae. Rep. Biol.*, **99**: 201-206.