Biochemical profiling of syzygium cumini (jamun) pulp extract: evaluation of hypolipidemic efficacy, hepato-renal safety, and antioxidant homeostasis in mus musculus

evaluation of hypolipidemic efficacy, hepato-renal safety, and antioxidant homeostasis

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Abstract—

Syzygium cumini, commonly known as Jamun, is a fruit with significant medicinal properties. It is abundant in polyphenols, flavonoids, and anthocyanins, which are recognised for their role in regulating metabolic and oxidative processes. This study aimed to assess the hypolipidemic effects, liver and kidney safety, and antioxidant capabilities of S. cumini pulp extract in healthy mice (Mus musculus). Jamun fruits were sourced from the Buldhana district in Maharashtra, India, and underwent methanolic cold extraction. Thirty male mice received oral doses of the extract at 200 and 400 mg/kg body weight for 28 days. The results showed a notable dose-dependent decrease ($P < 0.05$) in total cholesterol, triglyceride, and low-density lipoprotein (LDL) levels, along with an increase in high-density lipoprotein (HDL). Liver enzymes (ALT and AST) and kidney markers (creatinine and urea) remained within the normal physiological range, indicating no toxicity. Increased superoxide dismutase (SOD) activity and decreased malondialdehyde (MDA) levels demonstrated an improved antioxidant balance. These findings confirm the safety and metabolic regulatory potential of S. cumini pulp extract, supporting its development as a functional nutraceutical agent.

Index Terms— Syzygium cumini, hypolipidemic activity, antioxidant enzymes, hepato-renal safety, Mus musculus

I. INTRODUCTION

Globally, metabolic disorders, such as dyslipidemia, oxidative stress, and related liver and kidney dysfunction, significantly contribute to cardiovascular diseases and metabolic syndrome. Although synthetic hypolipidemic drugs, such as statins, are commonly used, their prolonged use is frequently associated with negative side effects, including liver toxicity, muscle disease, and kidney issues. This has led to growing interest in finding safer, plant-based alternatives (Sharma et al., 2008; Prince et al., 2004).

Syzygium cumini (L.) Skeels, commonly known as Jamun, is a tropical evergreen tree belonging to the family Myrtaceae, widely distributed across the Indian subcontinent. In traditional Indian medicine, various parts of the plant, including seeds, bark, leaves, and fruits, have been employed for the management of diabetes, inflammation, and gastrointestinal disorders (Ayyanar & Subash-Babu, 2012). While Jamun seeds have been extensively investigated for their antidiabetic and hypolipidemic potential, the fruit pulp remains comparatively underexplored, despite being a rich source of bioactive phytochemicals (Banerjee et al., 2005).

Jamun pulp contains significant concentrations of anthocyanins, such as delphinidin, cyanidin, and malvidin, along with flavonoids, including quercetin and myricetin, phenolic acids, and hydrolyzable tannins (Gajera et al., 2017). These compounds exert lipid-lowering effects by inhibiting cholesterol biosynthesis, enhancing lipid clearance, and reducing lipid peroxidation. Additionally, polyphenols have been shown to activate antioxidant defence mechanisms by modulating the nuclear factor erythroid 2–related factor 2 (Nrf2) signalling pathway, thereby protecting cells against oxidative stress-induced damage (Banerjee et al., 2005; Gajera et al., 2017).

Considering the limited experimental evidence on the biochemical effects of Jamun pulp, the present study aims to evaluate the hypolipidemic efficacy, hepato-renal safety, and antioxidant homeostasis of Syzygium cumini pulp extract in Mus musculus, using fruits collected from Buldhana district, Maharashtra, India.

II. MATERIALS AND METHODS

A. Study Area

Plant material was collected from the Buldhana district in the Vidarbha region of Maharashtra, India. The region experiences a tropical semi-arid climate with distinct seasonal variations, which influence phytochemical accumulation in medicinal plants.

B. Collection and Extraction of Plant Material

Fresh ripe Jamun fruits were collected during the peak fruiting season from the Buldhana district and authenticated using standard botanical keys. The pulp was manually separated, shade-dried, and subjected to methanolic extraction using the cold maceration method for 72 h. Cold extraction was employed to prevent the degradation of thermolabile anthocyanins and phenolic compounds. The extract was concentrated under reduced pressure and stored at 4°C until use.

C. Qualitative Phytochemical Screening

Preliminary phytochemical screening was conducted to identify the major bioactive constituents.

Table 1. Qualitative phytochemical profile of Syzygium cumini pulp extract

Bioactive Compound	Test Performed	Observation	Inference
Anthocyanins	NaOH test	Blue-green coloration	Strongly present
Flavonoids	Shinoda test	Magenta/red color	Present
Tannins	Ferric chloride test	Greenish-black color	Present
Phenols	Folin–Ciocalteu test	Blue coloration	High concentration

D. Experimental Animals and Ethical Compliance

Male Mus musculus weighing 25–30 g were maintained under standard laboratory conditions (25 ± 2°C; 12 h light/dark cycle) with free access to a standard pellet diet and water. All experimental procedures followed the CPCSEA guidelines and OECD Guideline 407 for repeated 28-day oral toxicity studies.

E. Experimental Design

Animals were randomly divided into three groups (n = 10 per group):

- Group A (Control): Standard diet + distilled water
- Group B (Low Dose): Jamun pulp extract (200 mg/kg b.w.)
- Group C (High Dose): Jamun pulp extract (400 mg/kg b.w.)

The extract was administered orally once daily for 28 days.

3. Results

3.1 Effect on Lipid Profile

Jamun pulp extract produced a significant dose-dependent improvement in lipid parameters. LDL cholesterol levels were calculated using the Friedewald equation.

Table 2. Effect of *Syzygium cumini* pulp extract on lipid profile

Parameter (mg/dL)	Control	Group B (200 mg/kg)	Group C (400 mg/kg)
Total Cholesterol	114.2 ± 3.8	98.4 ± 2.9*	86.1 ± 2.5**
Triglycerides	102.6 ± 4.5	88.5 ± 3.1*	76.8 ± 2.7**
HDL-Cholesterol	33.8 ± 1.4	38.2 ± 1.6	45.4 ± 1.9**
LDL-Cholesterol	60.1 ± 2.2	42.5 ± 1.8*	25.4 ± 1.5**

*P < 0.05, **P < 0.01 compared with control

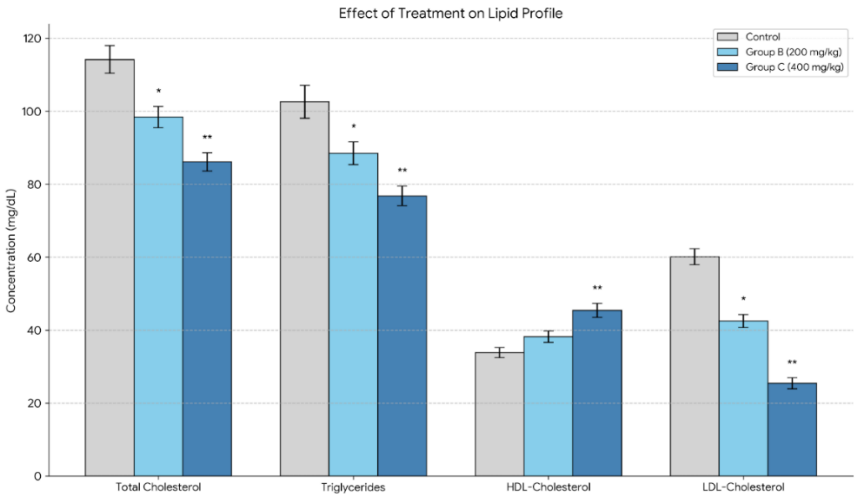

Figure 1: Comparison of lipid profile parameters across experimental groups. *Data are presented as Mean ± SEM (n=x). Group B (200 mg/kg) and Group C (400 mg/kg) were compared against the Control group. Statistical significance is indicated by *p < 0.05 and **p < 0.01.*

3.2 Hepato-Renal Function Parameters

No significant alterations were observed in the hepatic or renal biomarkers, indicating the safety of the extract.

Table 3. Hepatic and renal function markers

Marker	Control	Group B	Group C
ALT (U/L)	33.5 ± 2.1	32.4 ± 1.8	31.6 ± 2.0
AST (U/L)	46.2 ± 3.4	45.1 ± 2.9	44.8 ± 3.1
Creatinine (mg/dL)	0.66 ± 0.04	0.64 ± 0.03	0.65 ± 0.05
Urea (mg/dL)	28.4 ± 2.1	27.9 ± 1.7	28.1 ± 1.9

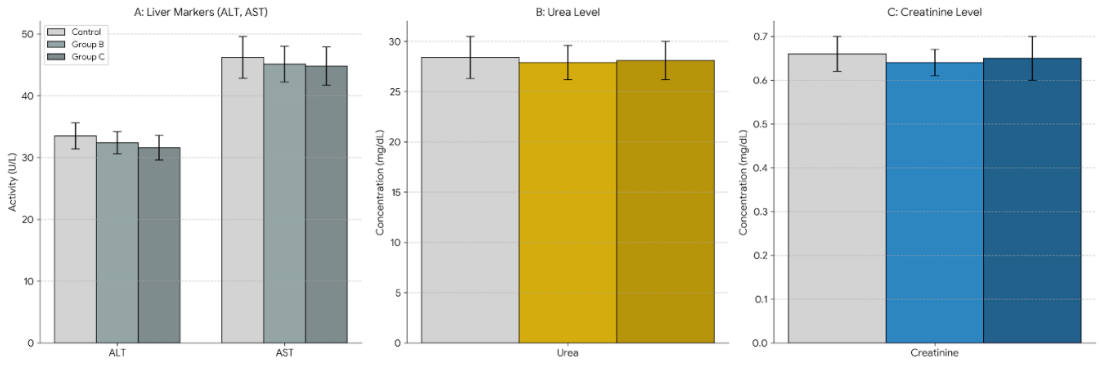

Figure 2: Evaluation of hepatic and renal safety markers. *(A) Liver enzymes (ALT and AST) activity. (B) Serum Urea levels. (C) Serum Creatinine levels. All data are expressed as Mean ± SEM (n=x). No significant differences were observed between the treatment groups (Group B and C) and the control group (p > 0.05), indicating a favorable safety profile.*

3.3 Antioxidant Status

- Superoxide Dismutase (SOD): Increased by ~52% in Group C
- Malondialdehyde (MDA): Decreased by ~38% in Group C

These results indicate a significant reduction in oxidative stress and lipid peroxidation.

4. Discussion

The present study demonstrates that oral administration of *Syzygium cumini* pulp extract significantly improves lipid metabolism while maintaining hepato-renal safety in *Mus musculus*. The observed reductions in total cholesterol, triglyceride, and LDL levels, along with an increase in HDL levels, indicate a strong hypolipidemic effect of the extract.

The lipid-lowering activity may be attributed to the presence of flavonoids, such as quercetin and myricetin, which are known inhibitors of HMG-CoA reductase, a key regulatory enzyme in cholesterol biosynthesis (Sharma et al., 2008). In addition, anthocyanins present in Jamun pulp have been reported to modulate lipid metabolism by activating PPAR-α and AMP-activated protein kinase (AMPK), thereby enhancing fatty acid oxidation and reducing lipid accumulation (Gajera et al., 2017). Similar hypolipidemic effects of *Syzygium cumini* constituents have been reported in previous experimental models (Prince et al., 2004). The absence of significant alterations in hepatic enzymes (ALT and AST) and renal markers (creatinine and urea) suggests that Jamun pulp extract does not exert hepatotoxic or nephrotoxic effects. This finding is consistent with previous studies reporting the protective role of *S. cumini* phytochemicals against oxidative and metabolic stress and contrasts favourably with the adverse effects commonly associated with the prolonged use of synthetic lipid-lowering drugs (Prince et al., 2004; Sharma et al., 2008).

The enhancement of antioxidant status observed in the present study, as evidenced by increased SOD activity and reduced MDA levels, indicates the effective suppression of oxidative stress. Polyphenolic compounds in jamun pulp are known to act as electrophilic activators of the Nrf2 pathway, leading to the upregulation of endogenous antioxidant enzymes, such as superoxide dismutase, catalase, and glutathione peroxidase (Banerjee et al., 2005; Gajera et al., 2017). This mechanism plays a crucial role in protecting cellular membranes and biomolecules from reactive oxygen species–mediated damage.

Furthermore, the environmental and edaphoclimatic conditions of the Buldhana district may contribute to enhanced phytochemical accumulation in jamun fruits, thereby influencing their biological efficacy, as reported for other medicinal plants grown under region-specific climatic conditions (Ayyanar & Subash-Babu, 2012).

5. Conclusion

The present study demonstrates that the *Syzygium cumini* pulp extract obtained from fruits collected in Buldhana district, Maharashtra, exhibits potent hypolipidemic and antioxidant effects while maintaining hepato-renal safety in *Mus musculus*. These findings provide scientific validation for the traditional use of jamun pulp and highlight its potential as a functional food or nutraceutical for managing dyslipidemia and oxidative stress-related disorders.

8. References

1. Ayyanar, M., & Subash-Babu, P. (2012). *Syzygium cumini* (L.) Skeels: A review of its phytochemical constituents and traditional uses. *Asian Pacific Journal of Tropical Biomedicine*, 2(3), 240–251.
2. Banerjee, A., Dasgupta, N., & De, B. (2005). In vitro study of the antioxidant activity of *Syzygium cumini* fruit. *Food Chemistry*, 90(4), 727–733.
3. Gajera, H. P., Gwevara, S. N., & Golakiya, B. A. (2017). Antioxidant profile of Jamun (*Syzygium cumini*) fruits. *Journal of Food Biochemistry*, 41(1), e12316.
4. OECD. (2025). *Guideline for the Testing of Chemicals No. 407: Repeated Dose 28-Day Oral Toxicity Study in Rodents*.
5. Sharma B., Balomajumder C., Roy P. (2008). Hypoglycemic and hypolipidemic effects of flavonoid-rich extract from *Eugenia jambolana* seeds. *Food and Chemical Toxicology*, 46(8), 2730–2735.
6. Prince, P. S., Kamalakkannan, N., & Menon, V. P. (2004). Antidiabetic and antihyperlipidemic effects of *Syzygium cumini* seeds. *Journal of Ethnopharmacology*, 91(2–3), 209–213.