North-East Research Conclave

Sustainable Science and Technology

Extended Abstract

May 20-22, 2020

Development of antioxidant rich edible active films & coatings incorporated with de-oiled ethanolic green algae extract: A candidate for prolonging the shelf life of fresh produces

Kona Mondal[1], Vaibhav V. Goud[1], and Vimal Katiyar[1*]

[1] Dpt. of Chemical Engineering, Indian Institute of Technology Guwahati, Guwahati, Assam – 781039, India

Corresponding author: vkatiyar@iitg.ac.in

1. Introduction

Active and edible packaging, an emerging concept aimed to deliver quality and safe food with pro-longed shelf life while at the same time mitigating environmental hazards caused by non-biodegradable food packaging waste. Besides, providing barrier properties, this innovative packaging act as the preservation method. The improved functionality of this packaging material is due to the incorporation of active substances, such as antioxidant, antimicrobials and others, which is not available in conventional packaging [1]. In this context, chitosan, a biodegradable, non-toxic, bio-based with good film forming property and bio-compatible polymer, obtained from deacetylation of chitin, found in crustaceans and insects [2], has received much attention for developing active and edible food packaging material [3]. The present study focuses on the ultrasound assisted green technology based liquid extraction of bioactive compounds from *Dunaliella* de-oiled algae biomass residue and development of chitosan based active edible bio-composite films and coating. The obtained extract was used as a bio-filler with varying concentration into the matrix. Furthermore, the developed filmogenic solution was applied on real food system as a primary packaging material as edible coating, targeting to extend the shelf life of fresh produces like green chilli.

2. Material and Methods

2.1 Materials

TERI, India, provided ABR, *Dunaliella tertiolecta*. Medium molecular weight chitosan, DPPH, MTT was acquired from Sigma, Aldrich, acetic acid and ethanol were procured from Finner. Foline Ciocalteu reagent, sodium carbonate, gallic acid and quercetin were purchased from Himedia.

2.2 Methods

Extraction of algae extract and fabrication of bio-composite Active edible films and coating

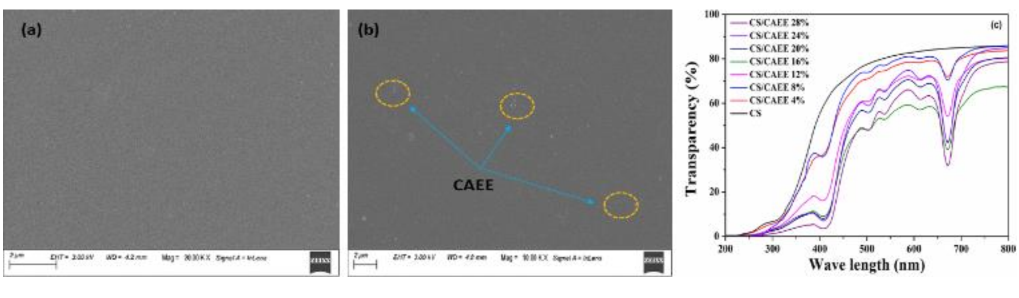
Probe ultrasonicator was used for extraction of crude algae ethanolic extract (CAEE) using 75% ethanol for 2-3 min, at room temperature followed by centrifugation (5000 rpm, 5 min) and filtration. The solution was stored in dark at -20 °C for rest of the study. Solvent casting was followed for fabrication of edible films. The chitosan (CS) (1 wt.%), acetic acid (0.3%) and varying concentration of CAEE was added (0, 4, 8, 12, 16, 20, 24 and 28 %) and stirred for 24 h at room temperature. The filmogenic solution was distributed into Teflon plates (140 cm dia) and subsequently dried for 24 h at 40 °C inside a hot air oven. Green chillies (*Capsicum annum L.*) were procured from local market and subjected to washing and drying at room temperature. Dip coating technique was followed to coat chilli (3 min) followed by drying and stored for two weeks (25±2° C, 50% RH) at room temperature.

3. Results and Discussion

3.1 Characterization of algae extract (CAEE)

The ultrasound assisted CAEE was rich in antioxidant with 44±1.41% DPPH radical scavenging activity, total phenolic content of 515.72±4.67 μg/g, total flavoind content of 151.75±2.05%, and total chlorophyll of 23.81± 1.1 mg/ml, L, a^*, b^* values of 72.62±0.04, -14.1±0.01, 59.29±0.05, respectively. The obtained results indicate CAEE is rich in antioxidant.

3.2 Surface Morphology & Transparency of bio-composites



The surface morphology of neat CS (nCS) film was observed as smooth, compact, and without any crack or pores. However, bio-composites exhibited heterogeneous rough surface and presence of small particles. The light barrier properties of bio-composites at visible and ultraviolet region (<400 nm) was improved as compared to nCS which could be due to presence of phenolics in CAEE.

Figure 1: Surface morphology of (a) nCS (b) CS/CAEE film, and (c) Transparency of bio-composites

3.3 Crystalline, Water Vapor Permeability and Mechanical properties of bio-composites

The x-ray diffraction pattern of bio-composites showed intensified peaks attributed to improved crystallinity with increasing the CAEE concentration as compared to nCS. The effectiveness of filler also confirmed by reduction in WVP ~60% and improved tensile strength from 28.62 to 54.1 MPa as compared to nCS which could be due to homogeneous and uniform distribution and strong hydrogen bonding bonding with matrix.

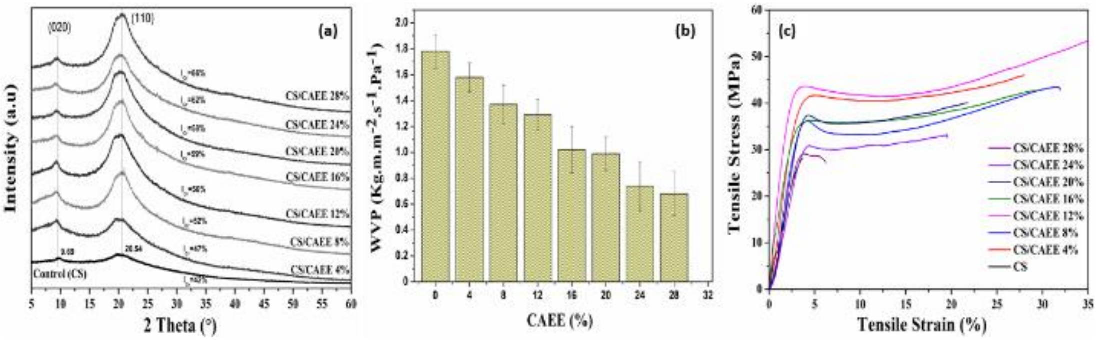


Figure 2: (a) Crystallinity (b) Water vapor permeability and (c) Stress-strain curve of bio-composites

3.4 Antioxidant, Antimicrobial and Cytotoxic properties of bio-composites

The DPPH radical-scavenging activity of the bio-composites was increased gradually from 24.81% to 48.23% with an increasing content of CAEE. The antioxidant activity of CAEE arises mainly from the phenolic hydroxyl and a small fraction may result because of the -CH2- site. The appearance of inhibition zones around the bio-composites confirmed the antimicrobial activity.

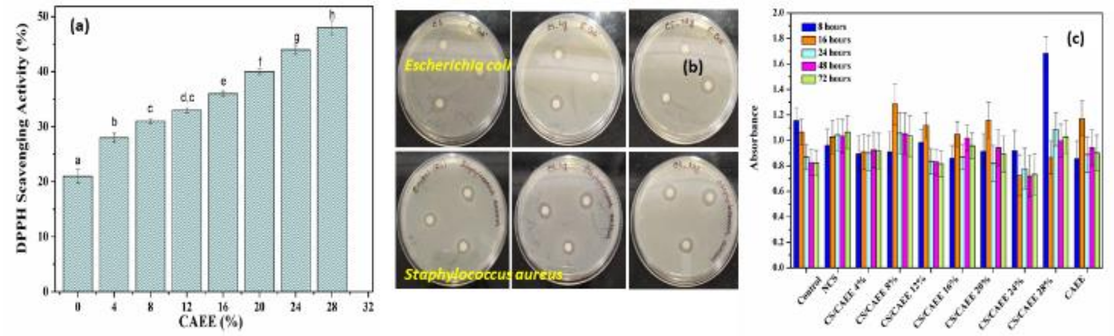


Figure 3: (a) Antioxidant activity (b) Antimicrobial properties and, (c) Cell-viability of bio-composites

3.5 Physiological properties of coated green chilli

The firmness dropped slightly with storage day in bio-composites by 6%, 18% in uncoated and 10% in nCS coated attributed to delayed respiration and good barrier properties of coating material. The shelf-life of coated chilli was enhanced by a week under ambient condition.

4. Conclusions

The current study provides successful utilization of algal bio-waste in a greener way and fabrication of edible active bio-composites films and coating for extending the shelf life of fresh produces.

References

[1] Siripatrawan, U., & Harte, B. R. 2010. Physical properties and antioxidant activity of an active film from chitosan incorporated with green tea extract. Food hydrocoll., 24, 770-775.

[2] Deshmukh, A. R., Aloui, H., Khomlaem, C., Negi, A., Yun, J. H., Kim, H. S., & Kim, B. S. 2021. Biodegradable films based on chitosan and defatted Chlorella biomass: Functional and physical characterization. Food Chem., 337, 127777.

[3] Mondal, K., Ghosh, T., Bhagabati, P., & Katiyar, V. 2019. Sustainable nanostructured materials in food packaging. In Dynamics of Advanced Sustainable Nanomaterials and their Related Nanocomposites at the Bio-Nano Interface, Elsevier, pp. 171-213.