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Mushroom (*Lentinus tigrinus* and *Lenzites betulina*) Extracts incorporated with Guava Essential Oil as Edible Coatings for Shelf-life Extension and Preservation of Physicochemical Quality of *C. chinense* (Scotch Bonnet pepper) during Storage

ADEOGUN, OO; OYEBISI, IB; ADONGBEDE, EM

Department of Botany, Faculty of Science, University of Lagos, Akoka, Nigeria

*Corresponding Author Email: ooadeogun@unilag.edu.ng

*ORCID: <https://orcid.org/0000-0002-8080-525X>

Tel: +2349134998727

Co-Authors Email: ibrahimtemitope52@gmail.com; eadongbede@gmail.com

ABSTRACT: Fresh fruits and vegetables are essential for a healthy diet, providing nutrients and bioactive compounds that prevent chronic diseases. However, postharvest losses, particularly in tropical regions, are a challenge due to perishability. Scotch Bonnet pepper (*Capsicum chinense*) is prone to rapid deterioration, which reduces its market value and contributes to food insecurity. This study investigates the potential of mushroom extracts (*Lentinus tigrinus* and *Lenzites betulina*) integrated with guava essential oil as edible coatings to extend shelf life and preserve the quality of Scotch Bonnet pepper during storage. The firmness, weight loss, pH, and electrical leakage were analysed over 12 days. *C. chinense* treated with *L. tigrinus* extract was the most effective, limiting weight loss to 7.31% by Day 12, compared to 24.81% in the Control. The addition of oil limited weight loss to 7.31–7.56%. By Day 12, *C. chinense* treated with *L. betulina* extract maintained the highest firmness (7.31 N), outperforming the Control (3.27 N), while other treatments dropped to 5.87–13.91 N. *C. chinense* treated with *L. tigrinus* extract + Guava oil and *C. chinense* treated with *L. betulina* extract + Guava oil exhibited the lowest Total Soluble Solids levels at 6.33 ± 0.24 °Brix and 6.43 ± 0.12 °Brix, respectively. *L. tigrinus* extract also showed the greatest reduction in electrical leakage (68.00 μ S/cm), indicating superior cell membrane stability. Water activity remained stable across all groups. This research offers sustainable strategies for enhancing the shelf life of perishable produce under tropical conditions.

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Fresh fruits and vegetables are essential components of a balanced, healthy diet, providing vital nutrients such as vitamins, minerals, dietary fiber, and bioactive phytochemicals that help prevent various chronic diseases. The World Health Organization (WHO) has emphasized the importance of increasing fruit and vegetable consumption to combat malnutrition and non-communicable diseases (Rodriguez-Casado, 2016). However, despite their

significant health benefits, the high moisture content of fruits and vegetables (ranging from 75% to 95%) makes them highly susceptible to physiological and microbial deterioration, which accelerates postharvest losses, especially under tropical conditions (Srivastava and Sit, 2025). These losses, according to Kader (2024), were particularly pronounced in developing countries, where inadequate storage, handling, and preservation systems often lead to

*Corresponding Author Email: ooadeogun@unilag.edu.ng

*ORCID: <https://orcid.org/0000-0002-8080-525X>

Tel: +2349134998727

reduced marketability, lower economic returns, and food insecurity. Postharvest losses in fruits and vegetables are a critical challenge that demands innovative, sustainable solutions to extend shelf life and reduce waste (Rizzo, 2025).

Capsicum chinense, commonly known as Scotch Bonnet pepper, is a widely cultivated species within the Solanaceae family, especially in tropical regions (Sarwa, 2012). This pepper variety is of significant economic importance due to its use in food products, sauces, and spice blends, and it plays a crucial role in local and international trade. Beyond its culinary value, *C. chinense* is recognized for its rich phytochemical profile, including capsaicin, phenolic compounds, carotenoids, and other antioxidants, which have been associated with various health benefits, including anti-inflammatory, antimicrobial, and anticancer properties (Gogoi, 2017 and Rastogi *et al.*, 2024). Despite its nutritional and economic value, *C. chinense* is highly perishable and prone to rapid deterioration during storage, particularly due to its high moisture content and susceptibility to moisture loss, membrane degradation, microbial contamination, and softening. These factors significantly reduce pepper's shelf life, resulting in postharvest losses of 30% to 50% under non-ideal storage conditions (Obayelu *et al.*, 2021).

Perez-Vazquez (2023) and Nguyen *et al.* (2025) established that postharvest handling and storage of fruits and vegetables have been extensively studied, with several preservation techniques proposed to extend shelf life and minimize losses. Among these techniques, edible coatings have emerged as a promising and environmentally friendly strategy. Edible coatings are thin layers, typically made from natural biopolymers such as polysaccharides, proteins, and lipids, which are applied to the surface of fruits and vegetables. These coatings act as semi-permeable barriers, reducing water loss, limiting gas exchange, delaying oxidative processes, and inhibiting microbial growth (Yuan *et al.*, 2016 and Salama *et al.*, 2019).

The use of edible coatings helps create a controlled microenvironment around the produce, slowing the metabolic processes responsible for ripening and spoilage. Furthermore, the incorporation of natural antimicrobial agents, such as essential oils, mushroom extracts and plant extracts, which contain bioactive compounds with medicinal properties, including antioxidants and antimicrobials, into edible coatings has attracted significant attention as a sustainable alternative to synthetic preservatives (Ebabhi *et al.*, 2019; Adeogun *et al.*, 2023). These

bioactive compounds enhance the preservation potential of the coatings, offering additional protection against oxidative stress and microbial contamination (Adekunle *et al.*, 2021 and Adeogun *et al.*, 2020).

Mushrooms are particularly notable for their bioactive metabolites, including phenolic compounds, polysaccharides, and terpenoids, which have been shown to possess strong antioxidant and antimicrobial activities (Lee *et al.*, 2020). Species within the *Polyporaceae* family, such as *Lentinus tigrinus* and *Lenzites betulina*, have demonstrated notable antifungal, antibacterial, and antioxidant properties, suggesting their potential as natural preservatives in food systems. These mushrooms have been investigated for their ability to inhibit the growth of foodborne pathogens and protect against oxidative damage, both of which are critical for preserving perishable produce (Lee *et al.*, 2020).

Despite the growing body of literature on the use of bioactive coatings in postharvest preservation, there remains a gap in the application of mushroom extracts, particularly those from *Lentinus tigrinus* and *Lenzites betulina*, for the preservation of *C. chinense*. While several studies have explored the use of mushroom-derived compounds in edible coatings for other fruits and vegetables, their potential in preserving *C. chinense* has not been extensively studied. Moreover, incorporating guava essential oil, known for its antimicrobial and antioxidant properties (Hernandez *et al.*, 2015), into mushroom-based coatings represents an innovative approach yet to be fully explored.

MATERIALS AND METHODS

Collection and Identification of Mushrooms: Wild mushroom samples were collected from forest locations in Kogi State (Ayede) and Lagos State, Nigeria. Geographic coordinates were recorded at each collection site. The samples were transported in sterile Ziplock bags to the laboratory for analysis.

Preliminary identification was carried out based on macroscopic characteristics, including cap morphology, gill or pore structure, stipe features, colour, and texture. Microscopic examination of spores and hymenial structures was conducted using a digital light microscope. Identification was confirmed using standard taxonomic keys and reference texts. Based on morphological characterization and previous studies, *Lentinus tigrinus* and *Lenzites betulina* were selected for extract preparation.

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Characterization of the Essential Oils: The volatile components of guava leaf essential oil were characterized in the previous work of Adeogun et al. (2025a) using the method adopted by Matche and Adeogun (2022). They were analyzed using a gas chromatography–mass spectrometry (GC–MS) system (Perkin Elmer Instruments, Norwalk, CT 06859, USA). Helium was used as the carrier gas at a 1:200 split ratio. Mass spectra were acquired over the range of 35 to 500 m/z and processed with TurboMass 6.1.0 software. Individual components were identified by comparing their mass spectra to the NIST library. The relative abundances of the components were quantified using the peak area integration method, with each component's peak area expressed as a percentage of the total.

Preparation of Mushroom Extracts: Fresh fruiting bodies were cleaned, air-dried, and milled into a fine powder. 10 g of each mushroom powder was extracted with 90 mL of distilled water using microwave-assisted extraction at medium power for 5 minutes. The extracts were centrifuged at 3000 rpm for 30 minutes, and the supernatant was filtered through Whatman No. 1 filter paper. The filtrates were stored at 4°C until further use.

Preparation of Edible Coating Formulations: Bioactive coating formulations were prepared by mixing 200 mL of mushroom extract with 12 mL of guava essential oil and 8 mL of Tween 20 as the emulsifier under magnetic stirring for 15 minutes to obtain a homogeneous emulsion. Two formulations were prepared:

LT + GO (*L. tigrinus* extract + Guava oil)

LB + GO (*L. betulina* extract + Guava oil)

Formulations were stored at 4°C prior to application.

Fruit Sampling and Experimental Design: Mature, healthy *Capsicum chinense* fruits were procured from a local market in Lagos State, Nigeria. The fruits were sorted to ensure uniformity in size, colour, and the absence of mechanical damage or visible infection. Samples were sanitized with 70% ethanol and air-dried at room temperature.

The experiment consisted of five treatments arranged in triplicate:

Control (untreated)

A extract (*L. tigrinus* extract)

C extract (*L. betulina* extract)

A + Oil coating (*L. tigrinus* extract + Guava oil)

C + Oil coating (*L. betulina* extract + Guava oil)

Coatings were applied by brushing to ensure uniform coverage. The fruits were air-dried and stored under

ambient laboratory conditions. Quality assessments were conducted on Days 0, 3, 7, and 12. Three fruits per treatment were analyzed at each sampling interval.

Quality Assessment: Cleaned *Capsicum chinense* fruit samples were rinsed twice with sterile distilled water and subjected to two distinct edible coatings (separately) for analysis. In a sterile setting, the prepared edible coatings, integrated with oil, were applied to the fruits by brushing. The fruits were then placed on a sterile surface covered with aluminum foil and left to air dry. These samples were stored at ambient room temperature (27°C) for 12 days. Quality evaluations were conducted on Days 0, 3, 7, and 12 to assess various quality parameters (Adeogun et al., 2020). The samples were categorized into five treatment groups: Control (untreated), *Capsicum chinense* fruits treated with *Lentinus tigrinus* extract (labeled A extract), *Capsicum chinense* fruits treated with *Lentinus betulina* extract (labeled C extract), *Capsicum chinense* fruits treated with the edible coating of *Lentinus tigrinus* extract and Guava oil (labeled A + Oil coating), and *Capsicum chinense* fruits treated with the edible coating of *Lentinus betulina* extract and Guava oil (labeled C + Oil coating).

Weight loss: The total weight loss of *Capsicum chinense* fruit samples subjected to different treatments was determined following the method described by Khaliq et al. (2015). Each fruit was weighed using an analytical balance prior to storage. Subsequently, the fruits were reweighed at 3-day intervals over a 12-day storage period (i.e. days 0, 3, 6, 9, and 12). Weight loss was calculated as the difference between the initial weight (day 0) and the final weight recorded on day 12. Physiological weight loss was assessed to determine the effectiveness of the edible coatings in reducing fruit dehydration and extending shelf life.

The percentage weight loss was calculated using the following formula:

$$\text{Percentage weight loss (\%)} = \frac{W_i - W_f}{W_i} \times 100$$

where: W_i = initial weight (g); W_f = final weight (g)

Firmness Test: The firmness of the *Capsicum chinense* samples was assessed every 3 days using a portable firmness metre (Bareiss, Germany), with readings taken in the equatorial zone of each fruit.

Table 1: Morphological characteristics of selected mushrooms

S/N	Description	Identification
1.	Cap: 13.5cm Cap width: 5.9cm Club: 3-10cm, 1-4cm Spores: black Not edible Substrate: wood Habit: saprophytic Smell: not distinctive Growth form: saprobic; solitary, clustered all year C: Sordariomycetes O: Xylariales F: Xylariaceae	<i>Xylaria polymorpha</i> (Dead man's fingers)
2.	Cap Feature: Concentric Surface (beneath): Tube-like Stem: Sessile Cap width: 15.3cm Cap: 7.2cm Color: brown, green, grey, white Habit: saprophytic Substrate: wood Spore: white Smell: mild Growth form: saprobic Not edible Semi circular or fan-shaped C: Agaricomycetes O: Polyporales F: Polyporaceae	<i>Lenzites betulina</i> (Birch mazegill)
3.	Cap Feature: Scaly with inrolled margin Gills (beneath): Unequal Cap: 0.4-1.4 inch Color: brown, yellow Habit: saprophytic Spore: rusty brown Growth form: solitary, gregarious Smell: mild Class: Agaricomycetes Order: Agaricales Family: Strophariaceae	<i>Pholiota granulosa</i> (Scalycap)
4.	Surface(beneath): Tubes Cap: smooth, 6-20cm, shell-shaped, Stem length: 0.3cm, 0.5, 1-2 Stem Breadth: 0.6cm Spores: Pale grey/lilac Gills: decurrent, white to yellow Color: grey/brown, white Substrate: wood Habit: saprophytic Smell: faint aroma of aniseed Growth form: clustered Class: Agaricomycetes Order: Agaricales F: Pleurotaceae	<i>Pleurotus ostreatus</i>
5	Cap: 8cm Pores: Whitish to pale brown Gills: Decurrent Color: White to cream colored Substrate: Grows on dead or dying hardwood trees Habit: Clustered or solitary Smell: Indistinctive odor Class: Basidiomycota Order: Polyporales Family: Polyporaceae	<i>Trametes versicolor</i>

6	Cap Feature: Concentric zones, often coated with green algae, white, Pores: Cream, 1-2 per mm Stem: Sessile Cap: 6-13cm Spores: white Color: Brown, grey Habit: saprophytic Substrate: wood Growth form: Saprobiic Smell: Mild Class: Agaricomycetes Order: Polyporales Family: Polyporaceae	<i>Corriolopsis gallica</i>
7	Cap: Fan-shaped Spores: Ellipsoid Size: 6-8 x 2.5-3.5 µm Stem: Shape: Cylindrical Length: 3-10 cm Diameter: 0.3-1 cm Cap: Diameter: 3-10 cm Shape: Initially convex, becoming plane with age Surface: Smooth to slightly scaly Colour: Cap: Brown to dark brown Stem: Brown to light brown Gills: White to cream Habit: Fruiting Body: Solitary or clustered Substrate: Commonly found on decaying wood, particularly hardwood Growth form: Saprophytic, growing on dead or decaying organic matter Smell: Distinctive strong odor, often described as fragrant or sweet Class: Agaricomycetes Order: Polyporales Family: Polyporaceae	<i>Lentinus tigrinus</i>

The fruit was rotated by 180° between readings to ensure accurate, consistent measurements (Adeogun *et al.*, 2025b).

Total Soluble Solids (°Brix): The total soluble solids (TSS) of the samples were determined using a portable refractometer at 20°C (Adeogun *et al.*, 2025b).

The refractive index was recorded and reported as Brix (Adeogun *et al.*, 2025b).

Water Activity: Water activity was quantified following the procedure outlined by the Association of Official Analytical Chemists (AOAC, 2016).

pH Measurement: The pH of the sample was measured using a pH meter, with 20 mL of the sample continuously stirred at room temperature.

The pH value was recorded as the negative logarithm of the hydrogen ion concentration in the sample solution (Adeogun *et al.*, 2025a).

Electrical Leakage: The electrical leakage (EL) of *Capsicum chinense*'s electrolyte leakage was determined using a conductivity metre. The EL of each sample was measured both before and after

boiling. A sample weighing 2-2.5 grams was cut and placed into a glass test tube, followed by the addition of 20 mL of distilled water.

The test tube was allowed to rest for a few minutes, sealed with aluminium foil and cotton wool, and labelled with the sample treatment.

It was then heated in a water bath at 100°C for 20 minutes. After heating, the EL was measured using a conductometer electrode.

Once the reading stabilised, the electrical leakage was displayed on the conductometer and reported in µS/cm (Adeogun *et al.*, 2025a).

Statistical Analysis: Data are expressed as the mean ± standard error of triplicate determinations. Statistical analysis was performed using one-way analysis of variance (ANOVA), followed by Tukey's post hoc test to determine significant differences among treatments at $p < 0.05$.

Analyses were conducted using IBM SPSS Statistics (Version 26.0), and graphs were generated using GraphPad Prism (Version 8.0.2).

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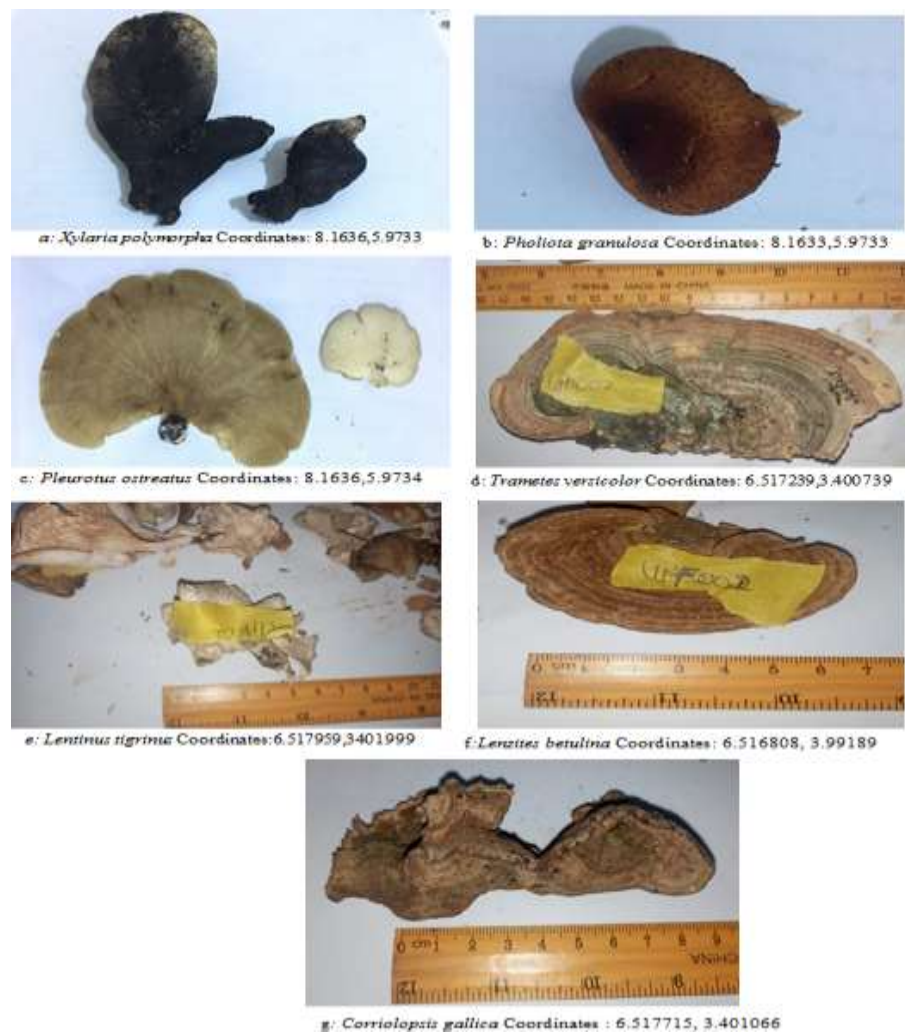


Fig. 1a-g: provide the micrographs of the identified mushrooms along with their geographical coordinates.

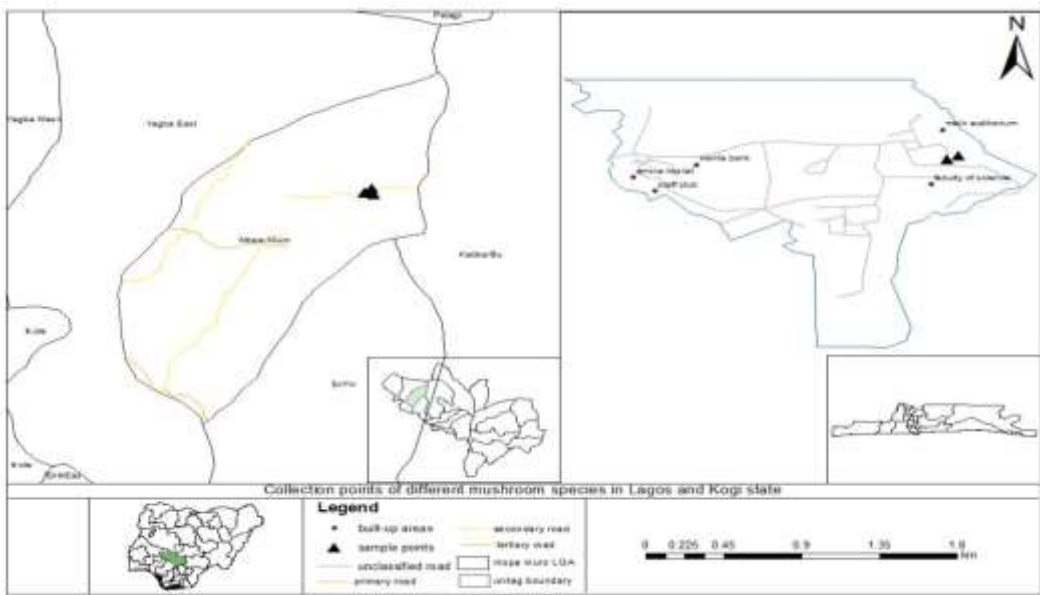


Fig 2: Map showing the location where the mushrooms were collected

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RESULTS AND DISCUSSION

Morphological Description of the sampled Mushrooms: Table 1 and Figures 1a-g present the morphological characteristics of various mushrooms, focusing on physical features such as cap size, stem, spores, growth form, and the conditions under which each species grows (Cordoba and Rios, 2012; Dawson *et al.*, 2018; and de Mattos-Shipley, 2018). The morphological characteristics of the sampled mushrooms reflect their ecological roles and align with existing literature (Ottosson *et al.*, 2015). Lonsdale *et al.* (2008) and Tennakoon *et al.* (2018) corroborated that species such as *Xylaria polymorpha* and *Lenzites betulina* are saprophytic fungi that decompose wood, thereby contributing to nutrient cycling in forests. Some species, such as *Pholiota granulosa* and *Trametes versicolor*, exhibit typical Polyporaceae characteristics, including scaly caps and decurrent gills (GBIF.org). *Pleurotus ostreatus* is

widely cultivated and plays a role in biotechnological applications. Other species, such as *Coriolopsis gallica* and *Lentinus tigrinus*, have unique features, including concentric cap zones and strong odours. Many fungi are essential decomposers, and variations in spore colour, cap shape, and growth form reflect their adaptability to different environmental conditions (Gómez-Jiménez *et al.*, 2025).

Characterization of the Essential Oils: The GC–MS analysis results reported by Adeogun *et al.* (2025b) are presented in Table 1, which reveals 12 major constituents of guava oil. Table 1 shows that β -caryophyllene (22.44%) is the constituent with the highest concentration, whereas limonene (9.24%) and α -humulene (4.76%) have considerable concentrations following β -caryophyllene, as shown in Table 2.

Table 2: Constituents of the *Psidium guajava* essential oil

S/No	Retention Time (mins)	Constituent	Retention Index	Occurrence (%)	Molecular Weight (g/mol)
1.	4.205	α -Thujene	925	0.92	136.23
2.	5.135	α -Pinene	944	0.68	136.24
3.	5.495	Myrcene	981	1.01	136.23
4.	9.851	β -Caryophyllene	982	22.44	204.36
5.	10.750	Limonene	1034	9.24	136.24
6.	11.157	Eucalyptol	1054	0.94	154.25
7.	11.801	Linalool	1121	0.24	154.25
8.	12.331	Eugenol	1389	1.84	164.2
9.	12.366	Aromadendrene	1429	0.28	288.25
10.	12.421	α -Humulene	1454	4.76	204.36
11.	12.661	γ -Muurolene	1464	1.24	204.35
12.	12.772	Globulol	1576	0.62	222.37
13.	12.931	Caryophyllene oxide	1588	2.46	220.35
14.	13.002	Guaiol	1642	0.42	222.37

Source: Adeogun *et al.* (2025a)

Weight loss: Fig. 4 illustrates weight loss trends over the 12-day storage period, clearly showing slower weight loss in the treated groups compared to the control, highlighting the treatments' efficacy in preserving fruit quality. The results of this study demonstrate the effects of various treatments on weight loss in *Capsicum chinense* fruits during storage. The control group exhibited an initial weight loss of $0.00 \pm 0.00\%$ on day 0, which progressively increased to $8.23 \pm 0.63\%$ by day 3. By day 12, the weight loss in the control group had escalated significantly to $24.81 \pm 0.45\%$, indicating rapid degradation and moisture loss, which is consistent with the findings from Adeogun *et al.* (2025a) and Adeogun *et al.* (2025b), who noted that untreated fruits experience accelerated moisture loss and cell wall degradation, leading to significant weight loss over storage periods. In contrast, the groups treated with various extracts and oils showed a slower rate of

weight loss. The A Extract + Oil group exhibited an initial weight loss of $0.00 \pm 0.00\%$ on day 0, which increased gradually to $5.99 \pm 0.48\%$ by day 3. By day 12, the weight loss in this group was $7.31 \pm 0.68\%$, indicating that the treatment slowed weight loss. Similarly, the C Extract + Oil group demonstrated a weight loss of $0.00 \pm 0.00\%$ on day 0, which increased to $3.51 \pm 0.19\%$ by day 3 and continued to rise, but at a much slower rate, reaching $7.56 \pm 0.39\%$ by day 12.

These results align with Adeogun *et al.* (2025c), who demonstrated that bioactive coatings, including plant extracts and oils, help reduce metabolic processes and moisture loss in postharvest fruits, thereby slowing the rate of weight loss during storage. The slower rate of weight loss in the treated groups suggests that the coatings acted as semi-permeable barriers, reducing moisture loss and stabilizing

metabolic activity, both of which are critical for maintaining fruit quality during extended storage periods (Aguiar *et al.*, 2011).

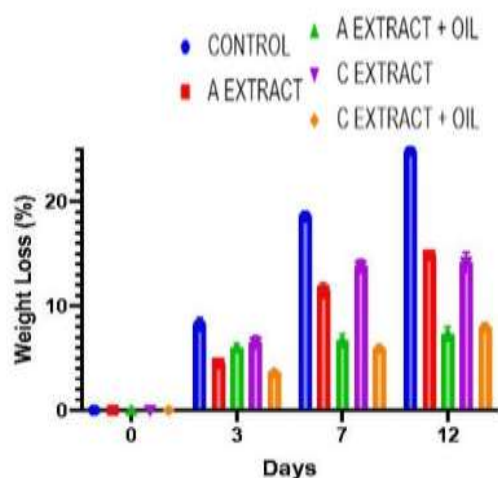


Fig. 4: Weight Loss (%) values of treated *Capsicum chinense* samples during storage for 12 days

Control: Untreated *C. chinense*

Where: A Extract: *C. chinense* treated with *L. tigrinus* extract; C Extract: *C. chinense* treated with *L. betulina* extract; A Extract + : *C. chinense* treated with *L. tigrinus* extract + Guava oil; C Extract + : *C. chinense* treated with *L. betulina* extract + Guava oil

Firmness: This served as a critical measure of textural quality in this study, and the results clearly showed that the coatings significantly enhanced firmness retention in *Capsicum chinense* during storage (Moosavi-Nezhad *et al.*, 2024). On day 0, the control group exhibited a firmness of $19.17 \pm 4.65\text{N}$, which rapidly declined over the course of storage. By day 3, the firmness had decreased to $7.38 \pm 0.08\text{N}$, showing a significant loss of texture. This rapid decline in firmness suggests that the untreated fruits experienced accelerated softening due to moisture loss, cell wall degradation, and destabilisation of cellular membranes (Jama *et al.*, 2025; Mthembu *et al.*, 2024). In contrast, the treated samples, particularly those with *Lentinus tigrinus* and *Lenzites betulina* extracts, showed much slower firmness decline. For instance, the A Extract + Oil group had a firmness of $22.92 \pm 0.93\text{N}$ on day 0, which decreased to $20.34 \pm 0.59\text{N}$ by day 3, and further to $17.23 \pm 0.57\text{N}$ by day 7, with a final value of $13.91 \pm 0.33\text{N}$ by day 12. Similarly, the C Extract + Oil group showed a firmness of $23.49 \pm 0.61\text{N}$ on day 0, which decreased to $20.41 \pm 0.62\text{N}$ by day 3 and $13.63 \pm 0.30\text{N}$ by day 12. These results suggest that the coatings acted as semi-permeable barriers, reducing moisture loss and slowing metabolic processes, which helped preserve the firmness of the fruits. The slower softening observed in the treated samples is crucial for maintaining the marketability and

consumer acceptance of fresh peppers (Jama *et al.*, 2025 and Mthembu *et al.*, 2024). This finding aligns with previous research showing that bioactive coatings can slow the softening of fresh produce by maintaining cellular integrity and reducing water loss (Maringgal *et al.*, 2020). Furthermore, the inclusion of guava essential oil in the treated samples enhanced firmness retention, likely due to the synergistic antimicrobial and antioxidant properties of the mushroom extracts and the guava oil, which helped reduce oxidative stress and microbial contamination, further preserving fruit texture during storage.

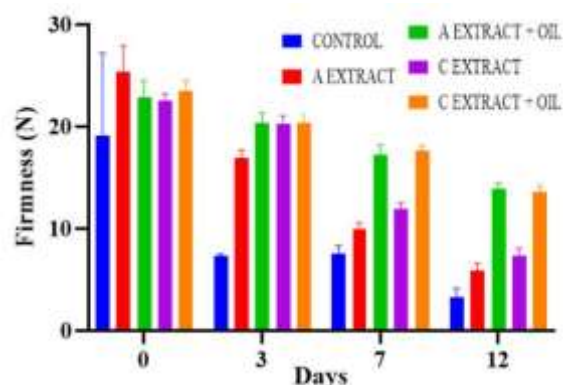


Fig. 5: Firmness values of treated *Capsicum chinense* samples during storage for 12 days

Total Soluble Solids: Fig. 6 illustrates the effect of different edible coatings on *Capsicum chinense* fruits across the various treatment groups. The control group and the group treated with *L. tigrinus* extract (A extract) initially showed a decrease in Total Soluble Solids (TSS) from day 0 to day 3, followed by an increase by day 12. Similarly, the group treated with *L. tigrinus* extract combined with guava oil (A extract + oil) showed a decrease in TSS during the first 3 days, but the increase by day 12 was less significant than in the control and A extract groups. In the group treated with *L. betulina* extract (C extract), TSS fluctuated, showing both increases and decreases before a final increase at day 12. The group treated with *L. betulina* extract integrated with guava oil (C extract + oil) displayed the most stable trend, with a steady increase in TSS by day 12 after an initial decrease.

The TSS content of *Capsicum chinense* fruits increased over the 12-day storage period. However, the application of edible coatings slowed senescence and starch breakdown, leading to a more controlled increase in TSS levels. This finding aligns with previous studies on edible coatings, such as bio-wax in lime fruits, which reduce TSS variation and juice pH, and suggests that mushroom extract coatings, especially when combined with essential oils, help

maintain fruit quality during storage (Adeogun, *et al.*, 2025a and Adeogun *et al.*, 2025b)

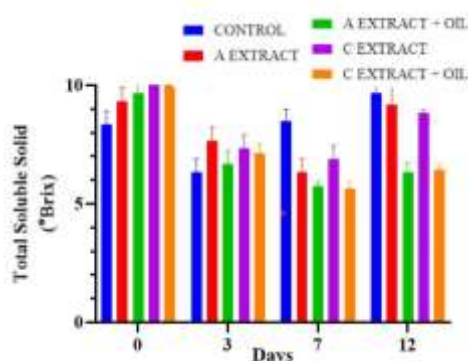


Fig. 6: TSS values of treated *Capsicum chinense* samples during storage for 12 days

pH: The pH levels of *Capsicum chinense* samples, as shown in Fig. 7, demonstrated distinct differences between the treated and control groups during storage. At day 0, the control group exhibited a pH of 6.27 ± 0.12 , while the treated samples showed varying pH values: A Extract at 6.43 ± 0.07 , A Extract + Oil at 6.50 ± 0.06 , C Extract at 6.50 ± 0.17 , and C Extract + Oil at 6.33 ± 0.09 . These initial values were relatively stable across the groups, indicating minimal biochemical breakdown at the start of storage. However, by day 3, the pH values in the control group had decreased to 5.30 ± 0.15 , indicating increased biochemical deterioration and an early onset of senescence. In comparison, the treated samples exhibited more stable pH levels, with A Extract at 5.70 ± 0.15 , A Extract + Oil at 6.13 ± 0.07 , C Extract at 5.43 ± 0.09 , and C Extract + Oil at 6.47 ± 0.07 , suggesting that the coatings effectively slowed down the natural biochemical processes that typically lead to pH shifts in fruits.

By day 7, the pH of the control fruits had declined further to 3.60 ± 0.10 , indicating more rapid degradation. The treated fruits showed slightly lower pH values: A Extract at 4.67 ± 0.12 , A Extract + Oil at 5.47 ± 0.09 , C Extract at 4.53 ± 0.15 , and C Extract + Oil at 5.70 ± 0.06 , though these values were more stable than those of the control group. By day 12, the control group's pH had further decreased to 2.50 ± 0.17 , while the pH values of the treated groups remained significantly more stable: A Extract at 3.80 ± 0.06 , A Extract + Oil at 4.70 ± 0.06 , C Extract at 3.70 ± 0.15 , and C Extract + Oil at 4.90 ± 0.06 . These results suggest that the coatings helped to moderate metabolic processes, slowing the natural biochemical breakdown and preventing drastic pH fluctuations that typically accompany fruit spoilage. The pH stability observed in the treated samples indicates that

the bioactive coatings, particularly those containing extracts of *Lentinus tigrinus* and *Lenzites betulina*, acted as protective layers. These coatings likely reduced oxidative stress and microbial invasion, which are major contributors to pH fluctuations in fruits during storage. This observation is consistent with findings from Bertolo *et al.* (2025), who showed that bioactive coatings reduced the acidity or alkalinity changes associated with fruit spoilage.

Additionally, the inclusion of guava essential oil in the coatings enhanced preservation, as evidenced by greater pH stability in the A Extract + Oil and C Extract + Oil groups. Guava oil, known for its antimicrobial properties, likely contributed to pH stabilisation by inhibiting microbial growth, which typically induces pH decreases. Similar results were observed by Adeogun *et al.* (2025b), who found that nanoencapsulated guava oil helped moderate pH levels in *Capsicum* fruits during storage. The combined effects of the mushroom extracts and guava oil in the coatings suggest a synergistic preservation mechanism, in which the antioxidant and antimicrobial properties of both components enhance the shelf life and quality of the peppers during storage.

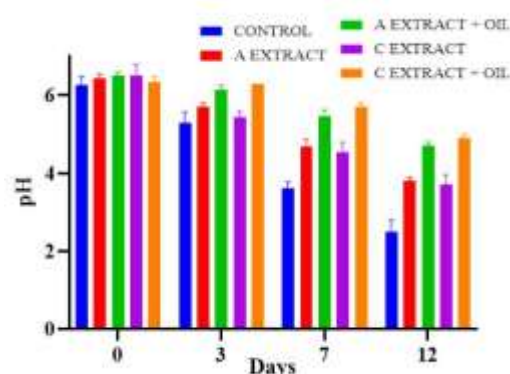


Fig. 7: pH values of treated *Capsicum chinense* samples during storage for 12 days

Electrical leakage: This was used in this study (Fig. 8) as an indicator of membrane integrity, and the results demonstrated that the coatings significantly improved the preservation of cellular structures in *Capsicum chinense* samples (Salman and Abdel Aziz, 2021). In the control group, EC values were higher, indicating greater electrolyte leakage from the cells. For instance, on day 0, the control group had an EL of $41.00 \pm 1.53 \mu\text{S}/\text{cm}$, which increased to $55.67 \pm 1.45 \mu\text{S}/\text{cm}$ by day 3, reflecting accelerated membrane degradation. This suggests that the membranes in untreated fruits became destabilised, likely due to oxidative stress and microbial activity during storage, leading to a breakdown of cell

structure (Choudhary and Jain, 2021). In contrast, the treated samples, particularly those with *Lentinus tigrinus* and *Lenzites betulina* extracts, showed significantly lower EL values. For example, A Extract + Oil had an EC of $45.67 \pm 0.88 \mu\text{S/cm}$ on day 3, which increased to $47.67 \pm 0.88 \mu\text{S/cm}$ by day 7, and C Extract + Oil showed the lowest value of $45.33 \pm 0.88 \mu\text{S/cm}$ on day 3, further increasing to $50.33 \pm 0.88 \mu\text{S/cm}$ by day 12. This increase in EL suggests that the coatings effectively preserved membrane integrity, reducing electrolyte leakage. The coatings likely acted as protective barriers, limiting the effects of oxidative stress and inhibiting microbial growth, both common causes of membrane degradation in fruits during storage (Adeogun *et al.*, 2025a). The A Extract group also showed an increase in EL from $42.00 \pm 1.15 \mu\text{S/cm}$ on day 0 to $59.33 \pm 0.88 \mu\text{S/cm}$ on day 7, while the C Extract group showed values of $42.67 \pm 0.67 \mu\text{S/cm}$ on day 0 and $46.00 \pm 1.00 \mu\text{S/cm}$ on day 7. The significant increase in EL values for the treated fruits suggests that the coatings helped preserve the cellular structure by reducing the damage typically caused by high respiration rates, dehydration, and microbial contamination (Nair *et al.*, 2020; Yousuf *et al.*, 2021). This observation aligns with findings from other studies, such as those of Nair *et al.* (2020) and Yousuf *et al.* (2021), which show that bioactive coatings reduce membrane degradation and extend shelf life in fresh produce.

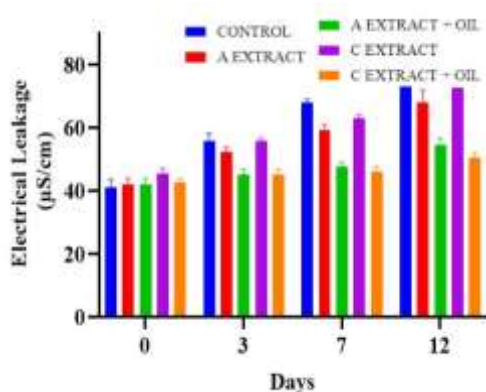


Fig. 8: Electrical Leakage values of treated *Capsicum chinense* samples during storage for 12 days

Water activity (a_w): This measures the amount of 'free' or unbound water in a material that supports microbial growth, enzymatic reactions, and chemical spoilage. Fig. 9 shows the water activity values of *Capsicum chinense* samples treated with various coatings, with minimal differences between the treated and control groups during storage. At day 0, the water activity across all groups was similar: control, 0.747 ± 0.003 ; A Extract, 0.750 ± 0.000 ; A

Extract + Oil, 0.747 ± 0.003 ; C Extract, 0.747 ± 0.003 ; and C Extract + Oil, 0.750 ± 0.000 . These initial values suggest that the bound water content at the start of storage was consistent across all groups, with no significant differences in water activity between treated and untreated fruits. By day 3, the water activity of the control group slightly decreased to 0.733 ± 0.003 , while the treated groups showed similar values: A Extract at 0.733 ± 0.003 , A Extract + Oil at 0.7133 ± 0.009 , C Extract at 0.730 ± 0.000 , and C Extract + Oil at 0.7160 ± 0.003 . These changes in water activity were relatively minor, indicating that the coatings did not have a substantial impact on moisture retention compared with the control group during the early stages of storage. At day 7, the water activity of the control group remained stable at 0.750 ± 0.000 . The treated groups also showed similar stability, with A Extract at 0.753 ± 0.003 , A Extract + Oil at 0.700 ± 0.001 , C Extract at 0.750 ± 0.000 , and C Extract + Oil at 0.683 ± 0.01 . These findings further support that the coatings did not significantly alter water activity levels compared to the control group, suggesting that water retention was similar across all treatments. By day 12, the water activity in the control group was 0.737 ± 0.003 , while the treated groups showed minimal changes: A Extract at 0.737 ± 0.003 , A Extract + Oil at 0.645 ± 0.003 , C Extract at 0.733 ± 0.003 , and C Extract + Oil at 0.649 ± 0.002 . These values indicate that, despite the coatings' potential to reduce moisture loss, the water activity remained largely unchanged in both treated and untreated groups throughout the storage period.

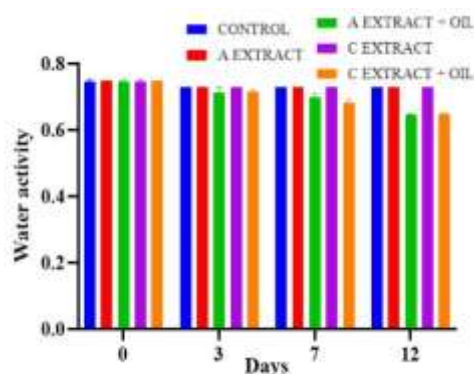


Fig. 9: Water Activity values of treated *Capsicum chinense* samples during storage for 12 days

Conclusion: This study demonstrated that edible coatings made from *Lentinus tigrinus* and *Lenzites betulina* extracts, enhanced with guava essential oil, effectively extended the shelf life of *Capsicum chinense* (Scotch Bonnet pepper). The coatings reduced weight loss, preserved firmness, stabilized pH, and improved texture, offering a sustainable, eco-friendly alternative to synthetic preservatives.

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These coatings show significant potential in reducing postharvest losses and can be applied to other perishable crops. Future research should focus on optimising formulations to maximise preservation, exploring additional natural bioactive compounds to enhance effectiveness, and conducting long-term trials to assess durability. Additionally, scaling up production for commercial use and applying these coatings to a broader range of fruits and vegetables could help reduce food waste and improve food security in tropical climates.

DECLARATIONS

Ethical Approval: Ethical approval was not required for this study, as no human or animal subjects were utilised. The authors ensured that all data handling and research practices adhered to the relevant ethical frameworks and institutional policies.

Declaration of Generative AI and AI-Assisted Technologies: The authors declare that no generative Artificial Intelligence (AI) or AI-assisted technologies—including Large Language Models (LLMs) such as ChatGPT, Microsoft Copilot, XLNet, or Ernie 3.0 Titan—were utilised in the drafting, editing, or image generation processes of this manuscript. The final content, including all text and graphical elements, was authored and reviewed solely by the human contributors listed.

Conflict of Interest Statement: The authors declare that there are no conflicts of interest, financial or otherwise, that are relevant to the research or findings presented in this manuscript.

Data Availability Statement: The data that support the findings of this study are available upon request from the corresponding author

REFERENCES

- Adeogun, OO; Ebabhi, AM; Adongbede, EM; Oluwa, OK; Adekunle, AA (2023). Influence of leaf extract of *Lantana camara* integrated with maize-based coating on the quality of fresh *Talinum triangulare* and *Telfairia occidentalis* leaves. *Caraka Tani: J. Sustain. Agric.* 38(1): 85-98. DOI: <https://doi.org/10.20961/carakatani.v38i1.57446>
- Adeogun, O; Lawal, M; Adekunle, A; Nejo, O; Oluwa, OK (2025a). Biocompatible Nanopolymer Coating Based on Chitosan Nanoprecipitation Containing Guava Oil to Control Fruit Rot, Enhance Defense-Related Enzymes, and Quality of Chili Pepper. *Fut. Postharv. Food.* 2(3): 335-360. DOI: <https://doi.org/10.1002/fpf2.70021>
- Adeogun, OO; Maroyi, A; Afolayan, AJ (2018). Comparative evaluation of essential oils from *Lippia javanica* L leaf obtained by two methods and their effect on *Artemia salina* L. *Trop. J. Pharm. Res.* 17 (1): 105-115. DOI: <https://doi.org/10.4314/tjpr.v17i1.16>
- Adeogun, OO; Maroyi, A; Afolayan, AJ (2020). Shelf-life enhancement of fresh-cut fruits of avocado treated with the essential oils from aerial parts of *Artemisia afra*, incorporated with gum Arabic edible coating. *Acta Hortic.* 1292: 239-250. DOI: <https://doi.org/10.17660/ActaHortic.2020.1292.31>
- Adeogun, OO; Oluwa, OK; Nejo, AO; Salami, SO; Egwu, PC; Adekunle, AA (2025b). Assessment of eucalyptus oil integrated with carboxymethyl cellulose (CMC) for controlling postharvest soft rot in Citrus sinensis fruits induced by *Colletotrichum gloeosporioides* and *Aspergillus niger*. *Bull. Natl. Res. Cent.* 49(1): 17. DOI: <https://doi.org/10.1186/s42269-025-01307-5>
- Adeogun, OO; Sanyaolu, AA; Samuel, T; Abubakar, A; Agbabiaka, MA; Adekunle, AA (2025c). Efficacy of peppermint oil-incorporated tragacanth gum coating on postharvest quality and antioxidant enzyme activity in banana fruits. *J. Hortic. Postharvest Res.* 8(4): 427-450. DOI: <https://doi.org/10.22077/jhpr.2025.8413.1448>
- Aguiar, RP; Miranda, MRA; Lima, ÁM; Mosca, JL; Moreira, RA; Enéas-Filho, J (2011). Effect of a galactomannan coating on mango postharvest physicochemical quality parameters and physiology. *Fruits.* 66(4): 269-278. DOI: <https://doi.org/10.1051/FRUITS/2011034>
- AOAC (2016). Official Methods of Analysis of the AOAC. 18th Edition, Association of Official Analytical Chemists, Washington, DC, USA.
- Bertolo, MRV; de Oliveira Filho, JG; Lamonica, GC; Bezerra, CC; Martins, VD; Ferreira, MD; Junior, SB (2025). Improvement of the physical-chemical, microbiological, volatiles and sensory quality of strawberries covered with chitosan/gelatin/pomegranate peel extract-based coatings. *Food Chem.* 471: 142755. DOI: <https://doi.org/10.1016/j.foodchem.2025.142755>
- Dawson, SK; Boddy, L; Halbwachs, H; Bässler, C; Andrew, C; Crowther, TW; Jönsson, M (2019). Handbook for the measurement of macrofungal functional traits: A start with basidiomycete wood

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- fungi. *Funct. Ecol.* 33(3): 372-387. DOI: <https://doi.org/10.1111/1365-2435.13239>
- Dulattos-Shipley, KM; Ford, KL; Alberti, F; Banks, AM; Bailey, AM; Foster, GD (2016). The good, the bad and the tasty: the many roles of mushrooms. *Stud. Mycol.* 85(1): 125-157. DOI: <https://doi.org/10.1016/j.simyco.2016.11.002>
- Ebabhi, A; Adeogun, O; Adekunle, A; Onafeko, A (2019). Bio-preservation Potential of Leaf Extracts of *Ocimum gratissimum* L.on Fresh-Cut Fruits of *Citrullus lanatus* (Thunb). *J. Appl. Sci. Environ. Manag.* 23(7): 1383–1389. DOI: <https://doi.org/10.4314/jasem.v23i7>
- GBIF.org (2022). GBIF Occurrence Download. DOI: <https://doi.org/10.15468/dl.9dqpud>
- Gogoi, B (2017). *Capsicum chinense* Jacq.(Bhut Jolokia)-rich source of capsaicin with wide application and economic potential. *Ann Plant Sci.* 6(8): 1664-1667. DOI: <https://dx.doi.org/10.21746/aps.2017.08.003>
- Jama, SO; Lufu, R; Opara, UL; Crouch, E; Tsige, AA (2026). Edible Coatings for Fresh Fruits: Functional Roles, Optimization Strategies, and Analytical Perspectives. *Plants* 15(1): 132. DOI: <https://doi.org/10.3390/plants15010132>
- Kader, AA (2004). Increasing food availability by reducing postharvest losses of fresh produce. *Acta Hortic.* 682: 2169-2176. DOI: <https://doi.org/10.17660/ActaHortic.2005.682.296>
- Lonsdale, D; Pautasso, M; Holdenrieder, O (2008). Wood-decaying fungi in the forest: conservation needs and management options. *Eur. J. For. Res.* 127(1): 1-22. DOI: <https://doi.org/10.1007/s10342-007-0182-6>
- Maringgal, B; Hashim, N; Tawakkal, ISMA; Mohamed, MTM (2020). Recent advance in edible coating and its effect on fresh/fresh-cut fruits quality. *Trends Food Sci. Technol.* 96: 253-267. DOI: <https://doi.org/10.1016/j.tifs.2019.12.024>
- Matche, RS; Adeogun, OO (2022). Physicochemical characterisations of nanoencapsulated Eucalyptus globulus oil with gum Arabic and gum Arabic nanocapsule and their biocontrol effect on anthracnose disease of *Syzygium malaccense* fruits. *Sci. Afr.* 18: e01421. DOI: <https://doi.org/10.1016/j.sciaf.2022.e01421>
- Moosavi-Nezhad, M; Homayoonzadeh, M; Tsaniklidis, G; Roessner, U; Woltering, EJ; Fanourakis, D; Aliniaiefard, S (2024). Enhancing shelf life of bell peppers through preharvest fertigation with calcium and potassium thiosulfate: A focus on antioxidant and cell wall degradation enzymes. *J. Agric. Res.*, 17: 101262. DOI: <https://doi.org/10.54112/bcsrj.v2024i1.1385>
- Mthembu, SS; Magwaza, LS; Tesfay, SZ; Mditshwa, A (2024). Advancing fruit preservation: Ecofriendly treatments for controlling fruit softening. *Horticulturae* 10(9): 904. DOI: <https://doi.org/10.3390/horticulturae10090904>
- Nair, MS; Tomar, M; Punia, S; Kukula-Koch, W; Kumar, M (2020). Enhancing the functionality of chitosan-and alginate-based active edible coatings/films for the preservation of fruits and vegetables: A review. *Int. J. Biol. Macromol.* 164: 304-320. DOI: <https://doi.org/10.1016/j.ijbiomac.2020.07.083>
- Nguyen, HN; Nguyen, TMT; Pham, TVA (2025). Postharvest preservation of fruits and vegetables by natural-based edible coatings–A review. *Vietnam J. Biotechnol.* 23(4): 429-448. DOI: <https://doi.org/10.15625/vjbt-22572>
- Obayelu, OA; Adegboyega, OM; Sowunmi, FA; Idiaye, CO (2021). Factors Explaining Postharvest Loss of Hot Pepper Under Tropical Conditions. *Int. J. Veg. Sci.* 27(6): 526-535. DOI: <https://doi.org/10.1080/19315260.2021.1879342>
- Ottosson, E; Kubartova, A; Edman, M; Jönsson, M; Lindhe, A; Stenlid, J; Dahlberg, A (2015). Diverse ecological roles within fungal communities in decomposing logs of *Picea abies*. *FEMS Microbiol. Ecol.* 91(3): fiv012. DOI: <https://doi.org/10.1093/femsec/fiv012>
- Perez-Vazquez, A; Barciela, P; Carpena, M; Prieto, MA (2023). Edible coatings as a natural packaging system to improve fruit and vegetable shelf life and quality. *Foods*, 12(19): 3570. DOI: <https://doi.org/10.3390/foods12193570>
- Rastogi, V; Porwal, M; Sikarwar, MS; Singh, B; Choudhary, P; Mohanta, BC (2024). A review on phytochemical and pharmacological potential of Bhut Jolokia (a cultivar of *Capsicum chinense* Jacq.). *J. Appl. Pharm. Sci.* 14(5): 079-090. DOI: <https://doi.org/10.7324/JAPS.2024.175359>
- Rizzo, V (2025). Sustainable Postharvest Innovations

- for Fruits and Vegetables: A Comprehensive Review. *Foods* 14(24): 4334. DOI: <https://doi.org/10.3390/foods14244334>
- Rodriguez-Casado, A. (2016). The health potential of fruits and vegetables phytochemicals: notable examples. *Crit. Rev. Food Sci. Nutr.* 56(7): 1097-1107. DOI: <https://doi.org/10.1080/10408398.2012.755149>
- Salama, AN; Abdou, AA; Helaly, AA; Salem, EA (2019). Effect of different nutritional supplements on the productivity and quality of oyster mushroom (*Pleurotus ostreatus*). *Al-Azhar J. Agric. Res.* 44(2): 12-23. DOI: <https://doi.org/10.21608/ajar.2019.101167>
- Sarwa, KK; Kira, J; Sahu, J; Rudrapal, M; Debnath, M (2012). A short review on *Capsicum chinense* Jacq. *J. Herb. Med. Toxicol.* 6(2): 7-10. URL: <https://api.semanticscholar.org/CorpusID:58089898>
- Srivastava, PK; Sit, N (2025). A review on fruit and vegetable processing using traditional and novel methods. *Fut. Postharv. Food* 2(1): 4-26. DOI: <https://doi.org/10.1002/fpf2.1204>
- Tennakoon, DS; Gentekaki, E; Jeewon, R; Kuo, CH; Promputtha, I; Hyde, KD (2021). Life in leaf litter: fungal community succession during decomposition. *Mycosphere* 12(1): 406–429. DOI: <https://doi.org/10.5943/mycosphere/12/1/5>
- Yuan, G; Chen, X; Li, D (2016). Chitosan films and coatings containing essential oils: The antioxidant and antimicrobial activity, and application in food systems. *Food Res. Int.* 89: 117–128. DOI: <https://doi.org/10.1016/j.foodres.2016.10.004>
- Yousuf, B; Wu, S; Siddiqui, MW (2021). Incorporating essential oils or compounds derived thereof into edible coatings: Effect on quality and shelf life of fresh/fresh-cut produce. *Trends Food Sci. Technol.* 108: 245-257. DOI: <https://doi.org/10.1016/j.tifs.2021.01.016>