A review on Hypoglycemic, Hypolipidemic and Anti-obesity effect of *Allium sativum*

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ABSTRACT

Garlic (*Allium sativum*) is among the oldest of all cultivated plants. It has been used as a medicinal agent for thousands of years. Obesity which is a risk factor for the development of metabolic disorders, dyslipidemia, atherosclerosis and Type 2 diabetes,hypertension, hyperlipediemia, hypercholesteromia, insulin resistance and glucose tolerance, is now a day's most common problem affecting the social and economic status of the people. The present review has been broadly discussed based upon both clinical and preclinical studies by demonstrating the significant hypoglycemic, hypolipidemic and anti-obese effects of garlic when given in the form of various dosage forms (either in ethanolic extract,aqueous extract, raw garlicjuice, garlic oil, garlic homogenate or with medicine i.e. Metformin, Glibenclamide, etc). The work has been reported and tabulated the significant results along with uttering of combination study (with turmeric and propranolol) and important role of herb drug interaction.

Key Words: *Allium sativum,* hypoglycemic, hypolipidemic, anti-obese effects, herb drug interaction

INTRODUCTION

Garlic, a member of the Liliaceae family, is a common food for flavor and spice and it is one of the herbs most commonly used in modern folkloric medicine. Garlic was an important medicine to the ancient Egyptians as listed in the medical text Codex Ebers (1550 BC) especially for the working class involved in heavy labour because it was an effective remedy for many ailments such as heart problems, headache, bites, worms and tumors (Augusti, 1996). It has been used as a medicinal agent for thousands of years. It is a remarkable plant, which has multiple beneficial effects such as antimicrobial, antithrombotic, hypolipidemic, antiarthritic, hypoglycemic and antitumor activity. Additionally, garlic has known hypoglycemic properties, which have been demonstrated in alloxan induced diabetic rats and rabbits.The extract of garlic [10] and its component, S-allylcysteine sulfoxide, significantly decreased blood glucose concentration. Its activity appears to be in part due to stimulation of insulin secretion from β-cell in the pancreas (Sheela, 1995; Augusti, 1996; Jain, 1975). Garlic has been used for thousands of years for culinary, medicinal and spiritual purposes. Garlic has been grown around the world, from Mediterranean climates to Siberia. Ancient Egyptians used it as a form of currency; its medical and magical powers were described on the walls of ancient temples and on papyrus dating to 1500 BC. Garlic was used by the Greek physicians, Hippocrates and Galen, and during the middle ages by Hildegard von Bingen. In the middle ages, garlic was used to ward off the evil eye, witches and vampires; it was also used as an aphrodisiac. In China, garlic was forbidden food for Buddhist monks because of its reputation as a sexual stimulant (Kemper, 2000). In Traditional Chinese Medicine, garlic is known as da suan. It is considered a warm, bitter herb with particular effects on the Large Intestine, Spleen and Stomach meridians. It is used to lower blood pressure, to treat parasitic infections, food poisoning and tumors, and as a mild anticoagulant (Bensky, 1993).

Antidiabetic activity of *Allium sativum*:

Preclinical Study: Several studies have been reported of regular and daily treatment of juices (Demerdash, 2005), aqueous extract (Mahesar, 2010), raw homogenate (Djankpa, 2012; Padiya Raju, 2011) ethanolic extract (Iweala, 2005)and methanolic extract (Asaduzzaman, 2010) of garlic on mice, albino rabbits, fructose fed rats, boiler chicks (Homidan, 2005) and STZ induced rats which showed significant antidiabetic activity. Pre-clinical data on hypoglycemic activity of *Allium sativum* has been stated in Table No.1.

Clinical study: An open labelled prospective comparative study reported on Type 2 diabetes mellitus patients and at the end of 3 months it was observed that both metformin and garlic reduced fasting blood glucose significantly but the percentage change in fasting blood glucose was more with garlic (Chhatwal, 2012). A study was conducted to assess the effect of garlic on metabolic control and lipid profile in type 2 diabetic patients with 59 patients which suggested that garlic could be used as a supplementary drug for the treatment of patients with diabetes and preventing diabetic

complications (Mohammad, 2011). Several clinical trials in type 2 diabetic patients have been carried outwith garlic and its podsalong with single-blind placebo controlled study (Rizwan, 2011) proving a significant lowering of serum glucose. Also the combined effect of garlic and turmeric extracts have been reported which ends with the conclusion that combination of both substances gave a better result compared to their individual usages. Clinical data on hypoglycemic activity of *Allium sativum* has been stated in Table No.2.

Hypolipidemic Activity of *Allium Sativum*:

Preclinical study: Study of treatment with repeated doses of garlic juices exerted hypolipidemic effect. Raw garlic possesses a beneficial potential in reducing cholesterol and triglycerides in diabetic rats. Administration of raw garlic to fructose fed rats significantly reduced serum glucose and insulin levels. The values of total cholesterol, Triglyceride and low density lipoprotein were significantly decrease in groups received garlic extract comparing with control and hypo cholesterolimic groups with non-significant increase in high density lipoprotein (HDL) in all groups have also been reported(Hadeel, 2012). The ethanolic extracts of garlic had been proved showing anti-hypercholesterolemic effect.Ademiluyi *et al (2013)* carried out a study to investigate the ameliorative effect of dietary inclusion of garlic (*Allium sativum*) on gentamycin-induced hepatotoxicity in rats and this showed significant reduction intotal cholesterol and Triglyceride level (Adedayo, 2013). The study on hyperlipidemic guinea pig of both species of garlic (A. *sativum, A. tuberosum*) showed significant hypolipidemic activity as they reduced serum cholesterol, triglyceride, LDL (Choudhary Raghuveer, 2008). A research *was*performed a study to know the influence of garlic alcoholic extract on lipid profile upon simultaneous intake of ezetimibe which showed significant hypolipidemic activity (Maheshwari, 2011). Farnaz *et al (2011)* suggested that oral garlic supplementation may be effective in decreasing serum cholesterol levels as much as 15% to 20% (Farnaz, 2011). Pre-clinical data on Hypolipidemic Activity of *Allium Sativum*has been stated in Table No.3.

Clinical study: An open labelled prospective comparative study reported on Type 2 diabetes mellitus patients where a total of 60 patients divided into two groups of 30 each were enrolled. At the end of 3 months it was observed that garlic reduced serum cholesterol, HDL, TG and LDL significantly (Chhatwal, 2012). A study was conducted to assess the effect of garlic on metabolic control and lipid profile in type 2 diabetic patients which enrolled Fifty nine patients and newly diagnosed dyslipidemia and it was concluded by suggesting that garlic could be used as a supplementary drug for the treatment of patients with diabetes and dyslipidaemia preventing cholesterolimic complications (Mohammad, 2011). This has been also reported that administration of monascus garlic fermented extract (MGFE) leads to lowering of lipid profile in hyperlipidemic subjects (Sumioka, 2006). A clinical trial has been carried out for evaluation of hypoglycemic activity of Garlic which was conducted on newly diagnosed type 2 diabetic patients (n=20). The results showed a significant reduction in lipid metabolism and serum cholesterol, triglyceride (TG) and low-density lipoprotein (LDL) while increasing the high-density lipoprotein (HDL) fraction (Mirunalini, 2011). Evaluation of the efficacy and safety of garlic and turmeric extracts combination as anti-hypercholesterolemic agent for type-2 diabetes- dyslipidemia showed showed that combination of both substances gave a better result compared to their single / individual usages. Clinical data on Hypolipidemic Activity of Allium Sativumhas been stated in Table No.4.

Anti-Obesity Activity of *Allium Sativum*:

Pre-clinical Study: Several studies have been reported that raw garlic homogenate and regular garlic ingestion is effective in reducing body weight in rats. Administration of the ethanolic extracts of *Allium sativum* reduced body weight in albino rabbits. A research have been evaluated to investigate the ameliorative effect of dietary inclusion of garlic (*Allium sativum*) on gentamycin-induced hepatotoxicity in rats and diets containing either 2% or 4% garlic inclusion were able to ameliorate the observed weight loss (Adedayo, 2013). 2% w/w garlic powder administration reported a significant loss in body weight of boiler chicks. Pre-clinical data on Antiobesity Activity of Allium Sativumhas been stated in Table No.5.

Clinical study:A 24 week, single-blind placebo controlled study with recruitment of 210 patients showed significant decrease in body weight in each garlic treated group. Highly significant reduction in body weight was observed at higher doses of garlic and with increase in the duration of study. Several studies of garlic and metformin showed significant reduction in body weight. The study with the dose of 2.4g of garlic and turmeric extracts combination performed which showed decreasing body weight and the treatment also showed no side effect on kidney and liver

function as well as the blood composition of the subjects. Clinical data on Antiobesity Activity of *Allium Sativum* has been stated in Table No.6.

Results and Discussion: Obesity is a global health problem, resulting from an energy imbalance caused by an increased ratio of caloric intake to energy expenditure. Obesity is also known to be risk factor for the development of metabolic disorders, dyslipidemia, atherosclerosis and Type 2 diabetes, hypertension, hyperlipediemia, hypercholesteromia, insulin resistance and glucose tolerance are known as cardiac risk factors that cluster in obese individuals.

Most studies pertaining to the antidiabetic, hypolipidemic and antiobesity researches have been related to Serum glucose level, serum cholesterol, LDL, HDL and triglycerides, Body Weight, serum uric acid, Serum creatinine, AST levels, ALT levels. Findings suggested that garlic decreases Serum glucose level, serum cholesterol, LDL, HDL and triglycerides, Body Weight, serum uric acid, Serum creatinine, AST levels, ALT levels.

The present review has demonstrated significant hypoglycemic, hypolipidemic and anti-obese effects of garlic when given in the form of various dosage forms (either in ethanolic extract,aqueous extract, raw garlicjuice, garlic oil, garlic homogenate or with medicine i.e. Metformin, Glibenclamide, etc).

Garlic plays a significant role in the reduction of deaths caused by malignant diseases as per epidemiological studies. Hence, numerous investigators have examined garlic with its constituents for their antidiabetic, hypolipidemic and antiobesity actions both in vitro (laboratory animals) and various subjects (diabetic, dyslipidemic, etc).

In case of Garlic, herb drug interaction also plays an important role in treatment of various diseases. The hypoglycemic effect observed with combinations of glibenclamide and *Allium sativum* extract (ASE) was greater than either of the drug given alone. Combined treatments of glibenclamide and Allium sativum extract resulted in higher increase in body weight than alone treatments. Garlic (*Allium sativum*) changes pharmacokinetic variables of paracetamol, decreases blood concentrations of warfarin and produces hypoglycaemia when taken with chlorpropamide (Poonam, 2013; Izzo, 2001).Thus we conclude that ASE shows a synergistic effect with glibenclamide. This could be important in reducing the dose of glibenclamide to achieve an enhanced therapeutic effect with minimal side effects.

The combined therapy of garlic homogenate and propranolol was found to be most effective in reducing systolic blood pressure, cholesterol, triglycerides and glucose. These observations suggest that careful addition of garlic in moderate doses in propranolol regimen might result in beneficial effect during treatment of hypertensive animals with myocardial damage (Asdaq, 2011).

It has been review on the usages and relevance of garlic and its bioactive compounds in controlling diabetes and diabetes associated pathogenesis (Padiya, 2013).

Table.1.Hypoglycemic activity of *Allium sativum*: Pre-clinical study

Extract	Dose	Model	Group	Main outcome	Initial value	Final value
Aqueous extract	1 ml/100g BW (For 4 weeks)	Alloxan-Induced Diabetic Rats	Group 2(c) [Garlic juice]	Significantly reduced Plasma glucose level (mg/dl)	287±7.2	91±4.86
Aqueous extract	1% sol./Kg BW (30	Alloxan-Induced Diabetic	Group I: (Chow and tap water) Group II: (Alloxan	Significantly reduced Blood glucose level (mg/dl)	300.00	216.00
Aqueous extract	20 ml (44 days)	A case study in mice	Group A (20 ml garlic extract)	Significantly reduced Mean glucose level	6.5±0.44	5.3±0.15
			Group C (20 ml garlic extract)	Significantly reduced Mean glucose level	5.3±0.98	5.2±0.93
Raw garlicjuic e	250 mg/kg (8	Fructose fed diabetic rats	Group 2 (65% fructose diet) Group 3 (65% fructose and raw garlic	Significantly reduced Serum glucose level (mg/dl)	NA	NA

Table.1.Hypoglycemic activity of *Allium sativum*: Pre-clinical study continution						
Ethanolic extract	0.5 and 1.0 ml/kg BW	Albino Rabbit	Group B (0.5 ml of extract)	Significantly reduced Blood sugar level (mg/dl)	95.6±9.0	32.6±27.3
			Group C (1.0 ml of extract)	Significantly reduced Blood sugar level (mg/dl)	100±8.6	31.4±31.1
Garlic powder	2% & 6% garlic diets (4	Broiler Chicks	Group 4 (2% w/w of power)	Significantly reduced Blood glucose level(mg/dl)	135.0±2.8	54.3±2.8
			Group 5 (6% w/w of power)	Significantly reduced Blood glucose level(mg/dl)	135.0±2.8	64.9±2.8
Aqueous extract	500 mg/kg (for 7 weeks)	Streptozotocin -induced diabetic rats	Group 2 (Garlic treated group)	Significantly reduced Serum glucose levels (mg/dl)	-	57% less than initial value.

Table.2.Antidiabetic activity of *Allium sativum*: Clinical study

Dose	Model	Groups	Main outcome	Initial value	Final value
Metformin 500mg & Garlic 250 mg BD/TDS (12 weeks)	Open labeled prospective randomized comparative study (Patients of Type-2 D. M)	Group 1 Metformin	Significantly reducedFasting blood glucose (mg/dl)	162.30±16.73	140.97±10.20
		Group 2 Metformin + Garlic	Significantly reducedFasting blood glucose (mg/dl)	151.10±13.51	29.80±9.11
Garlic 500mg BD (For 12 weeks)	Patient with Type-2 Diabetes Mellitus	Group II Odorless garlic extract	Significantly reducedFasting blood glucose (mmol/l)	9.3610±0.5272	8.0416±0.3575
			2 hour postprandial (mmol/l)	15.979±3.311	14.847±2.971
Metformin 500mg BD & Garlic 300 mg TDS (24 Wks)	Single-blind and placebo control Study.	Group 1 Garlic Tab. + Metformin	Significantly reducedFasting blood glucose (mg dl^{-1})	128.3±0.311	124.8±0.330
Raw garlic cloves 3.6g orally (30 days)	Patients with Type-2 Diabetes Mellitus	Garlic treated Diabetic group	Significantly reducedFasting blood glucose (mg dl^{-1})	243.3±23.9	107.3±9.7
Garlic pods 100 mg daily	Patients with Type-2 Diabetes Mellitus	Control group and Study group	Significantly reducedSerum glucose (mg %)	168.0	132.0
Garlic tablets 300, 600, 900, 1200 & 1500 mg. (24 weeks)	Single-blind study	Group A(Garlic 300 mg)	Significantly reducedFasting blood sugar (mg/dl)	127 ± 0.334	125 ± 0.379
		Group B (Garlic 600 mg)	Fasting blood sugar	128 ± 0.311	126 ± 0.446
		Group C (Garlic 900 mg)	Fasting blood sugar	128 ± 0.263	124 ± 0.289
		Group D (Garlic 1200 mg)	Fasting blood sugar	128 ± 0.315	123 ± 0.263
		Group E (Garlic 1500 mg)	Fasting blood sugar	129 ± 0.223	123 ± 0.225
1.2, 1.6 & 2.4 g garlic + curcuma capsule daily (12 weeks)	Double blind randomized study on type-2 diabetes-dyslipidemia patients	Group A (1.2 g garlic + curcuma cap. daily)	Significantly reducedFasting blood sugar	177.6±52.1	146.6±52.7
			2 hour postprendial	235.8±87.9	212.1±78.9
		Group B (1.6 g garlic + curcuma cap. daily)	Fasting blood sugar	177.2±45.0	157.1±34.4
			2 hour postprendial	249.4±65.5	249.4±69.3
		Group C (2.4 g garlic + curcuma cap. daily)	Fasting blood sugar	175.1±51.0	139.4±57.9
			2 hour postprendial	266.3±60.1	205.9±39.3

Table.3.Hypolipidemic activity of *Allium sativum*: Pre-clinical study

Extract	Dose	Model	Group	Main outcome	Initial value	Final value
Aqueous extract	1.0 ml/100g BW (4 weeks)	Alloxan-Induced diabetic rats	Group 2(c) Garlic juice	Significantly reduced LDH (mg/dl)	1474±54	1305±43
Ethanolic extract	300 mg/kg BW (4 weeks)	Cholesterol–enriched high fat diet	Garlic + Hyper-cholesterolemic group	Significantly reduced Total triglyceride (mg/dl)	81.5±3	42.0±1
				Total cholesterol (mg/dl)	132.7±2.0	90.5±2.4
				HDL (mg/dl)	45.4±2.5	50.4±3.1
				LDL (mg/dl)	71.2±4.4	20.4±1
Ethanolic extract	0.5 and 1.0 ml/kg BW (3 weeks)	Albino Rabbit	Group B (0.5 ml of extract)	Significantly reduced Total serum cholesterol level (mg/dl)	150±4.8	135±13.5
			Group C (1.0 ml of extract)	Total serum cholesterol level (mg/dl)	145±1.9	115±19.2
Aqueous extract	500 mg/kg (for 7 days)	Streptozotocin-induced diabetic rats	Group 2 (Garlic treated group)	Significantly reduced Serum cholesterol (mg/dl)Triglycerides levels (mg/dl)	NA	NA
Garlic	100mg/kg (27 days)	Gentamycin-induced hepatotoxicity and oxidative stress in rats	Groups 3 [Garlic 2%+ Gentamycin]	Significantly reduced Total cholesterol (mg/dl)	56.0 ± 1.4	41.8 ± 6.2
				Triglyceride (mg/dl)	54.0 ±2.7	46.7 ± 4.9
			Groups 4 [Garlic 4%+ Gentamycin]	Total cholesterol (mg/dl)	56.0 ± 1.4	45.1 ± 3.6
				Triglyceride (mg/dl)	54.0 ± 2.7	50.0 ± 1.7
Garlic	4 gm/kg BW (4 weeks)	Cholesterol fed guinea pig	**Group II** (4 gm/kg Garlic)	Significantly reduced Serum cholesterol	94.49±8.71	60.17±14.31
				Serum triglyceride	91.84±5.86	65.61±11.36
				HDL	11.43±0.98	12.22±1.40
				LDL	64.70±7.70	34.82±13.09
				VLDL	18.37±1.17	13.13±2.30
Alcoholic extract	10 mg/kg	Swiss Albino Rats	Group VII Garlic extract	Serum triglyceride (mg/dl)	27.1±0.43	26.8±0.5
				LDL Level (mg/dl)	34.9±2.15	29.7±1.34
				HDL Level (mg/dl)	17.12±1.73	19.67±1.22
Raw garlicjuice	250 mg/kg (8 weeks)	Fructose fed rats	Group 3 (Fructose + Garlic homogenate)	Significantly reduced Serum triglyceride	NA	NA
				Serum uric acid	NA	NA
Garlic	0.5% Cholesterol (CH) 3 & 10 mg garlic(G)	Cholesterol fed Rats	Group B CHO+ 3 mg G)	Significantly reduced Serum cholesterol level	-	198.91±12.54
			Group C (CHO+10 mg G)	Serum cholesterol levl (mg/dl)	-	175.43±28.36
Ethanolic extract	0.1, 0.25 & 0.5 g/kg BW (For 14 days)	Streptozotocin-induced diabetic rats	Group 6-8 (Garlic ethanolic extract)	Significantly reduced Serum TG (mg/dl)	NA	20.578
				total cholesterol (mg/dl)	NA	11.677

Table.4.Hypolipidemic Activity of *Allium sativum*: Clinical Study

Dose	Model	Group	Main outcome	Initial value	Final value
Metformin (500mg) Garlic (250 mg)	Type-2 D.M. (Open labeled prospective randomized Comparative study)	Group 2 Metformin 500 mg BD/TDS + Garlic 250 mg BD after meals	Significantly reduced Total cholesterol level (mg/dl)	254.07 ±16.03	238.50±19.49
			Serum TG Level (mg/dl)	82.60 ± 6.44	170.47 ± 7.17
			Serum HDL (mg/dl)	48.50 ± 8.96	48.97 ± 9.14
			Serum LDL levels (mg/dl)	187.33 ±36.46	178.77 ± 34.39
Garlic 500mg BD (For 12wks)	Patient with Type-2 Diabetes Mellitus	GroupII Odorless Garlic extract Soft Gel	Significantly reduced Total cholesterol (mmol/l)	6.741±0.219	5.999±0.168
			Triglycerides level (mmol/l)	5.999±0.168	2.842±5.770
			HDL (mmol/l)	0.769±6.792	0.806±5.515
			LDL (mmol/l)	4.661±0.230	3.900±0.179
			VLDL (mmol/l)	1.309±3.042	1.292±2.607
Garlic extract 900 mg/day (For 2wks)	Hyperlididemic Subjects	No group (11Men and 4 women recruited	Significantly reduced Serum TG level(mg/dL)	191±52	142±55
			LDH level (mg/dL)	180±34	178±29
Raw garlic cloves 3.6g (30 days)	Patients with Type-2 Diabetes Mellitus		Significantly reduced Serum cholesterol	208.3 ± 28.00	173.4 ± 8.9
			Triglycerides (mg/dL)	167.5 ± 27.80	153.6 ± 15.00
			HDL (mg/dL)	53.00 ± 8.00	60.00 ± 9.00
			LDL (mg/dL)	118.00 ±23.30	93.40 ± 18.3
1.2, 1.6 & 2.4 g garlic + curcuma capsule daily	Double blind randomized study on type-2 diabetes-dyslipidemia patients	Group A (1.2 g garlic + curcuma cap. daily)	Total cholesterol level (mg/dL)	248.0±24.7	244.4±31.7
			Triglycerides level (mg/dL)	293.0±82.1	240.7±70.7
			HDL (mg/dL)	40.4±7.1	49.6±11.4
			LDL (mg/dL)	169.2±11.5	164.3±30.2
		Group B (1.6 g garlic + curcuma cap. daily)	Total cholesterol level (mg/dL)	246.1±31.0	229.6±25.9
			Triglycerides level (mg/dL)	235.5±26.2	263.0±127.3
			HDL (mg/dL)	42.8±4.7	44.6±4.9
			LDL (mg/dL)	184.5±19.5	169.5±16.0
		Group C (2.4 g garlic + curcuma cap. daily)	Total cholesterol level (mg/dL)	234.1±35.0	236.7±33.2
			Triglycerides level (mg/dL)	237.3±32.3	164.0±30.5
			HDL (mg/dL)	42.5±4.8	48.7±4.8
			LDL (mg/dL)	180.7±41.0	164.7±46.5

Table.5.Anti-obesity activity of *Allium sativum*: Pre-clinical study

Extract	Dose	Model	Group	Main outcome	Initial value	Final value
Raw garlicjuice	250 mg/kg (8 weeks)	Fructose fed rats	Group 3 (65% fructose and raw garlic homogenate)	Significantly reduced Body weight (gram)	65.78±24.65	35.66±24.79
Aqueous garlic extract	20 ml (44 days)	A case study in mice	Group A (20 ml garlic extract)	Significantly reduced Body weight (gram)	38.7±2.89	20.7 ± 1.15
			Group C (20 ml garlic extract)	Significantly increased Body weight (gram)	21.3 ± 1.15	22.0 ± 0.00
Ethanolic extract	0.25&0.5 g/kg (21 days)	Albino Rabbits	Group B (0.5 ml of garlic extract)	Significantly reduced Body weight (gram)	893.33±8.33	890±8.60
			Group C (1.0 ml of garlic extract)	Significantly reduced Body weight (gram)	865.70±16.03	760±38.50
Garlic	100 mg/kg (4 weeks daily)	Alloxan-induced diabetic albino rats	Group 2: Garlic-treated control.	Significantly reduced Body weight (gram)	221±21.3	217.8±10.9
			Group 4: Garlic-treated diabetic group.	Significantly reduced Body weight (gram)	221±21.3	209.2±12
Garlic powder	2% & 6% garlic diets (4 weeks)	Broiler Chicks	Groups 4 (2% w/w of power)	Significantly reduced Body weight (gram)	903±14	894±14.7
			Group 5 (6% w/w of power)	Significantly reduced Body weight (gram)	903±14	812±14.2
Garlic	100mg/kg (27 days)	Gentamycin-induced hepatotoxicity and oxidative stress in rats	Groups 3 [Garlic 2%+ Gentamycin]	Significantly reduced Body weight (gram)	117.0±72.9	112.4±68.9
			Groups 4 [Garlic 4%+ Gentamycin]	Significantly reduced Body weight (gram)	171.4±73.4	168.5±73.1

Table.6.Anti-obesity activity of *Allium sativum*: Clinical study

Dose	Model	Groups	Main outcome	Initial value	Final value
Metformin 500mg Garlic 250 mg (12 weeks)	Open labeled prospective randomized comparative study (Patients ofType-2	Group I Metformin	Significantly reduced BMI (kg/m^2)	27.23±2.77	26.66 ± 2.69
		Group II Metformin + Garlic	Significantly reduced BMI	26.72 ± 1.74	26.37 ± 1.70
Garlic tab. 300, 600, 900, 1200 & 1500mg. Metformin tab. 500 mg	Single-blind placebo Controlled study with type 2 diabetes mellitus patients.	Garlic treated Group	Significantly reduced Body weight (Kg)	69.1 ± 7.58	68.2 ±10.45
		Metformin treated group	Significantly reduced Body weight (Kg)	69.1 ± 7.58	65.4 ±9.80
Metformin 500mg BD & Garlic 300 mg TDS (24 Wks)	Single-blind and placebo control Study.	Group 1 Garlic Tab. + Metformin	Significantly reduced Body weight (Kg)	69.1 ± 7.58	68.2 ±10.45
1.2, 1.6 & 2.4 g garlic + curcuma capsule daily	Double blind randomized study on type-2 diabetes-dyslipidemia patients	Group A (1.2 g garlic + curcuma cap. daily)	Significantly reduced BMI (kg/m^2)	25.53±3.26	24.86±3.21
		Group B (1.6 g garlic + curcuma cap. daily)	Significantly reduced BMI (kg/m^2)	27.50±4.83	26.77±4.52
		Group C (2.4 g garlic + curcuma cap. daily)	Significantly reduced BMI (kg/m^2)	29.17±3.46	27.93±3.56

CONCLUSION

This is a natural medicinal plant use for disease prevention and it cures internally, it's used against infection of all kinds. Externally it's used for nose eye ear and throat infections because of the thiamin content in it. Garlic has a measurable amount of germanium (a mineral that strengthens the immune system) and is excellent in healing of wounds.

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