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► To cite this version:

Chloë Bonnenfant, Nathalie Gontard, Chahinez Aouf. Active packaging : Incorporation of polyphenols in polyhydroxyalkanoate (PHA) : Thermal stabilization and antioxidant properties. Biopolymers and sustainable composites, Mar 2020, Valencia, Spain. hal-02943213

HAL Id: hal-02943213

<https://hal.inrae.fr/hal-02943213>

Submitted on 18 Sep 2020

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Active packaging : Incorporation of polyphenols in polyhydroxyalkanoate (PHA) : Thermal stabilization and antioxidant properties

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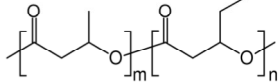
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Introduction : Pollution of environment by plastic is a worldwide issue. Today, packaging is mainly produced from conventional petroleum-based plastics especially in food industry. Plastic is everywhere, that is why ongoing research are attempting to develop biobased and biodegradable polymers. Polyhydroxyalkanoates (PHA) seem to be good candidates. The aim of this study is to enhance their thermal properties and confer antioxidant properties to PHA by adding polyphenols.

Polyhydroxyalkanoate (PHA)



Polymer under study:



Poly(3-hydroxybutyrate-co-hydroxyvalerate) = PHBV



Biobased polymer produced by bacterial fermentation



Biodegradable [1]

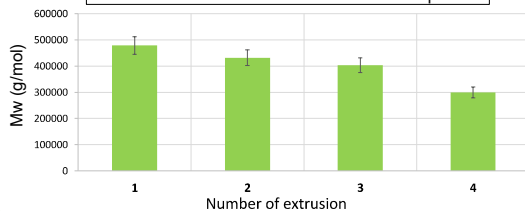


Processability window very tight (175°C < T_{process} < 210°C)



Expensive (compared to PET, PP)

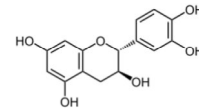
Evolution of Mw with the number of extrusion process



Polyphenols



Family of organic molecules mainly coming from plants

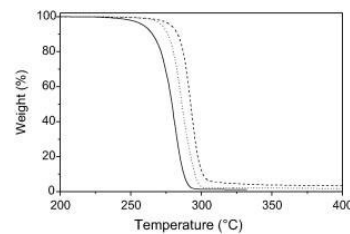


(+)-Catechin

Interesting properties :

- Antioxidant properties
- Improvement of thermal stability of materials

Thermogravimetric analysis of neat PHB (solid line), PHB/TA5 (dotted line), PHB/TA15 (broken line) [2]



TA5 = Tannic acid 5%
TA15 = Tannic acid 15%

PHA x Polyphenols Matrix



PHA

+



Polyphenols

Extrusion



PHA/Polyphenols blends/composites

Heat seal press



New active packaging

Properties expected :

- Better thermal stability → Possibility to consider mechanical recycling
- Wider processability window
- Antioxidant effect in contact with food

Underlying issues :

- Effect of the polyphenols on the biodegradability of the polymers
- Ability to food contact ?

Conclusion: We expect that this PhD research will lead to a new formulation of PHA derivatives with enhanced thermal stability. Polyphenols could be the answer to these issues and furthermore, they, could confer interesting properties as antioxidant ones to polymers dedicated for food industry's application.

References :

- [1] Zainuddin, S., et al. (2019). "Mechanical, Fire Retardant, Water Absorption and Soil Biodegradation Properties of Poly(3-hydroxy-butyrates-co-3-valerate) Nanofilms." *Journal of Polymers and the Environment* **27**(10): 2292-2304.
- [2] Auriemma, M., et al. (2015). "Blending poly(3-hydroxybutyrate) with tannic acid: Influence of a polyphenolic natural additive on the rheological and thermal behavior." *European Polymer Journal* **63**: 123-131.