EFFECT OF RAW GARLIC CONSUMPTION ON THE LIPID PARAMETERS OF PATIENTS WITH DYSLIPIDEMIA

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ABSTRACT

Dyslipidemia is a significant risk factor for atherosclerotic cardiovascular disease (ASCVD). It is manifested by solitary or combined disturbed levels of plasma lipids such as increased levels of total cholesterol (TC), increased levels of low-density lipoprotein cholesterol (LDL-C), elevated levels of triglycerides (TG), and a low level of high-density lipoprotein cholesterol (HDL-C). Dyslipidemia management includes lifestyle modifications and lipid-lowering medications. It has been reported that many patients are nonadherent adequately to medications. Garlic (Allium Sativum) is a common ingredient in food recipes. Owing to the content of bioactive compounds, garlic has been studied for its medicinal and therapeutic effects in the management of multiple diseases. The study aimed to determine the possible effect of daily dietary intake of raw garlic on the lipid profile of dyslipidemia patients. The study included 50 adult participants with newly discovered dyslipidemia, without an obvious cardiovascular complication. They were instructed to consume 5 gm fresh raw garlic daily for 4 weeks. A Lipid profile was done at the beginning and end of the study. The results revealed that anthropometric measures showed non-significant statistical differences. The lipid profile revealed a highly significant statistical difference regarding TC, HDL-C, TG, VLDL, and non-HDL-C, while LDL-C was of non-significant statistical difference. Atherogenic ratios (TC/HDL-C, LDL-C/HDL-C, and TG/HDL-C) showed a highly significant statistical difference. Daily consumption of 5 gm of raw garlic improved some lipid profile parameters. Thus, it would help as an adjuvant intervention for patients with dyslipidemia.

Keywords: Garlic, *Allium sativum*, Dyslipidemia, Lipid profile

INTRODUCTION

Dyslipidemia is a major risk factor for atherosclerotic cardiovascular disease (ASCVD) and the main cause of more than (30%) of deaths due to ischemic heart disease. It is manifested by solitary or combined disturbed levels of plasma lipid levels in the form of increased levels of total cholesterol (TC), increased levels of low-density lipoprotein cholesterol (LDL-C), elevated levels of triglycerides (TG), and a low level of high-density lipoprotein cholesterol (HDL-C) **(Pirillo *et al*., 2021)**.

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Over the past years, dyslipidemia prevalence has increased; around (39%) of adults worldwide have elevated TC levels (WHF, 2022). Attributed to the results of the Egypt National STEPS wise Survey (2017) was demonstrated that the prevalence of elevated blood cholesterol among Egyptians (15-69 years) including those on treatment was (19.2%) with females more commonly affected (23.4%) than males at (14.9%) (WHO, 2017 and Aboulghate et al., 2021).

Management of dyslipidemia includes both lifestyle modifications and lipid lower medications. Lack of adequate lipid profile control could be attributed to noncompliance with medical therapy. Economic issues and the undesirable side effects of drugs such as myopathy, and hepatotoxicity attributed to noncompliance (Tarn et al., 2021 and Desai et al., 2022).

Medicinal plant remedies are less expensive than synthetic drugs and many rural areas residents consider herbal medicine less toxic with fewer side effects compared to medical drugs (Nisar et al., 2017). It has been estimated that around 80% of Arab populations depend on herbal use for medicinal purposes (El-Dahiyat et al., 2020).

Garlic (*Allium sativum*) is one of the herbal plants that is widely cultivated and used as a flavoring food spice. It has been mentioned thousands of years ago in traditional medicine for its therapeutic benefits (Bazaraliyeva et al., 2022). The biological activities of garlic are attributed to the abundance of hundreds of bioactive compounds. It has been proposed for its cardioprotective potency, anti-inflammatory, antioxidant properties, and others (Qiu et al., 2022).

Experimental and clinical studies have shown that dietary intake of garlic with its various preparations could have a favorable effect on dyslipidemia parameters. This impact has been attributed mainly to its content of phytochemicals and sulfur-containing compounds such as alliin, and allicin (Verma et al., 2023). The antidyslipidemic effect of garlic has been deduced to occur through inhibition of the enzyme HMG-COA reductase as well as inhibition of hepatic fatty acid synthesis, enhancing excretion of bile acid and reducing LDL-C oxidation (Sun et al., 2018). Multiple studies concluded that using garlic

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can lead to reduced blood pressure, improved anthropometric measures, improved lipid profile and cardiovascular parameters (Imaizumi et al., 2023).

Thus, the objective of this study was to determine the possible effect of daily dietary intake of raw garlic on the lipid profile of patients with dyslipidemia

SUBJECTS AND METHODS

Study design: Single arm trial pretest-posttest design

Environmental aspect of the study: Using one of the natural plants (garlic) and studying its influence on the disease progression

Study setting: This study was conducted in the clinical nutrition outpatient clinic at Egyptian Railway Hospital in Cairo, Egypt.

Duration of the study: Data was collected over 5 months (March – July 2024)

Sample size calculation: 50 patients were included in the study. The sample size was calculated using the IBM Sample Power 3, it was based on the mean ±SD of serum TC and TG with an alpha level set at 0.05 and Power 80%. Based on this at least 50 patients were determined to be sufficient in the study.

Ethical Consideration: This study was approved by the Medical Research Ethics Committee at the National Research Center in Cairo (Approval doc No.10622); dated February 2024. All participants signed the informed consent after the comprehensive explanation of the whole study process.

Patient recruitment: Patients in the study were recruited at the clinical nutrition outpatient clinic upon referral from the cardiology and internal medicine who were newly diagnosed with dyslipidemia (any disturbed parameter) without obvious CVDs complications.

The Inclusion criteria: Adults who had been newly discovered with dyslipidemia either solitary or combined disturbed parameters without obvious cardiovascular complications

The Exclusion Criteria: Children and adolescents, any case diagnosed as genetic dyslipidemia, any patient on antidyslipidemic medication, patients with high CVDs risk by Framingham Risk Score (FRS), any patient with any form of obvious CVDs complication, and any GIT complaint that can alter patients' compliance with the study protocol**.**

The procedure:

Initial assessment and history taking including:

Sociodemographic data: Age, Sex, Occupation, and Residency.

Clinical and medical data: Blood pressure, FRS, medical history, and family history.

Anthropometric measures: Weight in kilogram (kg), using calibrated digital balance and standing height in centimeters (cm) using stadiometer. The body mass index (BMI) is then calculated as kg body weight divided by height meter^2. Waist circumference (WC) is measured in cm using a scaled measuring tape placed at the site locating the midpoint between the lower rib margin and the anterior superior iliac spine, where the tape runs parallel to the floor, does not compress the skin and the measurement is taken at the end of normal expiration.

Laboratory testing: The lipid profile is measured by Automated analysis was done using AU680 Clinical Chemistry using a serum sample collected in a serum separator tube (at the fasting state 12 hours). Lipid parameters are then measured and compared to the cutoff points recommended by the American Heart Association and the subsequent atherogenic ratios are also calculated.

Dietary assessment: Estimated by the analysis of the detailed (24-hour recall) by each participant for all food and beverage consumption as well as all dietary supplement intake.

Physical A**ctivity Level (PAL)**: Based on the types and duration of physical activity performed by the patients weekly. Extra active: (very hard training, including weightlifting, 2-3 days/week

Intervention: Each patient was instructed to dietary daily 5 gm raw garlic; the garlic included in the first meal, crushed into small pieces and not to be cooked or heated. Raw garlic cloves will be weighed by weighing balance, packed, and given to every patient every week during their weekly follow-up session. They will be given 7 packs of raw garlic gloves, each weighing (4.95 ±0.05 gm), to be used and added to the daily diet pattern. The duration of the study was 4 weeks, along which the raw garlic intake should not be missed any day. All patients were informed not to change their lifestyle patterns regarding dietary

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habits and physical activity patterns throughout the study duration. Each patient was scheduled for follow-up visits once a week to revise compliance with the study protocol.

Evaluation: The patients were reevaluated after 4 weeks with the same maneuver of the initial assessment and compared to the initial status at the start of the study with complete lipid profile and anthropometric measures, and then pre-post comparisons were done.

Statistical Analysis: Statistical Package for Social Sciences (SPSS) software version (26) was used to code, tabulate, and statistically analyze the obtained data. Descriptive statistics were done using numbers, percentages and means ± standard deviation (SD) to represent all of the results for quantitative variables. Regarding testing the significant relationship between variables, the paired sample t-tests were done to test the significance (effectiveness) of the intervention used in the study. The level of significance was presented as p-value; where p-value >0.05 is considered none-statistically significant (NS); p-value <0.05 is considered statistically significant (S) and p-value < 0.001 is considered highly significant (HS)**.**

RESULTS

Sociodemographic data and Lifestyle factors

The study included 50 adult patients of both genders; there were 30 (60%) females and 20 (40%) males. Their age range was (20-60) years with a mean age of (42.40±12.52) years. All patients were categorized as a low estimated 10-year CVDs risk as calculated by FRS. **Table (1)**, showed the general characteristics of the patients. The majority (82%) were categorized as obese, (16%) were overweight and only (2%) had normal body weight. A sedentary lifestyle pattern was prevalent among (80%) of the patients whereas only (20%) were adopting a light physical activity pattern. All patients were literate and from urban area. Half of the patients (50%) were employees whereas, (8%) were retired, (36%) were unemployed (housewives), and (6%) were students at different universities

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Table (1): The General characteristics and relevant history of the patients

Variable		Mean ±SD	Range
Age in years		42.40±12.52	20-60
		No	**%**
Gender	Female	30	60
	Male	20	40
Residency	Urban	50	100
	Rural	0	0
Literacy	Illiterate	0	0
	Literate	50	100
Body Mass Index	Normal weight	1	2
	Overweight	8	16
	Obese	41	82
Physical Activity Level	Sedentary	40	80
	Light activity	10	20
Occupation status	Employee	25	50
	Retired	4	8
	Housewife	18	36
	Student	3	6

Sedentary: (little or no exercise)**;** Lightly activity: (about 30 minutes of moderate training, 1-3 days/week)

Table (2) revealed that mean differences in the anthropometric parameters (Body weight, Body Mass Index, and Waist Circumference) of patients before and after consumption of 5 gm raw garlic per day were found to be non-significant differences ($p>0.05$) as regards all the three anthropometric parameters

Table (2): The mean difference of anthropometric parameters of the patients before and after the intervention

Variable	Before	After	p-value
	Mean ±SD	**Mean ±SD**	
Weight (Kg)	92.98±14.68	92.79±14.71	0.704 (NS)
Body Mass Index (kg/m^2)	34.49±5.16	34.19±5.03	0.221 (NS)
Waist Circumference	101.23±7.79	101.13±7.50	0.710 (NS)

p-value >0.05 NS

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Table (3) showed the mean differences in the lipid profile before and after raw garlic consumption with a highly statistically significant difference value ($p<0.001$) as regards TC, HDL-C, TG, non-HDL-C, and VLDL while value of LDL-C, was of statistical non-significant difference ($p>0.05$). The percentage difference (%) for the individual lipid parameters was (6.93%), (0.87%), (5.73%), (15.79%), (10.36%), and (15.8%) for TC, LDL-C, HDL-C, TG, non-HDL-C and very low-density lipoprotein cholesterol (VLDL), respectively.

Table (3): The Mean differences in the lipid profile for the patients before and after raw garlic consumption.

Variable (mg/dl) (N=50)	Before	After	Difference	p-value	Difference (%)
	Mean ±SD (mg/dl)	Mean ±SD (mg/dl)			
TC	231.86±21.28	215.80±23.49	16.06±7.29	<0.001**	6.93
LDL-C	142.78±19.01	141.54±20.65	1.24± 9.40	0.355 (NS)	0.87
HDL-C	49.48±6.69	52.32±6.17	-2.84± 2.17	<0.001**	5.73
Triglycerides (TG)	165.08±17.03	139.02±16.61	26.06±6.91	<0.001**	15.79
Non-HDL-C	182.38±18.19	163.48±21.43	18.90±7.34	<0.001**	10.36
Very low-density lipoprotein Cholesterol (VLDL)	33.02±3.41	27.80±3.33	5.22±1.38	<0.001**	15.80

Difference= mean value before - mean value after

p-value >0.05 NS; **p-value <0.001 HS

Table (4) showed the mean differences regarding atherogenic ratios TC/HDL-C, LDL-C/HDL-C, and TG/HDL-C before and after raw garlic consumption with a highly statistically significant difference ($p<0.001$) regarding all ratios. The percentage differences (%) for the atherogenic ratios were (12.24%), (6.82%), and (20.65%) for TC/HDL-C, LDL-C/HDL-C, and TG/HDL-C, respectively.

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Table (4): Mean values and percentage differences in atherogenic ratios for all the patients before and after raw garlic consumption

Variable (mg/dl) (N=50)	Before	After	Difference	p-value	Difference (%)
	Mean ±SD (mg/dl)	Mean ±SD (mg/dl)			
TC/HDL-C	4.74±0.55	4.16±0.47	0.58±0.26	<0.001**	12.24
LDL-C/HDL-C	2.93±0.48	2.73±0.43	0.20±0.23	<0.001**	6.82
TG/HDL-C	3.39±0.56	2.69±0.45	0.70±0.24	<0.001****	20.65

Difference= mean value before - mean value after
**p-value <0.001 HS

DISCUSSION

The antidyslipidemic effect of garlic with its various preparations has been deduced to have a beneficial effect on various lipid profile parameters **(Gyawali et al., 2021)**. This study was conducted to trace the impact of raw garlic on lipid parameters among adults with newly discovered dyslipidemia.

In the current study the gender contribution was (60%) females and (40%) males, which was similar to a study by **Choudhary et al., (2017)**, which showed a contribution of (62.5%) females and (37.5%) males. However, this was contrary to the study conducted by **Shahzad et al., (2023)** where the gender distribution of the sample was (38%) females and (62%) males. Also, **Lachhiramka and Patil (2016)** had the gender distribution (40%) for females and (60%) for males. The gender distribution differences for the different studies could be attributed to the prevalence differences of dyslipidemia in various nations and due to the variations in sample selection criteria of different studies.

Although dyslipidemia has been recorded in rural and urban zones however, all patients in this study were urban literate residents which could be related to the geographical location of the current study where patients on regular visits are mostly those from the nearby zones where urbanization is prevalent.

In this study, the majority of patients (82%) were classified as obese, and (16%) were overweight with only one patient was a normal body weight range. This matches the high prevalence of obesity in Egypt as demonstrated by Aboulghate et al., (2021) where Egypt

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ranked 18th according to global obesity levels. Also, Spannella et al., (2019) found that overweight and obesity were associated with higher atherogenic lipid profiles attributed to excess adiposity.

Also, in the present study, most patients (80%) led a sedentary life pattern and only (20%) performed light activity. This could be explained by the high percentage of females and housewives in the study This matches with the results revealed by Alebshehy et al., (2016) demonstrated that most Egyptians led a sedentary life in urban zones and about (60%) of females were housewives who didn't meet the guidelines for adequate physical activity engagement. Despite the scarcity of studies that traced the effect of garlic and PAL on dyslipidemia, Crichton and Alkerwi, (2015) concluded that adopting an active lifestyle and minimizing sedentary time is associated with a healthier lipid profile.

Moreover, the daily consumption of raw garlic 5 gm for 4 weeks showed a non-significant statistical difference as regards all the anthropometric parameters (body weight, BMI, and WC) denoting no impact against excess weight and abdominal obesity. The current study was consistent with the result of the Panbehkar-Jouybari et al., (2021) who conducted a meta-analysis and concluded that consumption of garlic supplementation or its derivatives had no significant changes to anthropometric measures. However, a study by Choudhary et al., (2017) found that after intake of 100 mg/kg crushed raw garlic twice daily for 4 weeks in patients with metabolic syndrome, there was a significant statistical decrease for WC, but BMI showed no significant statistical difference. Another study conducted by Aslani et al., (2016) used 20 gm of raw garlic for 8 weeks for patients with moderate dyslipidemia and showed a significant statistical decrease as regards BMI, however, WC was not tested in this study. The different results are attributed to the variations of determinants in the form of different doses and preparations as well as durations of studies.

Furthermore, daily consumption of 5 gm raw garlic led to highly significant statistical ($p<0.001$) improvement regarding TC (decreased 6.9%), HDL-C (increased 5.7%), TG, and VLDL (decreased 15.8%), and non-HDL-C (decreased 10 %), whereas LDL-C showed non-significant improvement with (< 1% decrease) after the intervention. Our results partially complied with the results revealed by Aslani et al., (2016) who showed significant

improvement in the lipid parameters TC (decreased 8.1%), TG (decreased 17.3%), HDL-C (increased 10.2%). Contrary to our study, there was a significant improvement in LDL-C (decreased 12.3 %) after consumption of raw garlic for 8 weeks. Also, Choudhary et al. (2017) showed that there was a significant improvement in TG (decrease 14%) as well as a HDL-C (increased 14.6%). Different results were revealed in the meta-analysis conducted by Sun et al., (2018), which traced the lipid-lowering capability of garlic and concluded that garlic can decrease levels of TC and LDL-C but with no impact on HDL-C, and TG levels. Maisaroh et al., (2020), used 4 gm of raw garlic and showed a significant decrease in TC levels, however, the study didn't reveal the impact on individual lipoprotein, The results in the current study were also in contrast to Gardner et al., (2007) who studied the lipid-lowering effect of 4 gm raw garlic, garlic powder and aged garlic extract and concluded that no clinical or statistical significance was revealed in any of the lipid profile parameters for any of the used garlic forms. Also, a systematic review conducted by Chan et al., (2020) reported that for various preparations of garlic, there is low evidence for its role in the management of dyslipidemia.

The conflicting results are mostly attributed to variations in garlic preparations, different standardization, and variable doses and duration of the studies.

Regarding the percentage effect of garlic consumption on individual lipid parameters, our results showed that the highest impact was on TG levels and non-HDL-C, and the TG/HDL-C ratio, whereas, the least was for LDL-C, these act in accordance with Berberich and Hegel (2022), were demonstrated that diet manipulation is more effective with cases of hypertriglyceridemia especially mild to moderate grades, in compared to hypercholesteremia patients (LDL-C).

As for the three atherogenic ratios, the current study revealed highly significant statistical results for TC/HDL-C (decreased 12%), LDL-C/HDL-C (decreased (6.8%), and TG/HDL-C (decreased 20.6%). Atherogenic ratios were not widely studied. However, opposite to this study, Gardner et al., (2007) found no significant impact of raw garlic consumption on TC/HDL-C. Whereas, Villaño et al., (2023), concluded that TC/ HDL-C ratio significantly improved after consuming 12 gm of black garlic cloves for 12 weeks.

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Regarding the improvement of TG/HDL-C, could be explained as the result of the concomitant decreased TG and elevated HDL-C levels. This association could be verified by the explanation offered for the inverse relation between TG and HDL-C where Berberich and Hegel (2022), reported that cholesterol ester transfer protein induced the HDL exchange for TG from apo B- lipoproteins.

CONCLUSION

Raw garlic consumption with a dose of 5 gm daily showed a positive impact on some of the lipid profile parameters. Thus, it would help as an adjuvant intervention for patients with dyslipidemia, but it cannot be used as a substitute for medical treatment.

RECOMMENDATION

It is recommended to include raw garlic as a natural plant among the components of healthy daily dietary patterns especially for individuals with or at risk of dyslipidemia when no contraindications are present. Further research is needed to explore more about functional food potency in dyslipidemia and other chronic diseases.

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CONFLICT OF INTEREST

All authors have no conflict of interest to disclose.

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تأثير استهلاك الثوم الخام على خصائص الدهون لدى المرضى الذين يعانون من عسر شحميات الدم

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المستخلص

إن عسر شحميات الدم هو عامل خطر كبير لمرض القلب والأوعية الدموية وتصلب الشرايين. يتجلى في مستويات مضطربة منفردة أو مجتمعة من الدهون في البلازما مثل زيادة مستويات الكوليسترول الكلي، وزيادة مستويات كوليسترول البروتين الدهني منخفض الكثافة، وارتفاع مستويات الدهون الثلاثية، وانخفاض مستوى كوليسترول البروتين الدهني عالي الكثافة. يتضمن علاج عسر شحميات الدم تعديلات نمط الحياة والأدوية الخافضة للدهون. لقد تم رصد العديد من المرضى لا يلتزمون بشكل كافٍ بالأدوية. الثوم عنصر شائع في وصفات الطعام. ونظرًا لاحتوائه على المركبات النشطة بيولوجيًا، تمت دراسة الثوم لتأثيراته الطبية والعلاجية في علاج أمراض متعددة. هدفت الدراسة إلى تحديد التأثير المحتمل للتناول الغذائي اليومي من الثوم الخام على مستوى الدهون لدى مرضى عسر شحميات الدم. تم تضمين 50 مشاركًا بالغًا يعانون من عسر شحميات الدم المكتشف حديثًا، دون حدوث مضاعفات واضحة في القلب والأوعية الدموية. طُلب منهم تناول 5 جرام من الثوم الخام الطازج يوميًا لمدة 4 أسابيع. تم فحص ملف الدهون الدم في بداية ونهاية الدراسة. أظهرت النتائج أن فروق القياسات الأنثروبومترية غير ذات `دلالة إحصائية. أظهر اختبار ملف الدهون دهون الدم وجود فروق ذات دلالة إحصائية كبيرة فيما يتعلق بالكوليسترول الكلي، والكوليسترول الدهني عالي الكثافة، والدهون الثلاثية، والبروتين الدهني منخفض الكثافة جدًا، والكوليسترول الدهني غير عالي الكثافة، في حين كان كوليسترول البروتين الدهني منخفض الكثافة ذو فروق غير ذات دلالة إحصائية. وأظهرت النسب تصلب الشرايين فروق ذات دلالة إحصائية كبيرة. أدى استهلاك الثوم الخام بجرعة 5 جرام يوميًا إلى تحسين بعض معايير دهون الدم. وبالتالي، فإنه من شأنه أن يساعد كتدخل مساعد في حالات عسر شحميات الدم

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