Int J Adv Life Sci Res. Volume 9(3) 208-218
https://doi.org/10.31632/ijalsr.2026.v09i03.016

International Journal of Advancement in Life Sciences Research

Online ISSN: 2581-4877

Journal homepage http://ijalsr.org

Original Article

Mechanistic Insights into the Antioxidant and Antidiabetic Potential of Longan (*Dimocarpus longan* L.) Fruit Peel

Tejeswini Raghuraman[1], Joshna Sri Kandalu Venkatesh Babu[1], Sarah Jane Monica[1*], Nousheen Irfana Syed[2], Deevena Jemima[3]

[1]*Department of Food Science, M.O.P. Vaishnav College for Women (Autonomous), Chennai 600034, Tamil Nadu, India*
[2]*Department of PG Studies and Research in Home Science, Justice Basheer Ahmed Sayeed College for Women (Autonomous), Chennai 600018, Tamil Nadu, India*
[3]*Department of Home Science, Women's Christian College (Autonomous), Chennai 600006, Tamil Nadu, India*

***Corresponding Author's Email:** sarahjanemonica.fsm@mopvaishnav.ac.in*

Abstract

Valorization of fruit peel offers a sustainable approach to extracting bioactive compounds with therapeutic potential. This study assesses the antioxidant and antidiabetic properties of longan peel extract (LPE). Antioxidant activity was determined using radical scavenging (superoxide, nitric oxide, and hydroxyl) and reducing assays (FRAP and phosphomolybdenum). The antidiabetic potential was determined by enzymatic assays (alpha-amylase and alpha-glucosidase) and a non-enzymatic assay (glucose uptake by yeast cells). The bioactive compounds were identified using Gas Chromatography-Mass Spectrometry (GC-MS). LPE exhibited concentration-dependent free radical scavenging activity, with the highest activity for nitric oxide (IC50 value = 15.03 µg/mL), followed by superoxide (IC50 value = 20.57 µg/mL) and hydroxyl radical scavenging (IC50 value = 97.68 µg/mL). The reducing power also increased in a concentration-dependent manner. Enzymatic inhibition assays showed an IC50 value of 28.59 µg/mL for alpha-amylase and 8.57 µg/mL for alpha-glucosidase. Glucose uptake by yeast cells increased linearly across all tested concentrations (5, 10, and 25 mM). GC-MS analysis detected various compounds, with the predominant compounds being 13-Docosenamide (40.25%), α-D-glucopyranoside (14.13%), hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl) ethyl ester (4.73%), benzoic acid, 4-ethoxy-, ethyl ester (4.60%), myristic acid (2.17%), geranylgeraniol (0.90%), and deoxyspergualins (0.65%). These findings highlight the antioxidant and antidiabetic properties of LPE; however, further research is needed to isolate bioactive compounds and determine their therapeutic potential.

Keywords: *Antidiabetic; Antioxidant; Fruit Peel; GC-MS, Longan*

Introduction

The processing of horticultural crops generates substantial waste as by-products, with approximately 1.3 billion tonnes discarded across the supply chain, from production to the consumer stage (Economou *et al*., 2024). This loss has environmental and economic repercussions, affecting food security and exacerbating climate change. The increasing global demand for processed fruits and vegetables has led to greater agro-industrial waste generation, creating significant challenges for waste management and sustainable disposal. The degradation of waste substrates contributes to the emission of greenhouse gases (methane and carbon dioxide), disrupts nutrient cycles, promotes leachate formation, produces unpleasant odour, and deteriorates the soil quality (Sarangi *et al*.,

Received on :15th March 2026; Revised version received on :21st June 2026; Accepted: 24th June 2026

2024). Fruit waste accounts for a significant portion of industrial by-products. During the processing of tropical and subtropical fruits into value-added products, waste substrates, including peels, seeds, rind, and pomace (constituting 25–35% of the total weight), are typically discarded, which contributes to environmental pollution, contamination, and increased landfill burden (Kumar *et al*., 2020; Kaushik *et al*., 2025). These discarded fractions are rich in bioactive compounds that remain underutilized despite their high economic potential. Conversely, multiple studies highlight fruit peels as a rich source of functional compounds with various therapeutic properties (Hasan *et al*., 2024). Thus, improper management of these waste substrates worsens environmental challenges and results in the loss of valuable bioresources (Liu *et al*., 2023). Therefore, exploring strategies for utilization of bioactive compounds from fruit waste has become an important area of research.

Longan (*Dimocarpus longan* L.), a member of the Sapindaceae family, is cultivated in South and Southeast Asia. The fruit is widely known for its unique flavor, nutrient profile, and medicinal significance in traditional medical systems. The pulp, peel, seeds, leaves, and flowers have been used in ethnomedicine to treat cognitive dysfunction, fever, gastrointestinal disorders, menstrual problems, and neuralgia (Zhang *et al*., 2020; Paul *et al*., 2021; Hu *et al*., 2025; Zubairu *et al*., 2025). The peel of this fruit is light brown. It has a translucent aril, which is a rich source of essential minerals (calcium, iron, magnesium, potassium, and sodium) (Yang *et al*., 2011). In addition to minerals, the fruit contains polysaccharides, phenolic compounds, and organic acids that confer various medicinal properties. The aril, seed, and pulp extracts exhibit significant antioxidant, anti-tyrosinase, and anticancer properties against A549, HepG2, and SGC7901 cell lines (Lal *et al*., 2020). The fruit peel extract exhibits greater antioxidant activity due to its increased polyphenol content (Begam *et al*., 2020). Additionally, the polyphenols in the peel extract effectively inhibit the enzymatic breakdown of starch (Fu *et al*., 2015).

Valorization of fruit peels is a promising approach to the sustainable management of agro-wastes. Fruit peels are often discarded, even though they are rich in phytochemicals with significant nutritional and therapeutic values. Converting these residues into bioactive extracts helps address waste accumulation, reduce environmental pollution, and develop value-added functional compounds for the food and pharmaceutical industries. This study aims to evaluate the antioxidant and antidiabetic potential of longan fruit peel extract, elucidate the mechanisms underlying its bioactivity, and enhance the sustainable use of horticultural by-products.

Methodology

Preparation of Extract

Fresh longan fruits sourced from Pazhamudhir Nilayam, Chennai, were washed with distilled water and peeled. The peels were shade-dried for 72 hours, then crushed with a mortar and pestle. For extract preparation, 5 g of crushed peel was mixed with 50 mL of ethanol and left for 72 hours. The supernatant was filtered using Whatman filter paper (No. 42), and the solvent was evaporated using a rotary vacuum evaporator. The resulting dry residue was stored at 4°C for further analysis.

Antioxidant Activity

Superoxide (O_2^-) Radical Scavenging Assay

Varying concentrations of LPE were mixed with 0.9 mL of 50 mM phosphate buffer (pH 7.4), 0.3 mL of 20 mM PMS, 150 mM NADH, and 50 mM NBT. The mixture was incubated for 15 min, after which the OD was measured at 590 nm (Hyland *et al*., 1983). Results are expressed as % inhibition of superoxide anion radicals.

$$\% \text{ inhibition of superoxide radical} = [(A_C - A_S / A_C) \times 100]$$

A_C corresponds to the control absorbance

A_S corresponds to the sample absorbance

Nitric Oxide Scavenging Assay

Varying concentrations of LPE were mixed with 0.5 mL of sodium nitroprusside (10 mM) prepared with phosphate buffer solution and incubated for 60 min at room temperature. Later, 0.5 mL of Griess reagent was added, and the mixture was incubated for 15 min at room temperature. The OD was measured at 540 nm (Taira *et al*., 2009). Results are expressed as % inhibition of nitric oxide radicals.

$$\% \text{ inhibition of nitric oxide radical} = [(A_C - A_S/A_C) \times 100]$$

A_C corresponds to the control absorbance

A_S corresponds to the sample absorbance

Hydroxyl Radical Scavenging Assay

Varying concentrations of LPE were mixed with 1 mL of iron EDTA, 0.5 mL of EDTA, and 1 mL of DMSO and incubated in a boiling water bath at 80ºC to 90ºC for 15 min. After incubation, 1 mL of ice-cold Trichloroacetic acid and 3 mL of Nash reagent were added to the test tubes and incubated for 15 min at room temperature. The OD was measured at 412 nm (Halliwell *et al*., 1987). Results are expressed as % inhibition of hydroxyl radicals.

$$\% \text{ inhibition of hydroxyl radical} = [(A_C - A_S/A_C) \times 100]$$

A_C corresponds to the control absorbance

A_S corresponds to the sample absorbance

FRAP Assay

Test tubes containing varying concentrations of LPE were mixed with 1 mL of Phosphate Buffer Solution (0.2 M; pH 6.6) and 1000 µL of 1% potassium ferricyanide (w/v). The test tubes were kept in a thermostatic bath at 50°C for 25 min. After cooling, 1 mL of 10% Trichloroacetic acid (w/v) and 0.5 mL of 0.1% freshly prepared ferric chloride (w/v) were added. The OD was measured at 700 nm (Benzie & Strain, 1999). Results are expressed as a % reduction of Fe^{3+} to Fe^{2+} ions.

$$\% \text{ reduction of } Fe^{3+} \text{ to } Fe^{2+} \text{ ions} = [(A_s - A_c/A_s) \times 100]$$

A_C corresponds to the control absorbance

A_S corresponds to the sample absorbance

Phosphomolybdenum Reducing Assay

Varying concentrations of LPE were mixed with 1000 µL of freshly prepared reagent solution [0.6 M H_2SO_4, 28 mM Na_3PO_4, and 4 mM $(NH_4)_2MoO_4$]. The test tubes were incubated for 90 min in a thermostatic bath at 95°C. After cooling, the OD was measured at 695 nm (Prieto *et al*., 1999). Results are expressed as a percentage reduction of Mo (VI) to Mo (V).

$$\% \text{ reduction of Mo (VI) to Mo (V)} = [(A_s - A_c/A_s) \times 100]$$

A_C corresponds to the control absorbance

A_S corresponds to the sample absorbance

For all antioxidant assays, the standard used was ascorbic acid.

Antidiabetic Activity

Alpha Amylase Inhibition Assay

Varying concentrations of LPE were added to 0.7 mL of sodium phosphate buffer containing 6 mM sodium chloride (0.02M; pH 6.9) and 15 µL of alpha-amylase solution. The mixture was then incubated for 10 min. Later, 0.6 mL of a 1% starch solution (w/v) was added, and the mixture was incubated for 1 hr. Later, 0.1 mL of dilute HCL was added to stop the reaction, and 0.2 mL of iodine

solution was added. The standard used was metformin. The OD was measured at 565 nm (Qasem *et al*., 2023). Results are expressed as % inhibition of alpha-amylase.

$$\% \text{ inhibition of alpha-amylase} = [(A_C - A_S/A_C) \times 100]$$

A_C corresponds to the control absorbance

A_S corresponds to the sample absorbance

Alpha-Glucosidase Inhibition Assay

Differentconcentrations of LPE weremixed with 100 µL of 50 mM phosphate buffer solution (pH7.0) and 25 µL of alpha-glucosidase solution and incubated for 20 min. Later, 25 µL of 5 mM p-NPG was added, and the mixture was incubated for 30 min. Finally, the enzymaticreaction was stopped by adding 70 µL of 0.1 M sodium carbonate. The absorbance was read at 405 nm (Shai *et al*., 2011). Metformin was used as the reference standard. The results were expressed as the percentage inhibition of α-glucosidase activity.

$$\% \text{ inhibition of alpha-glucosidase} = [(A_C - A_S/A_C) \times 100]$$

A_C corresponds to the control absorbance

A_S corresponds to the sample absorbance

Glucose Uptake Assay by Yeast Cells

Briefly, commercial baker's yeast was washed by repeated centrifugation (3,000×g; 5 min) in distilled water until the supernatant fluids were clear, and a 10% (v/v) suspension was prepared in distilled water. Varying concentrations of LPE were mixed with 0.5 mL of glucose solution of different concentrations (5 mM, 10 mM, and 25 mM) and 100 µL of yeast suspension solution and incubated for 1 hr at room temperature. After incubation, the solution was centrifuged at 4000 rpm for 15 min. The OD was measured at 520 nm (Elhaj *et al*., 2020). Metronidazole was used as the reference standard. The results were expressed as the percentage increase in glucose uptake by yeast cells.

$$\% \text{ increase in glucose uptake} = [(A_C - A_S/A_C) \times 100]$$

A_C corresponds to the control absorbance

A_S corresponds to the sample absorbance

GC-MS

The extract was injected into an HP column (30 mm x 0.25 mm ID with 0.25 µm film thickness) (Agilent Technologies 6890 N JEOL GC Mate II GC–MS model). For detection, an electron ionization system operated at 80 eV was used. Pure helium gas (99.999%) was used as a carrier gas at a constant flow rate of 1 mL/min. The injector temperature was maintained at 300ºC, while the ion source temperature was programmed to 250ºC. Initially, the oven temperature was maintained at 110ºC with an increase of 10ºC/min to 250ºC. The names, molecular weights, and structures of the compounds were determined using the NIST database (Dandekar *et al*., 2015).

Statistical Analyses

All assays were performed in triplicate, and data are expressed as mean ± SD. Data analysis was performed using SPSS (v15.0; IBM Corp., Endicott, NY, USA). One-way ANOVA followed by Duncan's Multiple Range Test (DMRT) was applied to determine significant differences ($P< 0.05$). IC_{50} values were calculated using GraphPad Prism software.

Results

LPE demonstrated concentration-responsive free radical scavenging activity against superoxide, nitric oxide, and hydroxyl radicals. The highest inhibition was observed at 100 µg/mL, reaching 93.84%, 78.16%, and 50.59%, respectively. Although LPE's scavenging activity was lower than that of

ascorbic acid at all tested concentrations, its relatively low IC_{50} values for superoxide (20.57 µg/mL) and NO radicals (15.03 µg/mL) indicate significant antioxidant potential.

Table 1:*Free Radical Scavenging Activity of LPE*

Concentration µg/mL	% Inhibition of Superoxide Radical		% Inhibition of NO Radical		% Inhibition of •OH Radical	
	LPE	Ascorbic Acid	LPE	Ascorbic Acid	LPE	Ascorbic Acid
10	36.17 ± 0.62[a]	89.87 ± 0.49[a]	33.35 ± 2.21[a]	79.39 ±4.31[a]	23.73 ± 5.27[a]	76.52 ± 0.41[a]
25	50.17 ± 5.81[b]	92.34 ± 0.88[b]	52.72 ± 0.65[b]	83.59 ± 2.70[ab]	26.08 ± 3.61[a]	78.46 ± 0.83[b]
50	83.80 ± 1.67[c]	95.80 ± 0.29[c]	63.83 ± 2.79[c]	88.55 ± 4.31[bc]	35.49 ± 6.93[a]	80.91 ± 0.66[c]
75	90.96 ± 6.16[c]	97.24 ± 0.20[d]	68.63 ± 3.05[c]	90.46 ± 2.70[bc]	37.06 ± 7.49[ab]	83.55 ± 0.25[d]
100	93.84 ± 3.42[c]	98.35 ± 0.19[d]	78.16 ± 0.99[d]	93.52 ± 1.62[c]	50.59 ± 2.77[b]	84.37 ± 0.74[d]
IC_{50} Value	**20.57**	**5.57**	**15.03**	**6.31**	**97.68**	**6.54**

Values are presented as the mean of three independent observations. Mean values within a column that do not share a common letter differ significantly based on ANOVA and Duncan's Multiple Range Test (P<0.05).

Table 2:*Reducing Power of LPE*

Concentration µg/mL	FRAP Assay		Phosphomolybdenum Assay	
	LPE	Ascorbic Acid	LPE	Ascorbic Acid
10	51.13 ± 0.39[a]	69.72 ± 0.76[a]	36.00 ± 6.98[a]	85.98 ± 0.18[a]
25	70.73 ± 1.11[b]	78.03 ± 0.74[b]	42.67 ± 5.56[a]	87.57 ± 0.14[b]
50	79.39 ± 0.79[c]	84.64 ± 0.52[c]	68.65 ± 1.94[b]	88.72 ± 0.16[c]
75	81.75 ± 0.72[d]	88.41 ± 0.19[d]	80.26 ± 2.20[c]	89.22 ± 0.20[d]
100	82.39 ± 0.13[d]	91.69 ± 0.08[e]	82.58 ± 1.32[c]	89.49 ± 0.25[d]

Values are presented as the mean of three independent observations. Mean values within a column that do not share a common letter differ significantly based on ANOVA and Duncan's Multiple Range Test (P<0.05).

LPE exhibited a concentration-dependent increase in reducing power, as evidenced by both FRAP and phosphomolybdenum assays. In the FRAP assay, LPE's reducing activity increased from 51.13% at 10 µg/mL to 82.39% at 100 µg/mL. Similarly, in the phosphomolybdenum assay, the reducing activity increased from 36% to 82.58% within the same concentration range. The results of the reducing power assays suggest that LPE is an effective electron donor, contributing to its significant antioxidant potential.

Table 3:*Alpha-Amylase and Alpha-Glucosidase Inhibitory Activities of LPE*

Concentration µg/mL	% Inhibition of Alpha-amylase		% Inhibition of Alpha-glucosidase	
	LPE	Metformin	LPE	Metformin
10	23.52 ± 2.09[a]	54.40 ± 3.39[a]	58.41 ± 3.27[a]	63.46 ± 4.27[a]
25	43.78 ± 2.26[b]	60.00 ± 2.26[ab]	66.09 ± 1.85[b]	65.94 ± 4.66[a]
50	68.31 ± 2.26[c]	70.80 ± 3.96 [bc]	74.28 ± 0.52[c]	76.37 ± 1.56[ab]
75	80.63 ± 2.09[d]	78.80 ± 1.70[cd]	80.94 ± 0.31[cd]	84.89 ± 3.49[b]
100	88.97 ± 0.81[e]	88.00 ± 4.53[d]	85.51 ± 0.62[d]	86.82 ± 3.88[b]
IC_{50} Value	**28.59**	**9.21**	**8.57**	**7.90**

Values are presented as the mean of three independent observations. Mean values within a column that do not share a common letter differ significantly based on ANOVA and Duncan's Multiple Range Test (P<0.05).

LPE demonstrated concentration-dependent inhibition of both α-amylase and α-glucosidase. Inhibition of α-amylase increased from 23.52% at 10 µg/mL to 88.97% at 100 µg/mL, while α-glucosidase inhibition rose from 58.41% to 85.51% over the same concentration range. The lower IC_{50} value for α-glucosidase (8.57 µg/mL) compared to α-amylase (28.59 µg/mL) indicates a stronger inhibitory effect against α-glucosidase. These results suggest that LPE has the potential to modulate carbohydrate digestion and glucose release by inhibiting these enzymes.

Table 4: *Effect of LPE on Glucose Adsorption by Yeast Cells*

Concentration µg/mL	5mM		10 mM		25 mM	
	LPE		LPE		LPE	
10	23.34 ± 2.45[a]	60.43 ± 1.02[a]	13.47 ± 1.46[a]	64.45 ± 3.15[a]	21.00 ± 2.35[a]	57.81 ± 1.10[a]
25	34.90 ± 6.27[ab]	66.01 ± 1.27[b]	26.47 ± 1.46[b]	70.95 ± 3.37[b]	49.76 ± 1.23[b]	60.94 ± 0.74[b]
50	46.05 ±11.46[bc]	73.92 ± 0.76[c]	35.29 ± 4.64[b]	78.10 ± 0.90[c]	52.22 ± 0.67[b]	65.24 ± 0.56[c]
75	56.03 ± 6.55[c]	87.23 ± 2.29[d]	56.53 ± 4.40[c]	89.69 ± 0.67[d]	54.28 ± 1.79[b]	68.75 ± 1.10[d]
100	77.08 ± 4.41[d]	92.27 ± 1.78[e]	73.95 ± 3.76[d]	92.86 ± 0.67[d]	71.76 ± 3.02[c]	72.53 ± 1.29[e]

Values are presented as the mean of three independent observations. Mean values within a column that do not share a common letter differ significantly based on ANOVA and Duncan's Multiple Range Test (P<0.05).

LPE significantly enhanced glucose absorption by yeast cells in a concentration-dependent manner at all tested glucose concentrations (5, 10, and 25 mM). At 100 µg/mL, glucose absorption reached 77.08% (at 5 mM glucose), 73.95% (at 10 mM glucose), and 71.76% (at 25 mM glucose). This increased glucose absorption capacity suggests that LPE could reduce glucose availability in the medium, thereby contributing to its antihyperglycemic activity.

Table 5:*Chemical composition of LPE*

Retention Time	Name	Peak Area %	Molecular Formula	Molecular Weight g/mol
3.43	1-Decene	0.19	$C_{10}H_{20}$	140.2
4.21	Nonanal	0.18	$C_9H_{18}O$	142.1
4.99	Cyclopropane, nonyl-	0.37	$C_{12}H_{24}$	168.2
5.79	Benzene, 1,3-bis (1,1-dimethylethyl)	0.76	$C_{14}H_{22}$	190.2
6.52	Ethyl 5-chlorothiophene-2carboxylate	0.42	$C_7H_7ClO_2S$	190
7.66	n-Tridecan-1-ol	0.63	$C_{13}H_{28}O$	200.2
8.37	1,3-Propanediol, 2-ethyl-2- (hydroxymethyl)	1.11	$C_6H_{14}O_3$	134.1
9.16	1-(4-Ethoxyphenyl) propan-1-ol	1.16	$C_{11}H_{16}O_2$	180.1
10.11	Benzoic acid, 4-ethoxy-ethyl ester	4.60	$C_{11}H_{14}O_3$	194.1
11.28	n-Tridecan-1-ol	0.49	$C_{13}H_{28}O$	200.2
12.08	Ethyl alpha-d-glucopyranoside	14.13	$C_8H_{16}O_6$	208.1
13.60	Undecane, 2-methyl	0.32	$C_{12}H_{26}$	170.2
14.66	Tetradecanoic acid	2.17	$C_{14}H_{28}O_2$	228.2
16.75	Phthalic acid, butyl oct-3-yl ester	0.06	$C2_0H_{30}O_4$	334.2
17.94	Diphenyl sulphone	0.83	$C_{12}H_{10}O_2S$	218
18.86	n-hexadecanoic acid	0.74	$C_{16}H_{32}O_2$	256.2
19.68	Decane, 1-fluoro	0.39	$C_{10}H_{21}F$	160.2
23.71	Cyclopentane undecanoic acid, methyl ester	0.16	$C_{17}H_{32}O_2$	268.2
25.91	Ethylene diacrylate	0.20	$C_8H_{10}O_4$	170.1
31.89	Cyclohexane, 1,1'-(2-methyl-1,3-propanediyl) bis	0.18	$C_{16}H_{30}$	170.1
32.64	9-Octadecenoic acid (Z)-n phenylmethyl ester	0.18	$C_{25}H_{40}O_2$	170.1
33.76	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl) ethyl ester	4.73	$C_{19}H_{38}O_4$	330.3
34.61	Deoxyspergualin	0.65	$C_{17}H_{37}N_7O_3$	387.3
36.16	Octadecanoic acid, 2,3-dihydroxypropyl ester	1.81	$C_{21}H_{42}O_4$	358.3
36.78	13-Docosenamide, (Z)	40.25	$C_{22}H_{43}NO$	337.3
37.18	trans-Geranylgeraniol	0.90	$C_{20}H_{34}O$	290.3
38.46	cis-10-Nonadecenoic acid	0.15	$C_{19}H_{36}O_2$	296.3
39.36	N-Ethyl-deoxy-veratramine	0.64	$C_{29}H_{43}N$	405.3
41.10	1-Heptatriacotanol	0.31	$C_{37}H_{76}O$	536.6

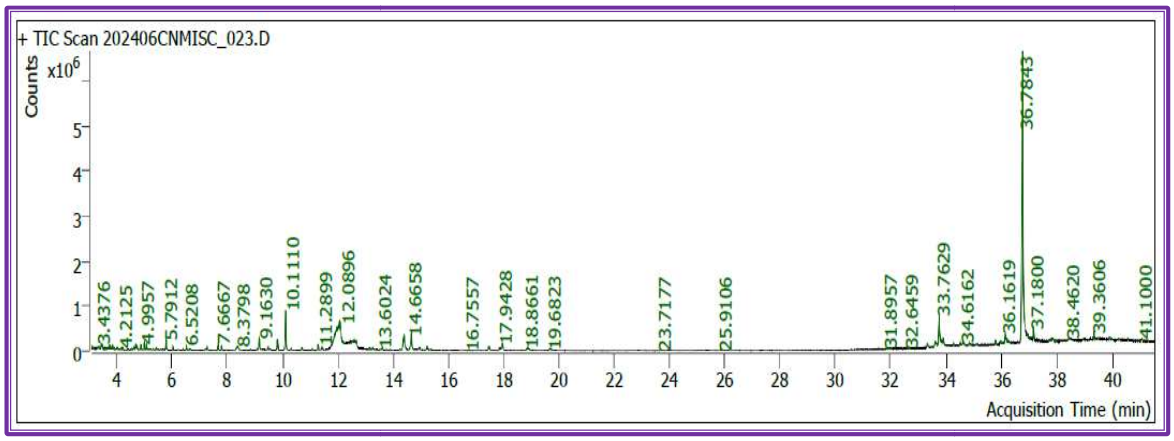

Figure 1: *GC-MS Chromatogram of LPE*

The different classes of bioactive compounds identified in LPE included fatty acids and their esters, both saturated and unsaturated fatty acids; phenolic derivatives (benzoic acid esters and phthalic acid esters); terpenoids and nitrogen- and sulphur-containing compounds, with the predominant compounds being 13-Docosenamide (40.25%), α-D-glucopyranoside (14.13%), hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl) ethyl ester (4.73%), benzoic acid, 4-ethoxy-, ethyl ester (4.60%), myristic acid (2.17%), geranylgeraniol (0.90%), and deoxyspergualins (0.65%).

Discussion

Plant-based bioactive compounds, particularly those derived from agricultural waste, have attracted attention for their sustainability, cost-effectiveness, and pharmacological potential. The growing global demand for natural, eco-friendly resources has prompted researchers to explore plant-derived compounds as potential alternatives to synthetic drugs. Fruit peels are rich in dietary fiber, micronutrients and secondary metabolites (Yadav *et al*., 2024; Wannavijit*et al*., 2026). A large quantity of by-products is produced during the processing of fruits from the Sapindaceae family (longan and rambutan), accounting for 24.9–40.7% and 52.9–74.7% of the total, respectively (Rakariyatham*et al*., 2020). The present study evaluated the antioxidant and antidiabetic potential of longan peel extract (LPE), supporting its potential as a functional component.

Free radical-directed oxidative stress is associated with the development of degenerative diseases. Antioxidants neutralise the deleterious effects of free radicals. The negative effects of synthetic antioxidants have led to the search for natural compounds with strong antioxidant properties (Chaudhary *et al*., 2023). In this study, LPE exhibited dose-dependent inhibitory effects on superoxide, nitric oxide, and hydroxyl radicals (Table 1). Based on the IC_{50} value, LPE's scavenging action of free radicals can be ranked as superoxide>nitric oxide>hydroxyl radicals. The significant activity against nitric oxide (IC_{50} value= 15.30 µg/mL) and superoxide radicals (IC_{50} value=20.57µg/mL) suggests a strong affinity of the peel's phenolic compounds for these free radicals. This reactivity is attributed to the structural characteristics and hydrogen-donating capacity of phenolic compounds such as gallic acid, ellagic acid, corilagin, and geraniin, which are abundant in the by-products of longan and rambutan (Rakariyatham*et al*., 2020). These findings support earlier studies that report that LPE can alleviate oxidative stress by effectively scavenging reactive oxygen and nitrogen species (Pan *et al*., 2008; Huang *et al*., 2012).

Recent advancements in analytical methods have led to the development of highly automated and sensitive detection technologies that enable precise evaluation of antioxidant potential through multiple mechanisms, including free radical scavenging, reducing power, and metal chelation (Munteanu & Apetrei, 2021). The reducing antioxidant power assay is based on the principle that higher absorbance indicates greater antioxidant activity. The underlying principle for assessing antioxidant capacity using the FRAP and phosphomolybdenum assays involves the reduction of $Fe^{3+}$to Fe^{2+} and of Mo(VI) to Mo(V). As shown in Table 2, LPE and ascorbic acid (standard reference)

had significantly stronger reducing capacities that increased with concentration. A comparative analysis of different parts of the fruit showed that the seed had the highest reducing power, followed by the peel and pulp extracts (Guo *et al*., 2003; Sangeetha *et al*., 2021). These observations indicate that the inedible portions of fruits are a good source of secondary metabolites, particularly phenolic compounds with therapeutic potential.

The antioxidant potential of LPE is significant in oxidative stress-induced metabolic disorders. Free radicals play a crucial role in β-cell dysfunction and insulin resistance. The free radical-scavenging potential of LPE may protect cellular biomolecules from oxidative damage and contribute to glucose homeostasis, thereby linking its antioxidant and antidiabetic effects. The inhibitory effects of LPE against enzymes involved in starch breakdown are given in Table 3. LPE exhibited significant α-amylase inhibitory activity, demonstrating 23.52% inhibition at 10 µg/mL and 88.97% inhibition at 100 µg/mL, with an IC50 value of 28.59 µg/mL ($P < 0.05$). In the α-glucosidase inhibition assay, LPE significantly inhibited 58.41% of the enzyme activity at 10 µg/mL and 85.51% at 100 µg/mL, with an IC50 value of 8.57 µg/mL ($P < 0.05$). Results indicate that LPE can delay starch hydrolysis and glucose absorption. A similar study by Fu *et al*. (2015) reported that LPE effectively inhibited the activity of α-amylase and α-glucosidase, with IC50 values of 75 µg/mL and 11.68 µg/mL, respectively, indicating that LPE is a reversible, non-competitive enzyme inhibitor. Apart from enzymatic inhibition studies, the effect of LPE on glucose adsorption by yeast cells was also evaluated at varying glucose concentrations (5 mM, 10 mM, and 25 mM). Yeast cells treated with different concentrations of LPE showed a dose-dependent increase in glucose absorption (Table 4). A linear increase in glucose uptake was observed. However, when glucose concentration was held constant while extract concentration varied, an inverse relationship was observed, suggesting that yeast cells absorb glucose more efficiently at lower concentrations.

The different classes of bioactive compounds present in LPE are depicted in Figure 1 and presented in Table 5. The compounds detected included fatty acids and their esters (both saturated and unsaturated), phenolic derivatives (benzoic acid esters and phthalic acid esters), terpenoids, and nitrogen- and sulphur-containing compounds. These compounds synergistically contribute to the antioxidant and antidiabetic potential of LPE. Nitrogen- and sulphur-containing compounds, such as deoxyspergualin and ethyl 5-chlorothiophene-2-carboxylate, exhibit immunomodulatory and anti-inflammatory properties by modulating cytokine expression and reducing oxidative stress-induced cellular damage. These compounds protect cellular components such as lipids, proteins, and DNA from oxidative damage. Geranylgeraniol, a terpenoid, contributes to both antioxidant and antidiabetic activity. Terpenoids mitigate oxidative stress by scavenging free radicals and modulating insulin secretion, indicating their potential role in maintaining glucose homeostasis and alleviating metabolic dysfunctions associated with hyperglycemia. The presence of various classes of secondary metabolites, including fatty acids and their esters, collectively contributes to LPE's bioactivity, underscoring its potential as a valuable source of bioactive compounds.

Limitations

While the present study provides valuable insights into the biofunctional properties of longan fruit peel extract, the use of a crude extract precludes the precise attribution of biological activity to individual phytochemicals. Furthermore, the effects of different drying and processing techniques on the preservation of bioactive compounds were not studied.

Future Scope of Research

The findings of this study provide a scientific basis for the utilization of longan fruit peel as a functional ingredient with antioxidant and antidiabetic properties. Future investigations should explore the molecular mechanisms underlying the observed bioactivities, validate the efficacy of the identified bioactive compounds in animal and clinical studies, and evaluate the impact of processing conditions on their stability and functionality. Such studies may support the development of standardized longan fruit peel-derived products for applications in the food, nutraceutical, and pharmaceutical sectors.

Conclusion

Effective utilization of fruit peel can bridge the gap between fruit waste management and the development of sustainable nutraceutical products. This study indicates that longan fruit peel, typically discarded due to its dry, leathery texture, exhibits antioxidant and antidiabetic properties, highlighting its potential as a natural source of functional compounds. These findings support the valorization of fruit waste for applications in the food and pharmaceutical industries. Further studies focusing on isolation, characterization, and evaluation of the therapeutic potential of functional compounds are required to explore their practical applications.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgement

The authors express their sincere gratitude to Affyclone Laboratories, Chennai, for providing the necessary facilities to carry out this research.

References

Begam, A., John, S., Monica, S., Priyadarshini, S., Sivaraj, C., & Arumugam, P. (2020). In vitro antioxidant activity and GC-MS analysis of peel and pulp extracts of Dimocarpus Longan. *International Journal Biology Pharmacy*, *9*, 1269-1283. https://doi.org/10.31032/IJBPAS/2020/9.6.5071

Benzie, I. F., & Strain, J. J. (1999). [2] Ferric reducing/antioxidant power assay: direct measure of total antioxidant activity of biological fluids and modified version for simultaneous measurement of total antioxidant power and ascorbic acid concentration. *Methods in Enzymology,299*, 15-27. https://doi.org/10.1016/S0076-6879(99)99005-5

Chaudhary, P., Janmeda, P., Docea, A. O., Yeskaliyeva, B., Abdull Razis, A. F., Modu, B., ... & Sharifi-Rad, J. (2023). Oxidative stress, free radicals and antioxidants: potential crosstalk in the pathophysiology of human diseases. *Frontiers in Chemistry*, *11*, 1158198. https://doi.org/10.3389/fchem.2023.1158198

Dandekar, R., Fegade, B., & Bhaskar, V. H. (2015). GC-MS analysis of phytoconstituents in alcohol extract of Epiphyllum oxypetalum leaves. *Journal of Pharmacognosy and Phytochemistry*,*4*(1), 148-154. https://www.phytojournal.com/vol4Issue1/Issue_may_2015/4-1-51.1.pdf

Economou, F., Chatziparaskeva, G., Papamichael, I., Loizia, P., Voukkali, I., Navarro-Pedreño, J., ... &Zorpas, A. A. (2024). The concept of food waste and food loss prevention and measuring tools. *Waste Management &Research*,*42*(8), 651-669.https://doi.org/10.1177/0734242X241237187

Elhaj, R., Ya'akob, H., &AbdMalek, R. (2020). Evaluation of antidiabetic activity of Carica papaya leaves extract using yeast cells method. *Food Research*, *4*, 67-70. https://doi.org/10.26656/fr.2017.4(s2).s01

Fontana, M., Mosca, L., &Rosei, M. A. (2001). Interaction of enkephalins with oxyradicals. *Biochemical Pharmacology*, *61*(10), 1253-1257.https://doi.org/10.1016/S0006-2952(01)00565-2

Fu, C., Yang, X., Lai, S., Liu, C., Huang, S., & Yang, H. (2015). Structure, antioxidant and α-amylase inhibitory activities of longan pericarp proanthocyanidins. *Journal of Functional Foods*, *14*, 23-32.https://doi.org/10.1016/j.jff.2015.01.041

Guo, C., Yang, J., Wei, J., Li, Y., Xu, J., & Jiang, Y. (2003). Antioxidant activities of peel, pulp and seed fractions of common fruits as determined by FRAP assay. *Nutrition Research*, *23*(12), 1719-1726. https://doi.org/10.1016/j.nutres.2003.08.005

Halliwell, B., Gutteridge, J. M., &Aruoma, O. I. (1987). The deoxyribose method: a simple "test-tube" assay for determination of rate constants for reactions of hydroxyl radicals. *Analytical biochemistry*, *165*(1), 215-219. https://doi.org/10.1016/0003-2697(87)90222-3

Hasan, M. M., Islam, M. R., Haque, A. R., Kabir, M. R., Khushe, K. J., & Hasan, S. K. (2024). Trends and challenges of fruit by-products utilization: Insights into safety, sensory, and benefits of the use for the development of innovative healthy food: A review. *Bioresources and Bioprocessing*, *11*(1), 10. https://doi.org/10.1186/s40643-023-00722-8

Hu, Y., Zhang, X., Li, D., Ma, C., Dong, L., Luo, Y., ... & Chen, F. (2025). A review on the chemical composition, biological activity, and potential health benefits applications of Longan (Dimocarpus longan Lour.). *Food Chemistry*, 145985. https://doi.org/10.1016/j.foodchem.2025.145985

Huang, G. J., Wang, B. S., Lin, W. C., Huang, S. S., Lee, C. Y., Yen, M. T., & Huang, M. H. (2012). Antioxidant and anti-inflammatory properties of longan (Dimocarpus longan Lour.) pericarp. *Evidence-Based Complementary and Alternative Medicine*, *2012*(1), 709483. https://doi.org/10.1155/2012/709483

Hyland, K., Voisin, E., Banoun, H., & Auclair, C. (1983). Superoxide dismutase assay using alkaline dimethylsulfoxide as superoxide anion-generating system. *Analytical Biochemistry*,*135*(2), 280-287.https://doi.org/10.1016/0003-2697(83)90684-X

Kaushik, R., Morya, S., Bashir, O., Bhadha, J. H., &Kasankala, L. M. (2025). Valorization of fruit waste through reutilization approach: A comprehensive review.*eFood*, *6*(4), e70073.https://doi.org/10.1002/efd2.70073

Kumar, H., Bhardwaj, K., Sharma, R., Nepovimova, E., Kuča, K., Dhanjal, D. S., ... & Kumar, D. (2020). Fruit and vegetable peels: utilization of high value horticultural waste in novel industrial applications. *Molecules*, *25*(12), 2812. https://doi.org/10.3390/molecules25122812

Lal, N., Sahu, N., Jayswal, D. K., Diwan, G., & Tandon, K. (2020). Traditional, medicinal and nutraceutical values of minor fruit: Longan. *Current Journal of Applied Science and Technology*. *39*(41), 59-70. https://doi.org/10.9734/CJAST/2020/v39i4131120

Liu, Z., De Souza, T. S., Holland, B., Dunshea, F., Barrow, C., &Suleria, H. A. (2023). Valorization of food waste to produce value-added products based on its bioactive compounds. *Processes*, *11*(3), 840.https://doi.org/10.3390/pr11030840

Munteanu, I. G., & Apetrei, C. (2021). Analytical methods used in determining antioxidant activity: A review. *International Journal of Molecular Sciences*, *22*(7), 3380. https://doi.org/10.3390/ijms22073380

Pan, Y., Wang, K., Huang, S., Wang, H., Mu, X., He, C., ... & Huang, F. (2008). Antioxidant activity of microwave-assisted extract of longan (Dimocarpus Longan Lour.) peel. *Food Chemistry*, *106*(3), 1264-1270. https://doi.org/10.1016/j.foodchem.2007.07.033

Paul, P., Biswas, P., Dey, D., Saikat, A. S. M., Islam, M. A., Sohel, M., ... & Kim, B. (2021). Exhaustive plant profile of “dimocarpus longan lour” with significant phytomedicinal properties: a literature based-review. *Processes*, *9*(10), 1803.https://doi.org/10.3390/pr9101803

Prieto, P., Pineda, M., & Aguilar, M. (1999). Spectrophotometric quantitation of antioxidant capacity through the formation of a phosphomolybdenum complex: specific application to the determination of vitamin E. *Analytical Biochemistry*, *269*(2), 337-341. https://doi.org/10.1006/abio.1999.4019

Qasem, A., Assaggaf, H., Mrabti, H. N., Minshawi, F., Rajab, B. S., Attar, A. A., ... &Bouyahya, A. (2023). Determination of chemical composition and investigation of biological activities of Ocimum basilicum L. *Molecules*, *28*(2), 614. https://doi.org/10.3390/molecules28020614

Rakariyatham, K., Liu, X., Liu, Z., Wu, S., Shahidi, F., Zhou, D., & Zhu, B. (2020). Improvement of phenolic contents and antioxidant activities of longan (Dimocarpus longan) peel extracts by enzymatic treatment. *Waste and Biomass Valorization*, *11*(8), 3987-4002.https://doi.org/10.1007/s12649-019-00723-9

Rakariyatham, K., Zhou, D., Rakariyatham, N., & Shahidi, F. (2020). Sapindaceae (Dimocarpus longan and Nephelium lappaceum) seed and peel by-products: Potential sources for phenolic compounds and use as functional ingredients in food and health applications. *Journal of Functional Foods*, *67*, 103846.https://doi.org/10.1016/j.jff.2020.103846

Sangeetha, S. T., John, S., Monica, S. J., & Sivaraj, C. (2021). Phytochemical profile and therapeutic values of pulp and peel extracts of hylocereusundatus. *Applied Biological Research*, *23*(4), 379-388. http://dx.doi.org/10.5958/0974-4517.2021.00048.3

Sarangi, P. K., Pal, P., Singh, A. K., Sahoo, U. K., & Prus, P. (2024). Food waste to food security: Transition from bioresources to sustainability. *Resources*, *13*(12), 164.https://doi.org/10.3390/resources13120164

Shai, L. J., Magano, S. R., Lebelo, S. L., & Mogale, A. M. (2011). Inhibitory effects of five medicinal plants on rat alpha-glucosidase: Comparison with their effects on yeast alpha-glucosidase. *Journal of Medicinal Plants Research*, *5*(13), 2863-2867.https://academicjournals.org/journal/JMPR/article-full-text-pdf/B77C8DD18612

Taira, J., Nanbu, H., & Ueda, K. (2009). Nitric oxide-scavenging compounds in Agrimonia pilosaLedeb on LPS-induced RAW264. 7 macrophages. *Food Chemistry*, *115*(4), 1221-1227.https://doi.org/10.1016/j.foodchem.2009.01.030.

Wannavijit, S., Ninyamasiri, P., Nonkrathok, W., Tongsiri, S., Seesuriyachan, P., Phimolsiripol, Y., ... & Paolucci, M. (2026). Effects of Fermented Longan Peel (Dimocarpus longan) on Growth Performance, Digestive Enzyme Activity, Intestinal Microstructure, Immune Response, and Gene Expression of Nile Tilapia (Oreochromis niloticus) Raised Under Biofloc System. *Antioxidants*, *15*(3), 394. https://doi.org/10.3390/antiox15030394

Yadav, S., Malik, K., Moore, J. M., Kamboj, B. R., Malik, S., Malik, V. K., ... & Bishnoi, D. K. (2024). Valorisation of agri-food waste for bioactive compounds: recent trends and future sustainable challenges. *Molecules*, *29*(9), 2055. https://doi.org/10.3390/molecules29092055

Yang, B., Jiang, Y., Shi, J., Chen, F., & Ashraf, M. (2011). Extraction and pharmacological properties of bioactive compounds from longan (Dimocarpus longan Lour.) fruit—A review. *Food Research International*, *44*(7), 1837-1842.https://doi.org/10.1016/j.foodres.2010.10.019

Zhang, X., Guo, S., Ho, C. T., & Bai, N. (2020). Phytochemical constituents and biological activities of longan (Dimocarpus longan Lour.) fruit: A review. *Food Science and Human Wellness*, *9*(2), 95-102.https://doi.org/10.1016/j.fshw.2020.03.001

Zubairu, I. K., Rakariyatham, K., Bai-Ngew, S., Leksawasdi, N., Regenstein, J. M., Lao, F., ... &Phimolsiripol, Y. (2025). Nutritional and Therapeutic Potential of Longan Fruit By-products for Liver Diseases: Pathway to Functional Foods. *Current Nutrition Reports*, *14*(1), 28. https://doi.org/10.1007/s13668-025-00617-4