Comparison indigo extraction from *Isatis tinctoria* L. with low-cost technology methods

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1. Introduction

Isatis tinctoria L. (Brassicaceae), which is commonly known as woad, is a specie with an ancient and well-documented history as an **indigo dye** and medicinal plant. The term "tinctoria" refers to the use that was done in the dye works. This species was introduced in Europe in late Prehistory and Protohistory periods, as confirmed by the discovery of textile remains dyed in blue and preserved from the Neolithic, Bronze, and Iron Ages. The crop was definitively abandoned in the late 19th century, when the production of synthetic dyes completely replaced natural indigo production [1]. The most of dyeing substances available for textile industry come from chemical synthesis sources [2]. Its consumption has been encouraged due to cheaper generation and lower dependency on natural production irregularities. Besides, the good fastness properties on different required substrates by the fashion industry generates a problematic situation when process needs to be implemented on industrial facilities and there is a gap of adequate reported techniques. Nevertheless, the advantages of lesser toxicity, better biodegradability, and easier waste-water treatments when using natural instead of chemical dyes are far bigger than the cost of focus on the complexity of achieving the level of knowledge that synthetic dyeing processes already have.

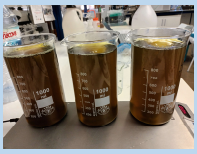
In this work we present a comparison of physicochemical against biochemical methods to produce indigo dye to be implemented on wool with the advantages to be lesser expensive, more eco-friendly, and efficiently produced [3]. The selected processes were improved and generated acceptable results even with almost a tenth of the reported needed biomass to produce the desire product [4]. Fast and mild thermal, aerobic, and anaerobic extraction were the selected methods of this work.

2. Methodology

2.1 Extraction process

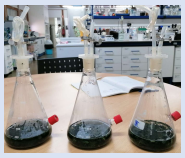
Water extraction

Conditions:
V_{total}=300 mL
LSR=10 (fresh weight)
10 min
60 and 70 °C
130 rpm



Anaerobic Fermentation

Conditions:
V_{total}=300 mL
LSR=10 (fresh weight)
72 h
30 °C
2 lb/in² N_2 (5 min)



Aerobic Fermentation

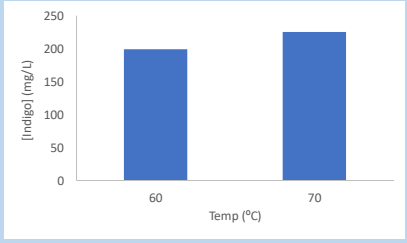
Conditions:
V_{total}=300 mL
LSR=10 (fresh weight)
72 h
30 °C
30 rpm and stopped

2.2 Indigo quantification

10 mL Sample → Centrifuge (9000 rpm 10 min) → Pellet → 0.5 mL Acetic Acid → 30min → 2.5 mL Ethyl Acetate → Abs 600 nm

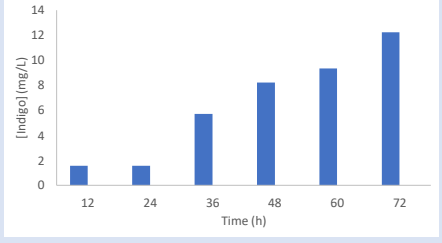
3. Results

Water extraction



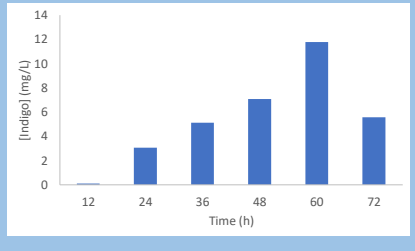
- The physicochemical procedure on hot water, beyond the expected results from former experiments, showed a better performance at 70 °C than at 60 °C.

Anaerobic Fermentation



- Anaerobic Fermentation produced 12.22 mg/L of Indigo dyeing. This effect shows a non-stopping increasing production, representing a robust and self-protective system of the molecule of interest.

Aerobic Fermentation



- Aerobic Fermentation was tested with rotative and steady conditions, showing a more efficient performance while stirring. The dyeing production shows an increasing behavior until 60 h with posterior decaying, as was inferred from former publications.

4. Conclusions

The dyeing production yield obtained with the physicochemical method surpassed by almost ten times the one obtained with the biochemical procedures. The results still need of confirmation by stability performance as a function of time to conclude the selection of on method over the other in terms of the desired product long-term stability.

References

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Acknowledgements: This work is taking place at GO - Natural Dyeing - Use of natural dyes in natural fibers (REF: PDR2020-101-031963), co-financed by the European Agricultural Fund for Rural Development (EAFRD) through the Rural Development Program PDR2020. MED and CEF, are funded by the Foundation for Science and Technology (FCT) from Portugal under the projects UID/AGR/00239/2020 and UIDB//05183/2020, respectively.