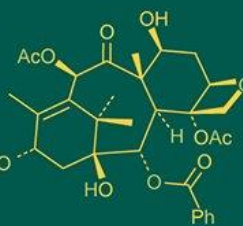
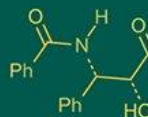


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Effect of Jamun (*Syzygium cumini*) seed powder on glycaemic index and insulin sensitivity in type 2 diabetes

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Abstract

Syzygium cumini (Jamun) is a medicinal plant widely known for its antidiabetic and therapeutic properties. Jamun seeds contain several bioactive compounds such as flavonoids, polyphenols, tannins, glycosides, anthocyanins, jambolin, and ellagic acid that contribute to glycaemic regulation and improvement in insulin sensitivity. The present review aims to evaluate the therapeutic role of Jamun seed powder in the management of Type 2 Diabetes Mellitus (T2DM). A systematic literature review was carried out using scientific databases including PubMed, Google Scholar, and Scopus for studies published between 2006 and 2025. A total of 140 records were identified, out of which 40 studies met the inclusion criteria and were included in the review. Findings from animal studies, clinical trials, and phytochemical analyses demonstrated that Jamun seeds possess significant antihyperglycemic, antioxidant, and antihyperlipidemic activities. Supplementation with Jamun seed powder was associated with reductions in fasting plasma glucose (FPG), postprandial glucose (PPG), and HbA1c levels, along with improvements in insulin sensitivity and lipid metabolism. The antidiabetic effects are mainly attributed to inhibition of starch-to-glucose conversion, enhancement of pancreatic β -cell function, and reduction of oxidative stress. Overall, Jamun seed powder shows strong potential as a natural and cost-effective adjunct therapy for T2DM management; however, further large-scale clinical studies with standardized dosages are required to validate its long-term efficacy and safety.

Keywords: Antidiabetic activity, Insulin sensitivity, Jamun seed powder, Phytochemicals, *Syzygium cumini*

Introduction

Black plum or *Syzygium cumini* is a good source of bioactive compounds like flavonoids, polyphenols, antioxidants, iron and vitamin C. The Jamun tree is a tropical evergreen flowering tree and is one of the significant medicinal plants of the family Myrtaceae that has been utilized for long in Indian and other regular medications around the globe. The main countries that grow jamun are Asian nations like Pakistan, India, Sri Lanka and Bangladesh (Bhakshu *et al.*, 2022; Syama, 2017; Rizvi *et al.*, 2022) [7, 39, 31]. Jamun fruit is oval to elliptic, 1.5 to 3.5 cm long, dark purple or almost black, juicy, fleshy and edible, having a sweet, astringent flavour with a single large seed (Kumar and Singh, 2021) [16].

Its fruits are delicious and have great importance in folk medicine. The jamun fruit is of less interest than the jamun itself, which is used medicinally. The medicinal and therapeutic uses of different parts like bark, fruit and seed (Arooj *et al.*, 2025) [2]. The priority of food fortification is to target micronutrients to staple foods, so that as many people as possible, including vulnerable groups, can access them. Jamun seed powder is also added to many food products to enhance their nutritional value (Nagar *et al.*, 2025) [24]. The jamun fruit contains 83.7-85.8g moisture, 0.7- 0.129g protein, 0.15-0.3g fat, 0.3-0.9g crude fiber, 14g carbohydrate, 0.32-0.4g ash, 8.3-15mg calcium, 35mg magnesium, 15-16.2 phosphorus, 1.2-1.62mg iron, 26.2mg sodium, 55mg potassium, 0.23mg copper, 13mg sulfur, 8mg chlorine, 80 I.U. vitamin A, 0.008- 0.03mg thiamine, 0.009-0.01mg riboflavin, 0.2-0.29mg niacin, 5.7-18mg ascorbic acid, 7 mg choline and 3 mcg folic acid per 100 g of edible portion (Safdar and Khan, 2006) [32].



Fig 1: *Syzygium cumini* seeds powder

1. Plant profile

- **Botanical Name:** *Syzygium cumini* (L.) Skeels
- **Common Name:** Jamun, Java plum, Black plum, Indian blackberry
- **Synonyms:** *Eugenia jambolana*, *Syzygium jambolanum*
- **Family:** Myrtaceae

2. Taxonomic hierarchy

- **Kingdom:** Plantae
- **Phylum:** Angiosperms
- **Order:** Myrtales
- **Family:** Myrtaceae
- **Genus:** *Syzygium*
- **Species:** *Syzygium cumini* (L.) Skeels (Maurya and Tandel, 2025)^[20].

The premise of "Food as Medicine" has been in place since time immemorial. Modern medicine has also acknowledged the healing properties of numerous foods derived from plants. There is an increasing awareness among the scientists that both nutrient and non-nutrient components of the diet may play a significant role in management of several chronic and metabolic diseases such as diabetes, cardio vascular diseases, cancer, cataract, gastro-protective, antioxidant, CNS depressant, anti-allergic, antibacterial, cardio-protective properties. (Banu and Jyothi, 2016; Kumar, and Singh, 2021; Hemavathi *et al.*, 2024)^[6, 16, 9].

Diabetes mellitus (DM) is an endocrinal disorder of carbohydrate, fat and protein metabolism commonly encountered. Chronic hyperglycaemia with a relative deficiency of insulin, resistance or both. Vascular complications are the most important cause of morbidity and mortality in DM patients, due to hyperglycaemia (Sidana *et al.*, 2017; Meharban, A.). (2021); Kumar *et al.*, 2023)^[35, 17]. It is referred to as the "third killer" of humanity, and it is affecting some 10% of the world's indigenous population today. It is a medical condition featuring high blood pressure, abnormal cholesterol levels, insulin resistance and visceral obesity, according to World Health Organization (WHO). (Rizvi *et al.*, 2022)^[31]

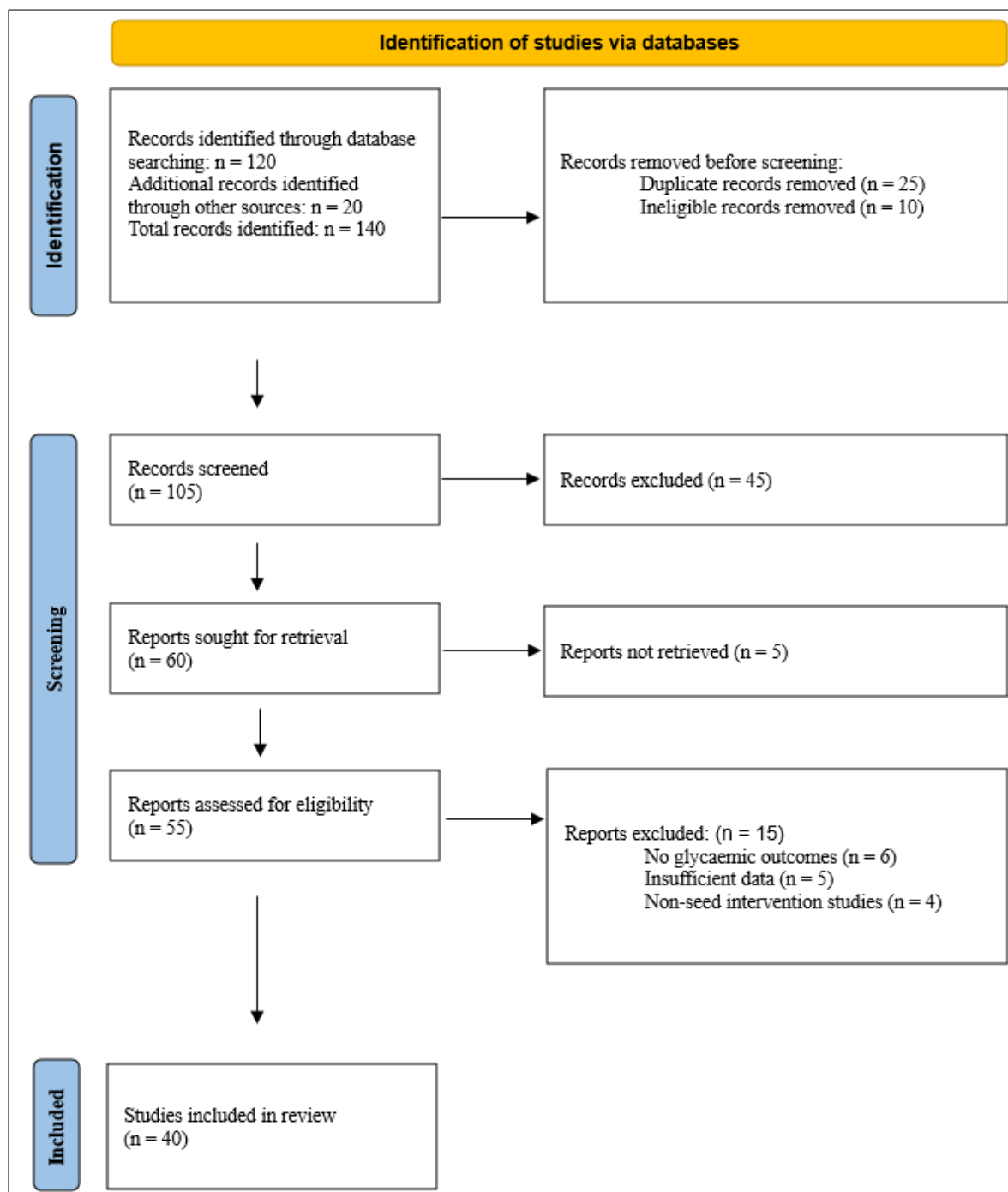
Globally, the incidence of diabetics is expected to hit over 300 million by 2025. India is home to the world's largest diabetic populace. Bangladesh, Pakistan, India, Indonesia

and China are expected to have five of the top 10 countries with the highest percentage of diabetics by 2030. T2DM is a global issue affecting about 230 million people in the world or about 6% of adult's population (Imran *et al.*, 2022)^[10]. Worldwide, 1 in 10 adults (20 to 79 years old) suffer from diabetes. Based on the IDF Diabetes Atlas, the total number of adult patients in the country is 537 million, of which the majority (>90%) have type 2 diabetes (T2DM). Metabolic diseases like diabetes mellitus and hyperlipidaemia are now an epidemic, and they will be a major public health problem in the world (Ni *et al* 2022; Gaurav *et al.*, 2025)^[26, 8].

Thus, the aim of the present review is the assessment of antidiabetic activity of seed powder of *Syzygium cumini* (Jamun) in the treatment of Type 2 Diabetes Mellitus (T2DM). It provides a summary of the existing scientific evidence relating to its effects on glycaemic control, insulin sensitivity and metabolic regulation. The review also emphasizes its phytochemical constituents, mechanism of action and identifies the gaps for further research and clinical validation.

Methodology

The effects of *Syzygium cumini* (Jamun) seed powder on glycaemic control and insulin sensitivity in Type 2 Diabetes Mellitus (T2DM) were evaluated using a systematic literature review. Electronic search was made on the scientific databases PubMed, Google Scholar, ScienceDirect and Scopus from 2006 to 2025. The following key words were used in the search process: Jamun seed powder, *Syzygium cumini*, antidiabetic activity, glycaemic control, and insulin sensitivity. The articles which included the Jamun seeds and diabetes were peer-reviewed, animal studies, clinical trials, phytochemical studies, and review papers. Articles that were not related to diabetic outcome, duplicate articles and articles not published in English were excluded. We found 140 records, and after screening and eligibility assessment, 40 studies were included in the final review. Information on phytochemical composition, dose, study design, fasting plasma glucose (FPG) level, postprandial glucose (PPG) level, HbA1c, insulin resistance, and antioxidant activity were gathered and evaluated descriptively.

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only**Nutritional Components of Jamun seeds**

The seeds of *Syzygium cumini* contain several nutritional and bioactive components, which make them medicinal and therapeutic of great significance. Protein in the seed's ranges from 6.3 to 8.5 per cent; fat 1.18 per cent; crude fibre 16.9 per cent; ash 21.72 per cent. They are also a good source of minerals such as calcium (0.41%) and phosphorus (0.17%). Moreover, the seeds are rich in starch (~41 per cent) and dextrin (~6.1 per cent) which adds to their nutritional benefits and indicates their nutritional value (Sood *et al.*, 2018; Marufa *et al.*, 2019) [38, 19].

The seeds of Jamun are also rich in fatty acids, fatty oils (30g/kg), palmitic, stearic, oleic, linoleic, lauric, malvalic, sterculic and vernolic acids. Of these the ones with a higher percentage are oleic acid (32.2%) and myristic acid (31.7%). Seeds also contain low level phytosterols including β -

sitosterol and relatively high levels of tannins (6-19%) in the form of corilagin, ellagitannins, ellagic acid, galloyl-galactosidase and gallic acid. The antioxidant, antidiabetic and other pharmacological properties of jamun seeds (Rai, 2003; Sood *et al.*, 2018; Marufa *et al.*, 2019) [38, 19] are mainly attributed to these phytochemical constituents.

Bioactive Components of Jamun

The nutrients and medicinal properties of Jamun are quite remarkable in the presence of a variety of bioactive compounds and phytochemicals. The therapeutic potential of its phytochemicals includes alkaloids, anthocyanins, tannins, cardiac glycosides, flavonoids, phenols, terpenoids, glycosides, steroids, saponins, reducing sugars, proanthocyanidins, amino acids and phytosterols (Mulkalwar *et al.*, 2021; Jagetia, 2024) [23, 12]. These

bioactive compounds contribute to various physiological effects of jamun, such as hypoglycemic, anti-inflammatory, anti-bacterial, anti-viral and neuroprotective properties (Singh *et al.*, 2019) [37].

Jamun seeds have a special medicinal importance when compared with other parts of the fruit. Traditionally, they are used for treating diabetes, allergies, viral infections, inflammation and gastric ulcers. Besides these, jamun seeds have diuretic, anti-nociceptive, hypothermic, chemo-protective and cardio-protective properties. Jamun seeds are regarded as one of the natural sources with several bioactive compounds, which make them potential sources for the management of cardiometabolic disorders (Kumar *et al.*, 2022) [15].

The processing technique is also found to contribute significantly towards the maintenance of nutritional and functional quality of jamun products. The antioxidant activity of the freeze-dried jamun powder has been reported as higher than that of hot-air-dried jamun powder, since the freeze-dried powder retains the essential bioactive compounds like ascorbic acid, anthocyanins and total phenols. The freeze-drying process requires little heating and no presence of liquid water, which makes it an effective method of preserving heat-sensitive nutrients and antioxidant compounds (Kumar *et al.*, 2023; Kapoor *et al.*, 2015) [17, 13]. Therefore, freeze drying is regarded as better processing method to preserve the nutritional and therapeutic value of jamun.

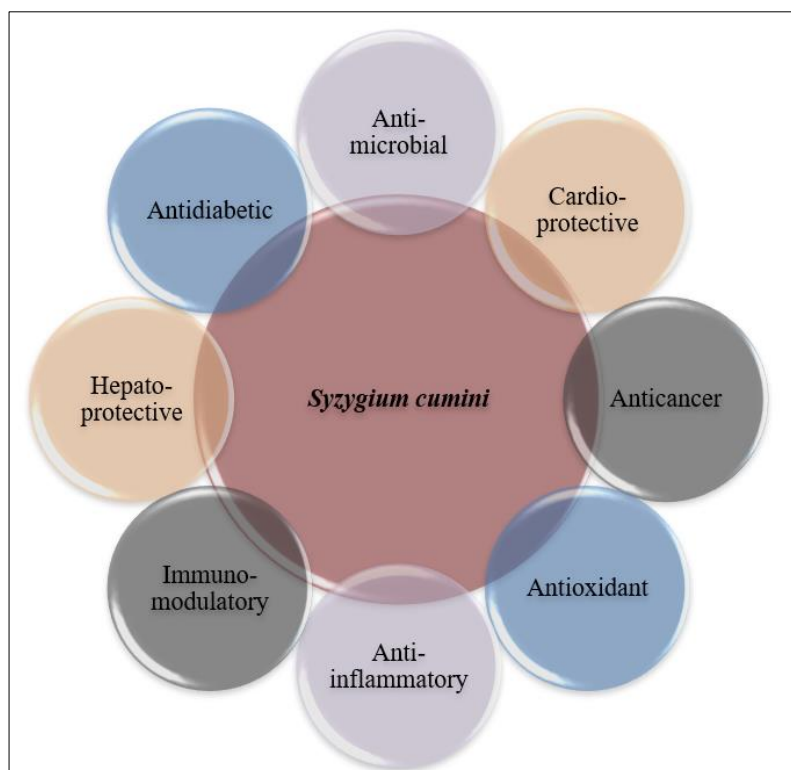


Fig 2: Bioactive and Therapeutic Potential of *Syzygium cumini* (Kumar *et al.*, 2025) [18]

Jamun seeds against Diabetes Mellitus

Syzygium cumini (Jamun) has a rich history of medicinal and antidiabetic applications, with numerous bioactive compounds such as flavonoids, terpenes, anthocyanins, glycosides, jambolin, and ellagic acid playing a crucial role in these therapeutic properties. Application of jamun for diabetes dates back to ages long before the discovery of insulin, through Ayurvedic and Indian folk medicine (Asanaliar and Nadig, 2020) [3]. These phytochemical components play a vital role in imparting the pharmacological properties of jamun, which can be used as a natural remedy for diabetes.

Diabetes is a growing health problem worldwide and in developing countries, it is especially difficult to manage due to the increase in prevalence in both rural and urban areas, low levels of awareness, poor health service provision, and cost of treatment. Chemical drugs are the normal method of treatment for diabetes, but they tend to have bad side effects. Hence, the medicinal plants have attracted interest as alternate, safe and economical method for reducing the incidence and control of diabetes (Yedjou *et al.*, 2023; Saini

et al., 2025) [40, 33]. Thus, early intervention via dietary improvement, physical activity, regular screening, and awareness are also seen as crucial in controlling diabetes and preventing its complications (Ramachandran, 2014; Kaur *et al.*, 2025) [27, 14].

The seeds and pulp of Jamun is found to be very helpful in the anti-diabetic activity. The glycosides found in jamun seeds are thought to have a significant role in reducing blood glucose levels and preventing diseases like neuropathy and cataract which are associated with diabetes (Baliga *et al.*, 2013; Amin, 2020) [5, 1]. Furthermore, these compounds like jambolin and ellagic acid help to prevent the conversion of starch to sugar when there is excess production of glucose, which helps in stabilizing blood sugar (Singh *et al.*, 2019; Mitra, 2007; Amin, 2020) [37, 1]. The polyphenolic compounds found in the jamun seed powder (JSP) also aid in the metabolism of starch into energy, helping to manage blood sugar levels and alleviate symptoms such as excessive urination and thirst, common in diabetes (Ayenampudi *et al.*, 2023) [4]. These good attributes make jamun an alternative treatment for type 2 diabetes.

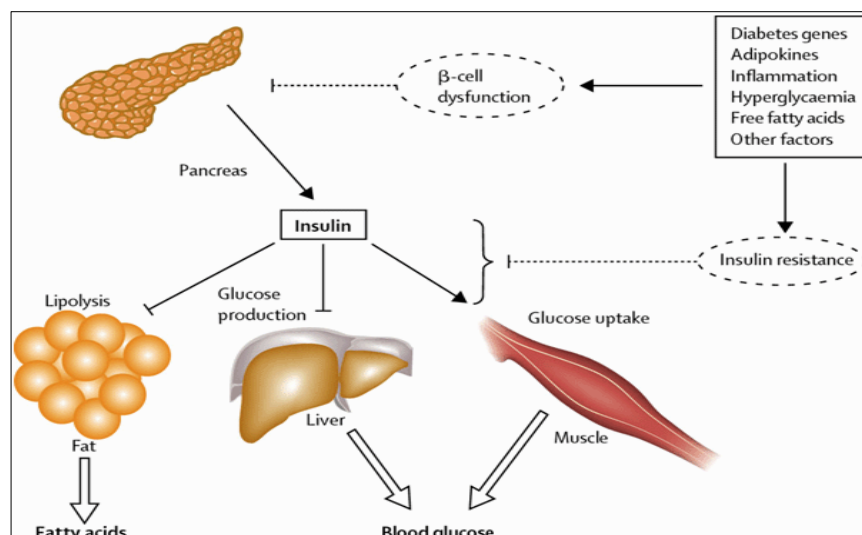


Fig 3: Pathophysiology of hyperglycaemia and increased circulating fatty acids in type 2 diabetes

Jamun seed extracts have also been found to have antidiabetic activity in a few experimental studies. Isolated compounds including mycaminose, ethyl acetate and methanol extracts of *Syzygium cumini* seed kernels significantly lowered blood glucose levels in diabetic rats induced by streptozotocin as reported by Rather *et al.* (2019) [28] and Neha *et al.* (2015) [25]. The antidiabetic activity of mycaminose was observed at 50 mg/kg and jamun seed kernel extracts at 200 mg/kg and 400 mg/kg respectively, which further supports the therapeutic potential of the constituents of jamun seed.

Jamun has also been proven to be effective in the treatment of diabetes in clinical studies. The fasting plasma glucose (FPG) level reduced by 9 per cent, 18 per cent and 30 per cent after 30 days, 60 days and 90 days respectively in the treatment group, whereas the postprandial plasma glucose (PP glucose) reduced by 8 per cent, 15 per cent and 22 per cent after 30 days, 60 days and 90 days respectively in the treatment group as given by Sidana *et al.* (2017) [35]. What's more, the HbA1c level in the treatment group dropped significantly from 8.99 ± 1.39 per cent to 8.31 ± 1.40 per cent after 90 days, while the control group experienced a slight rise. These results suggest that the use of Jamun has beneficial effects on glycaemic control in diabetic patients.

Jamun as antihyperlipidemic agent

Hyperlipidaemia is common with diabetes, and raises the risk of heart disease. The effect on lowering lipid levels is extensively studied in Jamun. The extracts of jamun seed and fruit have been shown to possess hypocholesterolaemia activity with a decrease in total cholesterol, LDL, VLDL and triglycerides and an increase in HDL in several experimental studies (Rekha *et al.*, 2010; Raza *et al.*, 2017) [30, 39]. Such effects have been noted in animal models on alloxan and streptozotocin induced diabetes in which jamun also lowered the activity of HMG-CoA reductase which is crucial to the formation of cholesterol (Siddiqui *et al.*, 2014) [36].

Apart from this, minor but significant antihyperlipidemic property of jamun has been observed in high cholesterol diet fed animals for both water and ethanol extracts (Sharma *et al.*, 2011) [34]. These observations are corroborated by some human studies which indicated that the jamun seed powder supplementation for 60 days caused decrease in blood cholesterol level. The outcomes from this suggest that

jamun can be used as a natural antihyperlipidemic agent (Jagatia, 2018) [11].

Recommendation

From the present review it can be inferred that *Syzygium cumini* (Jamun) seed powder has a promising scope of use as a natural adjunct in the management of Type 2 Diabetes Mellitus as it contains several antihyperglycemic, antioxidant and insulin sensitizing effects (Mulikalwar *et al.*, 2021; Sidana *et al.*, 2017) [23, 35]. Based on current evidence, Jamun seed powder can be used as a functional food ingredient or dietary supplement to enhance glycaemic control, lower fasting and postprandial blood glucose levels, and promote overall metabolic health (Amin, 2020; Kumar *et al.*, 2022; Rizvi *et al.*, 2022) [1, 15, 31].

Therefore, it could be observed that its application may be opted for as a complementary dietary intervention to the conventional antidiabetic treatment, especially during the early stage of diabetes and pre-diabetic condition (Yedjou *et al.*, 2023; Saini *et al.*, 2025) [40, 33]. Nevertheless, although these are encouraging results, additional well-designed clinical trials are needed to determine the optimal dose, safety, and effectiveness of this product in humans, before promoting its therapeutic use broadly (Bhakshu *et al.*, 2022; Ni *et al.*, 2022) [7, 26].

Conclusion

According to this review, *Syzygium cumini* (Jamun) seed powder could be a promising therapeutic agent for the control of type 2 diabetes mellitus. Existing literature reports that the seeds of jamun contain bioactive compounds like flavonoids, polyphenols, tannins, glycosides, and anthocyanins which synergistically support the antihyperglycemic, antioxidant, and insulin-sensitizing effects of jamun. Experimental studies and clinical trials indicate that Jamun seed powder has the potential to lower FBG, PPBG, HbA1c, improve insulin sensitivity and promote pancreatic beta cell function. Besides, its lipid regulating and antioxidant effect might also play a part in the prevention of diabetes-associated complications. Moreover, *Syzygium cumini* seed powder may be recommended as a potential, low-cost and natural co-therapy for glycaemic management in T2DM. Although promising results, differences in study design, dose and preparation require additional large-scale, long-term and

well-standardized clinical trials to ensure its safety, efficacy, and clinical applicability in daily clinical practice.

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