# Dopamine effect on flexible starch-based films for food packaging applications

MYCS 2023
RIMINI | 13-15 NOVEMBER 2023

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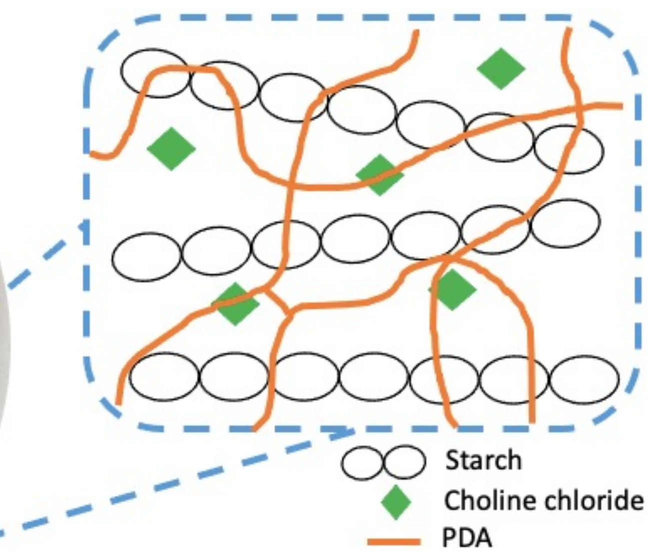
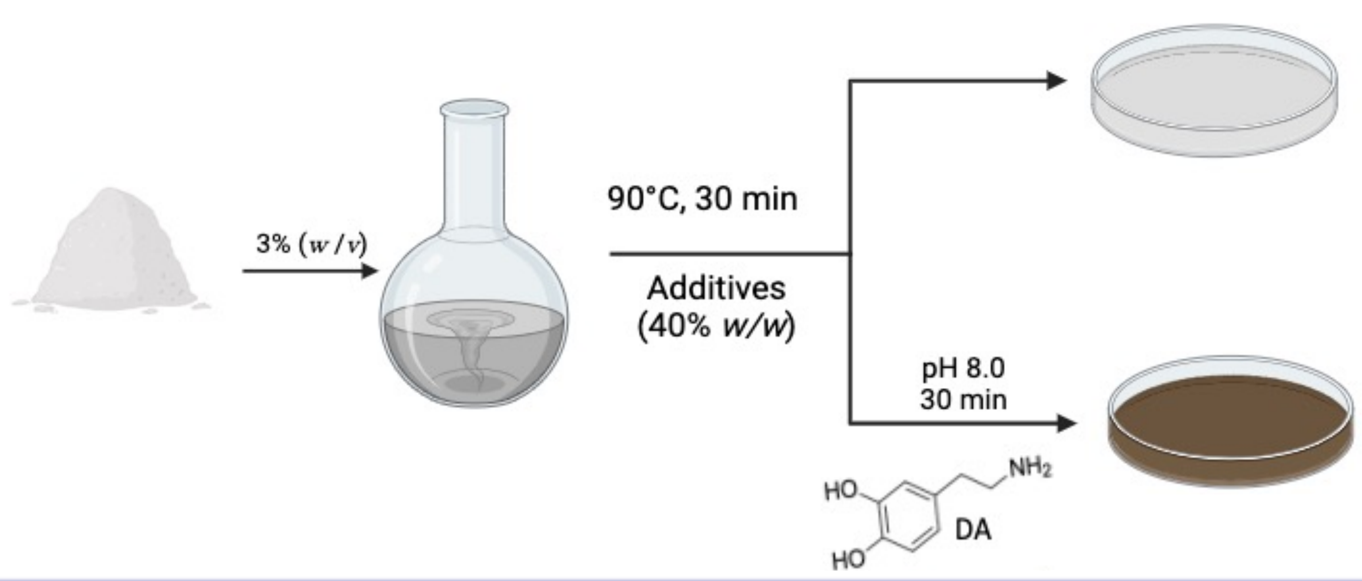
Food packaging plays a crucial role in preserving food quality and extending its shelf life. However, the widespread use of petroleum derived packaging materials has led to serious environmental concerns. In recent years, the quest for sustainable and biodegradable alternatives has intensified, with flexible starch-based films emerging as a promising eco-friendly option. One of the significant challenges in utilizing starch-based films for food packaging is their hydrophilicity and brittleness. To overcome this hurdle, various techniques have been explored to enhance the performance of starch-based films[1]. Dopamine is a small amine-rich molecule that in mild alkaline conditions starts the process of oxidative self-polymerization to form polydopamine (PDA) [2]. Thanks to the quinone structure existing in PDA, these conjugated systems enable PDA to absorb UV light in the range of 280-400 nm. As a result, PDA-coated surfaces can act as a protective barrier avoiding food spoilage and degradation of sensitive nutrients. In this study, the effect of self-polymerized dopamine on pure and acetylated starch films for food packaging applications will be evaluated.



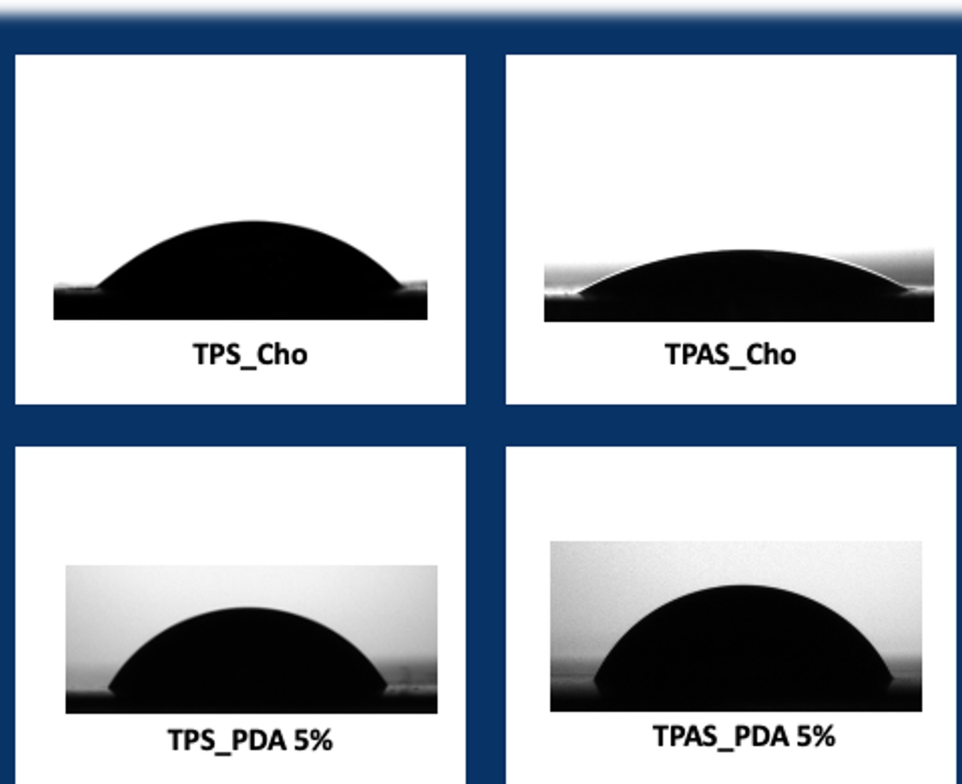

## Methods



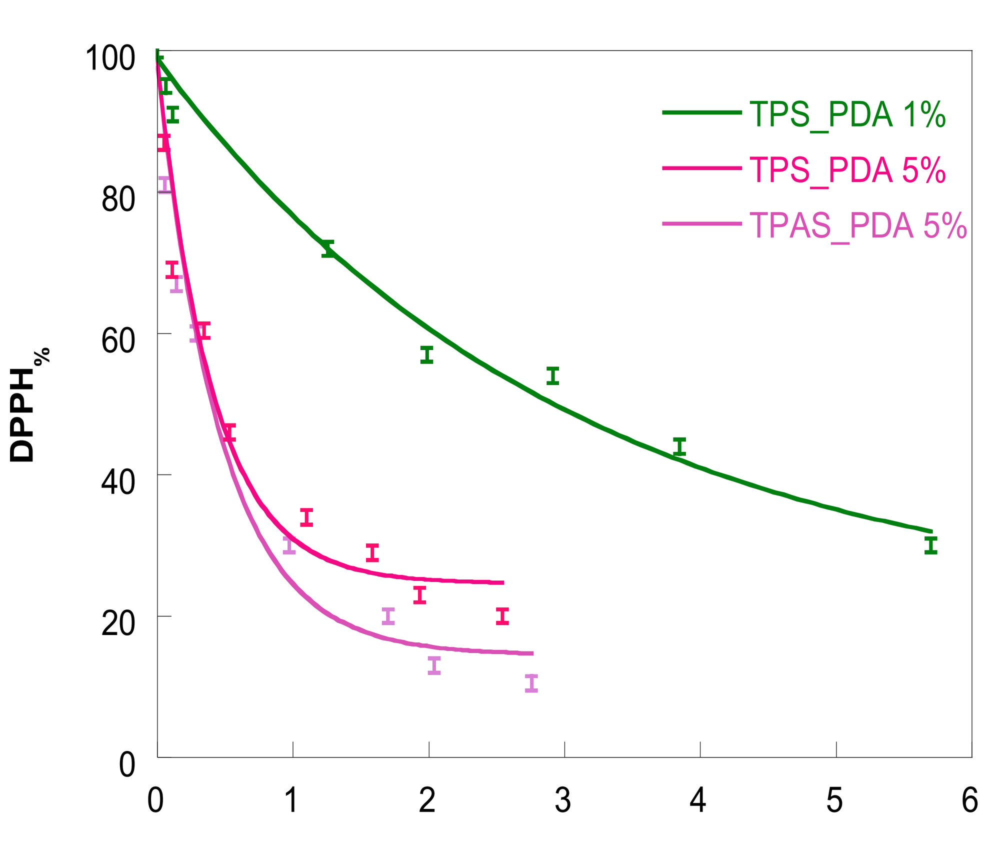

## Water contact angle

Water contact angle measurements on starch films provide valuable insights into their surface wettability and interaction with water. Generally, if the water contact angle is smaller than 90°, the solid surface is considered hydrophilic and if the water contact angle is larger than 90°, the solid surface is considered hydrophobic.

| | θ |
|---|---|
| TPS_Cho | 45 ± 3 |
| TPAS_Cho | 31 ± 4 |
| TPS_PDA 1% | 57 ± 7 |
| TPS_PDA 5% | 69 ± 5 |
| TPAS_PDA 5% | 59 ± 4 |

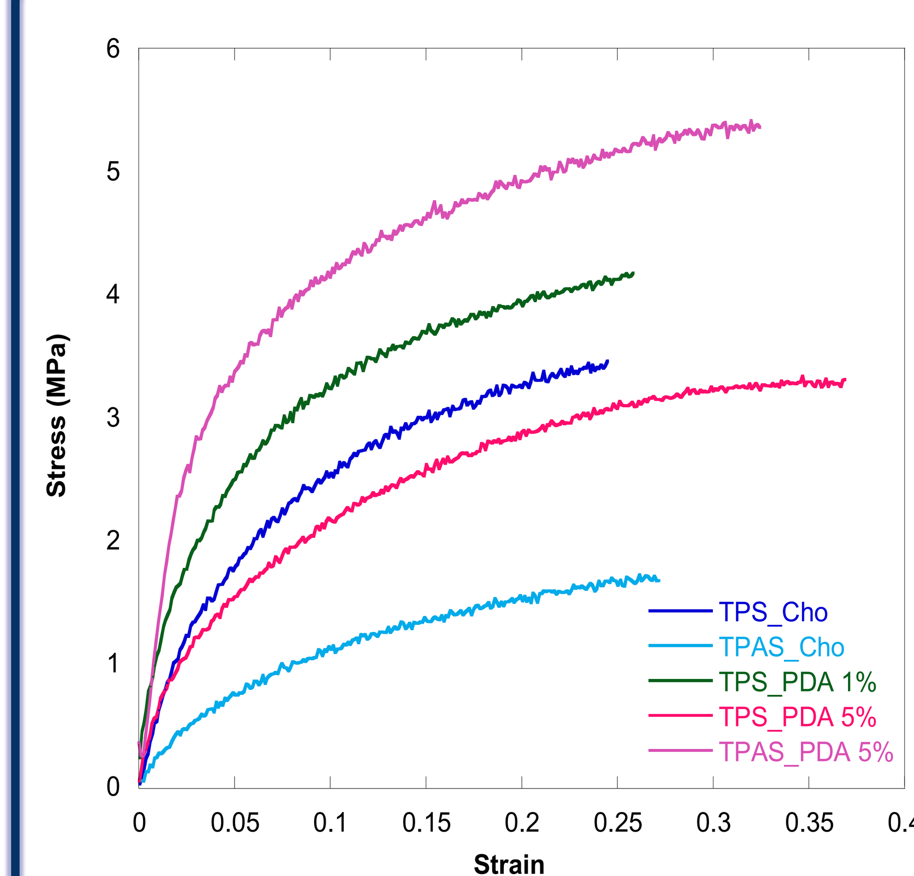



## Antioxidant activity




| Sample | $EC_{50}$ (g/L) |
|---|---|
| TPS_Cho | 51 ± 10 |
| TPAS_Cho | 50 ± 8 |
| TPS_PDA 1% | 3.0 ± 0.8 |
| TPS_PDA 5% | 0.50 ± 0.07 |
| TPAS_PDA 5% | 0.40 ± 0.03 |

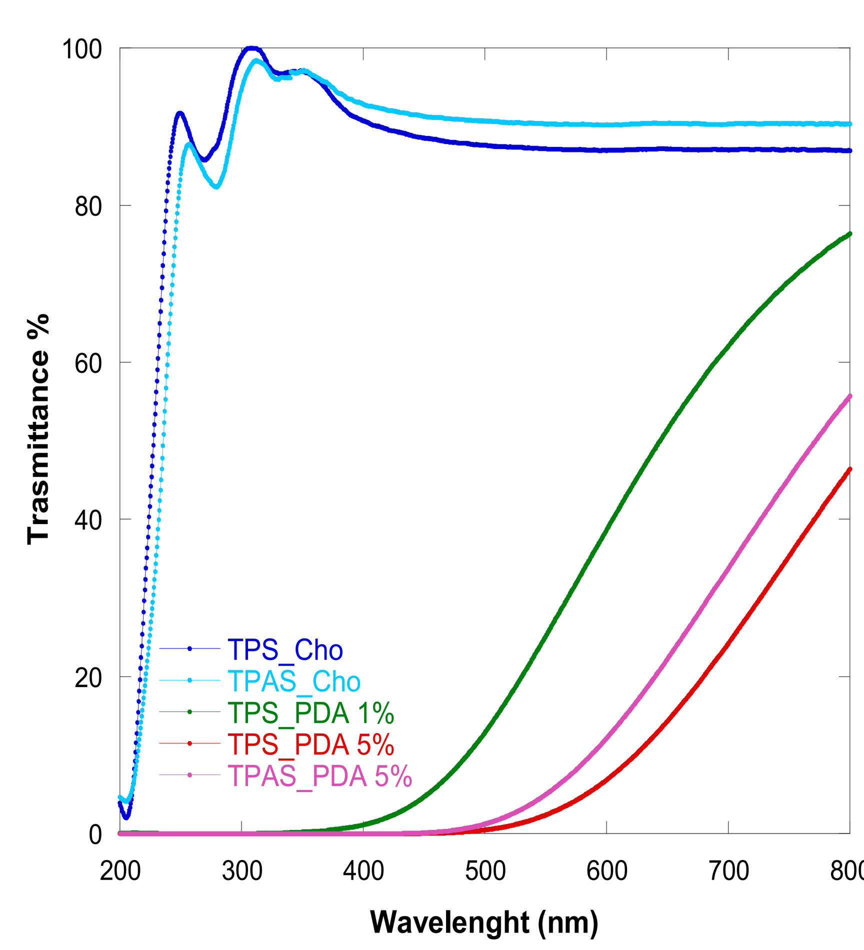
## Mechanical properties




| Sample | Young Modulus (MPa) | Tensile strength (MPa) | Elongation at break (ε%) |
|---|---|---|---|
| TPS_Cho | 65 ± 10 | 3 ± 1 | 23 ± 3 |
| TPAS_Cho | 29 ± 8 | 2 ± 1 | 33 ± 5 |
| TPS_PDA 1% | 52 ± 3 | 4 ± 1 | 25 ± 5 |
| TPS_PDA 5% | 61 ± 13 | 4 ± 1 | 41 ± 3 |
| TPAS_PDA 5% | 138 ± 17 | 6 ± 1 | 39 ± 6 |

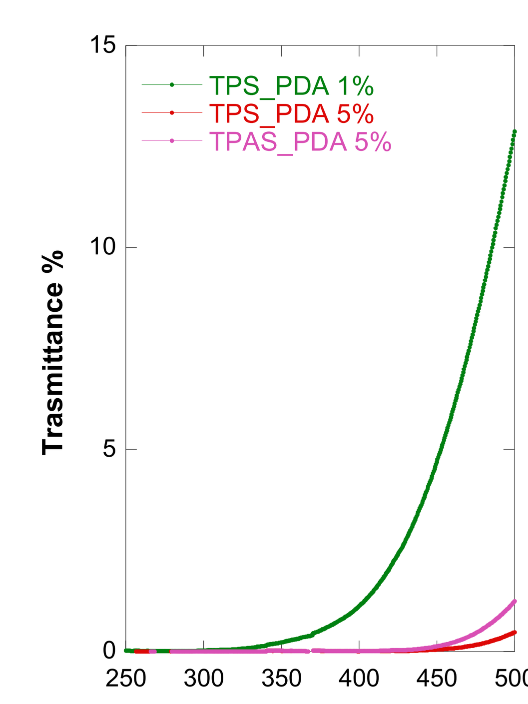
## UV shielding properties

The films' capacity to absorb UV was assessed, as many food items are vulnerable to photodegradation when exposed to this type of electromagnetic radiation.




The spectra of TPS_Cho and TPAS_Cho clearly indicated that the films plasticized only with choline chloride, both with unmodified and acetylated starch, did not absorb UV light.

The UV transmittance of TPS_PDA 5% and TPAS_PDA 5% was almost zero, increasing up to 1.5% at 400 nm for TPS_PDA 1%




## Conclusion

This work led to develop eco-sustainable materials for food packaging that replace common plastics, employing different amounts of natural additives and investigating their influences on films properties.

All the films showed good mechanical properties. The addition of polydopamine (PDA) led to produce materials with almost 100% UV shielding efficiency, enhanced hydrophobicity, and good antioxidant activity, developing materials capable of protecting food from degradation, suitable for food packaging applications.

## Future perspectives

- Test the possible antibacterial activity of the films
- Evaluate the applicability on food preservation tests
- Evaluate the biodegradation of such materials into the environment

[1] Romano, S.; De Santis, S.; Martinelli, A.; Rocchi, L.A.; Rocco, D.; Sotgiu, G.; Orsini, M. Starch Films Plasticized by Imidazolium-Based Ionic Liquids: Effect of Mono- and Dicationic Structures and Different Anions. ACS Appl Polym Mater 2023, doi:10.1021/acsapm.3c01235.
[2] Cheng, H., Chen, L., McClements, D. J., Yang, T., Zhang, Z., Ren, F., Tian, Y., & Jin, Z. (2021) Trends in Food Science & Technology, 114, 70–82.