Photocatalytic expanded polyethylene/gelatin-TiO_2 foam net to delay climacteric fruit ripening	ORAL/POSTER Professor Journal:

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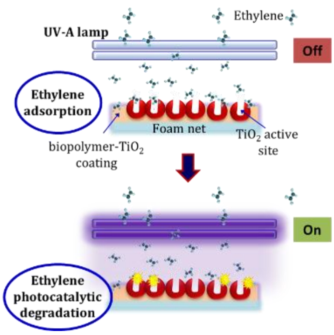

One of the biggest challenges of the food industry is reducing postharvest losses, especially of climacteric fruits, characterized by high respiration and ethylene production rates at the beginning of the maturation stage, resulting in accelerated ripening. Thus, this work aimed to develop a new active package with photocatalytic properties to scavenge ethylene from fruits. Expanded polyethylene foam nets were coated with gelatin-TiO_2 nanocomposite containing 1wt% TiO_2 by dip coating and tested to delay papaya ripening. Fruits wrapped in photocatalytic foam nets exhibited an ethylene accumulation 60% less than the control with reduced climacteric peak, higher preservation of the green peel and yellow pulp, and firmness without visual fungal growth.

Introduction

Transporting and distributing climacteric fruits is a big challenge for the postharvest sector because of their fast ripening caused by high respiration and ethylene production rates at the beginning of the maturation stage [1]. Thus, several technologies, such as refrigeration, wax coating, ethylene absorbents, and inhibitors, have been applied to preserve climacteric fruits. However, some of them, such as papayas, are very sensitive to these technologies, which has motivated the development and application of other technologies in postharvest preservation. One of them is the TiO_2 photocatalysis using biopolymers-TiO_2 as packaging films to photodegrade ethylene [2].
Although these composites exhibit photocatalytic properties to degrade ethylene and, several times, microorganisms, they present poor mechanical properties, increasing the risk of TiO_2 migration to food and TiO_2 agglomeration, compromising the photocatalysis efficiency due to light scattering [2]. Thus, in this research, the deposition of a gelatin-TiO_2 composite on expanded polyethylene (EPE) foam nets was proposed to improve the TiO_2 dispersion and increase the photocatalytic area, forming a new type of active package for fruit.

Material and Methods

Papayas (*Carica papaya* L. cv. 'Golden') were used as a climacteric fruit model (90–100 % green peel). EPE foam nets with a surface area of 0.132 m^2, bovine gelatin (bloom 250, Gelnex, Brazil), glycerol (99%, Neon, Brazil), Titanium dioxide (TiO_2) (average crystallite diameter < 10 nm, 100% anatase, Hombikat UV 100), and acetic acid solution were used as immobilizing support, biopolymer matrix, plasticizer, photocatalyst, and solvent, respectively. Gelatin-TiO_2 composite dispersion containing 1wt% TiO_2 (gel-1%TiO_2) was tested as film (fabricated by casting) and coating, deposited on EPE foam nets by dip coating (0x, 2x, and 4x immersions) to degrade ethylene in a batch system loaded with 5ppmv of ethylene at 30°C and RH = 85% and equipped UV-A lamp (λ = 365 nm, irradiances (I) of 9.80 mW cm^{-2}). The package prototype with the highest ethylene degradation efficiency was used in validation tests with papaya. Fruits were wrapped in EPE foam nets and stored for four days in a batch reactor (30°C and RH = 85%, and UV-A: λ = 365 nm, I = 1.44 mW cm^{-2}). They were characterized according to their respiration and ethylene production rates, visual aspect, color, and firmness.

Results and Discussion

Comparing the ethylene photodegradation data (**Figure 1** and **Table 1**) of gel-1%TiO_2 film and EPE-2x-gel-1%TiO_2 and EPE-4x-gel-1%TiO_2 foam nets prepared with 2x and 4x immersions in gel-1%TiO_2 dispersion, respectively, it is observed that EPE-2x-gel-1%TiO_2 presented a crescent and continuous ethylene degradation without plateau, characterizing a photocatalyst deactivation by a carbonaceous deposition resulting from biopolymer degradation (fouling). Furthermore, the same sample exhibited the highest photocatalytic efficiency, considering the concentration of degraded ethylene per weight of TiO_2 loaded [g] on the irradiated surface area [m^2] $C_{C_2H_4}([ppmv]m^2_{surface}g^{-1}_{TiO_2})$.

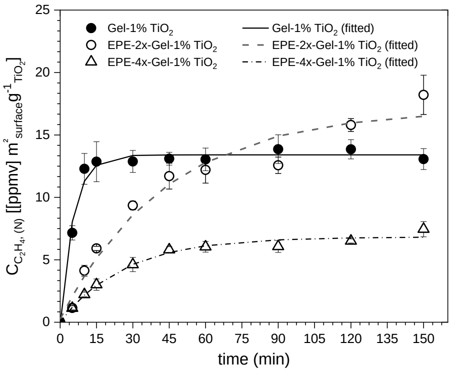

Figure 1. Photodegradation of ethylene by Gel-1%TiO_2 films and EPE-2x-gel-1%TiO_2 and EPE-4x-gel-1%TiO_2 foam nets.

Thus, EPE-2x-gel-1%TiO_2 was the foam net chosen for the prototype validation test with papayas. Papayas were characterized before and after storage in the photocatalytic reactor. Fruit wrapped in EPE blank foam nets and stored under UV-A light (control) exhibited similar respiration and ethylene production profiles with a climacteric peak at 12h after storage (**Figure 2**), visual fungal growth, higher color variation (peel and pulp), scalds caused by UV-A (**Figure 3**), and firmness loss of 60.4% in peel, 71.6% in pulp close to the peel and 70.7% in pulp close to the seeds. In contrast, fruits wrapped in EPE-2x-gel-1%TiO_2 foam nets exhibited an ethylene accumulation 60% less than the control with a reduction of the climacteric peak (CO_2 and ethylene emission rates), higher preservation of the green peel and yellow pulp and lower firmness loss (4% in peel, 44% in pulp close to the peel and 34% in pulp close to the seeds). Finally, none of the fruits from the photocatalysis experiment exhibited visual fungal growth.

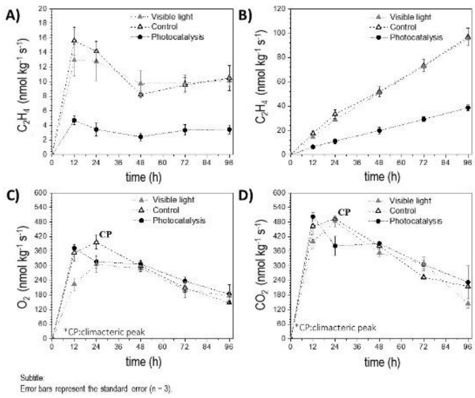

Figure 3. Respiration and ethylene production rates of untreated and treated papayas with photocatalysis.

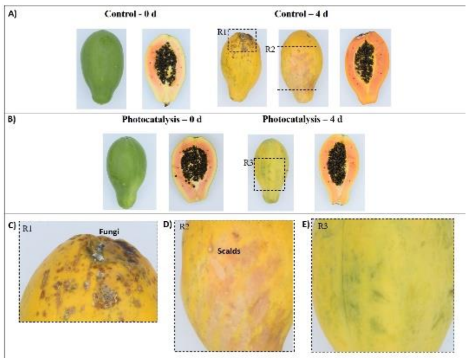

Figure 3. Images of untreated and treated papayas with photocatalysis.

Conclusions

The ethylene degradation using EPE-2x-gel-1%TiO_2 photocatalytic foam nets probably decreased the expression of enzymes that trigger the degradation of pectin, chlorophyll, malic, and citric acids in papayas, preserving the firmness and fresh colors. The photocatalytic foam nets also played a supplementary UV-A light blocker role, minimizing its absorption by the peel cells. Thus, EPE-2x-gel-1%TiO_2 foam net has a high potential to be used as postharvest technology to scavenge ethylene at the beginning of the fruit maturation stage.

Acknowledgments

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References

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