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Turning trash into treasure: PHB bioplastic production from agroindustrial waste by native *Bacillus* strains

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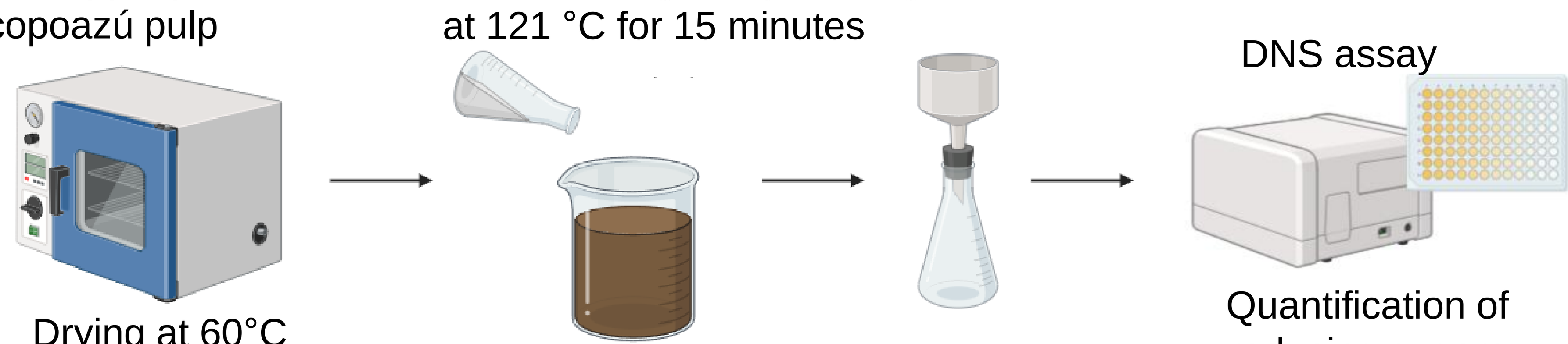
INTRODUCTION

Concurrently, the overproduction of petroleum-derived plastics exacerbates the environmental crisis due to their persistence and limited recyclability (1). In response, bioplastics particularly polyhydroxyalkanoates (PHAs) have emerged as sustainable alternatives, as they are biodegradable and biosynthesized by bacteria under nutrient-limited conditions. Nevertheless, their industrial implementation remains constrained by high production costs, primarily associated with expensive carbon feedstocks (2). The utilization of agroindustrial residues as cost-effective renewable carbon sources represents a promising approach to reducing production expenses while mitigating environmental impact. In Colombia, where agricultural activity is predominant, the valorization of these residues for PHA production constitutes a strategic opportunity to foster a circular and sustainable bioeconomy.

METHOD

1. Collection of residues and quantification of sugars



Pineapple peel and copoazú pulp

Drying at 60°C for 3 days

Extraction of sugars by heating at 121 °C for 15 minutes

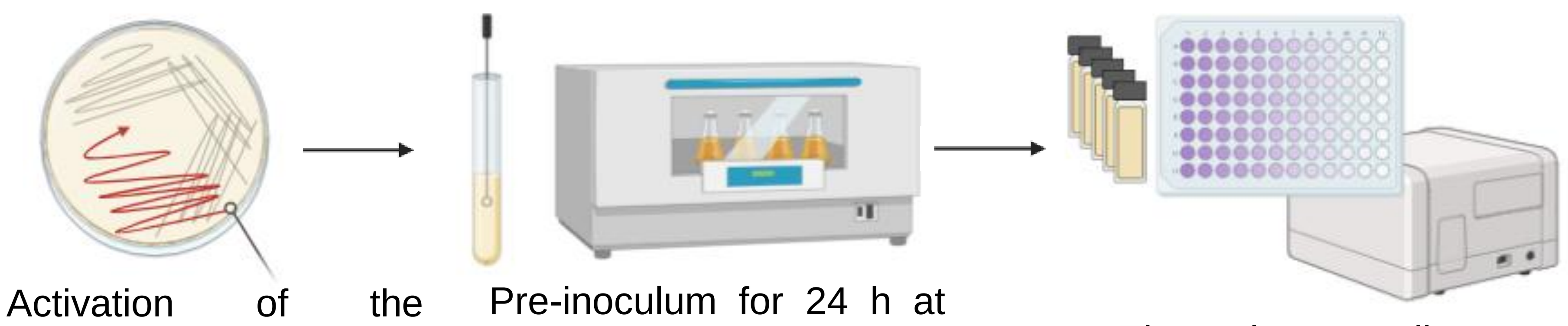
Type 1 water (10% w/v)

Filtration

DNS assay

Quantification of reducing sugars

2. Fermentation at 48 and 72 hours

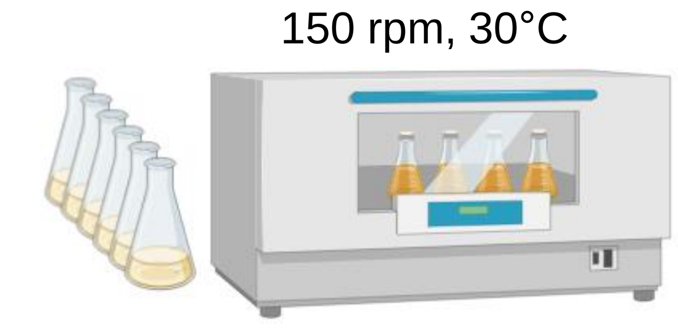


Activation of the bacterial strains *Bacillus cereus* (C02) and *Bacillus thuringiensis* (C01).

Pre-inoculum for 24 h at 30 °C and 150 rpm

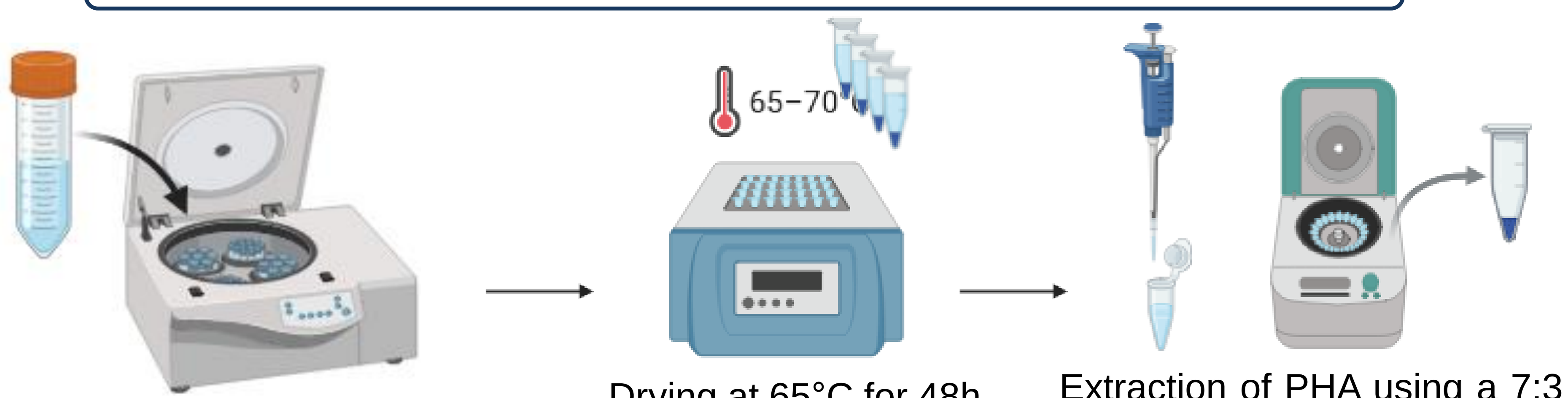
The culture medium was adjusted to a turbidity equivalent to a 2 McFarland standard

150 rpm, 30°C



2 mL of pre-inoculum per 100 mL of MMS

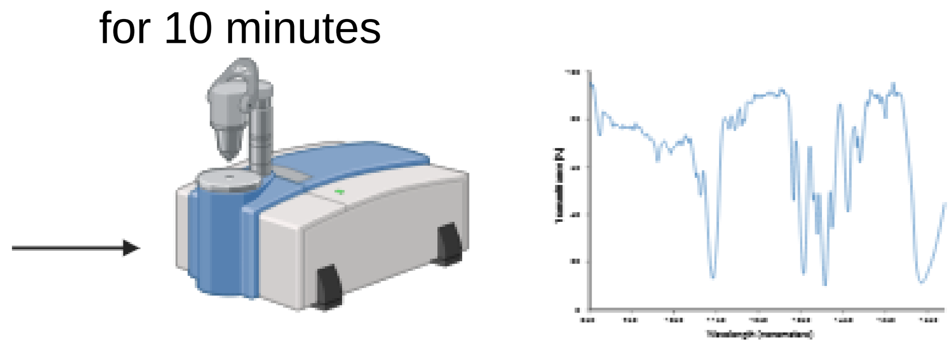
3. Extraction and Characterization of PHA



Centrifuged at 6000 rpm for 10 minutes

Drying at 65°C for 48h

Extraction of PHA using a 7:3 mixture of chloroform and 5% v/v sodium hypochlorite



FTIR Characterization

RESULTS & DISCUSSION

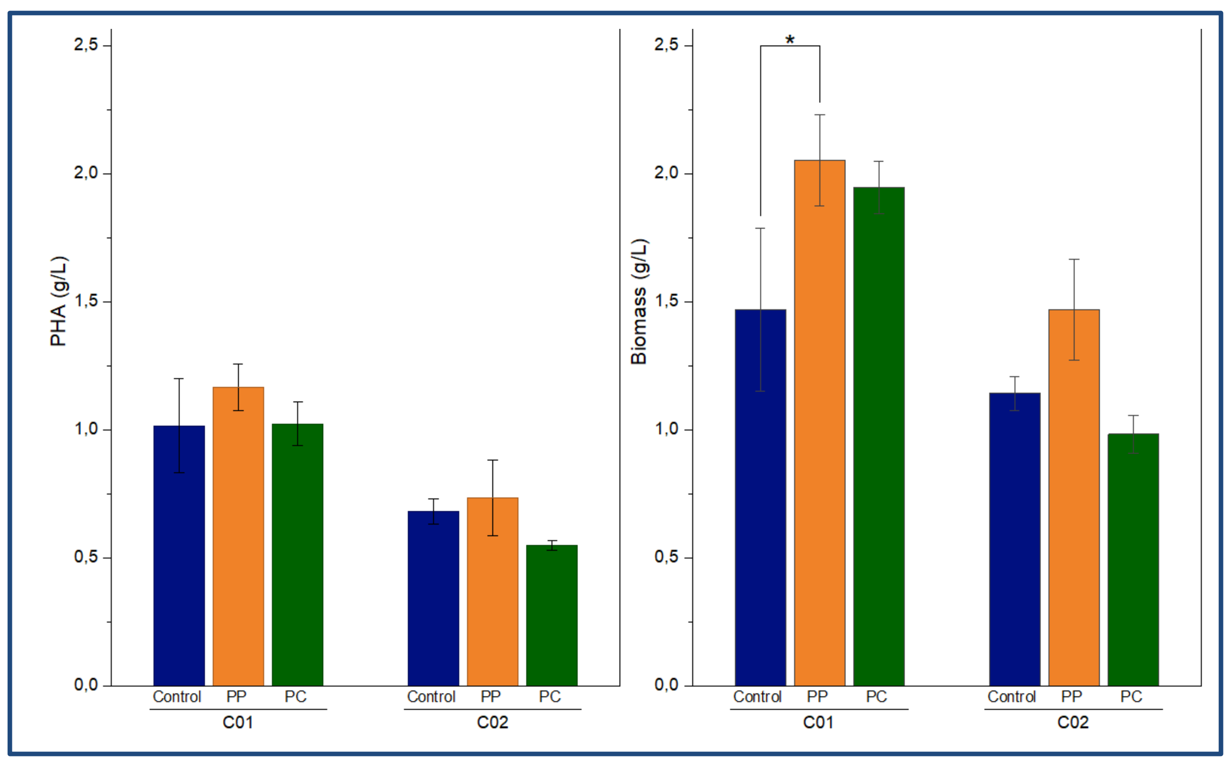


Figure 1. Biomass and PHA production by *Bacillus thuringiensis* (C01) and *Bacillus cereus* (C02) using pineapple peel (PP), cupuaçu pulp (PC), and glucose (Control) as carbon sources after 72 h of fermentation (*$p < 0.05$).

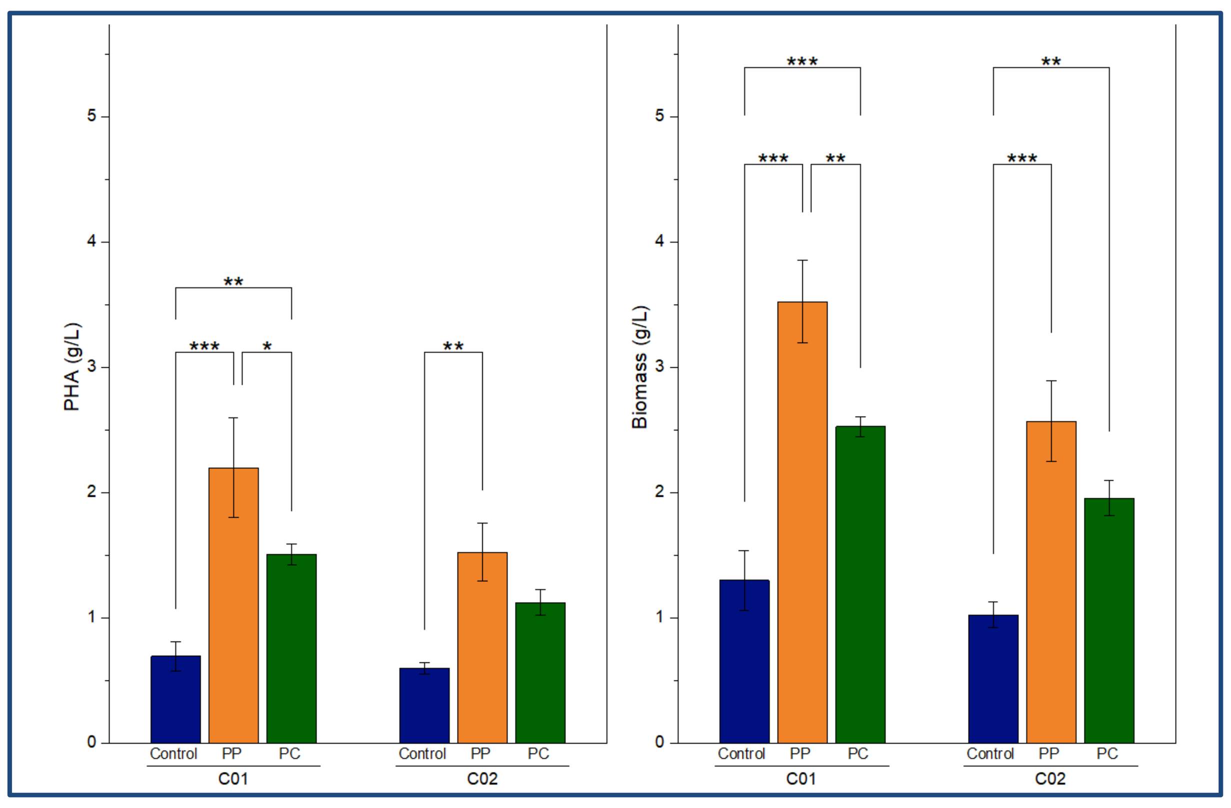


Figure 2. Biomass and PHA production by *Bacillus thuringiensis* (C01) and *Bacillus cereus* (C02) using pineapple peel (PP), cupuaçu pulp (PC), and glucose (Control) as carbon sources after 48 h of fermentation (*$p < 0.05$*, **$p<0,01$*, ***$p<0,001$*).

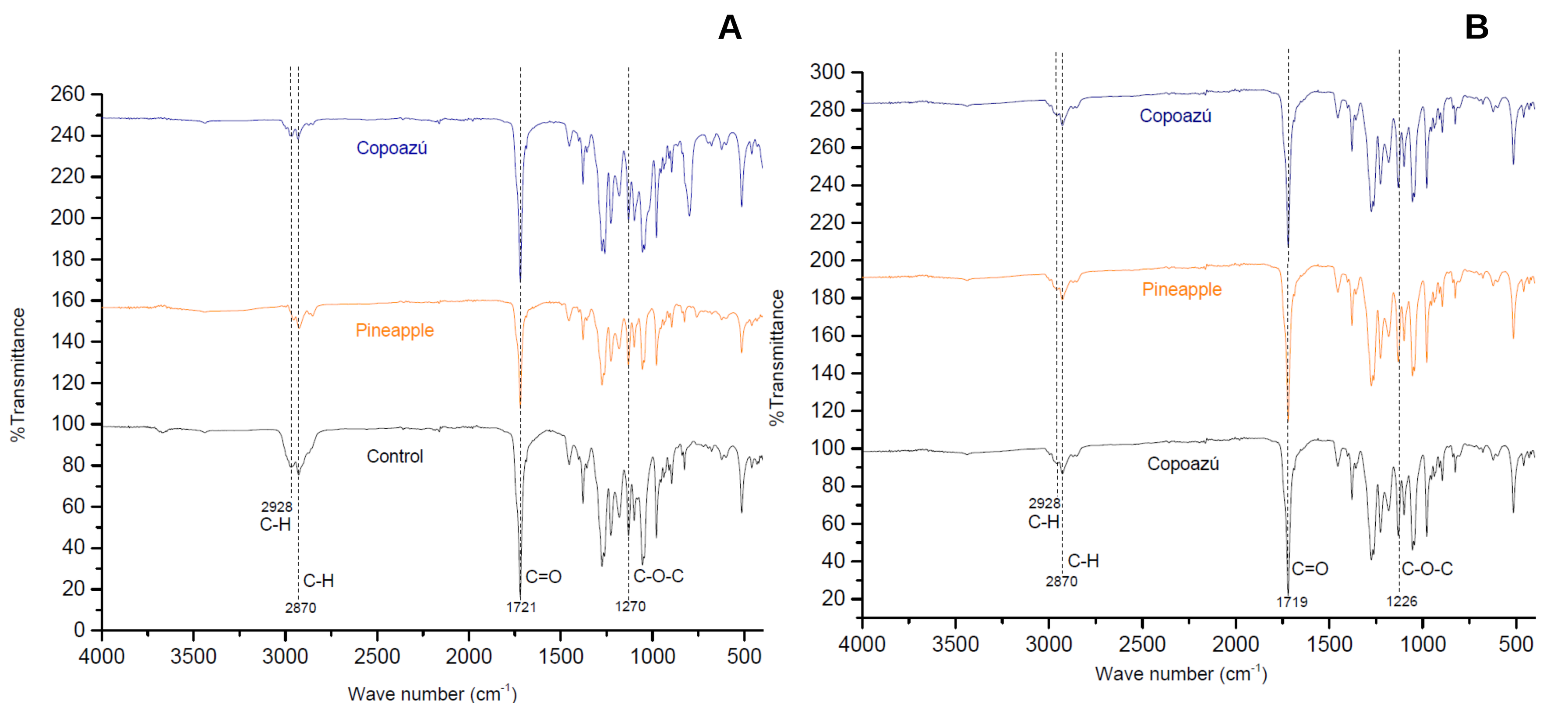


Figure 3. Comparison of infrared (IR) spectra of polyhydroxybutyrate (PHB) synthesized by *B. thuringiensis* (C01) (**A**) and *B. cereus* (C02) (**B**) using different carbon sources.

CONCLUSION

The reducing sugars obtained from pineapple peel demonstrated higher biomass and PHA production at 48 hours of fermentation in both bacterial strains evaluated (C01 and C02), compared to the results obtained using copoazú pulp and the control treatment. These findings position pineapple peel as a renewable carbon source with high biotechnological potential for large-scale PHA production, while simultaneously contributing to the valorization of agro-industrial residues and the reduction of the environmental impact associated with their inadequate disposal in the region.

REFERENCES

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2, Yusuf M. Agro-industrial waste materials and their recycled value-added applications: Review. In: Handbook of Ecomaterials. Springer International Publishing; 2017. p. 1–11.