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ANTI-GLYCEMIC AND ANTIOXIDANT ACTIVITY OF *SYZYGIUM CUMINI* L PLANT SKEEL PROTEIN

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ABSTRACT

The skeel proteins extracted from the Syzygium cumini L. plant were investigated for their antidiabetic and antimicrobial properties through an in vitro study. Standardized methods of analysis showed a prominent presence of proteins in the plant extract. The antioxidant capacity of the crude proteins was studied using a total antioxidant model, confirming their efficacy in neutralizing free radicals. To evaluate its antiglycemic properties, the extract was tested on assays targeting the inhibition of alpha-amylase and alpha-glucosidase enzymes that are a critical part of managing the postprandial blood glucose levels. It was further evaluated by carrying out glucose uptake studies using yeast cells, hence showing that it has potential to control glucose metabolism. Significant antioxidant and antiglycemic activities of the protein-rich extract were emphasized. Hence, these findings reveal that the pharmacological properties are mainly attributed to its content of protein. Oxidative stress is associated with chronic conditions; however, this property of antioxidant activity signifies an improvement in oxidative stress that combats this phenomenon.Further, its antiglycemic effects portray that the extract could act as an agent in diabetes treatment management. This study highlights the potential of *Syzygium cumini L*. proteins as bioactive compounds with

great promise in health and medicine, especially for conditions requiring antioxidant and glycemic control. Further research could open up avenues to understand better the mechanisms of these proteins and possibly explore their applications in drug development.

KEYWORDS: *Syzygium cumini L*, Proteins, Glycemic, antioxidant.

INTRODUCTION

Plants have been long sources of bioactive compounds that provide antioxidant, antidiabetic, and antimicrobial benefits, offering sustainable ways of managing different diseases and infections. (Bourais et al, 2023). The natural remedies not only offer therapeutic benefits but also minimize dependency on synthetic drugs, thereby reducing the risks of side effects and drug resistance (Muteeb, et al., 2023). Here, we discuss several notable plants known for their medicinal properties, focusing on their roles in managing chronic conditions such as diabetes and combating microbial infections.

Plants such as *Punica granatum* (pomegranate) (Kokila et al, 2010), *Mentha arvensis* (mint), *Bacopa monnieri* (Brahmi) (**Dinesha Ramadas et al, 2016)**, W*ithania Somnifera* (Ashwagandha) (**Dinesha Ramadas et al, 2016)**, *Piper longum* (long pepper) (Chikkanna et al., 2019; 2020), Turmeric (Curcuma longa) and *Spathodea campanulata* (African tulip tree) are studied extensively for their antioxidant activity due to their rich phytochemical composition and medicinal properties. The fruit Punica granatum (Pomegranate) is rich in polyphenols, including ellagic acid, punicalagins, and anthocyanins. These compounds scavenge free radicals, reduce oxidative stress, and prevent lipid peroxidation. It is used abundantly in the treatment of cardiovascular diseases, neurodegenerative disorders, and cancer as it has high antioxidant activity. Mentha arvensis or Mint contains menthol, rosmarinic acid, and flavonoids. It works through free radical scavenging, and enhancing the activity of enzymatic antioxidants such as superoxide dismutase and catalase (Rajesh Kowti et al., 2010). It heals inflammation, microbial infections, and oxidative damage. The plant Bacopa monnieri (Brahmi) rich in Bacopasides (triterpenoid saponins), flavonoids, and alkaloids (Sanyal et al., 2022). It protects neuronal cells from oxidative stress by enhancing endogenous antioxidant systems. It is commonly used as a neuroprotective agent and memory enhancer. The spice supplement *Piper longum* (Long Pepper) contains Piperine, lignans, and alkaloids (Biswas et al, 2022). It nhibits lipid peroxidation and enhances the activity of antioxidant enzymes. It displays promise in the management of inflammation, and liver disorders, besides the immunomodulator function. The plant Spathodea campanulata,

otherwise known as African Tulip Tree, contains phenolics and flavonoids with significant contents of tannins (Rajesh Kowti et al., 2010). Reported that it has very intense free radical scavenging ability and inhibits lipid peroxidation. Used by traditional medicine for healing and treating wounds, in control of inflammation, and maintenance of oxidative stress.

Turmeric is composed of a variety of bioactive compounds such as curcumin, proteins, and polyphenols that have been reported to have substantial antidiabetic and antimicrobial activities (Roney et al., 2024). Curcumin has been reported to decrease blood glucose by controlling the activity of insulin and carbohydrate-metabolizing enzymes (Murugan, and Maneemegalai, 2023). Its antimicrobial activity includes bacteria and fungi, making it a very versatile medicine for infections. The anti-inflammatory and antioxidant properties of turmeric help reduce symptoms related to chronic diseases, including diabetes, arthritis, and cardiovascular diseases (Dinesha and Leela Srinivas, 2011).

Bitter melon is an example of a tropical vegetable rich in charantin, vicine, and polypeptide-p, which are bioactive compounds simulating the action of insulin (Saleem et al, 2022). These enhance glucose uptake, regulate insulin secretion, inhibit carbohydrate breakdown enzymes, and thus has been highly effective in keeping blood sugar under control. It also has antibacterial actions, thus having dual value for diabetic patients who frequently develop infections.

Glycation is a non-enzymatic reaction between the amino groups of proteins and reducing sugars, which leads to the formation of advanced glycation end (AGE) products (Twarda-Clapa, 2022). The process is a significant component in the pathogenesis of age- and diabetes-related complications, such as cardiovascular diseases, nephropathy, and retinopathy. In living organisms, glycation impacts protein structure and function, impairing their physiological roles.

If oxidative steps are involved in glycation, the process is referred to as glycoxidation. This phenomenon produces free radicals, autooxidation products of glycating sugars, and a diverse group of substances that exacerbate oxidative stress. These reactive species not only damage cellular components but also contribute to chronic inflammation and metabolic dysfunction. Antioxidants derived from natural sources can neutralize free radicals and mitigate the adverse effects of glycation and glycoxidation, providing therapeutic benefits for managing diabetes and its complications (Song et al., 2021).

Syzygium cumini L., commonly known as jamun or black plum, is a tropical fruit-bearing plant valued for its potent antidiabetic and antioxidant properties (Qamar et al., 2022). Its seeds, bark, and fruit pulp are rich in bioactive compounds, including anthocyanins, flavonoids, ellagic acid, and tannins, which contribute to its therapeutic potential. These compounds have been extensively studied for their ability to regulate blood glucose and combat oxidative stress, making Syzygium cumini an excellent candidate for diabetes management and prevention of related complications.

The antidiabetic effects of *Syzygium cumini* are mediated through multiple mechanisms (Rashid et al., 2022). It enhances insulin secretion, facilitates glucose uptake by cells, and inhibits enzymes involved in carbohydrate metabolism, such as alpha-amylase and alpha-glucosidase. These actions collectively help maintain optimal blood sugar levels and reduce postprandial glucose spikes. Moreover, the strong antioxidant activity of the plant helps neutralize free radicals, thereby reducing oxidative damage and inflammation, which are common in diabetes and other chronic diseases.

In addition to its antidiabetic and antioxidant benefits, Syzygium cumini exhibits robust antimicrobial activity (Kotakadi et al., 2024). Studies have shown that its bark, seeds, and fruit extracts are effective against a wide range of pathogens, including bacteria and fungi. The bark, in particular, has been traditionally used for its stomachic, anti-helminthic, febrifuge, digestive, and diuretic properties. It also serves as a carminative, refrigerant, and astringent, with applications in relieving constipation and promoting digestive health.

The pharmacological potential of Syzygium cumini among others underlines the importance of seeking natural sources as new therapeutics. Although for centuries these plants have been used in traditional medicine, validation through modern scientific research helps include them in mainstream health care. Further studies are needed to isolate and characterize bioactive compounds by Advanced techniques such as high-performance liquid chromatography (HPLC) and mass spectrometry can help identify and characterize the active constituents responsible for therapeutic effects. It is important to explore the synergistic effects of plant constituents, which may be more effective and expand their clinical use; developing standardized extracts and determining appropriate dosages are important to achieve maximum benefits and ensure safety in clinical use. More rigorous clinical studies are required to establish the efficacy and safety of plant-based therapies in different populations.

MATERIAL AND METHODS

Syzygium cumini L. plant bark was obtained locally. The collected plant bark washed with 0.1% KMnO4 solution followed with double distilled. The shadow dried bark was grinded into fine powder.

Extraction

A 10g amount of *Syzygium cumini L*. plant peel powder was dissolved in 200 mL double-distilled water and then vortexed for 4 hours at 20°C. The solution was centrifuged at 10,000 rpm for 20 minutes and the supernatant collected. This supernatant was precipitated with 55% ammonium sulfate at 10°C overnight. The solution was then centrifuged again at 10,000 rpm for 20 minutes. The resulting protein precipitate was then dialyzed to remove salts using a 2.5 kDa molecular weight cut-off bio-membrane against water. The salt-free crude protein was then stored at -10°C for further analysis.

Proximate Analysis

The crude protein extract from Syzygium cumini L. peel was estimated for its proximate composition. Total protein estimation was measured by the Bradford method (Bradford, 1976), the total sugar by the method of the phenol-sulfuric acid assay (Dubois et al, 1956). Total phenolic was estimated using Folin–Ciocalteu reagent (Kujala et al., 2000), Ascorbic acid was evaluated (Dinesha and Leela Srinivas, 2011) and, the total flavonoids content was examined (Dinesha et al., 2010).

Antioxidant Activity

DPPH radical scavenging activity

The DPPH (1,1-Diphenyl-2-picrylhydrazyl) radical scavenging activity of the crude protein extract from the peel of the Syzygium cumini L. plant was determined using (Dinesha et al., 2021; Dinesha Ramadas et al., 2021). A 25 µg of dialyzed crude protein mixture was prepared by mixing with 1 mL of freshly prepared 0.5 mM DPPH ethanol solution and 2 mL of 0.1 M acetate buffer at a pH of 5.5. The mixture was incubated at 37°C for 30 minutes, and absorbance was measured at 517 nm using a UV-Visible spectrophotometer. Controls were ascorbic acid and alpha-tocopherol, each at a concentration of 15 µg, under the same conditions.

In vitro methods of anti-diabetic studies

Inhibition of alpha amylase enzyme

To assess the activity of Skeel proteins from *Syzygium cumini L*. plant, 500 µL of skeel proteins (SPSP) and standard drug solutions (100-1000 µg/mL) were mixed with 500 µL of 0.20 mM phosphate buffer, pH 6.9 containing α-amylase solution (0.5 mg/mL). The mixture was incubated at 25°C for 10 minutes, followed by the addition of 500 µL of 1% starch solution prepared in 0.02 M sodium phosphate buffer at a pH of 6.9. The reaction was continued at 25°C for a further 10 minutes. The reaction was terminated by adding 1.0 mL of 3,5-dinitrosalicylic acid and heating the mixture in a boiling water bath for 5 minutes. The reaction mixture was then cooled, diluted with 10 mL of distilled water, and the absorbance was measured at 540 nm. The control represented 100% enzyme activity (Gupta et al., 2020; Smina et al., 2020).

Inhibition of alpha glucosidases enzyme

SPSP proteins from the peel of *Syzygium cumini L*. were assayed for their inhibitory activity by incubating 1 mL of 0.2 M Tris buffer, pH 8.0, with a 2% (w/v) starch substrate of maltose or sucrose. Different concentrations of crude protein were added and incubated for 5 minutes at 37°C. The reaction was started by adding 1 mL of α-glucosidase enzyme and incubating for 10 minutes at 37°C. The reaction was then terminated by heating the mixture in a boiling water bath for 2 minutes. The amount of glucose released was quantified using the glucose oxidase-peroxidase method (Li et al., 2021; Zhang et al., 2021).

Glucose uptake in Yeast cells

Commercially available baker's yeast was obtained and washed several times with water by centrifugation until the supernatant became clear. A 10% (v/v) yeast suspension was prepared in distilled water. For glucose uptake determination, a maximum dose of 15 mg of Syzygium cumini L. plant peel proteins (SPSP) were added to 1 mL of glucose solution at 5, 10, and 25 mM concentrations and incubated for 10 minutes at 37°C. The reaction was started by the addition of 100 µL of yeast suspension. Then, it was vortexed and incubated at 37°C for 60 minutes. Following this incubation, glucose concentration in the supernatant was measured. The standard used was metformin, and the percentage increase in glucose uptake by yeast cells was calculated (Kumar and Khurana et al, 2018; Bubul et al. 2022)

STATISTICAL ANALYSIS

Statistical analysis was done in SPSS (Windows Version 10.0.1 Software Inc., New York) using a one-sided student's t-test. All results refer to means ± SD. $P < 0.05$ was considered as statistically significant when compared to relevant controls.

RESULTS AND DISCUSSION

Medicinal plants and spices are rich in phytochemicals, which confer significant antioxidant properties, making them highly valuable for health-promoting applications and as dietary supplements (Dinesha et al., 2023). *Centella asiatica* one of the herbs which stands out as a powerful antioxidant source with diverse applications, including skincare, neuroprotection, antidiabetic effects, and overall health support (Cristani and Micale, 2024). Its exceptional ability to combat oxidative damage is primarily due to its high content of triterpenoids and phenolic compounds.

Table 1: Proximate analysis of dialyzed *Syzygium cumini L.* plant skeel proteins (SPSP).

Phytochemicals	g%
Proteins	3.9
Carbohydrates	0.05
Polyphenols	0.1
Flavonoids	0.1
Ascorbic acid	0.05

Table 2: DPPH radical scavenging & Anti-glycation activity of dialyzed Syzygium cumini L. plant skeel proteins (SPSP).

	% Inhibition of DPPH radicals *scavenging activity*	% Inhibition of glycation activity
SPSP (25µg/ml)	59	55
Ascorbic acid (10µg/ml)	54	64
Vitamin – E (10µg/ml)	61	61

Proximate analysis

The proximate analysis results of ASAS shows that, it is rich with protein and contains very negligible amount of carbohydrates, polyphenols, flavonoids and ascorbic acid.

Evaluation of DPPH radical scavenging potential of SPSP

A dose-dependent study was conducted on the DPPH radical scavenging activity of SPSP with ascorbic acid and α-tocopherol as the positive controls. The scavenging activity for SPSP at 25 µg was 59%, that of ascorbic acid, 54%, while that for α-tocopherol was 61% when tested at the highest dose tested, which was 10 µg (Table 2). Therefore, it would be

evidenced that SPSP is one of the strongest DPPH radical scavengers when compared to ascorbic acid and α-tocopherol. The antioxidant activity of SPSP may be related to the donation of hydrogen that stabilizes free radicals.

Evaluation of anti-glycation activity

The study on the inhibition of Advanced Glycation End Products (AGEs) showed that SPSP was effective. The crude protein extracts inhibited AGE production by 55% at a maximum dose of 25 µg, compared to 64% for ascorbic acid and 61% for vitamin E, both at lower doses (Table 2). The glycation inhibitory activity of SPSP is probably due to its potent free radical scavenging properties. This may help in the potential management of diabetic patients, since it can inhibit both DPPH radical formation and AGE production. This dual action makes it valuable in managing complications associated with diabetes. The ability to prevent glycation and oxidative stress can be useful in developing antioxidant and antidiabetic therapeutic applications.

CONCLUSION

The study results of the present work indicated that the *Syzygium cumini L*. plant skeel proteins (ASAS) showed antioxidant, and anti-glycation properties. However, the *in vivo* antioxidant activity and the mechanism of action need to be further studied.

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Conflict of Interest

All authors declared no conflicts of interest.

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