

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

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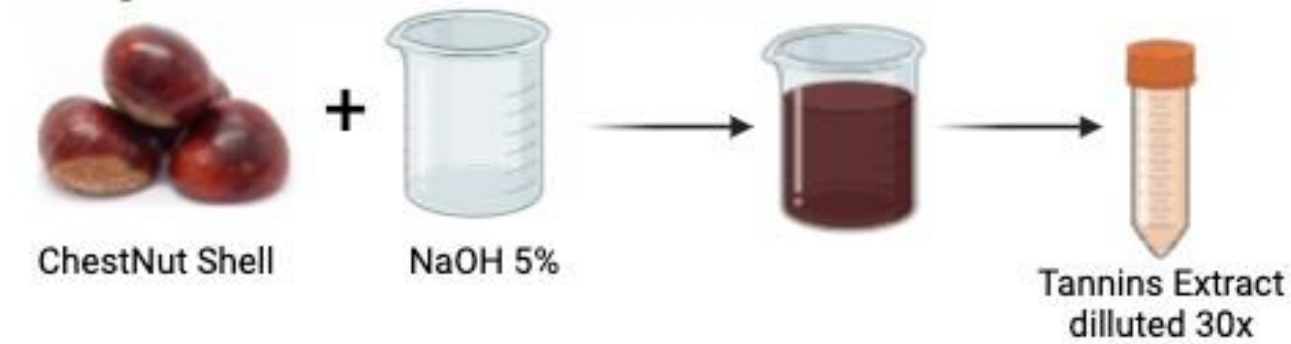
INTRODUCTION & AIM

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 establish more sustainable laboratory practices and improve the economic feasibility of the cellulosic material extraction process from CS.

METHOD

Preparation of tannins extract



Preparation of the BSY biosorbent material

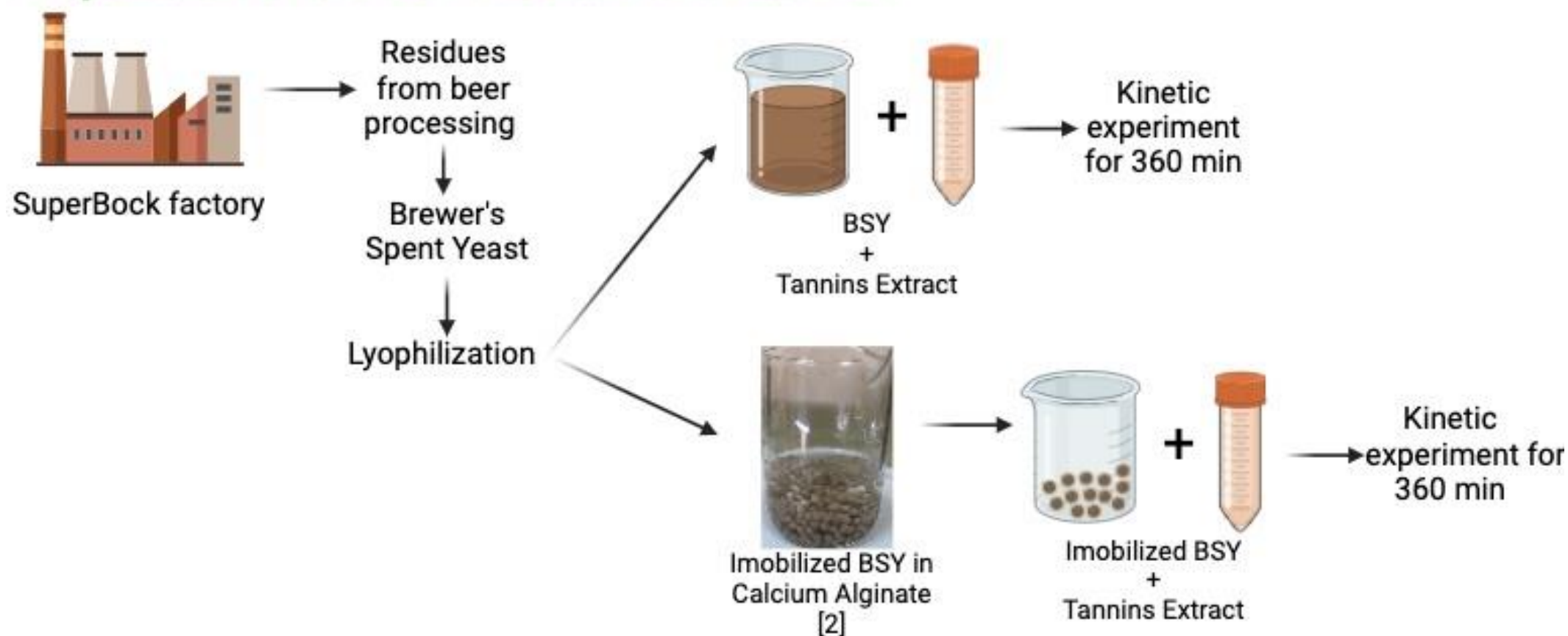


Fig 1. Preparation of tannins extract and BSY biosorbent material.

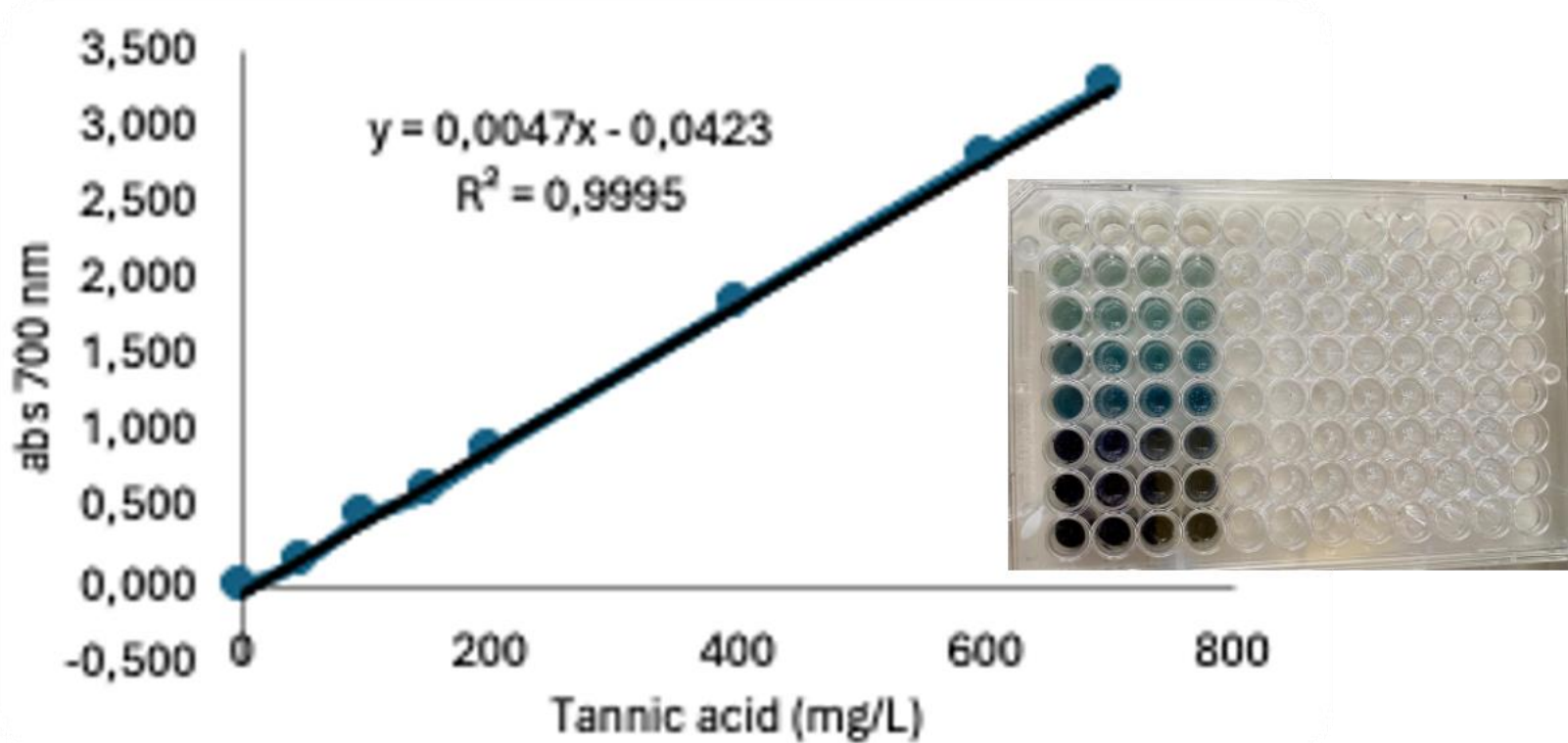


Fig 2. Spectrophotometric method for tannins quantification.

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.

RESULTS & DISCUSSION

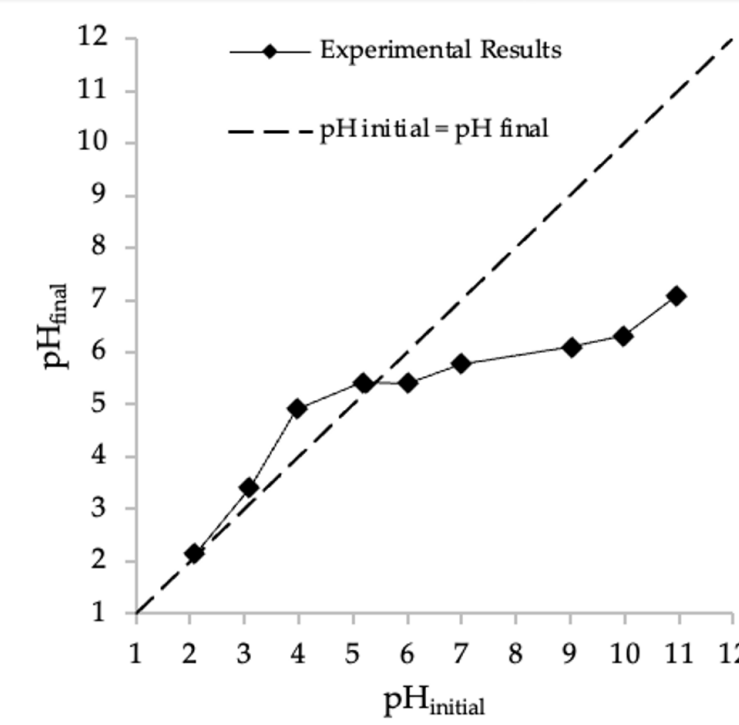


Fig 3. Point of zero charge (pH_{pzc}) determination in BSY biomass.

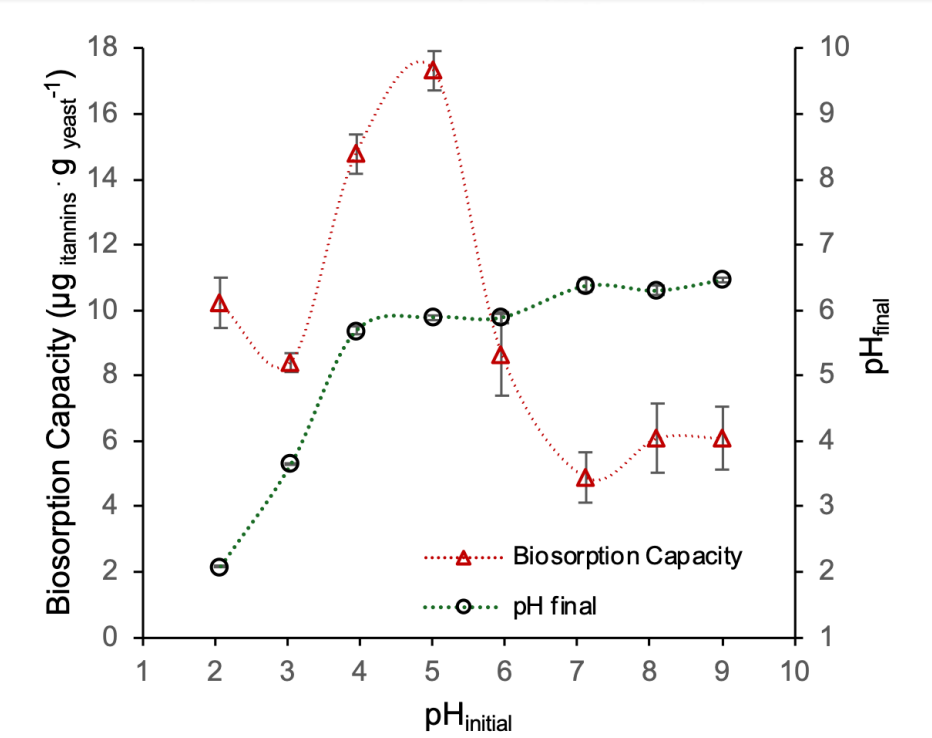


Fig 4. Influence of pH on tannins biosorption capacity by BSY biomass.

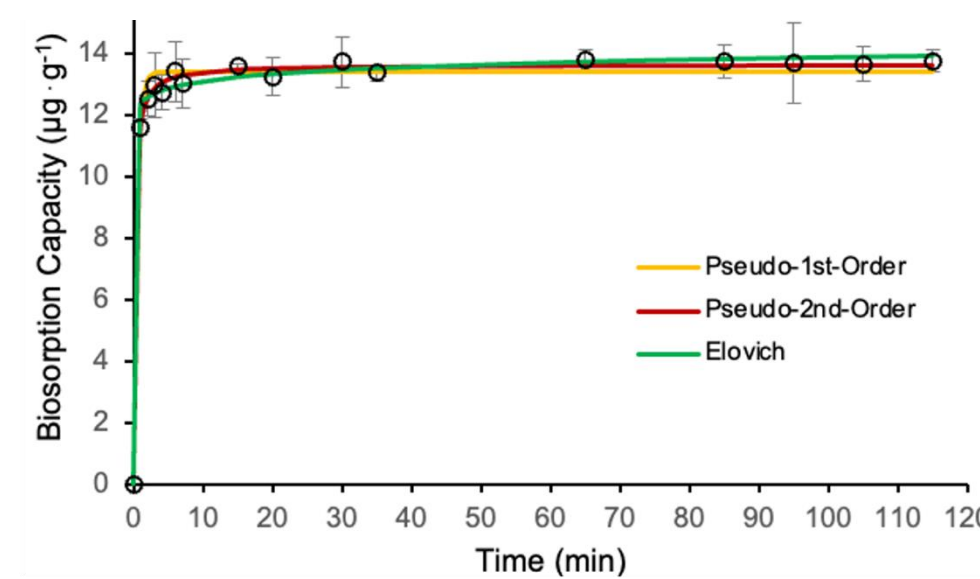


Fig 5. Kinetic experimental results with fitted models for tannins biosorption onto LIOF and IMO BSY.

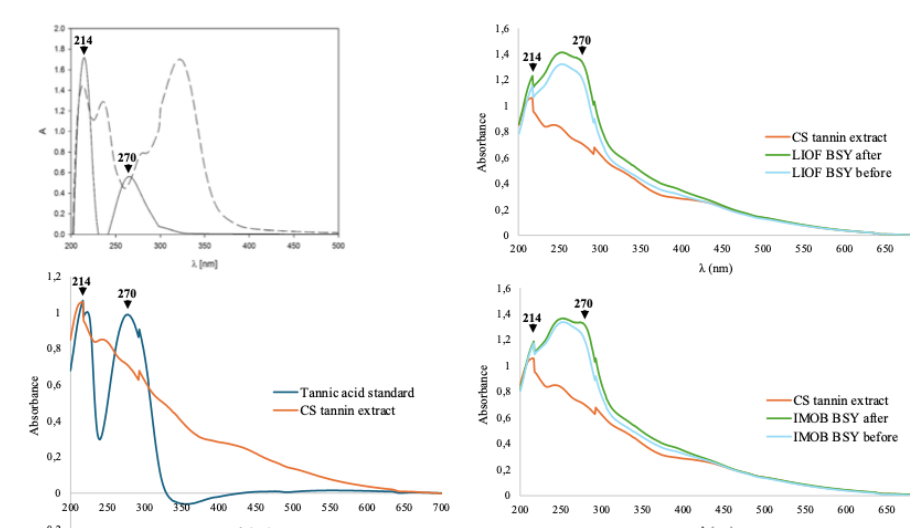


Fig 6. UV-Vis spectra of (A) tannic acid solution (25 mg L^{-1}): solid line at pH 4.8 and dash line at pH 9 reported by [4]; (B) tannic acid standard solution (25 mg L^{-1}) and CS-tannin extract (10 mg L^{-1}); (C) LIOF BSY before and after adsorption of CS-tannin extract; (D) IMO BSY before and after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

Model	Parameters	Lyophilized BSY	Immobilized BSY
Pseudo 1ªOrdem	Q_e ($\text{mg Tannins} \cdot \text{g yeast}^{-1}$)	31.81 ± 3.08	35.51 ± 0.97
	K_2 ($\text{g yeast} \cdot \text{mg Tannins}^{-1} \cdot \text{min}^{-1}$)	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
Pseudo 2ªOrdem	Q_e ($\text{mg Tannins} \cdot \text{g yeast}^{-1}$)	31.30 ± 0.50	37.96 ± 0.08
	K_2 ($\text{g yeast} \cdot \text{mg Tannins}^{-1} \cdot \text{min}^{-1}$)	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
Elovich	α ($\text{g yeast} \cdot \text{mg Tannins}^{-1} \cdot \text{min}^{-1}$)	$9.10E^3 \pm 2.3E^{10}$	$1.4E^{13} \pm 8.4E^{13}$
	β ($\text{mg Tannins} \cdot \text{g yeast}^{-1}$)	1.53 ± 0.16	1.50 ± 0.27
	SSE	0.3192	1.881
Elovich	R^2 ajustado	0.9985	0.9954
	$S_{y,x}$	0.1997	0.4848
	χ^2 reduzido	0.0399	0.2351

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

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 ($35.51 \pm 0.97 \text{ mg TAE g}^{-1}$ 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.

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