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Eco-friendly production of biosurfactant by *Penicillium rubens* applied to sustainable onion cultivation

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INTRODUCTION & AIM

Microbial biosurfactants have emerged as sustainable alternatives to promote plant growth and control phytopathogens in an eco-friendly manner. Their multifunctionality and low toxicity make them promising allies for modern agriculture (Abdoli et al., 2025). However, the economic viability of biosurfactant production remains a major challenge, with the cost of substrates being one of the main limiting factors. In this context, the use of agro-industrial waste emerges as a promising strategy to reduce production costs and enhance sustainability (Karmakar et al., 2025). Therefore, this study aimed to explore two potential alternative substrates for the sustainable biosurfactant (BS) production by *Penicillium rubens* UCP 1213. The prospects for agricultural application of the obtained molecule were also addressed, based on the onion seed germination assay and the inhibition test against phytopathogenic fungi.

METHOD

MICROORGANISM
Penicillium rubens UCP 1213
(UCP Culture Collection - UNICAP)

AGRO-INDUSTRIAL SUBSTRATES
post-frying soybean oil (PFSO)
corn steep liquor (CSL)

INOCULUM PREPARATION
discs of young mycelium of *P. rubens* grown in Sabouraud agar
(28°C, 96 h)

FORMULATION OF ALTERNATIVE MEDIA FOR BS PRODUCTION
2^2 full-factorial design (FFD) using substrates concentrations as variables, at minimum (-1), central (0) and maximum (+1) levels

PRODUCTION OF BS
Cultivation in alternative media
(28°C, 150 rpm, 96 h)

DETERMINATION OF SURFACE AND INTERFACIAL TENSION
(Kuyukina et al., 2001)

ISOLATION OF BS
(Bueno et al. 2010)

CMC DETERMINATION
(Pele et al., 2019)

GERMINATION ASSAY
(Brasil, 2009)

ANTIFUNGAL ACTIVITY
(Faisal, 2024)

RESULTS & DISCUSSION

Table 1. Results of the full-factorial design applied to investigate the production of biosurfactant by *P. rubens* UCP 1213 using PFSO and CSL as alternative substrates.

Assays	PFSO (%)	CSL (%)	Surface tension (mN/m)
1	3	4	26.8
2	10	4	30.5
3	3	8	41.6
4	10	8	43.0
5	6.5	6	42.1
6	6.5	6	42.9
7	6.5	6	42.2

Better result (higher reduction of surface tension)

Interfacial tension (*n*-hexadecan): 1.8 mN/m
Yield of BS: 2.40 g/L
CMC of BS: 500 mg/L

Figure 1. Evaluation of the effect of BS on the germination of onion seeds. Untreated onion seed (A), onion seed treated with distilled water (B), BS 0.5% (C), and BS 1% (D).

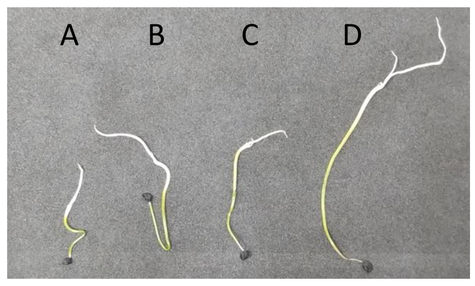
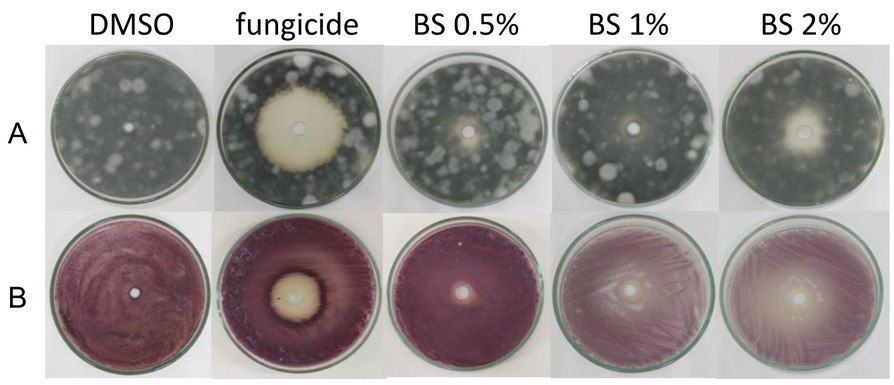


Figure 2. Antifungal activity of the BS against *Curvularia lunata* (A) and *Fusarium oxysporum* (B). Plates show fungal growth in the presence of DMSO (negative control), difenoconazole fungicide (positive control), and BS at concentrations of 0.5, 1, and 2%.



CONCLUSION

This study contributes to the valorization of agro-industrial waste through the sustainable production of a fungal biosurfactant, thereby contributing to the circular economy and regenerative agricultural practices in onion cultivation.

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CAPES

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