

***In Vivo* Evaluation of the Antihyperglycemic Activity of Polyherbal Unani
Formulation (Tablet Dolabi) Using an Oral Glucose Tolerance Test in Swiss Albino
Mice**

Abstract:

Diabetes mellitus remains a formidable global health challenge characterized by chronic hyperglycemia, impaired insulin dynamics, and progressive pancreatic β -cell dysfunction. Although conventional synthetic drugs are widely utilized, their associated limitations, including adverse side effects, high costs, and diminishing efficacy over time, drive the continuous search for safer, multi-targeted natural therapeutics. The Unani system of medicine relies heavily on polyherbal formulations to manage metabolic conditions through synergistic phytotherapeutic mechanisms. This experimental study evaluated the acute antihyperglycemic activity of Tablet Dolabi, a polyherbal Unani formulation comprising *Gymnema sylvestre*, *Bambusa bambos*, *Rumex vesicarius*, *Asphaltum* (Shilajit), and *Acacia arabica*.

Using an oral glucose tolerance test (OGTT) model, healthy adult Swiss albino mice were randomly divided into five groups (n=5): a normal control group, a glucose control group (4 g/kg body weight), a standard drug group (glibenclamide at 10 mg/kg), and two treatment groups administered Tablet Dolabi suspension at low (200 mg/kg) and high (400 mg/kg) doses. Blood glucose levels were monitored at 0, 30, 60, 90, and 120 minutes following oral glucose loading.

The glucose control group exhibited a marked postprandial glycemic surge, peaking at 190 ± 12 mg/dL at 60 minutes. Administration of Tablet Dolabi significantly mitigated this elevation in a dose-dependent manner. The low-dose formulation (200 mg/kg) achieved a 23% reduction in blood glucose elevation, whereas the high-dose formulation (400 mg/kg) demonstrated a robust 30% reduction, comparing favorably to the standard reference drug glibenclamide, which yielded a 32% reduction.

The observed antihyperglycemic properties are primarily attributed to the synergistic actions of the formulation's bioactive constituents. Gymnemic acids from *Gymnema sylvestre* inhibit intestinal glucose absorption and enhance insulin secretion, while polyphenols and flavonoids

from *Acacia arabica* and *Rumex vesicarius* contribute carbohydrate-digesting enzyme inhibition and potent antioxidant defense. Furthermore, the inclusion of *Bambusa bambos* and mineral-rich *Asphaltum* provides complementary metabolic and cellular protection against oxidative stress.

These findings provide strong preliminary scientific validation for the traditional use of Tablet Dolabi in managing impaired glucose regulation. Future investigations utilizing diabetic animal models, long-term metabolic assessments, and clinical trials are warranted to fully establish its therapeutic utility and safety profile for metabolic disorders.

Keywords: Diabetes Mellitus; Polyherbal Formulation; Tablet Dolabi; Oral Glucose Tolerance Test; Unani Medicine; Antihyperglycemic Activity;

1.0. Introduction:

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistently elevated blood glucose levels resulting from impaired insulin secretion, reduced insulin action, or a combination of both. It is one of the most significant global health challenges of the twenty-first century because of its increasing prevalence, associated morbidity, and economic burden. According to the International Diabetes Federation (IDF), diabetes affects hundreds of millions of individuals worldwide, and its prevalence continues to rise due to population growth, aging, sedentary lifestyles, and increasing rates of obesity (International Diabetes Federation [IDF], 2021). Diabetes mellitus is broadly classified into type 1 diabetes mellitus (T1DM), type 2 diabetes mellitus (T2DM), gestational diabetes mellitus, and other specific forms caused by genetic or secondary factors. Among these, T2DM accounts for the majority of diabetes cases and is mainly associated with insulin resistance, progressive pancreatic β -cell dysfunction, and impaired glucose homeostasis (American Diabetes Association [ADA], 2022). The maintenance of normal blood glucose levels depends on a complex interaction between insulin secretion from pancreatic β -cells, glucose uptake by peripheral tissues, hepatic glucose production, and hormonal regulation. In T2DM, insulin resistance reduces glucose utilization in skeletal muscle and adipose tissues, while increased hepatic gluconeogenesis contributes to fasting hyperglycemia. Continuous exposure to elevated glucose concentrations causes oxidative stress, inflammation, endothelial dysfunction, and progressive damage to multiple organs (DeFronzo et al., 2015). Long-term uncontrolled diabetes may result in microvascular complications, including diabetic nephropathy,

retinopathy, and neuropathy, as well as macrovascular complications such as cardiovascular disease and stroke (Forbes & Cooper, 2013). Although several therapeutic agents are available for diabetes management, achieving long-term glycemic control remains challenging. Current antidiabetic drugs include biguanides, sulfonylureas, thiazolidinediones, dipeptidyl peptidase-4 inhibitors, sodium-glucose cotransporter-2 inhibitors, and glucagon-like peptide-1 receptor agonists. These drugs primarily act by improving insulin sensitivity, stimulating insulin secretion, reducing glucose absorption, or promoting glucose excretion (Inzucchi et al., 2012). However, many synthetic drugs are associated with limitations such as hypoglycemia, gastrointestinal disturbances, weight gain, high cost, and reduced effectiveness over time due to progressive β -cell deterioration. Therefore, the search for safer, affordable, and effective antihyperglycemic agents from natural sources has gained considerable scientific interest.

Medicinal plants have been used traditionally for centuries in different healthcare systems, including Ayurveda, Traditional Chinese Medicine, and Unani medicine, for the treatment of metabolic disorders. Plant-derived compounds have contributed significantly to modern drug discovery, with several therapeutic agents originating from natural sources. Bioactive phytochemicals such as flavonoids, alkaloids, tannins, phenolic compounds, terpenoids, and saponins have demonstrated potential antihyperglycemic, antioxidant, anti-inflammatory, and insulin-modulating activities (Ekor, 2014). The increasing interest in herbal medicines for diabetes management is associated with their potential ability to target multiple metabolic pathways simultaneously. Unlike many single-target synthetic drugs, medicinal plants contain complex mixtures of bioactive compounds that may influence glucose metabolism through several mechanisms, including enhancement of insulin secretion, inhibition of carbohydrate-digesting enzymes, improvement of insulin sensitivity, reduction of oxidative stress, and protection of pancreatic β -cells (Ghorbani, 2013). The Unani system of medicine is one of the oldest traditional medical systems and utilizes natural substances, including medicinal plants and mineral preparations, for disease prevention and treatment. In Unani medicine, diabetes-like conditions have historically been managed using formulations containing plants believed to possess glucose-regulating properties. Polyherbal formulations are particularly important because combinations of different medicinal ingredients may produce additive or synergistic effects through complementary mechanisms.

Polyherbal formulations consist of multiple medicinal ingredients combined in specific proportions to enhance therapeutic efficacy and reduce adverse effects. The concept is based

on the principle that different constituents within a formulation may interact pharmacologically to influence disease pathways more effectively than individual components alone. Modern pharmacological research suggests that polyherbal preparations may provide broader biological activity because of the combined effects of multiple phytochemicals (Parasuraman et al., 2014). Tablet Dolabi is a polyherbal Unani formulation containing *Gymnema sylvestre*, *Bambusa bambos*, *Rumex vesicarius*, Asphaltum (Shilajit), and *Acacia arabica*. These ingredients have individually demonstrated biological activities associated with metabolic regulation, antioxidant protection, and glucose metabolism. However, scientific evaluation of the combined formulation is essential to establish its antihyperglycemic efficacy and provide evidence-based validation of its traditional use.

Gymnema sylvestre (Family: Apocynaceae), commonly known as “gurmar” or “sugar destroyer,” is one of the most extensively studied medicinal plants for diabetes management. It has a long history of use in Ayurvedic medicine for controlling excessive blood glucose levels. The major bioactive constituents of *Gymnema sylvestre* include gymnemic acids, gymnemasaponins, flavonoids, and related triterpenoid compounds. Experimental studies have demonstrated that *Gymnema sylvestre* may exert antihyperglycemic effects through several mechanisms. Gymnemic acids have been reported to inhibit intestinal glucose absorption and reduce sweet taste perception by interacting with taste receptors. Additionally, extracts of *Gymnema sylvestre* have shown potential to stimulate insulin secretion, improve pancreatic β -cell function, and enhance glucose utilization in peripheral tissues (Yoshikawa et al., 1997; Kumar et al., 2010). Studies using animal models have reported reductions in blood glucose levels following administration of *Gymnema sylvestre* extracts. The plant has also demonstrated antioxidant activity, which may contribute to protection against oxidative damage associated with diabetes progression (Kanetkar et al., 2007). These findings support the inclusion of *Gymnema sylvestre* as a major component of antidiabetic herbal formulations.

Bambusa bambos (Family: Poaceae) is traditionally used in various medicinal systems for inflammatory disorders, wound healing, and metabolic conditions. Bamboo species contain several phytochemicals, including flavonoids, phenolic compounds, silica, and antioxidant constituents. Although compared with *Gymnema sylvestre*, *Bambusa bambos* has been less extensively studied for diabetes, available evidence indicates that bamboo-derived compounds may contribute to antioxidant and protective effects. Oxidative stress plays an

important role in diabetes pathogenesis by damaging pancreatic β -cells and impairing insulin signaling pathways. Therefore, antioxidant-rich medicinal plants may indirectly contribute to improved glucose regulation by reducing oxidative injury. The incorporation of *Bambusa bambos* into a polyherbal formulation may provide complementary antioxidant support.

Rumex vesicarius (Family: Polygonaceae), commonly known as “bladder dock,” is an edible medicinal plant traditionally used for various health conditions. It contains biologically active compounds including flavonoids, phenolic acids, anthraquinones, and other secondary metabolites. Flavonoids and phenolic compounds present in medicinal plants have been associated with glucose-lowering effects through inhibition of carbohydrate hydrolyzing enzymes, enhancement of antioxidant defense, and modulation of inflammatory pathways. Experimental investigations of *Rumex* species have reported antioxidant and pharmacological activities, suggesting possible benefits in metabolic disorders (Kumar et al., 2014). The presence of these phytoconstituents suggests that *Rumex vesicarius* may contribute to the overall antihyperglycemic activity of Tablet Dolabi by supporting antioxidant mechanisms and improving metabolic regulation.

Asphaltum, commonly known as Shilajit, is a natural mineral-rich substance used traditionally in Unani and Ayurvedic medicine. It contains humic substances, including fulvic acid, along with minerals and bioactive compounds. Shilajit has been investigated for its antioxidant, anti-inflammatory, and adaptogenic properties. Oxidative stress and mitochondrial dysfunction are important contributors to insulin resistance and diabetic complications. Shilajit has been reported to improve mitochondrial function and antioxidant capacity, which may have beneficial effects on metabolic health (Carrasco-Galardo et al., 2012). Although more controlled experimental studies are required, its inclusion in polyherbal formulations may enhance overall metabolic activity.

Acacia arabica (synonym: *Acacia nilotica*, Family: Fabaceae), commonly known as babul, is a medicinal plant widely distributed in tropical and subtropical regions. Various parts of the plant, including bark, leaves, pods, and gum, have been traditionally used for their antimicrobial, anti-inflammatory, antioxidant, and metabolic regulatory properties. Phytochemical investigations have identified the presence of tannins, flavonoids, phenolic compounds, saponins, and alkaloids in different parts of *Acacia arabica* (Kalaivani & Mathew, 2010). Several experimental studies have suggested that *Acacia arabica* possesses potential antihyperglycemic activity. The glucose-lowering effects of *Acacia* species have

been associated with inhibition of carbohydrate digestion, enhancement of antioxidant defense systems, and improvement of insulin sensitivity. Polyphenolic compounds present in the plant may inhibit enzymes such as α -amylase and α -glucosidase, thereby reducing postprandial glucose elevation (Kumar et al., 2011). Furthermore, antioxidant activity may protect pancreatic β -cells from oxidative stress-induced damage, which is a major contributor to diabetes progression. The inclusion of *Acacia arabica* in Tablet Dolabi may therefore complement the activities of other herbal ingredients by providing antioxidant and glucose-regulatory effects. The combined presence of multiple bioactive compounds from different plants may result in a broader pharmacological response compared with individual plant extracts.

Oxidative stress is considered a major factor involved in the development and progression of diabetes mellitus. Chronic hyperglycemia increases the generation of reactive oxygen species (ROS), resulting in oxidative damage to proteins, lipids, DNA, and cellular structures. Pancreatic β -cells are particularly vulnerable because they possess relatively low antioxidant capacity compared with other tissues (Robertson et al., 2004). Oxidative stress contributes to insulin resistance by interfering with insulin signaling pathways and promoting inflammatory responses. Therefore, compounds possessing antioxidant properties may have beneficial effects in preventing metabolic deterioration associated with diabetes. Many medicinal plants used for diabetes contain antioxidant phytochemicals such as flavonoids and phenolic compounds, which may contribute to their antihyperglycemic effects. The ingredients of Tablet Dolabi, including *Gymnema sylvestre*, *Rumex vesicarius*, *Acacia arabica*, and *Asphaltum*, contain phytoconstituents associated with antioxidant activity. Therefore, the formulation may exert glucose-lowering effects through a combination of direct antihyperglycemic actions and indirect antioxidant mechanisms.

The oral glucose tolerance test (OGTT) is a widely accepted experimental method used to evaluate glucose handling capacity and assess antihyperglycemic activity of therapeutic agents. The test measures the ability of an organism to regulate blood glucose levels following an oral glucose challenge. It provides information regarding insulin secretion, peripheral glucose utilization, and overall glucose homeostasis. In experimental pharmacology, OGTT is commonly performed in rodents to evaluate the acute glucose-lowering effects of medicinal plants and antidiabetic compounds. Following administration of glucose, blood glucose levels typically rise and subsequently decline due to endogenous

insulin secretion and glucose uptake mechanisms. Agents with antihyperglycemic activity may reduce peak glucose levels or accelerate glucose clearance (Ayala et al., 2010). The OGTT model is particularly useful for screening natural products because it allows rapid evaluation of glucose regulation before conducting longer-term diabetes models. In the present study, OGTT will be used to investigate the antihyperglycemic potential of Tablet Dolabi in Swiss albino mice.

Animal models play a critical role in evaluating the pharmacological activity, safety, and mechanism of potential antidiabetic agents before clinical investigation. Rodents, especially mice and rats, are frequently used because of their physiological similarities with humans regarding glucose metabolism and insulin regulation. The selection of an appropriate animal model is essential because differences in species, strain, age, sex, and experimental conditions can influence glucose metabolism. Standardized experimental protocols and ethical animal handling practices are therefore necessary to ensure reliable and reproducible results. Swiss albino mice are commonly utilized in biomedical research due to their availability, well-characterized genetic background, and reproducible responses in metabolic experiments. These animals are suitable for evaluating glucose tolerance, insulin sensitivity, and pharmacological effects of herbal preparations.

Although traditional medicine provides valuable knowledge regarding the therapeutic use of medicinal plants, scientific validation through experimental studies is necessary to establish efficacy and safety. Traditional claims alone cannot confirm pharmacological activity; therefore, systematic evaluation using validated experimental methods is essential. Tablet Dolabi contains several medicinal ingredients with individually reported biological activities related to glucose regulation, antioxidant protection, and metabolic improvement. However, limited scientific evidence is available regarding the combined antihyperglycemic activity of this specific polyherbal formulation. The interaction among its components may produce additive or synergistic effects, but this requires experimental confirmation. Evaluation of Tablet Dolabi using an OGTT model in Swiss albino mice may provide preliminary scientific evidence regarding its ability to regulate post-glucose challenge blood glucose levels. Such findings may contribute to the development of evidence-based herbal therapeutic approaches for diabetes management.

Diabetes mellitus remains a major global health concern despite advances in pharmacological treatment. The limitations associated with existing therapies have encouraged researchers to

investigate natural products as potential complementary or alternative approaches. Numerous medicinal plants have demonstrated antihyperglycemic activity individually; however, fewer studies have investigated scientifically standardized polyherbal formulations containing multiple traditionally used ingredients. Since the pharmacological effects of combined herbal preparations cannot always be predicted from individual components, experimental evaluation is necessary. The present research aims to evaluate the antihyperglycemic activity of Tablet Dolabi, a Unani polyherbal formulation containing *Gymnema sylvestre*, *Bambusa bambos*, *Rumex vesicarius*, Asphaltum, and *Acacia arabica*, using an oral glucose tolerance test in Swiss albino mice. The findings may provide scientific support for its traditional application and contribute to future pharmacological investigations.

2.0. Materials and Methods:

2.1. Study Design:

The present study was designed as an experimental in vivo pharmacological investigation to evaluate the antihyperglycemic activity of Tablet Dolabi, a polyherbal Unani formulation containing *Gymnema sylvestre*, *Bambusa bambos*, *Rumex vesicarius*, Asphaltum, and *Acacia arabica*. The antihyperglycemic potential of the formulation was assessed using an oral glucose tolerance test (OGTT) model in Swiss albino mice. The OGTT is a well-established experimental approach for evaluating glucose homeostasis and determining the effects of pharmacological agents on postprandial blood glucose regulation (Andrikopoulos et al., 2008). The experimental design included appropriate control groups, a standard antihyperglycemic drug-treated group, and Tablet Dolabi-treated groups receiving different doses of the formulation. Changes in blood glucose concentration following oral glucose administration were measured at predetermined time intervals and compared among different experimental groups. The study was conducted following standard pharmacological principles for the evaluation of natural products and experimental drugs in animal models (Ghosh, 2007).

2.2. Preparation and Administration of Tablet Dolabi:

Tablet Dolabi, a commercially available polyherbal Unani formulation, was selected as the test sample for the present investigation. The formulation consisted of five active herbal and mineral ingredients, including *Gymnema sylvestre* (55 mg/tablet), *Bambusa bambos* (118 mg/tablet), *Rumex vesicarius* (79 mg/tablet), Asphaltum (35 mg/tablet), and *Acacia arabica*

(171 mg/tablet), along with pharmaceutical excipients in quantity sufficient (Q.S.). The total quantity of active ingredients per tablet was 458 mg. Before administration, Tablet Dolabi was finely powdered using a clean mortar and pestle, and the required amount of powder was suspended in a suitable vehicle, such as distilled water or 0.5% carboxymethyl cellulose (CMC), to prepare a uniform suspension for oral administration. The suspension was freshly prepared before each administration to ensure proper dispersion and stability of the active constituents. The administered dose of Tablet Dolabi was calculated according to the body weight of experimental animals and expressed as mg/kg body weight. The final dose selection was determined based on preliminary toxicity evaluation, available scientific literature, and institutional approval. The individual components of Tablet Dolabi contain various bioactive phytoconstituents that have been associated with glucose regulation and antioxidant activity. *Gymnema sylvestre* contains gymnemic acids, which have been reported to influence glucose absorption and carbohydrate metabolism (Porchezian & Dobriyal, 2003). Other phytoconstituents such as flavonoids, phenolic compounds, tannins, and triterpenoids present in medicinal plants may contribute to antioxidant activity and metabolic regulation (Kumar & Pandey, 2013).

2.3. Experimental Animals:

Healthy adult Swiss albino mice (6–8 weeks old, weighing 20–30 g; both male and female) obtained from the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) were used for the study. The animals were housed in polypropylene cages at the Biochemistry Laboratory, Faculty of Unani and Ayurvedic Medicine, Hamdard University Bangladesh, under standard environmental conditions ($22 \pm 2^{\circ}\text{C}$ temperature, 50–60% relative humidity, and a 12-hour light/dark cycle) with *ad libitum* access to standard laboratory feed and water. Following a one-week acclimatization period to minimize stress-related physiological variations, the animals were utilized for pharmacological evaluation in accordance with established guidelines (Festing, 2014; National Research Council, 2011).

2.4. Ethical Considerations:

All experimental procedures involving laboratory animals were conducted in accordance with internationally accepted guidelines for the care and use of laboratory animals, following the principles outlined in the *Guide for the Care and Use of Laboratory Animals* (NRC, 2011). Ethical approval for the study protocol was obtained from the Institutional Animal Ethics

Committee (IAEC). Appropriate measures were taken throughout the study to minimize animal discomfort and suffering through proper housing, careful handling, and adherence to established standards of laboratory animal welfare.

2.5. Experimental Animal Grouping and Treatment Protocol:

After completion of the acclimatization period, Swiss albino mice were randomly divided into five experimental groups, consisting of five animals per group ($n = 5$). Random allocation was performed to minimize experimental variation and ensure comparable distribution among treatment groups. The experimental design consisted of a normal control group, glucose-loaded control group, standard drug-treated group, and two Tablet Dolabi-treated groups receiving different doses of the formulation. The normal control group received only the vehicle treatment and was maintained without glucose challenge to represent normal physiological blood glucose conditions. The glucose control group received glucose loading at a dose of 4 g/kg body weight following vehicle administration to induce temporary elevation of blood glucose levels and served as the hyperglycemic reference group. The standard drug group received glibenclamide at a dose of 10 mg/kg body weight orally, which was used as a reference antihyperglycemic agent due to its established glucose-lowering activity through stimulation of insulin secretion (Rendell, 2004). The treatment groups received Tablet Dolabi suspension orally at doses of 200 mg/kg and 400 mg/kg body weight, respectively, to evaluate the dose-dependent antihyperglycemic effect of the formulation. All treatments were administered by oral gavage using an appropriate administration technique, and the selected doses were determined based on preliminary toxicity evaluation, available scientific information, and experimental requirements.

2.6. Acute Toxicity Assessment and Dose Selection:

Prior to pharmacological evaluation, an acute toxicity assessment was conducted to determine the safety profile and dose range of Tablet Dolabi in accordance with OECD Guideline 423 (OECD, 2002). Following oral administration, the animals were continuously monitored for behavioral alterations, locomotor activity, feeding patterns, respiratory changes, toxicity signs, and mortality. Based on the absence of severe adverse effects, appropriate doses were selected for the oral glucose tolerance test (OGTT) considering animal welfare, available literature, and institutional ethical approval.

2.7. Oral Glucose Tolerance Test (OGTT):

The antihyperglycemic activity of Tablet Dolabi was evaluated using the oral glucose tolerance test (OGTT), which is a widely used experimental model for assessing glucose regulation and postprandial glucose handling in laboratory animals (Andrikopoulos et al., 2008). Before performing the OGTT, experimental animals were fasted overnight for approximately 8–12 hours while maintaining free access to water. Fasting was performed to minimize variations caused by food consumption and to establish a uniform baseline glucose concentration. At the beginning of the experiment, fasting blood glucose levels were recorded at 0 minute before administration of glucose. Animals were then treated orally with Tablet Dolabi suspension or standard drug according to their respective experimental groups. After the predetermined treatment period, glucose solution was administered orally at a dose of 4 g/kg body weight. Blood glucose levels were subsequently measured at predetermined time intervals of 0, 30, 60, 90, and 120 minutes following glucose administration. The antihyperglycemic potential of Tablet Dolabi was evaluated by comparing the changes in blood glucose levels among treatment groups with the glucose control group. A reduction in glucose elevation following glucose loading was considered indicative of improved glucose tolerance.

2.8. Measurement of Blood Glucose Level:

Blood samples were collected from the tail vein of experimental animals using appropriate aseptic procedures. Blood glucose concentrations were measured using a validated handheld glucometer according to the manufacturer's instructions. All measurements were performed under similar experimental conditions to minimize analytical variation. The glucose-lowering activity of Tablet Dolabi was expressed as changes in blood glucose concentration and percentage reduction compared with the glucose control group. The percentage reduction in blood glucose level was calculated using the following equation:

$$\text{Percentage Reduction} = [(G_c - G_t) / G_c] \times 100$$

Where, G_c represents the mean blood glucose concentration of the glucose control group and G_t represents the mean blood glucose concentration of the treated group. The calculated percentage reduction was used to determine the antihyperglycemic activity of Tablet Dolabi compared with untreated hyperglycemic animals.

2.9. Statistical Analysis:

The experimental results were expressed as mean $\pm$ standard error of mean (SEM). Statistical analysis was performed using appropriate statistical software to determine differences among experimental groups. The significance of differences between multiple groups was evaluated using one-way analysis of variance (ANOVA), followed by Tukey's multiple comparison test for post hoc analysis when significant variation was observed. A probability value of $p < 0.05$ was considered statistically significant. The statistical analysis was performed to determine whether treatment with Tablet Dolabi produced significant alterations in blood glucose levels compared with the glucose control group.

3.0. Result: Effect of Tablet Dolabi on Oral Glucose Tolerance Test in Swiss Albino Mice:

The antihyperglycemic activity of Tablet Dolabi was evaluated using the oral glucose tolerance test (OGTT) model in Swiss albino mice, and the changes in blood glucose levels at different time intervals are presented in Table X. Following oral glucose administration, the glucose control group (Group II) showed a marked elevation in blood glucose concentration compared with the normal control group. The blood glucose level in the glucose control group increased from 92 ± 6 mg/dL at 0 min to a maximum value of 190 ± 12 mg/dL at 60 min, followed by a gradual decline to 145 ± 8 mg/dL at 120 min, confirming the successful induction of postprandial hyperglycemia (Table 3.1).

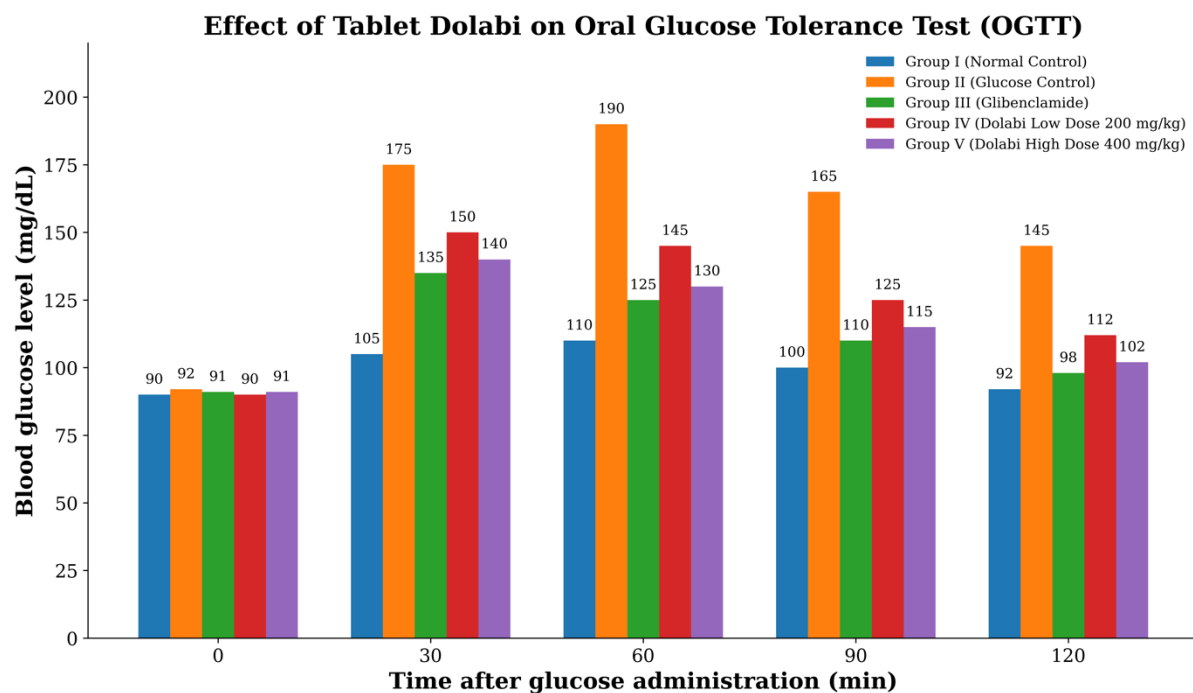
Table 3.1. Effect of Tablet Dolabi on Oral Glucose Tolerance Test (OGTT)

Experimental Group	Treatment	Blood glucose at 0 min (mg/dL)	Blood glucose at 30 min (mg/dL)	Blood glucose at 60 min (mg/dL)	Blood glucose at 90 min (mg/dL)	Blood glucose at 120 min (mg/dL)	Percentage Reduction
Group I	Normal Control	90 ± 5	105 ± 7	110 ± 6	100 ± 5	92 ± 4	
Group II	Glucose Control	92 ± 6	175 ± 10	190 ± 12	165 ± 9	145 ± 8	-
Group III	Standard Drug (Glibenclamide)	91 ± 5	135 ± 8	125 ± 7	110 ± 6	98 ± 5^a	32%
Group IV	Tablet Dolabi Low Dose (200 mg/Kg)	90 ± 6	150 ± 9	145 ± 8	125 ± 7	112 ± 6^a	23%
Group V	Tablet Dolabi High Dose (400 mg/Kg)	91 ± 5	140 ± 8	130 ± 7	115 ± 6	102 ± 5^a	30%

Values are expressed as mean $\pm$ SE ($n = 5$). a represents $p < 0.001$ compared to the respective control group.

Administration of Tablet Dolabi at a low dose of 200 mg/kg body weight (Group IV) showed a moderate improvement in glucose tolerance compared with the glucose control group. The blood glucose concentration reached 150 ± 9 mg/dL at 30 min and gradually declined to 112 ± 6 mg/dL at 120 min, resulting in a 23% reduction in blood glucose elevation. The high-dose Tablet Dolabi group (400 mg/kg body weight, Group V) demonstrated a greater antihyperglycemic response compared with the low-dose group. The blood glucose level increased to 140 ± 8 mg/dL at 30 min and decreased progressively to 102 ± 5 mg/dL at 120 min, showing a 30% reduction in glucose elevation (Table 3.1).

The normal control group (Group I) maintained relatively stable blood glucose levels throughout the experimental period, with values ranging from 90 ± 5 mg/dL to 110 ± 6 mg/dL, indicating normal glucose regulation in the absence of glucose challenge. Treatment with the standard drug, glibenclamide (Group III), significantly reduced the elevation of blood glucose levels compared with the glucose control group. The glibenclamide-treated animals showed a peak glucose level of 135 ± 8 mg/dL at 30 min, which gradually decreased to 98 ± 5 mg/dL at 120 min, demonstrating a 32% reduction in blood glucose elevation (Table 3.1).



Graph 3.1. Effect of Tablet Dolabi on Oral Glucose Tolerance Test (OGTT)

4.0. Discussion:

The present study investigated the effect of Tablet Dolabi on oral glucose tolerance in healthy Swiss albino mice. The oral glucose tolerance test (OGTT) is a widely used experimental approach to evaluate the ability of an organism to regulate blood glucose levels after a glucose challenge. In the present investigation, glucose administration produced a marked elevation of blood glucose concentration in the glucose control group, reaching a maximum level at 60 min (190 ± 12 mg/dL), followed by a gradual reduction at 90 and 120 min. In contrast, Tablet Dolabi improved glucose tolerance, as shown by reduced post-glucose blood glucose elevation compared with the glucose control group. The high-dose Tablet Dolabi group (400 mg/kg) showed a greater glucose-lowering effect (30% reduction) than the low-dose group (200 mg/kg), which produced a 23% reduction. These findings indicate a dose-dependent improvement in glucose handling after Tablet Dolabi administration.

The standard drug glibenclamide served as the reference treatment and showed a 32% reduction in elevated blood glucose levels. Glibenclamide is a sulfonylurea drug that improves glycemic control primarily by stimulating pancreatic β -cell insulin secretion through inhibition of ATP-sensitive potassium channels, leading to membrane depolarization and calcium-dependent insulin release (Rendell, 2004). The comparable response observed

with high-dose Tablet Dolabi suggests that the formulation may contain bioactive constituents that enhance glucose disposal or influence glucose regulatory pathways. However, since the present experiment was performed in normal mice, further studies using diabetic models are necessary to determine whether Tablet Dolabi can restore impaired glucose regulation under pathological conditions.

The glucose-lowering activity of Tablet Dolabi may be attributed to the combined pharmacological effects of its plant-derived ingredients. One of the major components of the formulation is *Gymnema sylvestre*, a medicinal plant traditionally used for glucose regulation. Previous experimental studies have reported that *Gymnema sylvestre* extracts exhibit antihyperglycemic activity through multiple mechanisms, including stimulation of insulin secretion, enhancement of peripheral glucose utilization, and possible regeneration or preservation of pancreatic β -cells (Shanmugasundaram et al., 1990). Gymnemic acids, the major bioactive constituents of *G. sylvestre*, have also been reported to reduce intestinal glucose absorption by interfering with glucose transport mechanisms (Porchezian & Dobriyal, 2003). Therefore, the presence of *G. sylvestre* in Tablet Dolabi may contribute to the observed reduction in postprandial glucose elevation during OGTT.

Clinical and experimental investigations further support the activity of *Gymnema sylvestre*. Baskaran et al. (1990) demonstrated that long-term supplementation of *G. sylvestre* leaf extract improved glycemic control in diabetic patients and reduced dependence on conventional antidiabetic therapy. Although the current study evaluated an acute glucose tolerance response rather than chronic glycemic control, the findings support the potential role of *G. sylvestre* as one contributor to improved glucose management.

Another component of Tablet Dolabi is *Acacia* species. Various species belonging to the genus *Acacia* contain flavonoids, phenolic compounds, tannins, and other secondary metabolites that may influence carbohydrate metabolism. Polyphenolic compounds have been reported to inhibit carbohydrate-digesting enzymes such as α -amylase and α -glucosidase, thereby reducing rapid glucose absorption after carbohydrate intake (Tadera et al., 2006). Inhibiting these enzymes delays glucose release from dietary carbohydrates and may reduce postprandial blood glucose elevation. Therefore, the phenolic constituents of *Acacia* may provide complementary glucose-regulating effects in the present formulation.

Including *Rumex* species may also contribute to the biological activity of Tablet Dolabi. Plants belonging to the genus *Rumex* are rich sources of phenolic compounds, flavonoids, anthraquinones, and antioxidant constituents. Oxidative stress is closely associated with disturbances in glucose metabolism, and antioxidant phytochemicals may improve metabolic regulation by reducing oxidative damage and supporting cellular function (Rahimi et al., 2005). Although specific OGTT studies with *Rumex*-containing formulations are limited, available phytochemical evidence suggests that its antioxidant constituents may contribute indirectly to metabolic benefits.

The role of *Bambusa* species in glucose regulation has been studied less extensively than that of *Gymnema sylvestre*. However, bamboo-derived plant materials contain flavonoids, phenolic compounds, and antioxidant molecules that may possess biological activities relevant to metabolic health. Researchers have widely investigated plant-derived phenolic compounds for their ability to modulate oxidative stress, inflammation, and carbohydrate metabolism (D'Archivio et al., 2010). Therefore, *Bambusa* constituents may contribute synergistically with other components of Tablet Dolabi.

Asphaltum (Shilajit) is another component included in the formulation. Shilajit contains fulvic acid and various mineral components and has traditionally been used in Ayurvedic medicine. Experimental studies suggest potential metabolic and antioxidant activities of purified Shilajit; however, direct evidence of acute glucose tolerance improvement remains limited (Agarwal et al., 2007). Therefore, further investigations are needed to clarify Asphaltum's specific contribution to the glucose-lowering activity of Tablet Dolabi.

The combined effect of multiple botanical ingredients may explain Tablet Dolabi's observed activity. Polyherbal formulations may exert pharmacological effects through synergistic interactions among different phytoconstituents. One compound may influence glucose absorption, while another may affect insulin secretion, antioxidant defense, or glucose utilization pathways. These multi-target effects are an important advantage of traditional polyherbal preparations; however, standardization of active constituents and mechanistic studies are needed to establish therapeutic potential.

In the present study, the high-dose Tablet Dolabi group showed glucose reduction approaching that of the standard drug glibenclamide (30% vs. 32%). This observation indicates promising glucose tolerance-improving activity; however, interpret the difference

cautiously because the experiment was conducted in healthy animals. Normal animals generally have intact insulin secretion and glucose-regulation mechanisms, which may limit the ability to observe therapeutic effects compared with diabetic models. Future studies using streptozotocin- or alloxan-induced diabetic models, along with biochemical evaluation of insulin levels, antioxidant markers, and carbohydrate-metabolizing enzymes, would provide stronger evidence regarding the antidiabetic potential of Tablet Dolabi.

In conclusion, Tablet Dolabi demonstrated significant improvement in glucose tolerance in healthy Swiss albino mice following glucose administration. The observed dose-dependent activity, particularly at 400 mg/kg, may be associated with the combined effects of bioactive compounds present in *Gymnema sylvestre*, *Acacia*, *Rumex*, *Bambusa*, and *Asphaltum*. The findings provide preliminary experimental support for the glucose-regulating potential of Tablet Dolabi; however, further pharmacological and mechanistic investigations are required before clinical application.

5.0. Conclusion

The present study demonstrated that Tablet Dolabi improved glucose tolerance in healthy Swiss albino mice following oral glucose administration. Both doses showed glucose-lowering activity, with the high dose (400 mg/kg) producing a greater effect (30% reduction) compared with the low dose (200 mg/kg; 23% reduction), while the standard drug glibenclamide showed a 32% reduction. The observed activity may be attributed to the synergistic effects of bioactive constituents present in the formulation, including *Gymnema sylvestre*, *Acacia*, *Rumex*, *Bambusa*, and *Asphaltum*. These findings provide preliminary evidence supporting the glucose-regulating potential of Tablet Dolabi; however, further studies using diabetic models, mechanistic investigations, safety evaluations, and clinical trials are required to confirm its therapeutic efficacy.

6.0. Recommendations

Based on the findings of the present study, further investigations are recommended to validate the glucose-regulating potential of Tablet Dolabi. Future studies should evaluate its antihyperglycemic activity using diabetic animal models to determine its effectiveness under pathological conditions of impaired glucose metabolism. Long-term administration studies should be conducted to assess its effects on fasting blood glucose, HbA1c, insulin sensitivity, and other metabolic parameters. Mechanistic studies are also suggested to explore the

possible pathways involved, including insulin secretion, glucose uptake, carbohydrate-digesting enzyme inhibition, and antioxidant activity. In addition, phytochemical standardization of the formulation should be performed by quantifying major bioactive compounds to ensure consistency and quality control. Comprehensive acute and chronic toxicity studies are necessary to establish its safety profile and therapeutic dose range. Finally, well-designed clinical trials are recommended to confirm the efficacy, safety, and potential application of Tablet Dolabi in glucose regulation and metabolic disorders.

7.0. Conflicts of interests

The authors disclose no conflicts of interest.

8.0. Acknowledgment

The authors gratefully acknowledge the Department of Unani Medicine, Faculty of Unani and Ayurvedic Medicine, Hamdard University Bangladesh for providing the necessary facilities and technical support to carry out this experimental research.

9.0. References (APA 7th Edition)

- Agarwal, S. P., Khanna, R., Karmarkar, R., Anwer, M. K., & Khar, R. K. (2007). Shilajit: A review. *Phytotherapy Research*, 21(5), 401–405. <https://doi.org/10.1002/ptr.2100>
- American Diabetes Association. (2022). Classification and diagnosis of diabetes: Standards of medical care in diabetes—2022. *Diabetes Care*, 45(Suppl. 1), S17–S38. <https://doi.org/10.2337/dc22-S002>
- American Diabetes Association. (2023). Pharmacologic approaches to glycemic treatment: Standards of care in diabetes—2023. *Diabetes Care*, 46(Suppl. 1), S140–S157. <https://doi.org/10.2337/dc23-S009>
- Andrikopoulos, S., Blair, A. R., Deluca, N., Fam, B. C., & Proietto, J. (2008). Evaluating the glucose tolerance test in mice. *American Journal of Physiology-Endocrinology and Metabolism*, 295(6), E1323–E1332. <https://doi.org/10.1152/ajpendo.90617.2008>
- Atanasov, A. G., Zotchev, S. B., Dirsch, V. M., & Supuran, C. T. (2021). Natural products in drug discovery: Advances and opportunities. *Nature Reviews Drug Discovery*, 20, 200–216. <https://doi.org/10.1038/s41573-020-00114-z>

522 Ayala, J. E., Samuel, V. T., Morton, G. J., Obici, S., Croniger, C. M., Shulman, G. I.,
 523 Wasserman, D. H., & McGuinness, O. P. (2010). Standard operating procedures for
 524 describing and performing metabolic tests of glucose homeostasis in mice. *Disease*
 525 *Models & Mechanisms*, 3(9–10), 525–534. <https://doi.org/10.1242/dmm.006239>

526 Baskaran, K., KizarAhmath, B., Radha Shanmugasundaram, K., & Shanmugasundaram, E. R.
 527 B. (1990). Antidiabetic effect of a leaf extract from *Gymnema sylvestre* in non-insulin-
 528 dependent diabetes mellitus patients. *Journal of Ethnopharmacology*, 30(3), 295–305.
 529 [https://doi.org/10.1016/0378-8741\(90\)90108-6](https://doi.org/10.1016/0378-8741(90)90108-6)

530 Carrasco-Gallardo, C., Guzmán, L., & Maccioni, R. B. (2012). Shilajit: A natural
 531 phytocomplex with potential procognitive activity. *International Journal of Alzheimer's*
 532 *Disease*, 2012, Article 674142. <https://doi.org/10.1155/2012/674142>

533 D'Archivio, M., Filesi, C., Vari, R., Scazzocchio, B., & Masella, R. (2010). Bioavailability of
 534 the polyphenols: Status and controversies. *International Journal of Molecular Sciences*,
 535 11(4), 1321–1342. <https://doi.org/10.3390/ijms11041321>

536 DeFronzo, R. A., Ferrannini, E., Groop, L., Henry, R. R., Herman, W. H., Holst, J. J., Hu, F.
 537 B., Kahn, C. R., Raz, I., Shulman, G. I., Simonson, D. C., Testa, M. A., & Weiss, R.
 538 (2015). Type 2 diabetes mellitus. *Nature Reviews Disease Primers*, 1, Article 15019.
 539 <https://doi.org/10.1038/nrdp.2015.19>

540 Ekor, M. (2014). The growing use of herbal medicines: Issues relating to adverse reactions
 541 and challenges in monitoring safety. *Frontiers in Pharmacology*, 4, Article 177.
 542 <https://doi.org/10.3389/fphar.2013.00177>

543 Festing, M. F. W. (2014). Animal models in biomedical research. *ILAR Journal*, 55(3), 363–
 544 370. <https://doi.org/10.1093/ilar/ilu032>

545 Forbes, J. M., & Cooper, M. E. (2013). Mechanisms of diabetic complications. *Physiological*
 546 *Reviews*, 93(1), 137–188. <https://doi.org/10.1152/physrev.00045.2011>

547 Ghorbani, A. (2013). Best herbs for managing diabetes: A review of clinical studies. *Brazilian*
 548 *Journal of Pharmaceutical Sciences*, 49(3), 413–422. <https://doi.org/10.1590/S1984-82502013000300003>

549

- 550 Ghosh, M. N. (2007). *Fundamentals of experimental pharmacology* (5th ed.). Hilton &
551 Company.
- 552 International Diabetes Federation. (2021). *IDF Diabetes Atlas* (10th ed.). International
553 Diabetes Federation.
- 554 Inzucchi, S. E., Bergenstal, R. M., Buse, J. B., Diamant, M., Ferrannini, E., Nauck, M.,
555 Peters, A. L., Tsapas, A., Wender, R., & Matthews, D. R. (2012). Management of
556 hyperglycemia in type 2 diabetes: A patient-centered approach. *Diabetes Care*, 35(6),
557 1364–1379. <https://doi.org/10.2337/dc12-0413>
- 558 Kalaivani, T., & Mathew, L. (2010). Free radical scavenging activity from leaves of *Acacia*
559 *nilotica* (L.) Wild. ex Delile. *Food and Chemical Toxicology*, 48(1), 298–305.
560 <https://doi.org/10.1016/j.fct.2009.10.013>
- 561 Kanetkar, P., Singhal, R., & Kamat, M. (2007). *Gymnema sylvestre*: A memoir. *Journal of*
562 *Clinical Biochemistry and Nutrition*, 41(2), 77–81.
563 <https://doi.org/10.3164/jcbrn.2007010>
- 564 Kumar, A., Ilavarasan, R., Jayachandran, T., Decaraman, M., Aravindhana, P., Padmanabhan,
565 N., & Krishnan, M. R. V. (2010). Phytochemicals investigation on a tropical plant.
566 *Pakistan Journal of Nutrition*, 9(1), 75–78. <https://doi.org/10.3923/pjn.2010.75.78>
- 567 Kumar, S., & Pandey, A. K. (2013). Chemistry and biological activities of flavonoids: An
568 overview. *The Scientific World Journal*, 2013, Article 162750.
569 <https://doi.org/10.1155/2013/162750>
- 570 Kumar, S., Kumar, D., Manjusha, Saroha, K., Singh, N., & Vashishta, B. (2011). Antioxidant
571 and free radical scavenging potential of *Acacia nilotica* pod extracts. *Journal of Herbal*
572 *Medicine and Toxicology*, 5(1), 95–99.
- 573 Kumar, V., Kumar, V., & Kumar, S. (2014). Phytochemical and pharmacological properties of
574 *Rumex* species: A review. *Journal of Pharmacognosy and Phytochemistry*, 3(2), 1–8.
- 575 Marles, R. J., & Farnsworth, N. R. (1995). Antidiabetic plants and their active constituents.
576 *Phytomedicine*, 2(2), 137–189. [https://doi.org/10.1016/S0944-7113\(11\)80059-0](https://doi.org/10.1016/S0944-7113(11)80059-0)

577 National Research Council. (2011). *Guide for the care and use of laboratory animals* (8th
578 ed.). National Academies Press. <https://doi.org/10.17226/12910>

579 Newman, D. J., & Cragg, G. M. (2020). Natural products as sources of new drugs over nearly
580 four decades. *Journal of Natural Products*, 83(3), 770–803.
581 <https://doi.org/10.1021/acs.jnatprod.9b01285>

582 Organisation for Economic Co-operation and Development. (2002). *OECD guideline for*
583 *testing of chemicals: Acute oral toxicity—Acute toxic class method* (Guideline 423).
584 OECD Publishing. <https://doi.org/10.1787/9789264070752-en>

585 Parasuraman, S., Thing, G. S., & Dhanaraj, S. A. (2014). Polyherbal formulation: Concept of
586 Ayurveda. *Pharmacognosy Reviews*, 8(16), 73–80. <https://doi.org/10.4103/0973-7847.134229>

588 Porchezian, E., & Dobriyal, R. M. (2003). An overview on the advances of *Gymnema*
589 *sylvestre*: Chemistry, pharmacology and patents. *Pharmazie*, 58(1), 5–12.

590 Rahimi, R., Nikfar, S., & Abdollahi, M. (2005). A review on the role of antioxidants in the
591 management of diabetes and its complications. *Biomedicine & Pharmacotherapy*,
592 59(7), 365–373. <https://doi.org/10.1016/j.biopha.2005.05.004>

593 Rendell, M. (2004). The role of sulphonylureas in the management of type 2 diabetes
594 mellitus. *Drugs*, 64(12), 1339–1358. <https://doi.org/10.2165/00003495-200464120-00004>

596 Robertson, R. P., Harmon, J., Tran, P. O., Tanaka, Y., & Takahashi, H. (2004). Glucose
597 toxicity in beta-cells: Type 2 diabetes, good radicals gone bad, and the glutathione
598 connection. *Diabetes*, 53(Suppl. 1), S119–S124.
599 <https://doi.org/10.2337/diabetes.53.2007.s119>

600 Shanmugasundaram, E. R. B., Rajeswari, G., Baskaran, K., Rajesh Kumar, B. R.,
601 Shanmugasundaram, K. R., & Ahmath, B. K. (1990). Use of *Gymnema sylvestre* leaf
602 extract in the control of blood glucose in insulin-dependent diabetes mellitus. *Journal of*
603 *Ethnopharmacology*, 30(3), 281–294. [https://doi.org/10.1016/0378-8741\(90\)90107-5](https://doi.org/10.1016/0378-8741(90)90107-5)

- 604 Singh, R., Kaur, N., Kishore, L., & Gupta, G. K. (2012). Management of diabetic
605 complications: A chemical constituents based approach. *Journal of*
606 *Ethnopharmacology*, 150(1), 51–70. <https://doi.org/10.1016/j.jep.2013.08.051>
- 607 Tadera, K., Minami, Y., Takamatsu, K., & Matsuoka, T. (2006). Inhibition of α -glucosidase
608 and α -amylase by flavonoids. *Journal of Nutritional Science and Vitaminology*, 52(2),
609 149–153. <https://doi.org/10.3177/jnsv.52.149>
- 610 Tiwari, A. K., & Rao, J. M. (2002). Diabetes mellitus and multiple therapeutic approaches of
611 phytochemicals: Present status and future prospects. *Current Science*, 83(1), 30–38.
- 612 World Health Organization. (2019). *WHO global report on traditional and complementary*
613 *medicine 2019*. World Health Organization.
- 614 World Health Organization. (2022). *Global report on diabetes*. World Health Organization.
- 615 Yoshikawa, M., Murakami, T., Kadoya, M., Li, Y., Matsuda, H., & Yamahara, J. (1997).
616 Medicinal foodstuffs. IX. The inhibitors of glucose absorption from the leaves of
617 *Gymnema sylvestre*. *Chemical & Pharmaceutical Bulletin*, 45(10), 1671–1676.
618 <https://doi.org/10.1248/cpb.45.1671>