



**THE POTENCY OF PALMYRA PALM IN TYPE 2 DIABETES: A REVIEW**

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**ABSTRACT**

Plants play a vital role in improving human wellbeing since the ancient civilization. Different parts of the plants like roots, stem, leaves, flowers, seeds are used as medicine to treat myriad array of diseases. The palmyra plant, scientifically known as *Borassus flabellifer*, is a plant of major therapeutic importance. Various parts of palmyra tree including roots, stem, flower, fruit, sprout, spadix, seed embryo are potent anti-inflammatory, antioxidant, antibacterial, anti-Diabetic activities due to the presence of diverse bioactive chemicals such as flavonoids and phenolic acids. The potential of the palmyra plant in pharmacology and traditional medicine is demonstrated by its rich biochemical composition, which renders it a great resource for a range of medicinal applications including managing type 2 diabetes. This review highlights palmyra palm as a useful but underutilized crop with potential health application in type 2 diabetes.

**Keywords:** Antidiabetic, Antioxidant, Medicine, Palmyra palm, Phytochemicals.

**INTRODUCTION**

The palmyrah palm (*Borassus flabellifer* L.), is a member of the Arecaceae family and is native to tropical Africa. It is now widely grown in many South Asian nations, especially India. This crop is both economically significant and dioecious. It belongs to the “Kingdom: plantae, sub-kingdom: tracheobionta, super division: spermatophyta, division: magnoliophyta, class: liliopsida, subclass: Arecidae, order: Arecales, family: Arecaceae, genus: *Borassus* L. species: *Borassus flabellifer* L.” (Behera and Nayak, 2022). Historically, different plant parts, including fruit, seeds, roots, and leaves, have been used for a variety of purposes in medicine such as; intestinal worms, scabies, and stomachaches (Aroonsrimorakot et al., 2020; Abu et al., 2019; Aman et al., 2018). Research has indicated that distinct palmyra plant parts, including the leaves, fruit pulp, and sap, have a variety of medicinal uses (Rao et al., 2023; Pammi et al., 2021). Due to its antidiabetic and antioxidant



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qualities revealed in experimental results, the fruit extract of palmyra palm has long been utilized to treat diabetes and its consequences (Priya et al., 2016).

Also, studies on drug delivery using naturally occurring palmyra palm kernel hydrogels have shown promise in encapsulating chemotherapy medications such as 5-fluorouracil for the treatment of colon cancer (Renuka et al., 2020). Additionally, the probiotic qualities of Toddy Palm Nectar, which is made from the palmyra palm, have been studied. According to Gummadi et al. (2016), isolated LAB strains have demonstrated promising probiotic and therapeutic properties, including anti-cancer activity. These combined results highlight the various therapeutic applications of the palmyra palm in conventional medicine. It has been demonstrated that the pulp of the palmyra fruit inhibit the uptake of glucose into the digestive tract, which may help lower blood glucose level in individuals with moderate diabetes (Nwaneri, 2015). Diabetes treatment has a long history; Egyptian, Hindu, and Greek medical texts all made reference to it, emphasizing the identification of symptoms such as polyuria and polydipsia (Uluwaduge et al., 2007). Additionally, Banting and MacLeod's discovery of insulin transformed the management of diabetes and saved numerous lives worldwide (Raja and Romanowska, 2021).

### **Distribution of Palmyra Palm**

Generally known by the names toddy palm, wine palm, longer palm, or palmyra in English, palmyra pulp is a tropical fruit that is also known by the names Taad (Hindi), Talam (Tamil), Taticettu (Telugu), Karimpana (Malayalam), Taal (Bengali), and Tala (Odia) (Nesbitt, 2005; Panda et al., 2018). The Greek terms "Borassus" and "flabellifer," which translate to "fruit with leather wrapping" and "fan-bearer," respectively, are the source of the name (Kurian et al., 2017). It is thought to have started in Africa, traveled across South Asia, and then moved into Southeast Asia as a result of the growth of trade networks and cultures. It is also, a native fruit of Southeast Asia, the Indian subcontinent, and tropical Africa. (Karthavi et al., 2020; Nesbitt, 2005).

### **Diabetes Management**

Numerous studies have confirmed the palmyra palm fruit's promise for treating diabetes. Research has indicated that the extract from the palmyra palm fruit has anti-diabetic qualities through controlling the metabolism of carbohydrates and glycogen, lowering blood sugar, and enhancing insulin sensitivity (Yedjou et al, 2023). Furthermore, the antidiabetic actions of palmyra palm fruit extract are supported by the presence of pharmacologically significant



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phytochemicals, such as alkaloids, flavonoids, saponins, coumarins, glycosides, tannins, phenols, and quinines (Athira et al., 2023; Sarki et al., 2022; Salsabila et al., 2022). Additionally, the usefulness of palmyra palm fruit in treating diabetes has long been acknowledged, underscoring its importance as a natural solution for diabetes treatment (Yasmin et al., 2023). These results highlight the palmyra palm fruit's therapeutic potential as a useful medicinal approach for the treatment of diabetes. Also, substantial quantities of phenolic and flavonoid content were discovered in the fruit extract; these substances are recognized for their antioxidant properties and possible health advantages (Danbature et al., 2020). These phytochemicals are essential to the medicinal qualities of palmyra palm, which makes it a useful material for creating dietary supplements and natural cures. The potential of Palmyra palm fruit extract in conventional medicine and pharmaceutical applications is highlighted by the existence of these bioactive chemicals.

### **Type 2 Diabetes**

The immature fruits of *Borassus flabellifer*, or palmyra palm, are traditionally used to treat type 2 diabetes. According to studies, the young palmyra palm fruits contain anti-diabetic qualities (Renuka et al., 2020). Furthermore, research has shown that Raffia palm wine, which is made from *Raphia hookeri*, may be able to treat the negative effects of type 2 diabetes, such as oxidative testicular injury (Erukainure et al., 2019). Additionally, studies suggest that Raffia palm wine may have neuroprotective advantages against diabetic neurodegeneration, emphasizing its potential for managing type 2 diabetes consequences including Alzheimer's disease and other neurodegenerative disorders. (Erukainure et al., 2019). Together, these studies show how well palm-derived products work to manage type 2 diabetes and its side effects.

### **Phytochemicals in Palmyra**

The therapeutic qualities of palmyra palm fruit extract are greatly influenced by the presence of phytochemicals. The presence of several chemicals such as fatty acids, ketones, and cyanides were found in the phytochemical examination of the fruit husk extract of palmyra palm, indicating that the extract has bioactivity against marine biofoulers (Athira et al., 2023). Furthermore, substances including saponins, tannins, terpenoids, and alkaloids were found in the phytochemical analysis of *Borassus flabellifer* seed and seed coat extract, which supported the plant's anti-inflammatory and antioxidant properties (Viju et al. 2020). Moreover, the extract from young palmyra palm fruits demonstrated strong antioxidant potential to the presence of alkaloids, flavonoids, glycosides, saponins, tannins,



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phytosterols, triterpenoids, and phenols in the young fruit (Danbature et al., 2020). The combined effects of these phytochemicals strengthen the therapeutic qualities of palmyra palm fruit extract, establishing it as a useful resource for a range of health advantages and therapeutic uses.

### **Tannins**

Condensed tannins, which are part of the tannins extracted from palmyra palms, have shown antidiabetic properties (Sanvee et al., 2020). It has been demonstrated that these tannins lower blood sugar levels in people with type 2 diabetes and exhibits antioxidant activity. Research has shown that the condensed tannins in palmyra palm fruits can improve insulin sensitivity, control the metabolism of carbohydrates and glycogen, and dramatically lower blood sugar levels in diabetic rats (Ratya, 2014).

Condensed tannins in particular have been found to possess insulin-like characteristics, as well as the capacity to inhibit the  $\alpha$ -glucosidase enzyme, stimulate pancreatic insulin secretion, and repair pancreatic  $\beta$  cells; all of which contribute to the antidiabetic effects of tannins (Sanvee et al., 2020; Renuka et al., 2020; Ajebli and Eddouks, 2019).

### **Saponins**

Saponins under the name of steroidal and triterpenoidal saponins, which are present in palmyra, can offer potential therapeutic effects in the treatment of diabetes by lowering serum blood glucose levels (Galas et al., 2023; Bildziukevich et al., 2023). By controlling many signaling pathways such as IRS-1/PI3K/Akt, AMPK, Nrf2/ARE, NF- $\kappa$ B-NLRP3, SREBP-1c, and PPAR $\gamma$  in diverse organs such as the liver, pancreas, gut, and skeletal muscle, these drugs exhibit multidirectional pharmacological actions (Zhou and Xu, 2023; Galas et al., 2023; Mazumder et al., 2023). Saponins are prospective substitute for the management of type-II diabetes because of their structural diversity, which enables them to prevent diabetic complications and decrease hyperglycemia through a variety of pathways (Choudhary et al., 2021). While additional research is required to improve the efficacy and safety of saponins from palmyra for medical use, overall, they offer a promising path toward the development of safer and more affordable anti-diabetic medicines.

### **Terpenoids**

Numerous research has demonstrated the potential anti-diabetic effects of terpenoids, such as abietane diterpenes and other terpenes (Gupta and Kumar, 2023; Salsabila et al., 2022).



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These organic substances have the ability to inhibit insulin-resistant enzymes, enhance glucose metabolism, and have a positive effect on insulin and plasma glucose levels. As a result, they may be used as therapeutic agents to treat diabetic complications such as retinopathy, neuropathy, nephropathy, and impaired wound healing (Behl et al., 2022). Terpenoids may provide advantages, but there are also hazards that should be taken into account when using them. Because of their poor absorption and undesirable side effects, synthetic antidiabetic medications frequently have limited efficacy. If natural terpenoids are not thoroughly studied, this could potentially be a problem (Etsassala et al., 2020).

### **Alkaloids**

Plants such as Palmyra palm contain alkaloids that have been used for the management of diabetes. According to studies (Gou et al., 2023; Sujatha and Alhaji, 2022; Okechukwu et al., 2021; Gutiérrez-Grijalva et al., 2021; Muhammad et al., 2021), alkaloids have antidiabetic qualities. These alkaloids have an effect on different proteins involved in glucose metabolism, scavenge free radicals, and prevent oxidative stress (Sujatha and Alhaji, 2022; Muhammad et al., 2021). Furthermore, because of their ability to target a variety of pathways, including AMP-activated protein kinase, glucose transporters, and glucokinase, alkaloids from Palmyra palm fruits have long been employed for their anti-diabetic properties (Renuka et al., 2020). These bioactive chemicals found in palmyra palm indicate that the plant may be used as a natural precursor for the production of anti-diabetic medications, providing a viable substitute for current medical procedures (Gou et al., 2023; Gutiérrez-Grijalva et al., 2021). Substances found in some plants, such as palmatine, have been shown to have antioxidant, antidiabetic, and tissue-damage-prevention properties. Furthermore, *Piper longum* alkaloids have demonstrated anti-diabetic effect through the inhibition of PTP1B and the activation of the PI3K/AKT pathway, which in turn promotes glucose metabolism. Herbal antidiabetic alkaloids work by increasing insulin secretion, decreasing insulin resistance, and triggering a number of metabolic processes. According to these results, alkaloids found in plants such as Palmyra palm may help control diabetes and its consequences, providing a possible substitute or addition to current medical therapies.

### **POLYPHENOLS**

Plants rich in polyphenols, such as palmyra palm, have shown to have a number of positive effects on diabetes. They reduce metabolic illnesses like insulin resistance, hyperglycemia, and obesity linked to Type-2 diabetes. They also have anti-diabetic, anti-inflammatory, anti-apoptotic, and anti-cancerous properties (Sharma et al., 2022; Mohd Nor et al., 2022). Strong



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antioxidants known as polyphenols, such as quercetin and curcumin, are essential in the management of diabetes because they enhance the release and synthesis of insulin from pancreatic  $\beta$ -cells that are malfunctioning (Sharma et al., 2021). Moreover, polyphenols have demonstrated potential in reducing diabetes-related cognitive impairment, providing therapeutic advantages with low toxicity and side effects (Zhang et al., 2020). Additionally, research has shown that polyphenols have hypoglycemic effects through their antioxidative actions, which help pancreatic cells restore their altered antioxidant defenses and insulin secretion mechanisms (Zaklos-Szyda et al., 2015).

### **Flavonoids**

Palmyra palm has been reported to be rich in bioactive molecules called flavonoids, which are important in the management of diabetes (Gupta and Kumar, 2023; Yi et al., 2023; Ansari et al., 2022; Venugopala et al., 2022).

These substances have hypoglycemic properties and can aid in blood sugar regulation. Type 2 diabetes mellitus (T2DM) and its consequences can be reduced by flavonoids' wide range of biological actions, which include anti-inflammatory, antioxidant, and glucose metabolism modulation. Research has demonstrated that flavonoids, such as quercetin, have a promising therapeutic potential in the management of type 2 diabetes by enhancing insulin secretion, improving oral glucose tolerance, suppressing pro-inflammatory indicators, and inhibiting important enzymes involved in glucose metabolism (Aghababaei and Hadidi, 2023; Yi et al., 2023). Studies on the structure-activity relationship of flavonoids have identified particular changes that augment their antidiabetic action, which makes them attractive options for novel antidiabetic medication development (Lam et al., 2024).

### **Other Applications of Palmyra Palm**

#### **Antioxidants**

Palmyra palm, and its derivatives, such as palm oil, palm wine, and immature fruits, have been found to exhibit significant antioxidant properties and potential antidiabetic effects. Research has indicated that palm oil, in particular, is rich in antioxidants, which protects against oxidative stress in diabetes (Alabi et al., 2020). Additionally, both unfermented and fermented palm wine have demonstrated antidiabetic and antioxidative effects, which have been attributed to compounds such as polyphenols, vitamins, and amino acids (Erukainure et al., 2019). The immature fruits of Palmyra palm have been traditionally used to treat



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diabetes, and they have proven to be both antidiabetic and antioxidants by regulating glucose metabolism and reducing oxidative stress (Marimuthu et al., 2023). According to Bettaieb et al. (2023), research conducted *in vitro* on Palmyra palm fruits demonstrated excellent antioxidant activity, which can be attributed to the presence of phytochemicals such as flavonoids and phenols. These findings imply that the fruit may have the capacity to reduce oxidative stress.

Palmyra palm antioxidants are essential for the management of diabetes and can be found in palmyra palm syrup (Thi Le et al., 2021), palm oil (Alabi et al., 2020), and other medicinal plants (Ahmed et al., 2023). Oxidative stress and inflammation are major contributors to the onset and consequences of diabetes (Kanwugu et al., 2022; Rais et al., 2022). Antioxidants guard cells against oxidative damage and enhance antioxidant defense systems by assisting in the fight against the increased production of reactive oxygen species (ROS) brought on by hyperglycemia. By neutralizing ROS, the antioxidant qualities of Palmyra palm may provide a safe and efficient natural method of controlling diabetes.

### **Antimicrobial Source**

The bioactive components of palmyra palm are responsible for its strong antibacterial capabilities. Research has revealed the presence of probiotic lactic acid bacteria (LAB) in Toddy Palm Nectar and Palmyra palm sugar, which exhibit potent antibacterial properties against a range of pathogens (Mitsuwan et al., 2022; Pammi et al., 2021). Furthermore, against bacteria that form biofilms, the fruit husk extract of Palmyra palm has antibacterial and antiadhesion properties (Viju et al., 2020). Additionally, using silver nanoparticles made from Palmyra palm inflorescences efficiently prevents the growth of fungi (Thananimit et al., 2022). The antimicrobial characteristics of Palmyra palm, such as its antibacterial, antifungal, and antiadhesion qualities, enhance its effectiveness in fighting infections and makes it a viable option for medical and pharmaceutical uses.

### **Palmyra Palm in Diet as Condiments**

Throughout history, the Palmyra palm has been used for a variety of purposes, including culinary, medical, and cultural ones. Tender fruit endosperm (PTFE) from the palmyra palm is used to treat variety of conditions including fever, skin conditions, hemorrhages, dyspepsia, flatulence, and hyperdipsia due to its aphrodisiac, laxative, sedative, and stomachic qualities (Mathanghi et al., 2022; Mathanghi et al., 2020). Recent inventions include adding Palmyra palm to bread, which adds a distinctive regional twist and can be



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added up to 35% of the recipe without sacrificing bread quality (Cherkasova, 2022). Additionally, different regions use palmyra palms in different ways; Pasuruan is best at using fresh sap, Tuban uses fresh fruits, and Sumenep Madura is very good at using jaggery and palm leaf products. These differences in use represent varied cultural preferences and economic activity (Saidi et al., 2021). These patterns show how old and modern applications can coexist demonstrating the palmyra palm's flexibility and adaptability throughout a range of industries.

### **Effect of Extraction Methods**

The concentration of phytochemicals in the extract of the palmyra palm fruit can be greatly influenced by the extraction technique used. It has been reported that the phytochemical composition of the extract is affected by a variety of extraction processes, including supercritical CO<sub>2</sub> extraction, green production of silver nanoparticles, and different drying methods (Tongkassae et al., 2023). For example, it has been discovered that, at certain concentrations, supercritical CO<sub>2</sub> extraction produces beneficial chemicals including beta-carotene and quercetin (Hoe et al., 2020). Similar to this, differing drying techniques have impacted the phytochemical composition of Palmyra palm flour, resulting in differences in its mineral content and antioxidant qualities (Danbature et al., 2020). Furthermore, employing Palmyra sprout extract for the green synthesis of silver nanoparticles, it was shown that phenols, saponins, alkaloids, and flavonoids were among the phytochemicals present and affected the larvicidal effectiveness of the nanoparticles (Abe-Inge et al., 2018).

### **Current Scientific Studies on Palmyra for Type 2 Diabetes**

Numerous methods have been used in recent scientific research to examine the effectiveness of palmyra (*Borassus flabellifer*) in treating diabetes. In one study, blood glucose levels and important metabolic enzymes in diabetic rats significantly improved as a result of the antidiabetic and antioxidant qualities of immature palmyra palm fruits (Pickering et al., 2022). The potential of palmitic acid, which is derived from the *Dandang gendis* plant, which grows in palmyra, as an AMPK protein activator to lower blood sugar levels was the subject of another study. (Renuka et al., 2020). Furthermore, studies have shown that palmyra fruit pulp inhibits intestinal glucose uptake and lowers serum glucose levels in individuals with moderate diabetes, suggesting that palmyra fruit pulp may have anti-diabetic properties as a food ingredient (Salsabila et al., 2022; Gummadi et al., 2016). Together, these studies demonstrate how palmyra's antidiabetic, antioxidant, and glucose-regulating qualities may help control diabetes.





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Many health advantages can result from including palmyra palm in a daily diet. Products made from palmyra palms, including syrup and granulated sugar, are beneficial additions to a diet since they are high in biological substances, vitamins, minerals, and antioxidants (Thi Le et al., 2021; Huynh Thi Le et al., 2020). For example, palmyra palm syrup has ten vitamins, the most prevalent of which is vitamin E, and demonstrates strong antioxidant activity (Mathanghi et al., 2020). According to Thivya et al. (2020), Palmyra palm granulated sugar also exhibits strong antioxidant qualities, a high total phenolic content and biological activity, all of which enhance cell viability. Palmyra palm products provide comparable benefits to other often used condiments, such as palm oil, without significantly altering cholesterol levels, making them a healthy and safe option (Medvedev and Medvedeva, 2021).

### CONCLUSION

The traditional use of palmyra palm fruit in the control of diabetes indicates great potential efficacy and safety because of its potential as an antidiabetic, palmyra palm fruit has long been used in traditional medicine. Natural products, such as those sourced from, Palmyra palm can provide benefits including antioxidant, anti-inflammatory, and anti-cancer qualities, which makes them advantageous for managing diabetes. As a result of improvements in glycemic control and general healthcare accessibility, fewer amputations are occurring as a result of contemporary pharmacological treatments for diabetic foot ulcers, which center on euglycaemia, antibiotics, and wound care. Still, the expense of wound care is an issue, which has led to research into safe and affordable traditional treatments using palmyra palm fruit.

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