Journal of Clinical and Nursing Research, 2024, Volume 8, Issue 3
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

Anti-Diabetic Activity of an Extract of *Syzygium Jambolanum* – A Review

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Abstract: *Syzygium jambolanum* is a promising natural treatment for diabetes. The potential benefits of *S jambolanum* for diabetes include lowering blood sugar levels, increasing insulin sensitivity, protecting pancreatic beta cells, and slowing the absorption of glucose into the bloodstream. The anti-diabetic activity of the crude extract of *S jambolanum* was evaluated in L6 myotubes and the lipid deposition in tissue was measured using Nile red Staining. Nile red staining confirmed that a considerable quantity of lipids had been deposited in the tissue treated with a crude extract of *S jambolanum*, comparable to the quantity of lipids deposited with a standard drug known as Rosiglitazone. This study analyzed the anti-diabetic activity of a crude extract of *S jambolanum* to understand its potential as a feedstock for extracting bioactive constituents to screen for bioactive molecules in the treatment of diabetes.

Keywords: *Syzygium jambolanum*; L6 myoblasts; Column chromatography; Nile red staining

Online publication: March 29, 2024

1. Introduction

Drug discovery using natural sources is highly preferred due to its minimal side effects as compared to chemically synthesized drugs. Many naturally occurring plants have been used in traditional medicine to cure a plethora of diseases [1,2]. The World Health Organization (WHO) has estimated that 80% of the world's population uses botanical medicine for their primary health care [3,4]. A well-acknowledged medicinal plant, *Syzygium jambolanum*, commonly known as Jambolan, has garnered widespread attention. Jambolan belongs to the member of the Myrtle family and is widely distributed throughout India [12]. It is reported to have astringent, stomachic, carminative, antiscorbutic, and diuretic properties. The juice of the ripened fruit or jambolan vinegar, may be administered in cases of enlarged spleen, chronic diarrhea, and urine retention [5,6].

The jambolan tree can grow up to 30 meters tall and has dark green, glossy leaves. It produces small, sweet-scented white flowers that develop into oval-shaped, dark purple to black fruits. Jambolan has been traditionally used in Ayurvedic and other traditional medicine systems for its medicinal properties. The bark, leaves, and seeds are used to make various herbal remedies. It is believed to have antidiabetic, antibacterial, antiviral, and antioxidant properties. It may exert positive effects on digestion and help manage weight [13].

Extracts of both, especially the seeds, in liquid or powdered form are given orally to patients with diabetes mellitus (DM) or glycosuria. However, the hypoglycemic value of jambolan is also disclaimed in some cases. The blood sugar-lowering activity of jambolan has shown good results in rabbits with alloxan-induced diabetes. In this study, we sequentially isolated different extracts of the dried fruit of jambolan and analyzed their effects on key factors that play a significant role in regulating the insulin signaling pathway. By combining information from traditional medicine and integrating it with modern medicine, novel drugs possessing specific actions and efficacy *in vivo* can be developed. Drugs that are less toxic to normal cells can also be discovered. Nonetheless, there exist challenges in the isolation of plant compounds that exhibit significant antidiabetic activity [7,8].

Jambolan contains several bioactive molecules that contribute to its medicinal properties. Jamboline is an alkaloid present in the seeds of jambolan. It has been found to possess hypoglycemic activity, which may help lower blood sugar levels and is often used in the management of diabetes. Ellagic acid is a polyphenolic compound found in the fruit and leaves. It has been reported to possess antioxidant and anti-inflammatory properties. Ellagic acid may help protect against cellular damage caused by free radicals and reduce inflammation. The dark purple fruits of jambolan are rich in anthocyanins, which are water-soluble pigments. Anthocyanins have been attributed to various health benefits, including antioxidant and anti-inflammatory effects. They may also have antitumor and cardioprotective properties. Besides that, jambolan contains several flavonoids, including quercetin and kaempferol. These compounds have antioxidant, anti-inflammatory, and antidiabetic activities. They may help reduce the risk of chronic diseases, including heart disease and diabetes. Tannins are polyphenolic compounds found in the bark, leaves, and fruit. Tannins possess astringent properties and have been reported to exhibit antimicrobial and antiviral activities, including potential anticancer effects. These bioactive molecules present in jambolan contribute to its pharmacological effects and are the basis for its traditional uses and potential medicinal applications. However, further research is still needed to fully understand the mechanisms of action, potential therapeutic uses, and safety of these compounds [15].

Several other herbal plants have been studied for their anti-diabetic properties. The *Gymnema Sylvestre* is an herb native to India and has been used for centuries in Ayurvedic medicine to treat diabetes. It contains compounds called gymnemic acids, which are believed to help control blood sugar levels by increasing insulin production and secretion, and by inhibiting sugar absorption in the intestine. Bitter melon is a fruit commonly used in traditional medicine to treat diabetes. It contains compounds such as charantin, vicine, and polypeptide-p, which have demonstrated anti-diabetic effects in reducing blood glucose levels and improving insulin sensitivity. Fenugreek seeds contain soluble fiber which helps slow down the digestion and absorption of carbohydrates, thus preventing blood sugar level spikes. Fenugreek seeds also contain compounds like trigonelline and 4-hydroxyisoleucine, which have been found to improve glucose tolerance and increase insulin sensitivity. Cinnamon is a popular spice that has been shown to have beneficial effects on blood sugar control. It contains cinnamaldehyde and hydroxychalcone, which have been found to increase insulin sensitivity and enhance glucose uptake into cells. Cinnamon also has antioxidant properties that can help reduce oxidative stress associated with diabetes. Aloe vera contains compounds like glucomannan, which can help lower blood glucose levels and improve insulin sensitivity. Aloe vera also has anti-inflammatory properties to help reduce complications associated with diabetes [9,10].

It is important to note that although these herbal plants have shown potential in managing diabetes, more research is needed to fully understand their safety, efficacy, and appropriate dosage for clinical use. It is crucial to consult with a healthcare professional before incorporating any herbal remedies into your diabetes management plan [11]. In homeopathy, jambolan is commonly used as a remedy for diabetes. It is believed to help regulate blood sugar levels and improve insulin sensitivity. It is also used for various other conditions like

gastrointestinal disorders, skin diseases, and female reproductive issues. As with any herbal or homeopathic remedy, it is important to consult a healthcare professional before incorporating it in the treatment of any specific medical condition [5].

There is some evidence to suggest that jambolana exerts antidiabetic activity. One study investigated the effects of jambolan extract on diabetic rats. The researchers found that treatment with the extract significantly reduced blood glucose levels and improved glucose tolerance in diabetic rats. They concluded that the jambolan extract may have antidiabetic effects by improving insulin secretion and reducing insulin resistance [14]. Another study reported the antidiabetic activity of the jambolan extract in streptozotocin-induced diabetic rats. The results showed that treatment with the extract significantly reduced blood glucose levels and improved lipid profile parameters. It also demonstrated protective effects against oxidative stress and decreased the levels of liver enzymes associated with diabetes [14].

While these studies suggest the potential antidiabetic activity of jambolan, further research is needed to fully understand its mechanism of action and determine its effectiveness in humans. Additionally, it is important to note that jambolan should not be used as a substitute for conventional diabetes medications without consulting a specialist.

2. Extraction process and chromatographic methods

To extract bioactive molecules from herbal plants for anti-diabetic activity, you can follow these general steps: 1. Plant Selection: Choose herbal plants known to have anti-diabetic properties such as bitter melon, fenugreek, cinnamon, gymnema sylvestre, ginseng and jambolan. 2. Preparation: Collect the parts of the plant that contain the bioactive compounds of interest, such as leaves, roots, or fruits. Clean and dry the plant material to remove any impurities. 3. Extraction Methods: There are several methods for extracting bioactive molecules from plant material, including solvent extraction (using solvents like ethanol or methanol), steam distillation, and supercritical fluid extraction. Choose a method that is suitable for the type of bioactive compounds you are targeting. 4. Purification: After extraction, the crude extract may contain impurities that need to be removed. Purification techniques such as column chromatography or liquid-liquid extraction can be used to isolate the bioactive molecules. 5. Characterization: Identify the bioactive molecules in the extract using techniques such as mass spectrometry, nuclear magnetic resonance (NMR), or high-performance liquid chromatography (HPLC). 6. Anti-diabetic Activity Assay: Test the isolated bioactive molecules for their anti-diabetic activity using in vitro or in vivo assays. Common assays include glucose uptake assays, insulin secretion assays, and animal models of diabetes. 7. Bioavailability Studies: Evaluate the bioavailability of the bioactive molecules to understand how they are absorbed and distributed in the body. 8. Safety Evaluation: Conduct safety studies to ensure that the bioactive molecules do not have any toxic effects at the effective doses. By following these steps, you can extract and characterize bioactive molecules from herbal plants for their anti-diabetic activity. It is important to collaborate with experts in the fields of phytochemistry, pharmacology, and diabetes research to ensure the success of your project.

To find lead molecules from herbal plants with anti-diabetic activity. 1. Literature Review: Start by conducting a thorough literature review to identify herbal plants that have been traditionally used for managing diabetes or have shown promising anti-diabetic activity in scientific studies.2. Database Search: Utilize databases such as PubMed, ScienceDirect, and Google Scholar to search for research articles, reviews, and patents related to anti-diabetic compounds derived from herbal plants.3. In silico Screening: Use computational tools and software to perform virtual screening of bioactive compounds present in herbal plants against diabetic

targets such as enzymes involved in glucose metabolism or insulin signaling pathways.4. Phytochemical Analysis: Conduct phytochemical analysis of selected herbal plants to identify bioactive compounds such as flavonoids, alkaloids, terpenoids, and phenolic compounds that could potentially have anti-diabetic properties.5. Bioassays: Perform in vitro and in vivo bioassays to evaluate the anti-diabetic activity of the identified lead molecules from herbal plants. This involves testing the compounds on diabetic animal models or cell lines to assess their efficacy and mechanism of action.6. Lead Optimization: Once lead molecules with significant anti-diabetic activity are identified, further optimize them through medicinal chemistry approaches to enhance their potency, selectivity, and bioavailability.7. Safety and Toxicity Evaluation: Assess the safety profile and toxicity of the lead molecules using in vitro and in vivo studies to ensure they are safe for human consumption. By following these steps, you can effectively identify and characterize lead molecules from herbal plants with potential anti-diabetic properties for further development and drug discovery.

2.1. Collection of plant materials

The dependable source of their natural habitat was where the dried fruit powder was gathered. All other substances, including organic solvents, were of HPLC quality.

2.2. Sequential extraction

Hexane, dichloromethane, ethyl acetate, and methanol were used in sequential extraction processes on the dried powdered plant material (100 g). A vacuum rota vaporizer (rotatory evaporator) was used with lowered pressure and a temperature appropriate to stop the deterioration of the plant extract deterioration, and the collected extracts were concentrated. For glucose uptake studies, a concentrated plant extract of 1 mg/mL was used as the stock and subsequently serially diluted to concentrations of 10 µg, 1 µg, 100 ng, and 1 ng/mL. To determine the ideal solvent system for chromatographic separations, TLC analysis was performed. **Figure 1** reveals the steps for the plant extract preparation.

2.3. Cell culture of L6 myoblasts for confirming anti-diabetic activity

The culture of differentiating monolayer myoblasts, known as L6 myoblasts, exhibited a consistent growth rate and a doubling time of 18–24 hours. Rat myoblasts (0.5×10^6) were cultured in DMEM containing 10% FBS, and antibiotics were added in a 5% CO_2 atmosphere with appropriate mixing according to standard concentrations. Once the cells were fully confluent, they were passaged and seeded accordingly and kept in a cryo-preservative medium (10% DMSO in serum) at -70ºC. After a day, the remaining cells were moved to liquid nitrogen. L6 myotubes are multinucleated skeletal muscle cells derived from L6 myoblasts. They are commonly used in vitro models for studying muscle differentiation, function, and metabolism. L6 myotubes are formed when L6 myoblasts fuse in response to serum deprivation or other stimuli. They are characterized by their elongated shape, striated appearance, and expression of muscle-specific proteins such as myosin heavy chain and actin. L6 myotubes are a valuable tool for studying a variety of biological processes. L6 myotubes can be used to study the mechanisms of muscle differentiation, including the role of growth factors, signaling pathways, and transcription factors. L6 myotubes can be used to study the contractile properties of muscle, as well as the mechanisms of muscle fatigue and adaptation to exercise. L6 myotubes can be used to study the uptake and utilization of glucose and other nutrients by muscle cells. L6 myotubes can be used to screen for drugs that target muscle cells, such as drugs for the treatment of muscle wasting or muscular dystrophy. L6 myotubes are also a versatile and easy-to-use model system.

2.4. Nile Red O staining

Nile red, a phenoxazone dye, was used to develop a sensitive fluorescent histochemical stain for tissue lipids from L6 myotubes. A stock solution containing 1mg/mL Nile red in acetone was stored at 4°C, protected from light. Before each staining, the stock was diluted to 1:1000 in PBS. The cells were treated with 500 µL of diluted stock, and left at room temperature for five minutes, and then visualized at 540 nm.

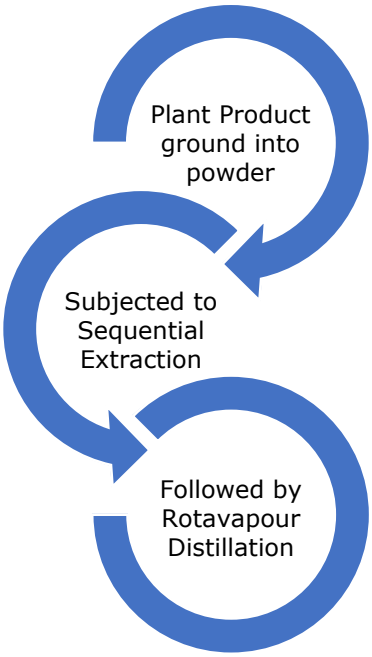

Figure 1. Steps in the preparation of plant extract

3. Scientific investigation

DM is a common disease with increasing incidences every year [16]. The basic pathophysiology of type 2 DM includes uncontrolled hepatic glucose production, impaired pancreatic insulin secretion, and decreased tissue uptake of glucose [17]. While peripheral insulin resistance in skeletal muscle is probably the main cause of type 2 DM, persistent hyperglycemia, the common feature of diabetes, can cause the majority of diabetic complications. The goal of diabetic treatment is to lower blood glucose levels to normal [18]. Many herbal remedies are used to treat a variety of chronic illnesses, including DM. Based on this theory, an *in vitro* model for investigating the potential impact of *S jambolanum* on diabetes was investigated. In 1940, Mercier refuted the claim that jambolana extracts were hypoglycemic. He discovered that while the aqueous extract of the seeds did not lower blood sugar when given orally, it did so when injected into dogs for extended periods. Reduction of blood sugar was demonstrated in rabbits with alloxan diabetes. The effect of *Baccharis trimera* and *Syzygium cumini* on glycemia in diabetic and non-diabetic mice was studied due to the hypoglycemic impact of water-soluble fiber and defatted *Syzygium cumini* seeds. Based on compelling evidence, L6 myotubes were selected as the *in vitro* model in this study.

3.1. Application of crude extract to find lead molecule via TLC

Thin layer chromatography (TLC) is a common technique used to separate and analyze compounds in a mixture. For analyzing the plant extract for antidiabetic activity using TLC. 1. Preparation of TLC plate: -

Choose a suitable TLC plate (usually silica gel or cellulose) and mark a baseline on the plate.- Prepare the plant extract sample by dissolving it in a suitable solvent (such as ethanol or methanol).- Spot the plant extract sample on the baseline of the TLC plate using a capillary tube.2. Development of TLC plate:- Place the TLC plate in a developing chamber containing a suitable mobile phase (such as a mixture of solvents).- Allow the mobile phase to move up the plate through capillary action, carrying the components of the plant extract with it.- Remove the plate from the developing chamber once the solvent front reaches near the top of the plate.3. Visualization of spots:- Allow the TLC plate to dry completely.- Visualize the separated compounds on the TLC plate using UV light, iodine vapor, or a suitable staining reagent.- Mark the spots corresponding to different compounds in the plant extract.4. Analysis of TLC results:- Compare the TLC plate with standards or known compounds to identify the compounds present in the plant extract.- Calculate the Rf (retention factor) values for the spots to help identify the compounds.- Evaluate the presence of any compounds that may have antidiabetic activity based on previous studies or literature. TLC is a qualitative technique, so further confirmation of the activity of specific compounds identified in the plant extract would require additional analytical methods or bioassays. It is also important to consult relevant literature and consider collaborating with experts in the field of antidiabetic research for a more comprehensive analysis.

Thin layer chromatography (TLC) is a common technique used to separate and analyze compounds in a mixture. The procedure involves spotting the sample mixture onto a TLC plate, which is then placed in a developing chamber containing a solvent. The compounds in the mixture will move up the plate at different rates based on their affinity for the stationary phase and the mobil phase. To obtain a thin layer chromatographic profile of *syzygium jambolanum* crude extracts, the sample was prepared. This could involve extracting the compounds of interest from the plant material using an appropriate solvent (such as ethanol or methanol). Once you have the crude extract, you can spot a small amount of it onto a TLC plate using a capillary tube or a micro-pipette. The plate is then placed in a developing chamber with a suitable solvent system (such as a mixture of ethyl acetate and hexane). After allowing the plate to develop, you can visualize the separated compounds by using a UV lamp or by staining the plate with a suitable reagent. The resulting chromatographic profile will show different spots corresponding to the various compounds present in the syzygium jambolanum crude extract. Interpreting the TLC profile involves comparing the Rf (retention factor) values of the spots with known standards or reference compounds. This can help identify the individual compounds present in the extract and provide information about their relative quantities. Overall, conducting thin layer chromatography on *syzygium jambolanum* crude extracts can help in characterizing the chemical composition of the plant material and identifying potential bioactive compounds for further study.

To extract the constituents from the crude solution and develop an optimal solvent system with better resolution, thin-layer chromatography (TLC) was used. Solvent systems include: a) chloroform: methanol (70:30), b) hexane: ethyl acetate (80:20), c) hexane: ethyl acetate (50:50), and d) hexane: ethyl acetate (40:60). The components were visible on the produced TLC plates at both short (254 nm) and long (365 nm) wavelengths when exposed to UV light (**Figure 2**). For spraying reagents, 10% sulphuric acid in methanol and ammonium molybdate were utilized.

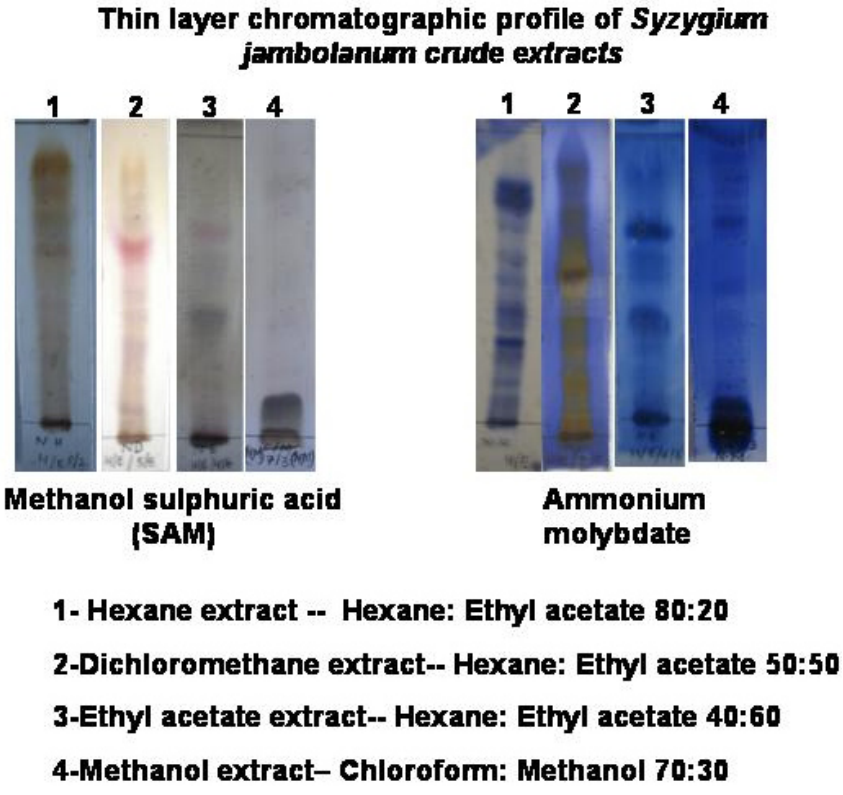

Figure 2. Thin layer chromatography of the plant extract (20, 21)

Figure 2 shows the TLC of the plant extract using various solvents and its retardation factor (Rf) value to determine the potential solvent system for the extraction of bioactive molecules.

Chloroform was used as the mobile phase in column chromatography, with increasing methanol concentrations. Ethyl acetate, methanol, and water were used in TLC in the following ratio: 70:30:10.

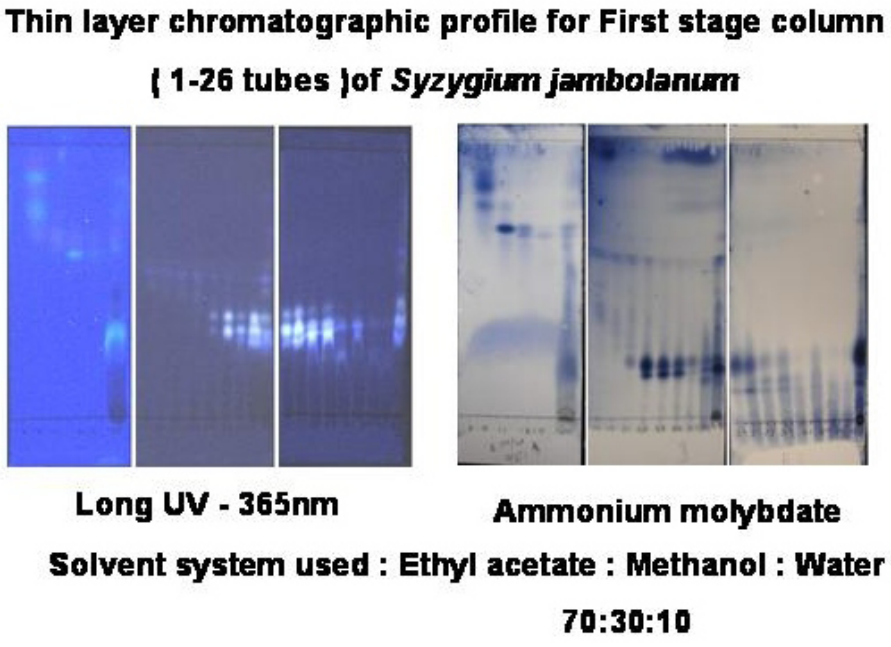

Figure 3. TLC of first stage column (20, 21)

The TLC profile for the first stage column of jambolan is shown in **Figure 3**.

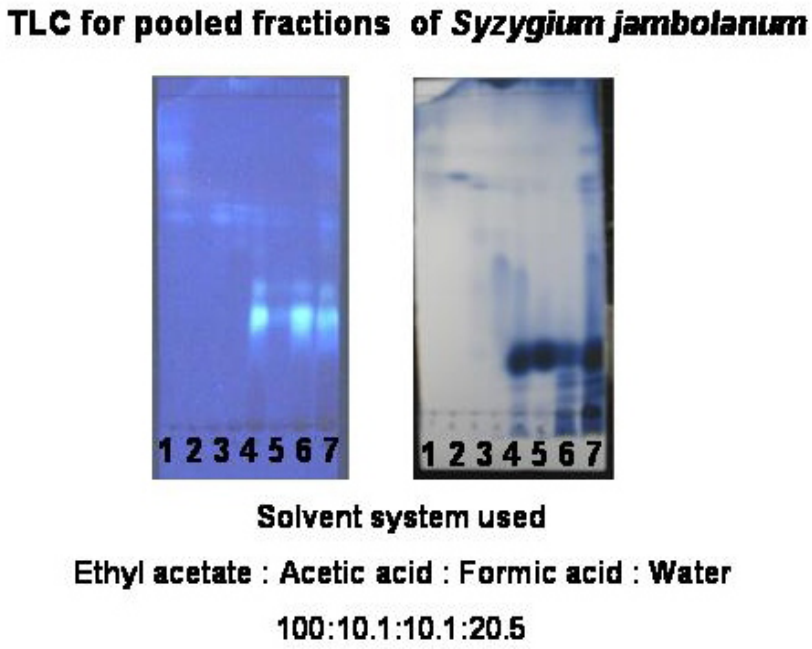

Figure 4. TLC of fractions of extract of *S Jambolanum* (20,21)

Column fractions that shared a TLC profile were combined into a pool. Six distinct fractions were found, as shown in **Figure 4**. Fractions 3 and 4 were combined based on this TLC profile. The glucose uptake assay was performed on the 5 fractions that were obtained. After identification, the active fractions underwent further characterization.

3.2. Nile O Red Staining for Cells (L6 Myotubes)

Skeletal muscle plays a crucial role in maintaining overall glucose balance in the body as an insulin-target tissue. Insulin facilitates glucose uptake in skeletal muscle cells by translocating glucose transporter 4 (GLUT4) from the endoplasmic reticulum to the plasma membrane. Insulin resistance can occur due to impaired glucose transport efficiency and GLUT4 activity. Despite the established importance of GLUT4 translocation in insulin-mediated glucose uptake in muscle cells, the precise regulatory mechanism remains to be fully understood. Efforts have been made to establish effective in vitro models for studying glucose uptake involving GLUT4 in muscle cells. However, existing skeletal muscle cell lines generally exhibit limited insulin-dependent glucose uptake and GLUT4 translocation, with exceptions noted in rat L6 and mouse C2C12 myotubes. Studies have shown that L6 myotubes may demonstrate greater glucose uptake upon insulin stimulation compared to C2C12 cells, suggesting that L6 myotubes currently represent a promising candidate for an efficient in vitro model system for investigating glucose uptake in muscle cells. L6 myotubes are a type of muscle cells that are derived from satellite cells and used in research to study muscle development, function, and disease. These myotubes are cultured in the laboratory and can be used to investigate various aspects of muscle biology, such as contractility, metabolism, and gene expression. Researchers often use L6 myotubes to study muscle-related conditions, such as muscular dystrophy, diabetes, and sarcopenia.

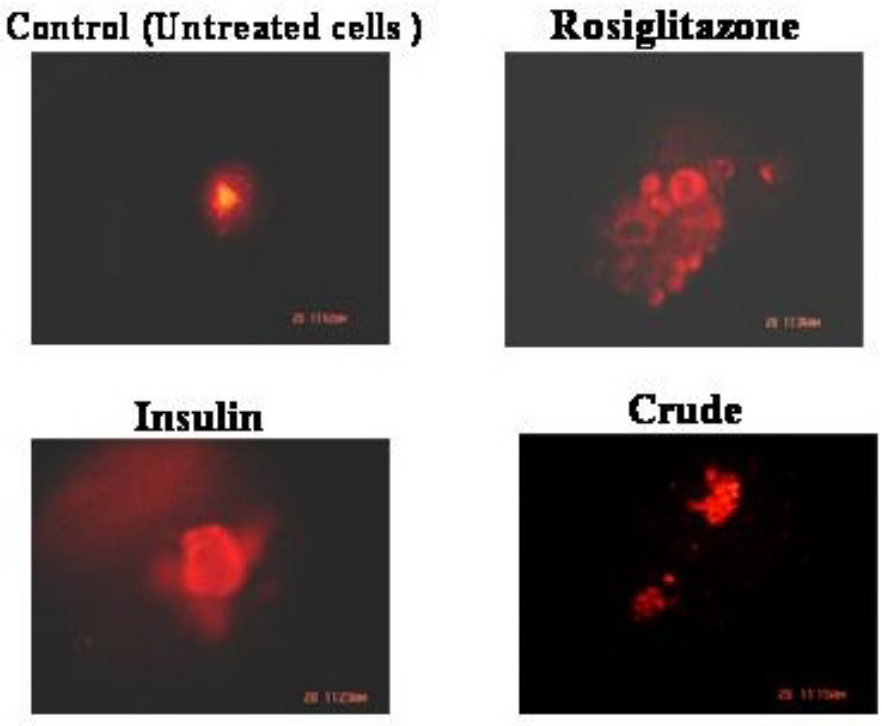

Figure 5. Nile Red O staining of cells

Nile red is a lipophilic dye that stains intracellular lipid droplets yellow according to the relative hydrophobicity. It is a versatile tool that can be used to study a variety of biological processes, including lipid metabolism, cell signaling, and drug discovery. It is a non-toxic and non-invasive dye that can be used to stain live cells and is highly specific for lipid droplets. It is also fluorescent, hence it can be easily detected using fluorescence microscopy. Nile red staining is a valuable tool for biologists to study lipids and their role in cellular processes.

Rosiglitazone is a medication used to treat type 2 diabetes. It belongs to a class of drugs known as thiazolidinediones, which help improve insulin sensitivity and control blood sugar levels. Rosiglitazone works by increasing the body's sensitivity to insulin, allowing it to more effectively lower blood sugar levels. It is often prescribed along with diet and exercise to help manage diabetes. However, it is important to note that rosiglitazone has been associated with certain risks and side effects, so it should be used with caution and under the guidance of a healthcare provider. This drug can be used as a standard drug for scientific studies and was used as a positive control. Rosiglitazone is a medication that belongs to a class of drugs called thiazolidinediones, which are used to treat type 2 diabetes mellitus. The mechanism of action of rosiglitazone involves several processes that ultimately help improve the body's response to insulin and lower blood sugar levels. 1. "Activation of PPAR-gamma receptor": Rosiglitazone works by activating peroxisome proliferator-activated receptor-gamma (PPAR-gamma) in the nucleus of cells. PPAR-gamma is a nuclear receptor that plays a key role in regulating genes involved in glucose and lipid metabolism. 2. "Increased insulin sensitivity": Activation of PPAR-gamma by rosiglitazone results in increased sensitivity of cells to insulin. This means that the body's cells are better able to respond to insulin and take up glucose from the bloodstream, leading to lowered blood sugar levels. 3. "Decreased hepatic glucose production": Rosiglitazone also helps reduce the production of glucose in the liver. By inhibiting the release of glucose from the liver, the medication helps prevent excessive glucose production and release into the bloodstream. 4. "Improved lipid profile": In addition

to its effects on glucose metabolism, rosiglitazone also helps improve lipid metabolism. It can increase levels of high-density lipoprotein (HDL) cholesterol and decrease levels of triglycerides, which are beneficial for overall cardiovascular health. Overall, rosiglitazone works by improving insulin sensitivity, reducing hepatic glucose production, and improving lipid metabolism, all of which contribute to its anti-diabetic effects in the treatment of type 2 diabetes mellitus. It is important to note that rosiglitazone should be used under the supervision of a healthcare provider and as part of a comprehensive treatment plan for diabetes management.

Based on **Figure 5**, it is clear that the crude extract of jambolan showed significant lipid deposits when compared to the control, but the positive control (rosiglitazone) exhibited the highest lipid accumulation. Given this correspondence, the crude extract of jambolan demonstrates anti–diabetic activities, which results in lipid deposition. As Nile red staining is quick, easy to use, and requires little biomass, it is often used as a substitute method for determining microalgal lipids. The spectral characteristics of Nile red, a lipophilic dye, are influenced by the polarity of its surroundings. When it comes into contact with lipid bodies and hydrophobic organic solvents, it emits intense fluorescence. Hence, it is an obvious choice for lipid quantification and staining.

It is well known that treatment with HMG-CoA reductase inhibitors prevents cholesterol accumulation, which promotes lipid accumulation, as demonstrated by Nile red staining. After being treated with the crude extract of jambolan and stained with Nile red, lipid droplet-filled myotubes revealed greater fluorescence intensity than the Nile red-stained control myotubes. In this study, the crude and fractions 5 and 2 both exhibited a moderate downregulation of HMG-CoA, indicating that their functions as HMG-CoA inhibitors were similar to those of statins [19,20].

Numerous bioactive compounds are present in the extract of *Syzygium Jambolanum* for various pharmacological properties. The stem bark of the plant contains Friedelin, friedelan-3-a-ol, betulinic acid, b-sitosterol, kaempferol, b-sitosterol-d-glucoside, gallic acid, ellagic acid, gallotannin, and ellagitannin and myricetine. The leaves of the plants consists of b-Sitosterol, betulinic acid, mycaminose, crategolic (maslinic) acid, n-hepatcosane, n-nonacosane, n-hentriacontane, noctacosanol, n-triacontanol, n-dotricontanol, quercetin, myricetin, myricitrin and the flavonol glycosides myricetin 3-O-(4¢-acetyl)-a-l-rhamnopyranosides. The other parts of the *Syzygium Jambolanum* contain Oleanolic acid, ellagic acids, isoquercetin, quercetin, kampferol and myricetin, Anthocyanins, delphinidin, petunidin, malvidin-diglucosides, Jambosine, gallic acid, ellagic acid, corilagin, 3,6-hexahydroxy diphenoylglucose, 1-galloylglucose, 3-galloylglucose, quercetin, b-sitoterol, 4,6-he xahydroxydiphenoylglucose, a-Terpeneol, myrtenol, eucarvone, muurolol, a-myrtenal, 1,8-cineole, geranyl acetone, a-cadinol and pinocarvone [22].

For centuries, Jamun has been utilized as a treatment for diabetes. Recent scientific research has confirmed its effectiveness in managing both insulin-dependent and non-insulin-dependent diabetes. Studies have shown that Jamun seeds are particularly beneficial in reducing glucose production, enhancing glucose utilization, and preventing diabetic complications. Mechanistic research indicates that Jamun possesses antioxidant properties, prevents lipid peroxidation, regenerates beta cells, and improves glucose utilization. These actions help in reducing hyperglycemia and mitigating the secondary complications of diabetes. While traditional and animal studies have supported Jamun's antidiabetic properties, clinical trials with small sample sizes have yielded inconclusive results. Further research is needed, including randomized double-blinded clinical trials with larger sample sizes and standardized extracts, to validate these traditional observations [22].

4. Conclusion

S jambolanum is a promising natural treatment for diabetes. However, more research is needed to confirm its

long-term safety and efficacy. The potential benefits include lowering blood sugar levels, increasing insulin sensitivity, protecting pancreatic beta cells, and slowing the absorption of glucose into the bloodstream. The anti-diabetic activity of the crude extract of jambolan was evaluated in L6 myotubes and the lipid deposition in tissue was evaluated using Nile O Red Staining. Nile O Red staining confirmed that a considerable quantity of lipids was deposited in the tissue treated with a crude extract of jambolana, including a comparable quantity of lipids deposited by Rosiglitazone. This proves the anti-diabetic activity of the crude extract of jambolan, which can be used as a feedstock for extracting bioactive constituents for the screening of bioactive molecules that exhibit anti-diabetic activity.

Disclosure statement

The authors declare no conflict of interest.

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