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Review Article

Exploring the Role of Garlic (*Allium sativum*) in the Management of Diabetes Mellitus: An Overview

Kuber[1], Gitesh Sahu[1], Gitesh Sinha[1], Ujjawal Jaiswal[1], Raushani Kumari[2] and Gyanesh Kumar Sahu[2]*

[1]*Rungta Institute of Pharmaceutical Sciences Kohka, Bhilai, India*

[2]*Rungta Institute of Pharmaceutical Sciences and Research Kohka, Bhilai, India*

***Corresponding Author:** Gyanesh Kumar Sahu, Professor and Dean, Rungta Institute of Pharmaceutical Sciences and Research, Kohka, Kurud, Bhilai, India.

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Abstract

Garlic, or *Allium sativum*, is a known herb with several health benefits, including possible anti-diabetic effects. The purpose of this review was to explore the anti-diabetic properties of garlic, with a focus on the active ingredients, including allicin, and how they function to control blood sugar levels. Long term hyperglycemia is a main root cause of diabetes mellitus, which is associated to insulin resistance, poor glucose metabolism, and elevated oxidative stress. Garlic has showed potential in regulating these changes because of its bioactive components.

When garlic extract was assisted to diabetic animal models in animal trials, the blood glucose levels of the treated group were much lower than those of the untreated control group. The effects of the extract were attributed to its ability to improve insulin secretion, improve insulin sensitivity, and promote glucose uptake by peripheral tissues. Additionally, garlic also exhibit an inhibitory effect on essential enzyme consider for the carbohydrate digestion, such as α-amylase and α-glucosidase, which helps regulate postprandial blood glucose spikes.

Garlic also possesses potent antioxidant properties, which play a important role in reducing oxidative stress and protecting the damage of pancreatic beta cell. By neutralizing free radicals, garlic helps prevent complications associated with diabetes, such as neuropathy and nephropathy. Additionally, garlic's anti-inflammatory effects contribute to the overall improvement in metabolic health.

This review emphasizes the potential of *Allium sativum* as an alternative treatment for managing diabetes.

Keywords: Introduction; Diabetes mellitus; *Allium sativum*; Mechanism of Diabetes; Antidiabetic Property

Introduction

The World Health Organization summarise a new definition of health in 1948, stating that it not only defined the absence of illness and disability but also the presence of mental, social, and physical well-being [1]. People all across the world are aware that diabetes is an emerging epidemic that affects practically every country, age group, and economy worldwide [2].

On World Health Day, April 7, 2016, which was dedicated to diabetes, the 1st WHO Global Report on Diabetes was launched. Although diabetes is recognized as a serious illness and has been mentioned in ancient texts, medical practitioners and healers do not seem to have encountered it often. The increasing number of patients with this illness has had an increasing impact on human development and health in the last few decades [3]. The International Diabetes Federation estimates that approximately 415 million people worldwide had diabetes in 2015, and by 2040, this number is estimated to cross over 640 million [2]. According to current reports, 425 million patients are recognized with diabetes in 2017, and by 2045, that figure is predicted to cross to 629 million [4].

This is brought on by the global increase in the widespread presence of obesity and unhealthy habits like poorly eating and lacking the physical exercise, which are further promoted by broader societal factors like global dietary shifts (also known as the "nutritional shift or transformation") [4].

Diabetes and the day-to-day responsibilities of managing the condition can be difficult for many people with the illness. And the demands are high. In an oftenpointless attempt to simulate the physiological conditions of those without diabetes, patients must manage their diabetes all day, every day, and make multitudinous decisions [1].

Diabetes mellitus

Diabetes mellitus (DM) is a life time metabolic disease that is rapidly elevating around the world and has significant impact on social, health, and financial reverberation. According to roughly calculated report 285 million persons throughout the globe or roughly 6.4% of the adult population were cause suffering with this illness in 2010 [5].

Over 100 million of people around the worldwide or 6% of total population of the world are mostly affected by Diabetes, the most commonly disease [6].

This metabolic illness known as metabolic disease characterized by the tenacious hyperglycemia, which is abide by a greater or lesser disfigurement in the metabolism of carbohydrates, lipids and protein throughout the course of disease [7].

Insulin resistance, insufficient insulin production, or excessive glucagon secretion are the main reason that generates hyperglycemia due to a set of physiological dysfunctions [8].

An inadequate or insufficient production of insulin by the pancreas a condition known as metabolic disorder is caused. This may lead to either a rise or a decrease in the blood glucose concentrations in the body [6].

Malady may be a long-term condition that develops when the exocrine gland is no longer able to create endocrine or when the body is unable to use the endocrine it produces. An endocrine hormone may be a type of endocrine that is produced by the exocrine gland. It functions as a sort of key to allow aldohexose, which is derived from the food that we consume, to travel from the bloodstream into the cells of the body in order to give them with energy. All macromolecule meals are reverse into aldohexose in the circulation. The transport of aldohexose to cells is facilated by endocrine system. It also transports sugar from the bloodstream into your cells to be stored or used for energy is maintained [9].

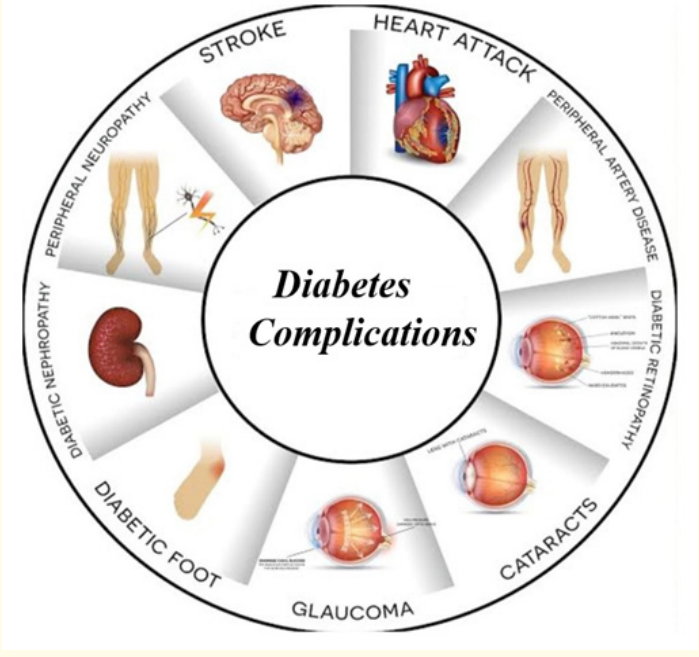

Figure 1: Complications.

It is established that many of the bodie's organization particularly blood vessels, eyes, kidney, heart and nerves are damaged [6]. There may be a subsequent vary in origin and etiology of DM but all the times or every time it includes inadequacy either in insulin secretion or retaliation or in both at some point in the duration of disease [7].

Along with hyper glycemia, it causes hyperlipidemia, oxidative stress, excessive urination (polyuria), Polydipsia, an increase in ketone bodies (ketosis), nerve dysfunction (neuropathy), kidney damage (nephropathy), retinopathy and a variety of heart disorders [10-12,18].

Diabetes related to long term hyper glycemia may be further contributed by stress. It has been known that metabolic functions are significantly altered by stress. Blood sugar level is raised that may be caused by number of hormones released during the stress [21].

Types of diabetes mellitus

Diabetes mellitus is a long-term condition that impairs the body's potentiality to manage blood glucose levels. Based on its fundamental causes and the way it interferes with normal glucose metabolism; it is designate into a few types. The commonly forms are Type 1 diabetes, Type 2 diabetes, gestational diabetes, and various other forms are the main types of the disease.

Type 1 diabetes mellitus

The autoimmune-mediated destruction of pancreatic beta cells, which culminates in complete insulin deficiency, is the basic characterization of type 1 diabetes mellitus (T1D), also referred to as a heterogeneous and auto-immune disorder [11-13]. It is most commonly referred to as ketosisprone polygenic disease or juvenile onset diabetes [9]. Individuals with Type 1 diabetes either produce very little or no insulin, because of this, a hormone that is essential for facilitating the uptake of glucose by cells for energy. Hyperglycemia and ketosis are results hence insulin replacement is essential for managements [12,13]. This kind of diabetes usually manifests in childhood or adolescent but may also occurs at any age [9,11-13]. The symptoms include Polyurea, Polydipsia, and weight loss. One of the acute consequences that need to be treated right away is Diabetic ketoacidosis. Both macrovascular and microvascular diseases are chronic consequences [12]. People with Type 1 diabetes require lifelong insulin therapy, to control their blood glucose level, which can be administered via injections or an insulin pump. It is common in patients with type 1 diabetes to have a psychological problems and other autoimmune disorder [13].

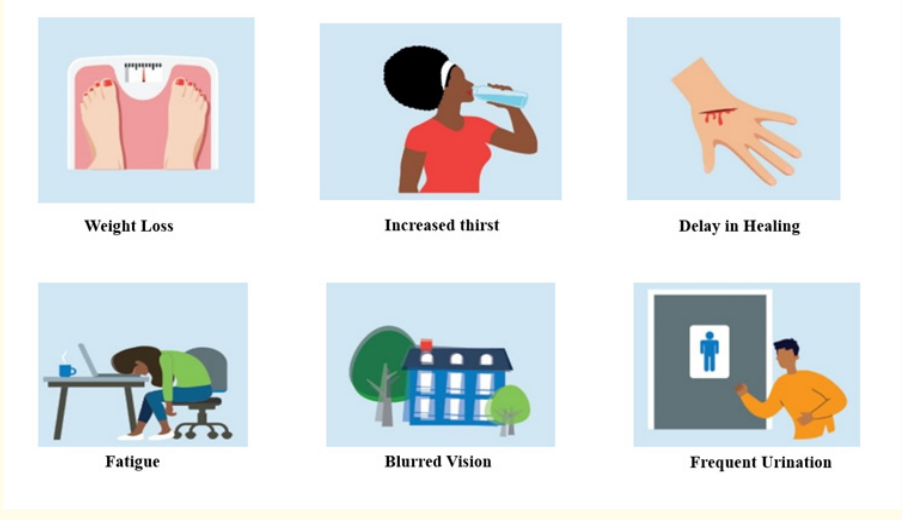

Figure 2: Symptoms.

Type 2 diabetes mellitus

Type 2 diabetes mellitus (T2DM) a growing global health concern is closely associated with obesity [14]. This chronic metabolic disorder prevalence has been steadily rising worldwide [15]. People with type 2 diabetes are at a augmentin risk for microvascular consequences, such as retinopathy, nephropathy, and neuropathy, as well as macrovascular complications, such as cardiovascular co occuring conditions, due to hyper glycemia and certain elements of the insulin resistance (metabolic) syndrome [14,16,18]. The main authentication of type 2 diabetes, the most prevalent kind of the disease, is Insulin resistance or the poor ability of body cells to insulin response [14-16]. In 1988, type 2 diabetes was initially identified as a part of the metabolic syndrome [15]. The pancreas initially generates additional insulin to compensate, but it eventually fails to keep up, resulting in increased blood sugar levels. Lifestyle factors such as obesity, physical inactivity, and a poor diet are frequently associated with Type - 2 diabetes, but genetics also play a role [9,18]. It is becoming more common in younger groups as obesity rates rise but primarily diagnosed in adults. Lifestyle modifications, oral medicines, and, in rare cases, insulin therapy are used to manage the condition.

Gestational diabetes

Gestational diabetes mellitus (GDM) is defined as glucose intolerance of varying degrees that first appears during pregnancy [17]. Gestational diabetes develops when the body demands is increased during pregnancy and is unable to produce enough insulin to satisfy it [19]. It commonly onset at the 24th week of pregnancy and resolves after deliveries [20]. However, women are more likely to be affected by Type 2 diabetes later on life, who have experienced gestational diabetes. GDM is identified by screening pregnant women for clinical risk markers and testing at-risk women for impaired glucose tolerance, which is typically mild and asymptomatic but not always [17]. While gestational diabetes might raise the risk of delivery problems, such as huge birthweight and preterm delivery but not often cause permaanent harm to the baby [9].

Other specific types

There are various unusual types of diabetes caused by certain genetic mutations, medical conditions, or drugs. Maturity-Onset Diabetes of the Young (MODY) is a hereditary type of diabetes that usually occurs in adolescence or early adulthood [9]. Another example is neonatal diabetes, which develops in neonates due to a genetic abnormality. Furthermore, cystic fibrosis and hormonal abnormalities such as polycystic ovarian syndrome (PCOS) can raise the chance of getting diabetes [9].

Pathophysiology

Diabetes mellitus is a set of metabolic disorders characterized by increased blood glucose levels (hyperglycemia), abnormal insulin secretion, insulin action, or both are the causes. Diabetes pathophysiology is defined in following ways.

Type 1 diabetes mellitus (T1DM)

- **Beta cell autoimmune destruction:** This result in complete lack of insulin. The autoimmune destruction of the pancreatic beta cells that produce insulin is a authenticate of type 1 diabetes [22].
- **Reduction in insulin secretion:** Hyperglycemia occurs when there is inadequate insulin to allow glucose to enter cells.
- **Ketosis:** The breakdown of fatty acids and the generation of ketones stops glucose from being used as an energy source, which result from the absence of insulin. That can develop to ketoacidosis, it left untreated.

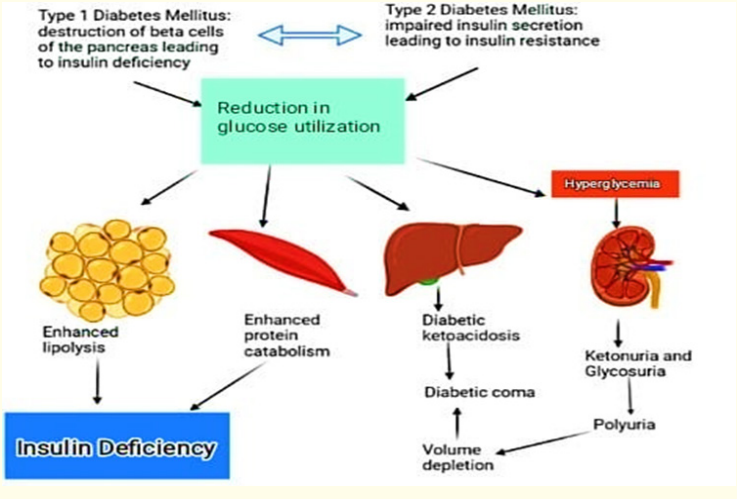

Figure 3: Pathophysiology of Diabetes Mellitus.

Type 2 diabetes mellitus (T2DM)

- **Insulin resistance:** Insulin ability to assist glucose uptake into cells, particularly in muscle, liver, and adipose tissue, is reduced in type 2 diabetes because the body's cells develop resistant to it [23].
- **Dys functioning of beta cell:** Insulin secretion becomes compromised over time in order to adjust insulin resistance as a result of pancreatic beta cells inability to increase insulin production [24].
- **Elevated hepatic glucose production:** Gluconeogenesis is a glucose metabolism cycle which is continuously ongoing in liver leads to production of glucose, contributes to high blood glucose levels [25].
- **Hyperglycemia:** Elevated blood glucose level due to the effect of both insulin resistance and inadequate insulin secretion [26].

Management

From the past 90 years the treatment of type 1 and type 2 diabetes has advanced significantly. In 1922 insulin was discovered which enables a long-term glycemic management ushered in a new era, thus decreasing the morbidity and death rate. Due to advancements in insulin formulations over the years, increased the flexibility and effectiveness of managing type 1 diabetes including long-acting and rapid-acting insulin analogues that more closely resemble physiological insulin production [27].

Healthy diet, physical activity, blood sugar monitoring, medication compliance, effective problem-solving techniques, healthy coping mechanisms, and risk-reduction measures are the seven key self-care behaviors that are predictive of positive outcomes for individuals with diabetes. There is a positive correlation between all seven of these habits and improved quality of life, decreased complications, and effective glucose control [28].

Type 2 diabetics were no longer required to inject insulin after being diagnosed due to the development of 1st oral medications for diabetes i.e, biguanides and sulfonylureas [27]. Biguanides, sulfonylureas, meglitinide, thiazolidinedione (TZD), dipeptidyl peptidase 4 (DPP-4) inhibitors, sodium-glucose cotransporter (SGLT2) inhibitors, and α-glucosidase inhibitors are the main groups of oral antidiabetic drugs [29].

There are many herbal plants that may help the patient to cope up frequently and ease patient compliance. These herbs are eco-friendly, safe, cheap, less side effects and may use permanently to deal with their illness. Few of them are Garlic, Aloe-vera, Rai, Jamun, Papaya, Coriander, Catharanthus Roseus, Neem, Bael, Onion [30].

Role of garlic in managing diabetes mellitus

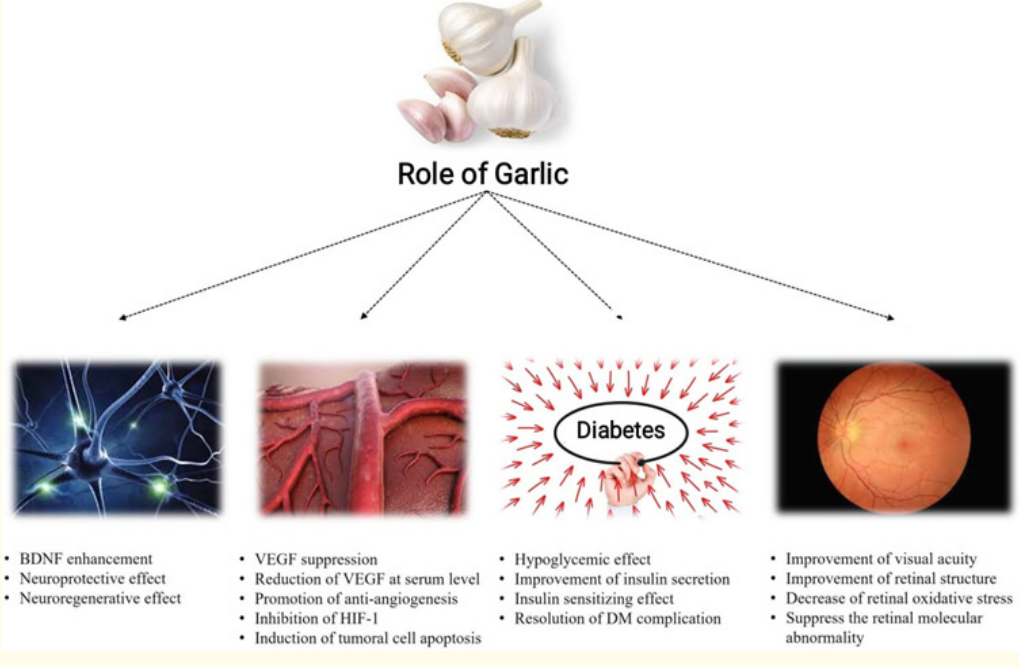

Figure 4: Effect of Garlic.

It is most popular herb used in every house's and scientifically known as *allium sativum* and belongs to family liliaceae [30]. Every part in the world it is consumed either in food, drink or chewed directly. The wide range of chemical constituent found in garlic were allicin, allin, Ajoen, Diallyl sulfide, Diallyl disulfide, Quercetin, kaempferol, vitamin C, B6 and minerals like calcium, iron, manganese. It has showed that it has a many potential health benefits such antimicrobial, anti-inflammatory and cardiovascular effects.

Research indicates that garlic's have anti-inflammatory and antiglycative due to that its ability to slow the advancement of diabetes and the emergence of problems linked to the disease [31]. Compared to glibenclamide, a precursor of several allyl sulfide components of garlic oil, S-allyl-cysteine sulfoxide, was demonstrated to have a hypoglycemic impact. In diabetic rats and mice which has been induced by STZ and alloxan, garlic has been found effectively to lower serum glucose level. According to the majority of research blood glucose levels in diabetic mice, rats and rabbits is due to the help of garlic. Garlic may have a hypoglycemic effect by releasing bound insulin, improving insulin sensitivity or increasing the amount of insulin secreted by β-cells in the pancreas but the precise mechanism via which garlic show hypoglycemic effect is unknown [32].

One studied also showed that there is significant decrease in fasting blood glucose and improvement in serum HBA1C. It was found that, the patient received high dose of garlic such as 300 to 600 mg has significant impact in reduction than the metformin which has been given at 900, 1200 and 1500. There is more improvement in glucose control level when this were collated with placebo and Antidiabetic agent metformin [33].

Garlic can alter blood glucose levels, but not in diabetic patients is demonstrated in majority of clinical studies. Thus, indicating to favour more research is necessary to proof garlic potential effect in managing of diabetes mellitus [34].

Conclusion

In conclusion, diabetes mellitus is a complex and chronic condition that requires comprehensive management to prevent complications. Garlic, with its bioactive compounds such as allicin, has demonstrated potential benefits in managing diabetes by improving insulin sensitivity, lowering blood glucose levels, and reducing oxidative stress. While the evidence from clinical studies supports garlic's role as a supplementary therapeutic agent, it should not be considered a replacement for conventional diabetes treatments. Future research is needed to fully understand the mechanisms through which garlic may aid in diabetes management and to determine optimal dosages for clinical use. Therefore, garlic can be considered as part of a holistic approach to diabetes care, alongside lifestyle changes and pharmacological interventions.

Bibliography

1. Rubin RR and Peyrot M. "Quality of life and diabetes". *Diabetes/Metabolism Research and Reviews* 15.3 (1999): 205-218.

2. Papatheodorou K., *et al*. "Complications of diabetes 2017". *Journal of Diabetes Research* (2018).

3. Roglic G. "WHO Global report on diabetes: A summary". *International Journal of Noncommunicable Diseases* 1.1 (2016): 3-8.

4. Forouhi NG and Wareham N J. "Epidemiology of diabetes". *Medicine* 47.1 (2019): 22-27.

5. Kaul K., *et al*. "Introduction to diabetes mellitus". *Diabetes: An Old Disease, A New Insight* (2013): 1-11.

6. Deshmukh CD., *et al*. "Diabetes mellitus: a review". *International Journal of Pure and Applied Bioscience* 3.3 (2015): 224-230.

7. Conget I. "Diagnóstico, clasificación y patogenia de la diabetes mellitus". *Revista española de Cardiología* 55.5 (2002): 528-535.

8. Blair M. "Diabetes mellitus review". *Urologic Nursing* 36.1 (2016).

9. Kumar R., *et al*. "A review on diabetes mellitus: type 1 & Type 2". *World Journal of Pharmacy and Pharmaceutical Sciences* 9.10 (2020): 838-850.

10. Hajam YA., *et al*. "Diabetes Mellitus: Signs and Symptoms, Epidemiology, Current Prevention, Management Therapies, and Treatments". In Antidiabetic Potential of Plants in the Era of Omics (2022): 31-77.

11. Katsarou A., *et al*. "Type 1 diabetes mellitus". *Nature Reviews Disease Primers* 3.1 (2017): 1-17.

12. Syed F Z. "Type 1 diabetes mellitus". *Annals of Internal Medicine* 175.3 (2022): ITC33-ITC48.

13. Haller M J., *et al*. "Type 1 diabetes mellitus: etiology, presentation, and management". *Pediatric Clinics* 52.6 (2005): 1553-1578.

14. DeFronzo R A., *et al*. "Type 2 diabetes mellitus". *Nature Reviews Disease Primers* 1.1 (2015): 1-22.

15. Olokoba A B., *et al*. "Type 2 diabetes mellitus: a review of current trends". *Oman Medical Journal* 27.4 (2012): 269.

16. Galicia-Garcia U., *et al*. "Pathophysiology of type 2 diabetes mellitus". *International Journal of Molecular Sciences* 21.17 (2020): 6275.

17. Buchanan TA and Xiang AH. "Gestational diabetes mellitus". *The Journal of Clinical Investigation* 115.3 (2005): 485-491.

18. Choudhury AA and Rajeswari VD. "Gestational diabetes mellitus-A metabolic and reproductive disorder". *Biomedicine and Pharmacotherapy* 143 (2021): 112183.

19. Catalano PM. "Trying to understand gestational diabetes". *Diabetic Medicine* 31.3 (2014): 273-281.

20. Sweeting A., *et al*. "A clinical update on gestational diabetes mellitus". *Endocrine Reviews* 43.5 (2022): 763-793.

21. Surwit R S., *et al*. "Stress and diabetes mellitus". *Diabetes care,* 15.10 (1992): 1413-1422.

22. Yoon JW and Jun H S. "Autoimmune destruction of pancreatic β cells". *American Journal of Therapeutics* 12.6 (2005): 580-591.

23. Jellinger PS. "Metabolic consequences of hyperglycemia and insulin resistance". *Clinical Cornerstone* 8 (2007): S30-S42.

24. Cerf ME. "Beta cell dysfunction and insulin resistance". *Frontiers in Endocrinology* 4 (2013): 37.

25. Consoli A., *et al*. "Predominant role of gluconeogenesis in increased hepatic glucose production in NIDDM". *Diabetes* 38.5 (1989): 550-557.

26. Mouri M and Badireddy M. "Hyperglycemia". In StatPearls. StatPearls Publishing (2023).

27. Chatterjee S and Davies M J. "Current management of diabetes mellitus and future directions in care". *Postgraduate Medical Journal* 91.1081 (2023): 612-621.

28. Chaudhury A., *et al*. "Clinical review of antidiabetic drugs: implications for type 2 diabetes mellitus management". *Frontiers in Endocrinology* 8 (2017): 6.

29. Shrivastava SR., *et al*. "Role of self-care in management of diabetes mellitus". *Journal of Diabetes and Metabolic Disorders* 12.1 (2013): 1-5.

30. Verma S., *et al*. "Diabetes mellitus treatment using herbal drugs". *International Journal of Phytomedicine* 10.1 (2018): 1-10.

31. Liu CT., *et al*. "Does garlic have a role as an antidiabetic agent?". *Molecular Nutrition and Food Research* 51.11 (2007): 1353-1364.

32. Londhe VP., *et al*. "Role of garlic (Allium sativum) in various diseases: An overview". *Angiogenesis* 12.13 (2011): 129-134.

33. Phil RA., *et al*. "Effects of garlic on blood glucose levels and HbA1c in patients with type 2 diabetes mellitus". *Journal of Medicinal Plants Research* 5.13 (2011): 2922-2928.

34. Foroozand R., *et al*. "Clinical Trials on Role of Garlic (Allium sativum) in Managing Diabetes: Systematic Review". *Systematic Reviews in Pharmacy* 14.2 (2023).