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Abstract

With the global increments in cardiovascular disease related hypercholesteremia and obesity, plants derived secondary metabolites become a promising approach to prevent or control these conditions risk factors. Garlic and vinegars may act as a functional food with nutraceuticals and probiotic properties. In this study, hypercholesteremic obese rat model, induced by high fat (22%) and cholesterol (4%) diet for 4 weeks, is used to evaluate weight reduction, hypocholesteremic, and improving health effects of garlic infusion in each of apple and balsamic vinegars for 10 days as Syrian demotic recipe versus individual administration of aqueous garlic extract, garlic, apple and balsamic vinegars as 2ml/day plus continue on high fat, cholesterol diet for additional 4 weeks. The results showed that liquid extracts of soaked garlic in different vinegar types for 10 days restored normality values of BWG% and biochemical parameters of lipid profile, liver lipids content, antioxidant status plus liver and kidney functions and enlarged the good effects of each garlic and vinegar alone. These perfect effects may be due to several suggestions as increase concentration of bioactive compounds or keep its bioactivity more or even production of new bioactive ingredients with probiotic properties by fermentation or all of these by acetic acid phase and long extract duration, emphasizing the need for further specific chemical and biological searches to detect these respects plus perfect safe dose, period, and type of used vinegar. These extracts can be accepted as beneficial, natural flavoring agents of foods such salad dressing.

Keywords: *Allium sativum*, overweight, antioxidant, high fat diet, hypercholesterolemia.

Introduction

hyperlipidemia including hypercholesterolemia, which increased dramatically in the global population and so established as a vital challenge for worldwide public health, really endangers health and cause death contributing to several diseases as metabolic diseases, hypertension, hepatic steatosis, heart disease and stroke. The risk of blood vessel and heart disease increase by 1.8 times when cholesterol levels >200mg/dl than it less. Globally, third of ischemic heart diseases is caused by hypercholesterolemia. Atherosclerosis is a disorder described as blockages due to forming plaques by fatty deposits on arterial blood vessel walls and can happen in various organs blood vessels as brain, kidneys, and others (***Syarfaini etal., 2020*** and ***Song etal., 2024***). Cardiovascular disease, (CVD) arrange at top for a serious concern of public health worldwide since the deaths rate because it has been raised to 20.5 million cases in 2021, approximately a third of global demises and 85% of these fatalities from CVD are resulted from heart attack and stroke ***(WHO, 2020*** and ***WHR, 2023***). In China, CVD prevalence is expected to rise by 9.2 million between 2010 and 2030 **(*Wang etal., 2023***).

Obesity is a growing worldwide epidemic described by excessive or abnormal accumulation of body fat, often due to a combination factor of genetic, environmental plus lifestyle **(*Jehan etal., 2020*)**. It relates to elevating risk of many chronic diseases as metabolic syndrome, type 2 diabetes, hypertension, cardiovascular illness, certain common cancers plus osteoarthritis (***Mir etal., 2019***). As WHO reported in 2016 more over 1.9 billion grownups were overweight globally, of whom over 650 million being obese (***WHO, 2021***). World Obesity Federation's 2023 Atlas expected that by 2035 over half of globe's populace will be obese or overweight (***Reuters, 2023***).

Food choices as dietary intake of unhealthy fats and Lifestyle have been related to CVD, and other metabolic diseases of fatty liver disease, hypertension, and obesity (***Chiriac etal., 2021***). Increasing the global occurrence of illness has elevated the need to regulate our new lifestyles to diversifying and balancing our daily nutrients in the diet **(*Rabail etal 2024*)**, since both exercise and nutrition play vital roles in its prevention and treatment **(*Mir etal., 2019*)**.

Plants have been utilized in the control of metabolic dysfunction such obesity due to the attendant of plant derivative secondary metabolites that are abundant source of active natural compounds, a promising approach for repression of inflammation plus oxidative stress in obese subjects **(*Mir etal., 2019*)**. Also, Nutraceuticals, mostly

grounded on natural elements, have been showed to manage the CVD risk factors as lipid levels, blood pressure, plus atherosclerosis formation effectively and recently have obtained large interest because of potential nutritional value, safety, plus therapeutic effects. fruits, can be act as the raw material or source of nutraceuticals to preventing or helping the CVD management **(*Sinaga etal., 2021*)**.

Throughout history, Vinegar has been a mainstay in cuisines all over the world, it is a fermented, water-soluble acetic acid solution (***Budak et al., 2014***). Vinegar has been utilized as a taste enhancer, food preservative, and therapeutic ingredient **(*Maske etal., 2024*)**. The vinegar is primarily divided into two categories based on its basic ingredients as fruit or cereal vinegar (***Liu etal., 2022***). Recently, research about the vinegar's use as a functional food has grown, since its consumption has been related to favorable health benefits as promoting digestion, antibacterial, antioxidant blood glucose managing, cardio-diseases risk, adiposeness reduction and weight loss (***Launholt etal., 2020*** and ***Xia etal., 2020***). Acetic acid, a vital vinegar constituent in the diet of humans, has suggested as a hopeful new strategy for preventing or managing obesity (***Wang etal., 2022*)**. Vinegar has rich nutrients and bioactive substances as phenolics, organic acids, melanoidins, tetramethylpyrazine, amino acids, plus phytochemicals found in fruit, which can supply a useful material and new ideas serve for developing functional vinegar as published by many studies as ***Costa etal., (2013), Liu etal., (2017), Chen etal., (2017), Ozdemir etal., (2022)*** **and** ***Bai etal., (2024)***. Because the variety of fermented microbiota and raw materials complication, vinegar still contains a lot of undiscovered bioactive chemicals **(*Bai etal., 2024*)**. Many searches have demonstrated that apple and balsamic vinegars may act as natural remedies for several conditions as weight reduction and dyslipidemia, contributing by their bioactive compounds of, minerals, vitamins, amino acids and phenols. They are made by fermenting apple and grape juices (***Khalifa etal., 2024***).

Moreover, A varied colony of lactic acid bacteria (LAB) can be found in vinegar, which is recognized by its sour flavor and acidic qualities caused by the metabolism of acetic acid bacteria. The primary genera discovered through natural fermentation include Lactobacillus, Lentilactobacillus, Limosilactbacillus, Lacticaseibacillus, Pedicoccus, and Leuconostoc Numerous documented LAB species achieve the (WHO)World Health Organization's probiotic criteria. Because of the high frequency and proliferation of LAB in the early phases of fermentation, vinegar currently shows significant promise as a postbiotic

product. To guarantee functional advantages, research should concentrate on improving LAB viability through vinegar fermentation plus identifying strains with probiotic qualities and developing suitable dosage and intake guidelines **(*Maske etal., 2024*)**.

Garlic (*Allium sativum L.*, family Alliaceae) for long time is an extremely considerable traditions crop cultivated worldwide that is esteemed for its cooking, plus therapeutic benefits (***Dehariya etal., 2021*)**. Some of the titles are still under use nowdays, have been named to garlic being "natural antibiotic"; "stinking rose"; "herbal Viagra"; "nectar of the gods"; "Russian penicillin"; "herbal talisman" plus "snake grass" (***Lidikova etal., 2023***). The main garlic producers are India, China, Egypt, Spain, Italy, Argentina, plus the United States (***Thakur etal., 2024***). Bulbs of fresh garlic contain about 66% water plus 28% carbohydrate; 2.4% Sulphur oregano components;1.3% amino acids; protein; 1.5% fiber, beside considerable amount of vitamins B and C; plus, potassium; sodium; and magnesium (***Zhang etal., 2020***). Garlic is rich phytochemical composition mainly make up 82% of sulphur compounds as allicin and ajoene (***Puvača, 2022***), and it is often esteemed as a strong functional food by frequent nutraceuticals advantages due to rich bioactive compounds of it in all parts (***Thakur etal., 2024***). Frequent studies established the garlic potential health benefits such cardiovascular protection, antiatherogenic; hypolipidemic antihepatotoxicity, anti-inflammatory plus antioxidant properties and a lot of other health benefits (***Mir etal., 2019*** and ***Gupta etal., 2024***). It is worthy mentioned that compounds derived from garlic showed drug-like features accordance decided criteria, supporting their appropriateness for the expansion and optimization of pharmaceuticals, and offer the importance for more exploration and implementation in the field of health enhancement. Nevertheless, little is understood about the function of microorganisms derived from garlic in fermented foods, and there are contradictory findings between studies that suggest adding garlic accelerates kimchi ripening by LAB derived from garlic and those that suggest it retards the ripening by inhibiting aerobic bacteria (***Cho etal., 2001***), but some new consensus of researches showed that garlic is significant potential source of microbial inoculation in fermented foods such kimchi as ***Choi etal., (2024)*** who found that the addition of garlic can result in the production of various metabolites by regulating the ratio of *Lactobacillus* and *Leuconostoc* in kimchi.

So, in this study, experimental hypercholesteremic obese rat model is used to evaluate the anti-obesity, hypocholesteremic, cardioprotective and improving health effects of the liquid extracts from infusion of garlic

in each of apple and balsamic vinegars for 10 days as derived from Syrian demotic recipe versus fresh garlic aqueous extract, garlic vinegar and other types of vinegar being apple and balsamic vinegars.

Materials and Methods

Materials:

Studied materials:

Garlic (*Allium sativum L.*), garlic vinegar and some other types of vinegar being apple vinegar and balsa mic vinegar were purchased from Agriculture Research Center, Giza, Egypt.

Chemicals

Biochemical assay kits were obtained from the Company of Alkan Medical, St. El-Doky, Egypt. Other chemicals were obtained from Company of El-Gomhoria, Cairo, Egypt.

Animals

A total number of 48 rats (adult male), Rattus norvegic, being 150 ± 5 g weight were got from Institute of Medical Insects Research, Doki, (Cairo, Egypt). Rats were kept in groups in well-ventilated cages under sanitary conditions in Biological Laboratory, Home Economics Faculty, Nutrition and Food sci. Department, Shibin El-kom (Menoufia), Egypt and consumed standard diet AIN-93 as reported by ***Reeves etal., (1993)*** for a seven-day adaption period. This investigate was ethically accepted by the Institutional Animal Ethics committee. Menoufia University. (Reg. No, MUFHE /F/NFS/27/24).

Methods

Preparing of aqueous garlic extract and other extracts

Preparing of fresh garlic aqueous extract was done according to **Hosseini etal., (2007)** by crashing 100 g of garlic (Allium sativum) to obtain fine juice then homogenize in 100 ml of saline or distilled water and carry out in a blender for a total of 15 min. and left it for 2 h. at room temperature 25°c then filtered and the liquid will be kept in dark glass at cool (4°c) for use.

The prepared extracts from infusion of garlic in each of apple vinegar and balsamic vinegar were prepared as a Syrian demotic recipe by mix equal amounts of crash garlic and vinegar types each alone then left it for 10 days in which the first three days being at room temperature while the remain period at cool (4°c); the infusion was be filtered at the end of each period (10 days), then the liquid extracts from infusion of each type were be kept in dark glass at cool (4°c) for use.

Experimental protocol

A total number of 48 rats will separate into two principal groups: The first main group (n=6) will feed on the standard diet for total studied

period as a negative control group. While the second main group (hypercholestrolemic obese rats, n=42) will be fed on high fat high cholesterol diet (22% fat = 40% from total calories, including 10% corn oil plus 12% tallow as a model of saturated fat and 4% cholesterol) for 4 weeks which done in accordance with previous animal investigations as ***Miyake etal., (2006)*** then hypercholestrolemic obese rats will continue to receive high fat high cholesterol diet plus orally received studied extracts and vinegars as 7mg/kg body weight (approximately, 2 ml/day) for 4 weeks, in which rats will be divided into 7 subgroups (n=6) as following: Subgroup (1): will serve as a positive control group (Hypercholestrolemic obese rats), while Subgroups (2,3,4,5,6, and 7) will orally receive fresh garlic aqueous extract, garlic vinegar, apple vinegar, balsamic vinegar, liquid extract from soak of garlic in apple vinegar for 10 days and liquid extract from soak of garlic in balsamic vinegar for 10 days respectively as 2 ml/kg body weight for 4 weeks.

Blood and tissue samples collection

All rats underwent an overnight fast at the conclusion of the trial. Blood samples were taken from the portal vein of the liver after scarification by ether anesthesia in cleaned centrifuge tubes. Blood was centrifuged at - 4̊C for 10 minutes at a speed of 4000 rpm to obtain serum samples. Then, until analysis, the serum was placed in the plastic vial and maintained frozen at -20̊C **(*Schermer, 1967*)**. At once, liver and heart tissues were dissected quickly on ice for weight and lipids assay in liver.

BWG% and relative organs weight calculation

At the end of studied period the body weight gain (BWG%) and also organ/ body weight% were determinate according to ***Chapman etal., (1959)***.

Biochemical analysis

Via commercial kits, the following analysis and calculations were done:

lipid profile including serum triglycerides, cholesterol, and HDL.c (High Density Lipoprotein) were detected as ***Fossati and Prencipe (1982)***, ***Allain (1974)*** **and** ***Lopez (1977)***, in arrange. LDL.c (Low Density Lipoprotein) and VLDL.c (Very Low-Density Lipoprotein) were estimated according to the following equations of ***Lee and Nieman (1996)***: VLDL (mg/dl) = Triglycerdes / 5 and LDL (mg/dl) = Total cholesterol – (HDL+VLDL). atherogenic index (AI = LDL-C + VLDL-C/HDL-C) plus atherogenic combined index (ACI = log 10 [Tri × "non-HDL-C÷HDL"]) were be calculated as ***Toprak etal., (2024)***.

liver lipids were detected by gravimetric methods after extraction with (2:1) chloroform-methanol according to ***Folch etal. (1957)***.

Oxidative status as determination of lipid peroxide as evaluated MDA (malondialdehyde) levels, SOD (superoxide dismutase), reduced glutathione (GRd) and GSH.Px (glutathione peroxidase) activities were assayed in serum using a modified method published with ***Ohkawa etal., (1979), Masayasu and Hiroshi (1979), Sedlak & Lindsay (1968)*** **and** ***Necheles etal., (1968)***, respectively.

Liver function as AST, ALT, ALP and γGT were detected according to the methods of ***Henry (1974)*****;** ***Young (1975); IFCC (1983*****) and** ***Willemsen etal., (2010)*** in arrange. And determination of total protein, albumin and globulin were assessed by methods of ***Gowenlock etal., (1988)*****;** ***Spencer & Price (1977)*** **and** ***Srivastava etal., (2002),*** respectively. While albumin/globulin ratio was calculated.

Kidney functions as serum creatinine, urea, and uric acid levels were evaluated accordance to***, Tietz (1986)*****;** ***Patton and Crouch (1977)*** **and** ***Fossati etal., (1980)***, regulatory.

Statistical analysis:

Statistical program SPSS for Version 10 Windows was used to evaluate the findings, which were presented as Means ± Standard Deviation. The statistics package program's one-way ANOVA testing was utilized to analyze the variances between groups, and Duncan's multiple comparison test was utilized as a post hoc test to evaluate the levels of significance at a significance level of $P \leq 0.05$ as the statistics package program (***Artimage and Berry, 1987***).

Results and discussion

Impact of garlic, some types of vinegar and their soakage for 10 days on blood lipids profile and atherogenic indices of hypercholestrolemic obese rats

Table (1) displays the effects of garlic, various vinegars, and their soakage for 10 days on blood lipids profile and atherogenic indices of hypercholestrolemic obese rats. Feeding rats on a high fat high cholesterol diet (22% fat and 4% cholesterol) for 4 weeks results in bad lipid profile characterized by significant increases in total lipids (TL), phospholipids (PL) and triglycerides (TG), total cholesterol (TC), low-density lipoprotein-cholesterol (LDL-C), very low-density lipoprotein (VLDL-C) plus atherogenic indices of atherogenic index (AI) and atherogenic combined index (ACI). Additionally, significant lower in high-density lipoprotein (HDL-C).

Three distinct lipoprotein types are included in total cholesterol (TC) measurements: LDL, VLDL, and HDL. While HDL is believed to be

cardioprotective at higher concentrations, both LDL and VLDL are positively associated with atherosclerosis (***Brown, 2011***). ACI, considered as a new and strong comprehensive atherogenic biomarker to the occurrence and severeness of CAD (coronary artery disease) that evaluates the balance between antiatherogenic and atherogenic particles of lipids (***Toprak et al., 2024***). Many researchers have demonstrated that animals with elevated dietary fat and/or cholesterol intake by different levels and duration developed obesity, hypercholesterolemia and dyslipidemia described by higher serum total lipid levels, triglycerides, VLDL-C), (LDL-C) plus atherogenic index as ***Halima etal., (2018), Sinaga etal., (2021)*** and ***Yamamoto etal., (2023)***. High cholesterol diet induced increases in both liver triglycerides and cholesterol, leading to complications as hypertension and atherosclerosis (***Samad etal., 2016***). ***Lassale etal., (2018)*** showed that obesity enlarges risk of cardiovascular disease by 28% linked to non-obese peoples.

In regard to total lipids (TL), phospholipids (PL) and triglycerides (TG) the findings showed that the treatment groups receiving water garlic extract (WGE) and other types of vinegar did not significantly differ from one another. Moreover, there was no significant difference compared to positive control (C+) group found for only garlic vinegar (GV) in TL, for WGE and various vinegar types in PL and for various vinegar types in TG. But at the same time, there are no significant different from negative control group for Apple vinegar (AV) and balsamic vinegar (BV) groups in each of TL and PL. The groups of soaked garlic in apple or balsamic vinegar for 10 days (GAV-10D and GPV-10D respectively) showed the significant greatest impact from C+ group on TL, PL and TG that did not differ significantly from the negative control (C-) group.

Interestingly for total cholesterol (TC), there were no significant differences either between all experimental extracts and vinegars each other or compared to C- group by significant change from C+ group. For HDL-c improvements, it comes by insignificant changes from C- group for all treatments except for GV group being the least effect. However, all studied extracts and vinegars significantly reduced LDL-c, VLDL-c, atherogenic index (AI) plus atherogenic combined index (ACI) from C+ group, but soaking garlic in vinegar for 10 days can restore normal values for all these biomarkers.

Table (1): Impact of garlic, some types of vinegar and their infusion for 10 days on blood lipids profile and atherogenic indices of hypercholestrolemic obese rats.

Groups / Parameters	C-	C+	WGE	GV	AV	BV	GAV-10D	GBV-10D
TL (mg/dl)	452.15^{c} ± 26.02	583.185^{a} ± 45.34	513.06^{bc} ± 37.12	531.13^{ab} ± 41.15	509.3^{bc} ± 41.72	512.54^{bc} ± 32.66	448.94^{c} ± 25.21	449.75^{c} ± 19.89
PL (mg/dl)	226.77^{c} ± 18.2	271.53^{a} ± 20.76	251.9^{abc} ± 16.35	260.24^{ab} ± 22.41	240.4^{abc} ± 19.7	239.15^{abc} ± 13.75	223.24^{c} ± 10.58	229.39b^{c} ± 10.42
Tri (mg/dl)	105.27^{c} ± 8.84	150.6^{a} ± 12.37	128.62^{b} ± 11.26	137.09^{ab} ± 11.65	133.28^{ab} ± 12.3	140.82^{ab} ± 12.44	106.71^{c} ± 8.65	102.42^{c} ± 7.87
TC (mg/dl)	120.12^{b} ± 10.45	160.99^{a} ± 13.42	132.55^{b} ± 12.1	133.8^{b} ± 7.15	135.59^{b} ± 10.06	132.58^{b} ± 7.39	118.99^{b} ± 6.06	117.95^{b} ± 9.69
HDL-C (mg/dl)	66.35^{a} ± 8.22	49.95^{c} ± 3.13	65.94^{a} ± 8.37	53.17^{bc} ± 3.73	61.44^{ab} ± 5.76	58.93^{abc} ± 5.33	63.93^{ab} ± 5,14	60.1^{abc} ± 4.49
LDL-C (mg/dl)	32.72^{e} ± 3.56	80.92^{a} ± 8.14	40.89^{cd} ± 4.25	53.21^{b} ± 1.74	47.49^{bc} ± 2.7	45.49^{c} ± 4.37	33.72^{de} ± .78	37.37^{de} ± 3.81
VLDL-C (mg/dl)	21.05^{c} ± 1.77	30.12^{a} ± 2.47	25.72^{b} ± 2.25	27.42^{ab} ± 2.33	26.66^{ab} ± 2.46	28.16^{ab} ± 2.49	21.34^{c} ± 1.73	20.48^{c} ± 1.57
AI	.817^{e} ± .101	.2.22^{a} ± .947	1.019^{d} ± .125	1.519^{b} ± .059	1.21^{c} ± .628	1.257^{c} ± .137	.864de ± .058	.962d^{e} ±.024
ACI	2.931^{e}±.032	3.526^{a} ± .05	3.114^{c} ± .052	3.317^{b} ± .026	3.206^{c} ± .026	3.246^{c} ± .039	2.963^{e} ± .013	2.993^{e} ± .039

Data are expressed as mean ± standard deviation. Values within a row having different super scripts are significantly different ($p \leq 0.05$) as indicated by one-way ANOVA followed by Duncan's multiple range test (a > b > c > d > e > f).

WGE: Water Garlic Extract; GV: Garlic Vinegar; AV: Apple Vinegar; BV: Balsamic Vinegar; GAV-10D: Liquid extract from soaked garlic in apple vinegar for 10 days; GBV-10D: Liquid extract from soaked garlic in balsamic vinegar for 10 days.

TP, total lipids; PL, phospholipids; TG, triglyceride; TC, total cholesterol; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; VLDL-C, very low-density lipoprotein cholesterol; AI (LDL-C + VLDL-C/HDL-C), atherogenic index; ACI (log 10 [Tri × "non-HDL-C÷HDL"]), atherogenic combined index.

These results showed that liquid extracts of soaked garlic in different types of vinegar for 10 days as derived from Syrian demotic recipe can restore normality values of lipids profile and atherogenic indices in hypercholestrolemic obese rats and enlarged the good effects for each of garlic and vinegar alone. These perfect effects may be due to several suggestions as increase concentration of bioactive compounds or keep its bioactivity more or even production of new bioactive compounds by fermentation or all of these by acid phase and long period of extract process, emphasizing the need for further specific chemical searches to detect these respects, in addition to biological studies in

different experimental animal models and in humans to prove and detect the perfect safe dose, period, and type of used vinegars toward these benefits. These extracts can be used as green salad dressing or even as it is as drops on the water.

The first line of treatment for coronary artery diseases is typically dietary therapies. Dietary therapies primarily involve the herbs usage in the diets along with reduced dietary daily consume of cholesterol (<200 mg/day) and fats (lower than 7% of totally consumed calories), as well as increased physical activity and an avoidance of sedentary lifestyles (***Brown etal., 2011***). Since numerous studies have demonstrated the advantages of using herbs or their extracts in the treatment of cardiovascular diseases (CVDs). When compared to other forms of medicine, plant-based medicine is comparatively less expensive and has positive effects with little to no side effects in clinical trials Accordingly, studies have demonstrated the antimicrobial and blood fat-lowering properties of garlic, which is one of the herbs that has been consumed in large quantities since ancient times (***Thomson etal., 2006***).

Garlic has hypolipidemic and cardiovascular protect effects that have been documented and verified by numerous studies as ***Mir etal., (2019)*** who showed that garlic acts strongly against dyslipidemia and lower triglycerides, cholesterol and LDL-C levels. These features are in line with those of ***Shabani etal., (2019)*** since garlic can correct lipid profiles and be a useful therapeutic in patients with cardiovascular diseases. Garlic juice for 21 days at 1 ml/ day acted as antihyperlipidemic and prevented cardiovascular disease as found by ***Anthony etal., (2020)***. Garlic extract protects vascular density and main artery diameter, restoring retinal arterioles in streptozotocin-diabetic rats (***Bastaki et al., 2024***). Furthermore, ***Park etal., (1999)*** results showed that the diabetic rats given a garlic vinegar diet supplement had significantly lower plasma LDL-cholesterol concentrations and an atherogenic index than the control rats. Consequently, in streptozotocin-induced diabetic rats, the supplement's overall effect may play a part in its antiatherogenic role.

Researchers assume that allicin's diallyl disulfide (DADS) breakdown is primarily responsible for the medicinal effects of garlic and its constituents on regulating sterols excretion and lipid synthesis (***Song etal., 2021***). Garlic inhibits enzymes activity involved in cholesterol synthesis and reduces the absorption of cholesterol (***Reinhart etal., 2009***). Garlic able to prevent atherosclerosis and lower blood pressure by two mechanisms: suppression of LDL oxidation (***Lau, 2006***) and inhibition of cholesterol synthesis (***Singh and Porter, 2006***). Garlic contains sulfur-containing amino acids, including diallyl disulfide, ajoene, S-allylcysteine, allicin, and S-methylcysteine. These amino acids

are primarily responsible for the hypolipidemic effect of garlic (***Sobenin etal., 2010***). Different organosulfur components in garlic preparations may have varying effects or benefits on the cardiovascular system. The active ingredient in aged garlic extract, S-allylcysteine (abbreviated SAC), has been found to be stable and active, allowing preparations to be standardized by S-allylcysteine dose. However, the active ingredient in garlic powder is lower well-established because allicin, a derivative of alliin, is volatile plus it is most likely only temporarily responsible for the cardiovascular effects (***Amagase, 2006***). Furthermore, ***Ried etal., (2013)*** propose that aged garlic extract lowers total serum cholesterol more effectively than garlic powder or oil. Moreover, there are many garlic commercial and patent products that used for several purpose to prevent or cure many ailments like hyperlipidemia, lipids metabolic disorders, and arteriosclerosis such garlic oral administration liquid from garlic extract, fermented garlic composition with active ingredient of garlic bulb, composition containing dried powder of black garlic, black garlic chewing gum from black garlic blub and compound garlic oil capsules from garlic cloves (***Gupta etal., 2024***).

Vinegar is a fermented natural product, and carbohydrate opulent foods are brilliant sources for substrates to vinegar produce. It's one from the very famous folk, effective and low-cost medicines and the responsibility for its beneficial effects is acetic acid and other compounds (***Samad etal., 2016***). The main ingredient in vinegar, acetic acid, lowers plasma TG levels in rats by increasing fatty acid beta-oxidation and suppressing hepatic lipogenesis (***Shishehbor etal., 2008***). Dietary acetic acid also inhibits the expression of the sterol regulatory element binding protein-1 (SREBP-1) gene, which lowers the activity and amounts of mRNA and ATP citrate lyase (ATP-CL), respectively. This reduces the availability of acetyl CoA plus HMG-CoA that are necessary for fatty acids plus cholesterol synthesis (***Samad etal., 2016***). The impact of vinegar's polyphenols, which prevent intestinal lipid release, may be the cause of the changes in HDL and LDL levels (***Shishehbor etal., 2008***). Also, ***Wang etal., (2022)*** found that acetic acid supplementation can restore bile acids (BAs) balance for high fat diet. Daily consumption of 750 mg acetic acid as drink including 15 mL vinegars was found to improve lifestyle-related illness as obesity, hyperlipidemia and hypertension plus elevate HDL-C and lower LDL-C levels (***Samad etal., 2016***).

Numerous experimental studies have also reported hypolipidemic effects from apple cider vinegar as ***Ostman etal., (2005)***, who hypothesized that using apple vinegar may help patients with hyperlipidemia see reductions in their LDL, triglyceride, and cholesterol levels. Additionally, apple cider vinegar can utilize to treat and prevent

the complication as well as potentially other cardiac problems. Research of ***Soltan and Shehata (2012)*** indicates that fruit vinegar can significantly increase levels of HDL-C while decreasing triglycerides, total cholesterol, and LDL-C. Additionally, ***Khalifa etal., (2024)*** reported that both apple and balsamic vinegars are preventing from cardiovascular problems by suppressing LDL oxidation.

Impact of garlic, some types of vinegar and their fermented infusion for 10 days on BWG%, liver and heart relative weights and liver lipids content of hypercholestrolemic obese rats.

Table 2 displays the impact of garlic, some types of vinegar and their extracts for 10 days on body weight gain (BWG%), liver and heart relative weights and liver lipids content of hypercholestrolemic obese rats. It could be noticed significant elevation in all these biomarkers in hypercholestrolemic obese rats compared to normal rats by feeding high fat and cholesterol diet. These results come in harmony with that well known and revealed by ***Mir etal., (2019)*** that obesity is caused by consuming more energy than one expends. Obesity is a main global public health concern resulted of its increasing occurrence and strong correlation with diseases like cardiovascular, liver, and many other chronic diseases. And according to that found by several searches as ***Matsumura etal., (2024)*** which high fat diet caused obesity, fatty liver and adipocyte hypertrophy in rats. Also, ***Wang etal., (2022)*** showed that high-fat diet affected BAs (bile acids) balance and caused obesity. ***Lassale etal., (2018)*** and ***Fabbrini etal., (2010)*** evaluated that obesity enlarges cardiovascular disease risk by 28% plus liver disease by 65 - 80% linked to non-obese peoples.

Table (2): Impact of garlic, some types of vinegar and their fermented infusion for 10 days on BWG%, liver and heart relative weights and liver lipids content of hypercholestrolemic obese rats.

Groups / Parameters	C-	C+	WGE	GV	AV	BV	GAV-10D	GBV-10D
BWG %	$33.78^{b} \pm 3.45$	$48.4^{a} \pm 3.76$	$36.85^{b} \pm 2.47$	$34.29^{b} \pm 2.45$	$35.15^{b} \pm 2.34$	$35.54^{b} \pm 2.6$	$36.7^{b} \pm 2.45$	$37.67^{b} \pm 2.45$
Liver weight%	$2.92^{b} \pm .19$	$3.82^{a} \pm .42$	$2.72^{b} \pm .17$	$3.11^{b} \pm .36$	$3.21^{b} \pm .34$	$2.9^{b} \pm .36$	$2.87^{b} \pm .3$	$2.85^{b} \pm .15$
Heart weight %	$0.35b^{c} \pm .036$	$0.437^{a} \pm .056$	$0.37^{abc} \pm 0.044$	$0.387^{abc} \pm 0.005$	$0.395^{ab} \pm 0.028$	$0.323^{c} \pm 0.036$	$0.32^{c} \pm 0.04$	$0.327^{bc} \pm 0.029$
Liver Lipids (mg/g tissue)	$105.2^{d} \pm 9.07$	$200.82^{a} \pm 16.55$	$123.67^{cd} \pm 16.69$	$137.2^{bc} \pm 13.88$	$139.84^{bc} \pm 12.21$	$150.3^{b} \pm 12.78$	$109.83^{d} \pm 9.13$	$116.67^{cd} \pm 10.39$

Data are expressed as mean ± standard deviation. Values within a row having different super scripts are significantly different ($p \leq 0.05$) as

indicated by one-way ANOVA followed by Duncan's multiple range test (a > b > c > d > e > f).

WGE: Water Garlic Extract; GV: Garlic Vinegar; AV: Apple Vinegar; BV: Balsamic Vinegar; GAV-10D: Liquid extract from fermented soaked garlic in apple vinegar for 10 days; GBV-10D: Liquid extract from fermented soaked garlic in balsamic vinegar for 10 days.

BWG: body weight gain.

The last body weight gain and liver relative weight for all experimental extracts and vinegars didn't significantly different either from each other or compared to C- group by significant reduction from C+ group. Although the relative heart weight was reduced to insignificant levels from C- group for all treated groups except for AV group but the significant reduction from C+ group recorded only for BV, GAV-10D and GBV-10D being the perfect effects. Also, by focusing on liver lipids content results, it was significantly reduced for all studied extracts and vinegars from C+ group, but only soaking garlic in vinegar for 10 days in GAV-10D and GBV-10D groups plus WGE group reaching to insignificant changes from normal values.

Understanding the body's weight regulation system is necessary for the development of functional foods for losing weight. Incorporating active chemicals into food systems, limiting nutritional bioavailability, stimulating the expenditure of energy (thermogenesis), and altering gut microbiota composition are the primary methods for controlling body weight (***Trigueros etal., 2013***). Consumers these days are also conscious of their health, and they favor goods that offer both basic nutrition and health protection. Plant secondary metabolites are a rich source of active ingredients linked to preventing issues related to obesity. (***Mir etal., 2019***).

In the realm of food science, research on obesity has concentrated on finding food ingredients that may prevent the buildup of body fat. The study by ***Ali etal., (2018)*** suggested both garlic and vinegar as dietary supplements for the prevention of obesity and metabolic syndrome because they are well-known functional foods that reduce obesity.

The findings of this study are supported by ***Kondo etal., (2009)***, who discovered that the administration of vinegar had favorable effects on body weight regulation. Fruit vinegars have been shown to significantly reduce triglyceride levels, total cholesterol, lipid profile, and body weight in animals (***Wei etal., 2005***). Moreover, ***Abou- Khalil etal., (2024)*** found that apple cider vinegar (ACV) consumption by any of three doses 5, 10 and 15 ml for period between 4 to 12 weeks improves

anthropometric measurements being weight, body mass index, waist/hip circumferences and body fat ratio in addition to lowers triglyceride and cholesterol levels in overweight or obesity peoples which indicating a promising anti-obesity supplement without side effects. Foods or their products containing polyphenols or vinegar have been shown to have anti-obesity and anti-hypercholesterolemic properties (***Beh etal., 2017*** **and** ***Kondo etal., 2009***).

According to various statistics, acetic acid or vinegar consumption may help with hyperlipidemia and help people lose weight. In recent years, vinegar beverages that combine a variety of phytochemicals found in fruit have become more and more popular as the public's interest in vinegar has grown (***Costa etal., 2013***). Also, ***Wang etal., (2022)*** found that acetic acid supplementation can restore BAs (bile acids) balance for high fat diet caused obesity via modifying taurine conjugated bile acids metabolism. And according to study by ***Ostman etal., (2005)***, acetic acid lowers obesity by elevating satiety and so lowering the overall consumed food amount. Also, it inhibits lipogenesis, which is mediated by a decrease in the expression of the ACC (acetyl-CoA carboxylase), FAS (fatty acid synthase), and malic enzyme genes, thereby suppressing body fat mass (***Yamashita etal., 2007***). Thus, a new recipe containing apple, balsamic, or garlic vinegar was created in order to examine its impact on obesity.

Consuming dietary garlic lowers body mass and weight in different types of white adipose tissues (***Lee etal., 2011***). In diet-caused obese mice, dietary supplementation with garlic reduces body weight and is linked to a raise in uncoupling protein (UCP) mRNA and a lower in the expression of adipogenic genes (***Lee etal., 2011*** **and** ***Kim and Kim, 2011***). Furthermore, the health benefits of garlic's organosulfur compounds, which include allicin and its byproducts, are significant. According to ***Fujisawa etal., (2008)***, allicin decomposes into a variety of compounds, including vinyldithinins, sulfides, and ajoene. Ajoene has been documented to restrains lipid accumulation and mediate apoptosis in 3T3-L1 adipocytes (animal cell cultures) (***Yang etal., 2006***). Also, it affects the process of energy expenditure in rats and contributed to weight loss independent of food intake as suggested by ***Han etal., (2011)***. Vinyldithinins inhibited the differentiation of human pre-adipocytes to adipocyte and contributed to the reduction of lipid accretion by lowering the expression of lipoprotein lipase (LPL) plus important genes which are a transcription factor including peroxisome proliferator activated receptor gamma (PPARg) and (cytosine-cytosine-adenosine-adinosine-thymidine) CCAAT-enhancer-binding proteins

(C/EBP) in human adipocytes (***Keophiphath etal., 2009***). Also, ***Chen etal. (2014)*** explained that garlic has many active compounds as S-allyl-l-cysteine sulphoxide and S-allyl cysteine with anti-obesity effects which reduced last body weight, liver relative mass plus tissues fat content in rats fed a high-fat diet through a number of mechanisms, including raised fecal lipid level, upregulated adenosine monophosphate-activated protein kinase, Sirtuin1, adipose triacylglyceride lipase, hormone-sensitive lipase, Acyl-CoA oxidase, and palmitoyl transferase1 and downregulated cluster of differentiation. Furthermore, there are some garlic commercial and patent products that used for several purpose as reduce weight such black garlic chewing gum from black garlic blub and pharmaceutical plus dietary supplement composition contain extract of wild garlic leaf (***Gupta etal., 2024***).

It has been proposed that snoozing combined with lipid deposition is an effective means of treating obesity (***Mopuri etal., 2015***). Garlic and vinegar have been shown to reduce lipid deposition, which helps reduce body weight. The expression of genes regulating lipolysis and lipogenesis, including leptin and sterol regulatory element binding protein-1c (SREBP-1c), was significantly influenced by lipid metabolism (***Lee etal., 2010***). Adipocytes produce leptin, and there is a correlation between leptin production and adipocyte fat storage. Consequently, the reduction in body fat accumulation and adipocyte size was the outcome of the decrease in serum leptin levels brought on by the beverage. Lowering serum leptin levels through beverage intake was appeared to be attributed with a lower in food intake in hypercholesterolemic obese subjects, and it was also found to be related to satiety. According to ***Mopuri etal., (2015)***, a lower in serum leptin was also implicated in controlling the expression of the SREBP-1c gene, a transcription factor involved in initiating the metabolism of fats and carbohydrates through glucose regulation.

Impact of garlic, some types of vinegar and their infusion for 10 days on antioxidant status and malondialdehyde of hypercholestrolemic obese rats.

Table 3 illustrated the effect of garlic, some types of vinegar and their infusion for 10 days on antioxidant status and malondialdehyde of hypercholestrolemic obese rats. Hypercholestrolemic obese rats in the C+ group were sharply having decreased levels of total antioxidant capacity (TAC) and antioxidant enzymes of SOD (superoxide dismutase); CAT (catalase); GPX (glutathione peroxidase) and GRD (glutathione reductase). While MDA (malondialdehyde) levels, an end product of lipid peroxidation, was significantly increased among

hypercholestrolemic obese rats related to normal rats. This feature of impaired antioxidant status and increasing lipid peroxidation was shown by feeding high fat diet specially saturated fat or cholesterol at different concentrations and durations as found by a lot of studies as ***Wang etal., (2014)*** plus ***Haque etal., (2024)***.

Table (3): Impact of garlic, some types of vinegar and their fermented infusion for 10 days on antioxidant status and malondialdehyde of hypercholestrolemic obese rats.

Groups / Parameters	C-	C+	WGE	GV	AV	BV	GAV-10D	GBV-10D
TAC (ng/ml)	$6.49^{a} \pm .45$	$3.21^{d} \pm .29$	$4.27^{bc} \pm .35$	$4^{c} \pm .3$	$4.3^{bc} \pm .2$	$4.88^{b} \pm .42$	$6.01^{a} \pm .46$	$6.12^{a} \pm .6$
MDA (Mmol/l)	$47.88^{e} \pm 4.49$	$156.52^{a} \pm 11.66$	$129.9^{b} \pm 9.19$	$124.22^{b} \pm 7.72$	$93.54^{c} \pm 5.77$	$106.4^{c} \pm 8.98$	$66.02^{d} \pm 5.31$	$53.06^{de} \pm 3.7$
SOD (U/l)	$51.36^{a} \pm 3.85$	$16.44^{d} \pm 1.42$	$25.78^{c} \pm 2.58$	$24.76^{c} \pm 2.31$	$25.03^{c} \pm 1.63$	$34.62^{b} \pm 3.06$	$46.16^{a} \pm 4.16$	$50.53^{a} \pm 3.14$
CAT (Mmol/l)	$140.77^{a} \pm 10.61$	$60^{e} \pm 5.36$	$82.45^{d} \pm 7.16$	$73.76^{d} \pm 5.95$	$77.44^{d} \pm 5.69$	$86.25^{d} \pm 6.45$	$106.92^{c} \pm 7.3$	$126.15^{b} \pm 10.8$
GPX (ng/ml)	$33.09^{a} \pm 2.9$	$9.4^{g} \pm 1.04$	$17.53^{ef} \pm 1.36$	$21.59^{cd} \pm 2.02$	$19.73^{de} \pm 1.46$	$15.11^{f} \pm 1.3$	$24.7^{c} \pm 2.5$	$29.15^{b} \pm 1.75$
GRD (ng/l)	$3.69^{a} \pm .358$	$1.3^{e} \pm .269$	$2.55^{c} \pm .218$	$2.04^{d} \pm .14$	$2.1^{d} \pm .183$	$2.36^{cd} \pm .217$	$3.08^{b} \pm .249$	$3.2^{b} \pm .229$

Data are expressed as mean ± standard deviation. Values within a row having different super scripts are significantly different ($p \leq 0.05$) as indicated by one-way ANOVA followed by Duncan's multiple range test ($a > b > c > d > e > f$).

WGE: Water Garlic Extract; GV: Garlic Vinegar; AV: Apple Vinegar; BV: Balsamic Vinegar; GAV-10D: Liquid extract from fermented soaked garlic in apple vinegar for 10 days; GBV-10D: Liquid extract from fermented soaked garlic in balsamic vinegar for 10 days.

TAC, total antioxidant capacity; MDA, malondialdehyde; SOD, superoxide dismutase; CAT, catalase; GPX, glutathione peroxidase; GRD, glutathione reductase.

The findings established that a combination of vinegar and garlic for 10 days was more effective than either one ingredient alone. GAV-10D and GBV-10D only had the higher total antioxidant activity (TAC) and SOD that did not change significantly than normal values and significantly higher than WGE or studied vinegars alone, although all studied vinegars and extracted significantly improved TAC and SOD from C+ group. At the same line, all studied vinegars and extracted significantly elevated CAT, GPX and GRD levels from C+ group, but GAV-10D and GBV-10D had the highest impact on improving these antioxidant enzymes by significant change from WGE and studied

vinegars alone except for GPX since GAV-10D and GV didn't significantly different from each other. Also, its worthy mentioned that GAV-10D and GBV-10D groups didn't significantly change from each other for TAC and antioxidant enzymes except CAT and GPX in which GBV-10D had significant improvements for these enzymes than GAV-10D.

By focusing on MDA levels, an end product of lipid peroxidation, Water garlic extract or different type of vinegar individually decreased the values of MDA as related to positive control group. There are no significant changes between the C- group and GBV-10D which didn't significantly different from GAV-10D, being the best impact.

Plant flavonoids help prevent and reduce the oxidative inflammatory status linked to obesity by regulating different molecular pathways, including sterol regulatory element-binding protein-1c, nitrogen-activated protein kinase, adenosine monophosphate activated protein kinase, and peroxisome proliferator-activated receptor (PPARa) (***Yu etal., 2014***).

Gupta etal., (2024) reported that garlic cloves contains many bioactive compounds either sulphur or non-sulphur with antioxidant activity in which non-sulphur phytochemicals of garlic, being polyphenols, flavonoids, steroid, saponins, organoselenium, polysaccharides and allixin, can promote the expression of antioxidant enzymes. In addition to different garlic sulphur components with antioxidant activity, being alliin (S-allylcysteine sulfoxide), allicin (diallyl thiosulphinate), allylpropyl disulphide, diallyl sulphide (DAS), diallyl disulphide (DADS), diallyl trisulphide (DATS), S-allylcysteine, S-allylmercaptocysteine, S-allylmercaptoglutathione, E-ajoene, Z-ajoene, allyl methyl sulphide, allyl methyl disulphide. Also, ***Chen etal., (2013)*** and ***Thakur etal., (2024)*** appeared that garlic contains a chemical called allicin, which improves antioxidant status by lowering reactive oxygen species and raising glutathione and endogenous antioxidant enzyme synthesis. Moreover, ***Thakur etal., (2024)*** described that DADS in garlic decreased production of reactive nitrogen and oxygen species plus lowers cyclooxygenase (COX)-2 by blocking $_{k}$B nuclear factor (NF-$_{k}$B) activity; garlic 2- vinyl-4H-1,3-dithiin help to neutralize harmful free radicals and g-glutamyl-S-allyl-L-cysteine (GSAC) scavenge the free radicals so preventing from damage of cells and tissues induced by these hurtful molecules. ***Jamadi et al., (2023)*** found that fresh garlic juice at 800 mg/kg. body weight/day/rats in drinking water can reduce MDA and increased levels of SOD and GPX.

A raise concentrations of thiol group and antioxidant enzymes of CAT SOD, and GPx activities, plus vitamin E concentrations was observed by oral administration of apple cider vinegar which normalized various biochemical and metabolic changes in rats with high-fat diet, and by modifying the antioxidant defense system and lowering the atherogenic risk, it can help reduce obesity-caused oxidative stress in rats fed a high-fat diet as finding by ***Halima etal., (2018)*** experiment. Also, balsamic vinegar considers one from functional vinegars that has antioxidant activity contributing to its bioactive compounds as revealed by ***Bai etal., (2024)***. Moreover, ***Khalifa etal., (2024)*** explain that both apple and balsamic vinegars have antioxidant activity which related to defend from oxidative stress, suppress LDL oxidation and lower lipid peroxidation and LDL lysophosohatidyl-choline.

Because of their high organic acid and polyphenol content, fruit vinegars have been found to be a good dietary source of antioxidants (***Liu etal., 2019***). Corroborating these results are studies by ***Abdulrauf etal. (2018)*** that demonstrate a decrease in serum catalase activity and lipid peroxidation (MDA) after apple cider vinegar treatment. According to ***Liu etal., (2019)***, Fruit-based condiments are consumed in large quantities all over the world also fruit vinegars' organic acids and antioxidant content are primarily responsible for their flavors and health benefits.

Impact of garlic, some types of vinegar and their infusion for 10 days on liver function and proteins profile of hypercholestrolemic obese rats.

Table 4 illustrated the impact of garlic, some types of vinegar and their infusion for 10 days on liver functions and proteins profile of hypercholestrolemic obese rats. It could be significantly detected the elevation of all liver enzymes (AST: aspartate amino transferase; ALT: alanine amino transferase; GGT: gamma-glutamyl transferase and ALP: alkaline phosphatase) with less levels of total protein (TP), albumin and ratio of albumin/ globulin (A/G) than that of normal rats by administration high fat high cholesterol diet for total experimental period. While globulin levels didn’t significantly change. These results come in agree with that found by many studies since high fat diet at different levels and period induced steatohepatitis (nonalcoholic fatty liver disease) with elevated liver enzymes levels and less A/G ratio as ***Yamamoto etal., (2023)*** and ***Matsumura etal., (2024)***. ***Fabbrini etal., (2010)*** appeared that obesity elevates risk of liver disease by 65 - 80% corelated to non-obese ones.

Table (4): Impact of garlic, some types of vinegar and their fermented infusion for 10 days on liver function and proteins profile of hypercholestrolemic obese rats.

Groups / Parameters	C-	C+	WGE	GV	AV	BV	GAV-10D	GBV-10D
AST (U/l)	165.33^{cd} ± 22.67	254.06^{a} ± 17.14	206.93^{b} ± 22.67	207.7^{b} ± 20.6	220.8^{b} ± 22.55	197.7^{c} ± 9.9	165.1^{cd} ± 12.97	161.8^{d} ± 10.55
ALT (U/l)	97.15^{c} ± 7.49	164.42^{a} ± 18.69	150^{ab} ± 12.34	143.1^{ab} ± 13.65	132.65^{b} ± 9.69	100.02^{c} ± 11.12	95.63^{c} ± 9.16	96.7^{c} ± 14.87
GGT (U/l)	45.08^{c} ± 4.98	81.41^{a} ± 8.18	66.42^{b} ± 6.05	67.6^{b} ± 6.3	66.8^{b} ± 7.28	59.9^{b} ± 5.43	46.98^{c} ± 3.85	43.94^{c} ± 3.76
ALP (U/l)	191.09^{c} ± 18.51	328.93^{a} ± 28.16	298.73^{ab} ± 27.91	289.45^{ab} ± 24.23	288.8^{ab} ± 22.36	251.99^{b} ± 40.46	192.34^{c} ± 16.37	189.29^{c} ± 21.54
TP (mg/dl)	7^{a} ± .571	5.79^{b} ± .51	6.11^{ab} ± .61	6.33^{ab} ± .56	6.39^{ab} ± .31	6.23^{ab} ± .64	6.88^{a} ± .32	6.79^{a} ± .26
Albumin (A) (mg/dl)	4.12^{a} ± .2	2.74^{e} ± .24	3.19^{de} ± .29	3.35^{cd} ± .31	3.48^{bcd} ± .38	3.29^{cd}e ±.31	3.97^{ab} ± .45	3.85^{abc} ± .36
Globulin (G) mg/dl)	2.88^{a} ± .37	3.05^{a} ± .27	2.92^{a} ± .32	2.98^{a} ± .25	2.91^{a} ± .11	2.94^{a} ± .33	2.91^{a} ± .15	2.94^{a} ± .29
A/G ratio	1.44^{a} ± .128	.898^{c} ± .001	1.094^{bc} ± .021	1.124^{bc} ± .01	1.2^{ab} ± .171	1.12^{bc} ± .021	1.367^{ab} ± .216	1.308^{ab} ± .261

Data are expressed as mean ± standard deviation. Values within a row having different super scripts are significantly different ($p \leq 0.05$) as indicated by one-way ANOVA followed by Duncan's multiple range test (a > b > c > d > e > f).

WGE: Water Garlic Extract; GV: Garlic Vinegar; AV: Apple Vinegar; BV: Balsamic Vinegar; GAV-10D: Liquid extract from fermented soaked garlic in apple vinegar for 10 days; GBV-10D: Liquid extract from fermented soaked garlic in balsamic vinegar for 10 days.

AST, aspartate amino transferase; ALT, alanine amino transferase; GGT, gamma-glutamyl transferase; ALP, alkaline phosphatase; TP, total protein.

While the improvement in liver enzymes levels (AST, ALT, GGT and ALP) for WGE and different types of vinegar various between significant and insignificant changes from C+ group, the treatments of

GAV-10D and GBV-10D always had the best effect that didn't significantly different either between each other or compared to normal levels. Also, BV showed good effects since its AST and ALT levels didn't significantly change from GAV-10D group.

Interesting to protein fraction profile, it could be observed that increase of TP levels came by insignificant changes from each of C+ and C- groups for GWE and different types of vinegars, but GAV-10D and GBV-10D treatments significantly increased TP from C+ group reaching to insignificant levels from normal values. For albumin (A) levels, there were significant elevation for all treatments except WGE showed insignificant elevation from C+ group, while only GAV-10D and GBV-10D treatments reached to insignificant levels from normal values. Globulin (G), on the other hand, remained relatively constant in all experimental groups. As for A/G ratio, all treated groups showed no significant changes from C+ group but the exceptions were the AV, GAV-10D and GBV-10D groups that showed significant increases reaching to value of C- group.

These results showed that liquid extracts of soaked garlic in different types of vinegar for 10 days as derived from Syrian demotic recipe can restore healthy status of liver in hypercholestrolemic obese rats and enlarged the good effects for each of garlic and vinegar alone.

Talal and Gathwan, (2022) showed that 100 mg garlic strengthens detoxification system' s capacity of glutathione-s-transferase (GSH-GST) plus lowers oxidative stress. According to ***Durrington (2003)***, the alcoholic extract of garlic significantly reduced ALT and AST. Also, ***Thakur etal., (2024)*** described that garlic's S- allyl cysteine (SAC) that soluble in water has liver protection action by inhibits cholesterol synthesis via inhibits HMG-CoA reductase activity; and garlic's allicin has considerable hepatoprotective effects from a different hepatic illness described by lipid peroxidation and oxidative damage. Furthermore, ***Samra etal., (2020)*** stated that allicin oral administration raise a cell proliferation measure in acetaminophen-induced liver damage by its capacity to block liver oxidative stress and inflammasome system. Similar results showed by ***Saleh etal., (2021)*** in a case study of Thioacetamide-induced acute hepatic encephalopathy with improved serum liver function, lowering inflammatory mediators and oxidative stress. Moreover, ***Gupta etal., (2024)*** reported that garlic's diallyl trisulphide (DATS) has hepatoprotective effects; and there are some garlic commercial and patent products that used for several cases as liver diseases such fermented garlic composition with active ingredient of

garlic bulb and pharmaceutical plus dietary supplement compositions contain extract of wild garlic leaf.

Previous research has indicated that vinegar's main ingredient, acetic acid (***Kondo etal., 2001***), It was proposed that treatment by acetic acid reduced the levels of triacylglycerol and TC by improving bile acid purging and inhibiting hepatic lipogenesis. The body converts acetic acid to acetate, which then activates AMPK, an important enzyme involved in lipid homeostasis that may explain why acetic acid is so effective at lowering cholesterol (***Yamashita etal., 2007***). Sterol regulatory element 240 binding protein (SREBP) gene-expression mRNA levels are suppressed by the acetic acid in vinegar, this could result in a drop in the concentrations of vital substrates (HMG-CoA and acetyl-CoA) needed for the fatty acids plus serum cholesterol synthesis (***Kim etal., 2013, Ali etal., 2018***). So, acetic acid is a key component of this study protocol, the same mechanism can be assumed.

Impact of garlic, some types of vinegar and their infusion for 10 days on renal function of hypercholestrolemic obese rats.

Table 5 illustrated the impact of garlic, some types of vinegar and their fermented infusion for 10 days on kidney function of hypercholestrolemic obese rats. The results indicated to renal dysfunction resulting in feeding high fat high cholesterol diet described by significant increasing levels of creatinine, urea and uric acid related to normal group. The kidney is one of the body's most important organs, because of its essential metabolic functions (excretory and regulatory), When renal impairment results in decreased renal clearance then serum urea levels rise. This clarifies the finding of this investigation, which showed that the hypercholestrolemic obese rats' s serum urea was noticeably elevated (***Ghalehkandi etal., 2012***). Also, ***Arman etal., (2021)*** showed that high fat high cholesterol diet elevates the severity of renal toxicities by enhancing renal casts, lower protein phosphatase expression, induced inflammatory mediators' dysregulation, and lower urinary excretion and detoxification. Chronic kidney disease (CKD) has an evaluated global occurrence of 13.4% (***Coresh, 2017***) and it is usually attributed with obesity, hypertension and diabetes (***Soderland etal., 2010***). ***Wang, etal., (2008)*** found that obesity upsurges risk of kidney disease by 24 - 33% related to non-obese peoples. Moreover, high fat high cholesterol diet caused fatty liver illness and multiple studies indicated to fatty liver illness as a chronic renal illness risk factor as hypothesized by ***Arman etal., (2021)***.

Table (5): Impact of garlic, some types of vinegar and their fermented infusion for 10 days on kidney function of hypercholestrolemic obese rats.

Groups / Parameters	C-	C+	WGE	GV	AV	BV	GAV-10D	GBV-10D
Creatinine (mg/dl)	$0.6^{f} \pm .05$	$1.15^{a} \pm .105$	$1.01^{b} \pm .085$	$0.837^{cd} \pm 0.065$	$0.95^{bc} \pm .082$	$0.74d^{e} \pm .06$	$0.63^{ef} \pm .06$	$0.617^{ef} \pm .05$
Urea (mg/dl)	$26.16^{e} \pm 2.84$	$48.26^{a} \pm 4.55$	$42.33^{b} \pm 3.52$	$34.58^{d} \pm 2.19$	$41.66^{bc} \pm 3.52$	$36.13^{cd} \pm 3.19$	$30.33^{de} \pm 3.51$	$27.77^{e} \pm 1.96$
Uric Acid (mg/dl)	$1.16^{c} \pm .122$	$2.975^{a} \pm .109$	$2.03^{b} \pm .161$	$1.25^{c} \pm .132$	$2.14^{b} \pm .16$	$1.18^{c} \pm .101$	$1.17^{c} \pm .098$	$1.15^{c} \pm .141$

Data are expressed as mean ± standard deviation. Values within a row having different super scripts are significantly different ($p \leq 0.05$) as indicated by one-way ANOVA followed by Duncan's multiple range test ($a > b > c > d > e > f$).

WGE: Water Garlic Extract; GV: Garlic Vinegar; AV: Apple Vinegar; BV: Balsamic Vinegar; GAV-10D: Liquid extract from fermented soaked garlic in apple vinegar for 10 days; GBV-10D: Liquid extract from fermented soaked garlic in balsamic vinegar for 10 days.

As illustrated from the results, all studied vinegars and extracts significantly lowered creatinine, urea and uric acid levels but GAV-10D and GBV-10D showed the lowest levels of creatinine, urea and uric acid that did not differ significantly from each other or when compared to C- group, being the best effects. Also, hypercholestrolemic obese rats which received balsamic vinegar (BV) showed good effects for curing the biomarkers of renal disorders without significant differ from groups of GAV-10D and GBV-10D. Moreover, especially for uric acid levels, BV and GV treatments also had good hypouricemic effects since didn't significantly change from C- group.

Serum urea and creatinine levels were lowered at the end of experimentation, this hypothesis was reinforced by many researchers who have exposed that garlic and vinegar have therapeutic and anti-inflammatory effects for kidney disease. Also, antioxidant qualities were demonstrated by garlic, garlic extract, and garlic compounds (***Jeong etal., 2012***).

Faezeh etal., (2011) concluded that garlic juice significantly decreased serum urea levels. Garlic juice was found to significantly prevent functional and histological injuries caused by renal reperfusion, which is consistent with this research findings (***Bagheri etal., 2011***). Also, garlic oil at 100 mg/kg/day in rats reduced hypertension and improved system of kidney's H_2S-generating and nitric oxide bioavailability as found by ***Tain etal., (2022)***. And 10% of garlic powder in diet reduced nephrotoxicity induced by 8 mg/kg of cisplatin in rats as

obtained by ***Kadhim and Al Salih, (2022)***. Furthermore, there are some garlic commercial and patent products that used for several purpose as renal protective such dietary supplement composition contain wild garlic leaf extract (***Gupta etal., 2024***).

On the other hand, because of their antioxidant content, plants and plant-derived products are typically linked to defense against oxidative damage caused by free radicals in bodily systems. According to ***Budak etal., (2014),*** the polyphenolic compounds found in apple cider vinegar (APCV) have significant antioxidant qualities and it is especially rich in catechin, epicatechin, gallic acid, chlorogenic acid, caffeic acid, and P-coumaric acid. It is widely accepted that APCV acted as a detoxifying and purifying agent to improve the physiological state and function of the body's essential organs (***Hlebowicz, 2007***). According to ***Asejeje etal., (2020)***, apple cider vinegar may be used therapeutically to guard against renal impairment and related problems. It's interesting to note that APCV treatment appears to improve the kidney's capacity to prevent blood creatinine buildup by reducing the upsurge.

Conclusion

It could be concluded that liquid extracts of soaked garlic in apple and balsamic vinegars for 10 days as derived from Syrian folk recipe can restored normality values of BWG% and biochemical parameters of lipid profile, liver lipids content, antioxidant status plus improved liver and kidney functions in hypercholesteremic obese rats and enlarged the good effects of each garlic and vinegar alone. These perfect effects may be due to several suggestions as increase concentration of bioactive compounds or keep its bioactivity more or even production of new bioactive ingredients with probiotic properties by fermentation or all of these by acetic acid phase and long extract duration, emphasizing the need for further specific chemical and biological searches to detect these respects plus perfect safe dose, period, and type of used vinegar. These extracts can be accepted as beneficial, natural flavoring agents of foods such salad dressing, chips, or even as drops in the water.

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المستخلص السائل لمنقوع الثوم مع أنواع مختلفة من الخل يستعيد القيم الطبيعية للمؤشرات البيوكيميائية في الفئران المصابة بالسمنة وارتفاع كوليسترول الدم

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قسم التغذية وعلوم الأطعمة – كلية الاقتصاد المنزلي – جامعة المنوفية

الملخص العربي

هناك حالات كثيرة تعاني من فرط كوليسترول الدم والسمنة المرتبطة بأمراض القلب والأوعية الدموية، ومع زيادة معدل الاصابة عالميا أصبحت المركبات الثانوية النباتية الناتجة من بعض المركبات تسلك دورا كبيرا في الوقاية والتحكم في عوامل الخطورة لهذه الحالات. قد يعمل الثوم والخل كغذاء وظيفي ذات مركبات غذائية وخصائص بروبيوتيك مفيدة صحيا. في هذه الدراسة، تم استخدام الفئران المصابة بالسمنة وارتفاع كوليسترول الدم بواسطة غذاء عالي الدهون (22%) والكوليسترول (4%) لمدة 4 أسابيع، للتعرف علي نقص الوزن وكوليسترول الدم وتحسين الصحة لمنقوع الثوم في كل من خل التفاح والبالسميك لمدة 10 أيام والمشتق من وصفة سورية شعبية مقارنة بالمستخلص المائي للثوم وكل من خل الثوم والتفاح والبالسميك بجرعة 2 مل/اليوم مع استمرار الوجبة عالية الدهون والكوليسترول لمدة 4 أسابيع اخري. أظهرت النتائج أن المستخلصات السائلة لمنقوع الثوم في أنواع الخل المختلفة لمدة 10 أيام عززت التأثيرات الجيدة لكل من الثوم والخل منفردا واستطاعة استعادة القيم الطبيعية لكل من معدل اكتساب الوزن، صورة دهون الدم، محتوى الدهون بالكبد، وحالة مضادات الأكسدة بالإضافة لتحسين وظائف الكبد والكلى. قد ترجع هذه التأثيرات المثالية إلى عدة اقتراحات مثل زيادة تركيز أو فاعلية المركبات النشطة بيولوجيًا أو حتى وجود عناصر فعالة جديدة ذو خصائص بروبيوتيك نتيجة التخمير وذلك بوجود الوسط الحامضي ومدة الاستخلاص الطويلة، مما يؤكد الحاجة إلى مزيد من الأبحاث الكيميائية والبيولوجية المتخصصة للكشف عن هذه النواحي بالإضافة إلى تحديد الجرعة الآمنة المثالية ومدة الاستخدام ونوع الخل الافضل. ويمكن قبول هذه المستخلصات كعوامل منكهة طبيعية مفيدة صحيا للأطعمة مثل تتبيلة السلطة وغيرها.

كلمات مفتاحية: الثوم، الوزن الزائد، مضدات الأكسدة، الوجبات عالية الدهون، ارتفاع كوليسترول الدم.