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Innovative Use of Brewing Spent Yeast for Tannin Adsorption from a Treatment Solution

Elsa F. Vieira[1]*, Tomás Amaral[2]; Ricardo Ferraz[2], Cristina Delerue-Matos[1]

[1]REQUIMTE/LAQV, School of Engineering (ISEP/IPP), Polytechnic of Porto, Portugal

[2]School of Health, Polytechnic of Porto (ESS/IPP), Porto, Portugal

*elsavieiraf@gmail.com; EMFVA@isep.ipp.pt

INTRODUCTION & AIM

The three largest beer-producing nations (USA, China, and Brazil) collectively account for 2.1 million tons of brewer´s spent yeast (BSY) biomass annually. While much of this residue is traditionally used as animal feed or fertilizer, it presents an exciting opportunity to enhance human nutrition [1]. Notably, yeast cell walls can bind phenolic compounds like tannins, offering a novel way to extract value from these residues [2]. Chestnut shells (CS), a by-product of the chestnut processing industry and an excellent source of tannins [3], could be synergistically combined with BSY for dietary enrichment.

This study evaluated the potential of BSY to adsorb tannins and other phenolic compounds from a CS-tannin extract obtained through alkaline treatment with 5% NaOH (v/v). This method is commonly used for extracting cellulosic material from CS [3]. Hence, data obtained within this research is important to stablish more sustainable laboratory practices and improve the economic feasibility of the cellulosic material extraction process from CS.

METHOD

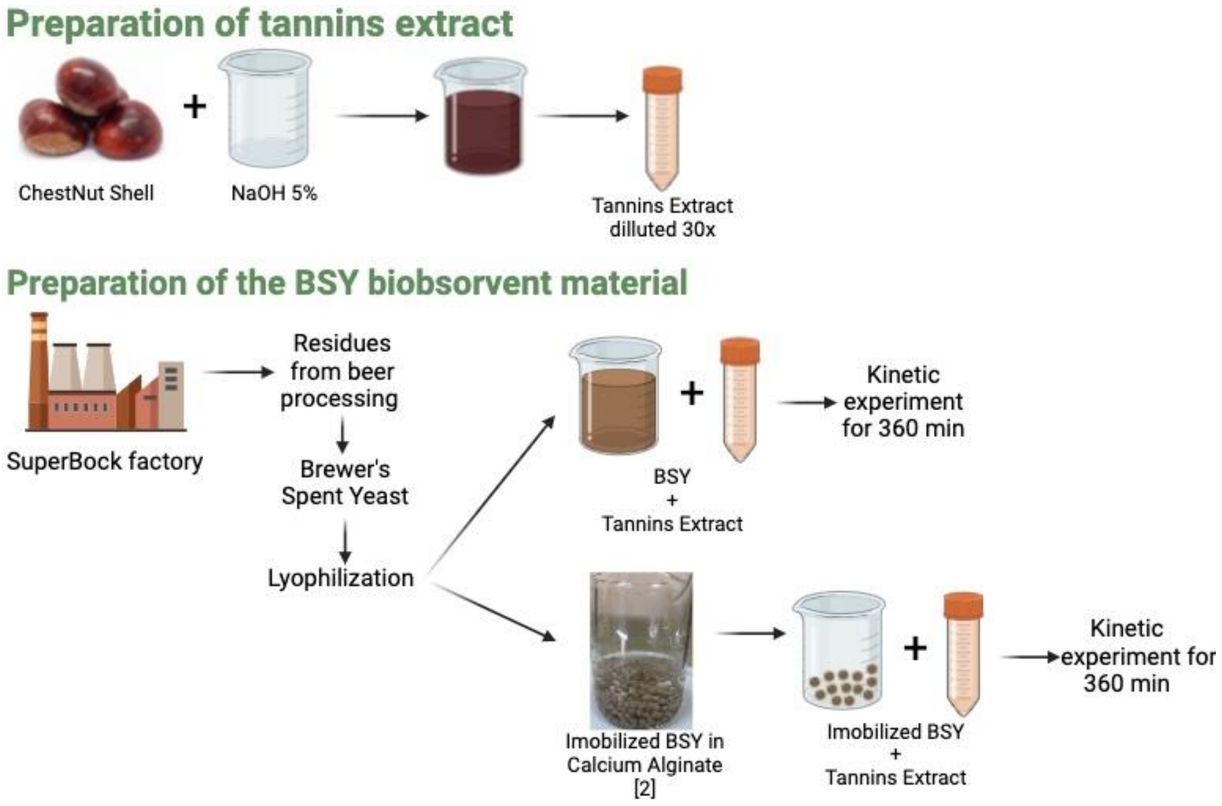

Fig 1. Preparation of tannins extract and BSY biosorvent material.

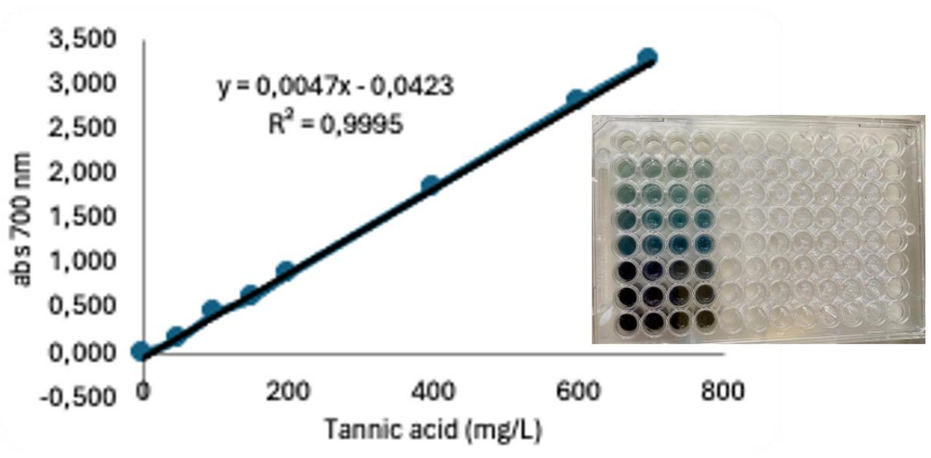

Fig 2. Spectrophotometric method for tannins quantification.

RESULTS & DISCUSSION

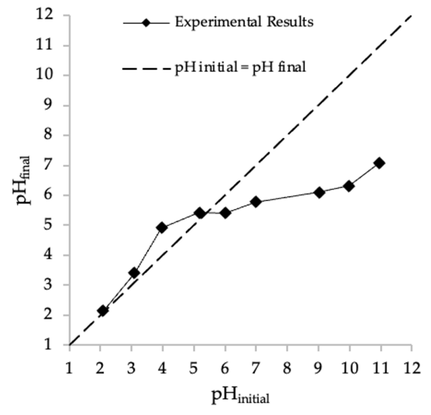

Fig 3. Point of zero charge (pH_{pzc}) determination in BSY biomass.

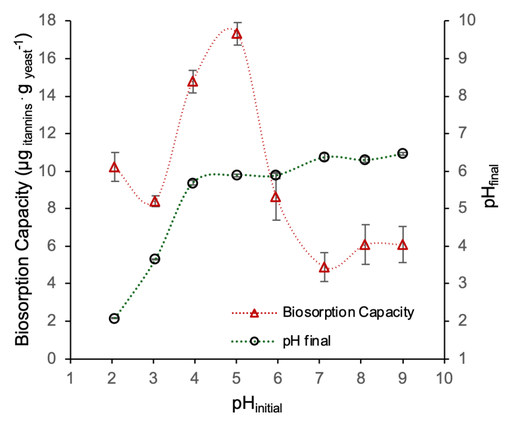

Fig 4. Influence of pH on tannins biosorption capacity by BSY biomass.

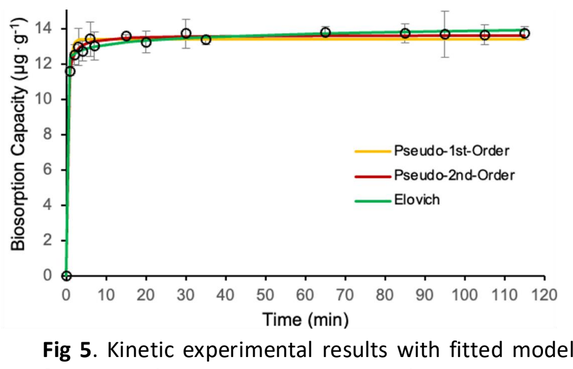

Fig 5. Kinetic experimental results with fitted models for tannins biosorption onto LIOF and IMO BSY.

Model	Parameters	Lyophilized BSY	Immobilized BSY
Pseudo 1ªOrdem	q_e ($mg_{Tannins} \cdot g_{yeast}^{-1}$)	31.81± 3.08	35.51 ± 0.97
	K_2 ($g_{yeast} \cdot mg_{Tannins}^{-1}\ min^{-1}$)	5.2 ± 7.4	1.83 ± 0.76
	SSE	0.0979	0.2821
	$R^2_{ajustado}$	0,.9999	0.9998
	$S_{y,x}$	0.1180	0.1878
	$X^2_{reduzido}$	0.0140	0.0380
Pseudo 2ªOrdem	q_e ($mg_{Tannins} \cdot g_{yeast}^{-1}$)	31.30 ± 0.50	37.96 ± 0.08
	K_2 ($g_{yeast} \cdot mg_{Tannins}^{-1}\ min^{-1}$)	5.2 ± 7.4	1.83 ± 0.76
	SSE	0.0955	0.2897
	$R^2_{ajustado}$	0.9965	0.9977
	$S_{y,x}$	0.1109	0.1668
	$X^2_{reduzido}$	0.0234	0.0456
Elovich	α ($g_{yeast} \cdot mg_{Tannins}^{-1} \cdot min^{-1}$)	$9.10E^{9}$ ± $2.3E^{10}$	$1.4E^{13}$± $8.4E^{13}$
	β ($mg_{Tannins} \cdot g_{yeast}^{-1}$)	1.53 ± 0.16	1.50 ± 0.27
	SSE	0.3192	1.881
	$R^2_{ajustado}$	0.9985	0.9954
	$S_{y,x}$	0.1997	0.4848
	$X^2_{reduzido}$	0.0399	0.2351

Table 1. Kinetic parameters for tannins biosorption onto BSY liophilized and immobilized biomass.

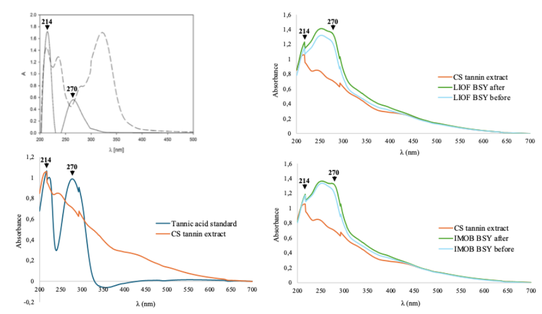

Fig 6. UV-Vis spectra of **(A)** tannic acid solution (25 mg L^{-1}): solid line at pH 4.8 and dash line at pH 9 reported by [4]; **(B)** tannic acid standard solution (25 mg L^{-1}) and CS-tannin extract (10 mg L^{-1}); **(C)** LIOF BSY before and after adsorption of CS-tannin extract; **(D)** IMOB BSY before and after contact adsorption of CS-tannin extract.

CONCLUSION

- The equilibrium was reached within 10 minutes and the highest (p <0.05) biosorption capacity of tannins from CS-tannin extract was achieved with BSY submitted to lyophilization (35.51 ± 0.97 mg TAE g^{-1} BSY.
- Sips models adequately described the process and revealed that biosorption of tannins by BSY is a chemisorption process.
- Many different functional groups were identified in BSY by FTIR; suggesting that carboxyl, amino/hydroxyl and amide groups were mainly involved in the biosorption of tannins.
- Overall, these findings suggest that BSY holds promise as a delivery system for valorizing tannins from a treatment solution.

REFERENCES

[1]Ferreira, I. M. P. L. V. O., et al. (2010). *Trends Food Sci Technol* **2010**, 21(2), 77-84. DOI: 10.1016/j.tifs.2009.10.008. [2]De Rossi, A., et al. *J Env Chem Eng* **2020**, 8(4), 104009. DOI: 10.1016/j.jece.2020.104009. [3]Amaral, L., et al. *Food Chem* **2022**, 396, 133609, DOI: 10.1016/j.foodchem.2022.133609. [4]Barbasz, A., et al. Appl Biochem Biotechnol 2015, 176(3), 817–834. DOI: 10.1007/s12010-015-1613-3.

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