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AN OVERVIEW OF INTEGRATED CHEMICAL PROCESS USED FOR CONVERTING VALUABLE TEXTILE WASTE

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Introduction

Nowadays, high quantities of textile waste are generated due to consumption. Cheaper clothes are consumed more and more by the population due to the affordable price. This request generates significant quantities of textile waste along with their deterioration. Textile waste has two disposal streams: landfill or incineration. However, these solutions have a negative impact as they lead to a waste of valuable resources and environmental pollution. Many researchers from worldwide are working to find new strategies to recover textile waste into more valuable products. Textile waste is generally composed of cotton fibres and cellulose which are renewable and biodegradable polymers that can be recovered and recycled and given a variety of uses. Cellulose can be a source of biofuel, chemicals, building materials, etc. There are many advantages for cotton-based waste compared to cellulose-based waste due to useful components recovery. For coloured textile waste, a bleaching process must be applied. Thus, finding environmentally friendly methods to retain dyes is a novelty in this field. The main goal of this study is to present chemical methods described in the literature as an alternative for converting textile waste into value-added compounds (e.g. lactic acid and sorbitol, respectively).

Materials and methods

For the recovery of the valuable compounds from cotton-based textile waste, the following chemical pretreatment methods can be applied:

✓ Chemical method uses NaOH pre-treatment for cotton-based textile waste. For this aim uncoloured cotton waste was treated with NaOH solution. In order to obtain a neutral pH, the pre-treated cotton waste was washed with distilled water, previously filtering it. The enzymatic hydrolysis step followed, using cellulose, and the product was glucose.

✓ Another chemical method uses hydrogen peroxide and acetic acid (HPAC) for coloured cotton-based textile waste. Initially, these were treated with hydrogen peroxide and acetic acid to bleach them. This stage was followed by filtration and washing with water in several stages. The textile waste samples were further pre-treated with NaOH for the uncoloured cotton waste, followed by filtration and washing with distilled water. Finally, the enzymatic hydrolysis step followed, using cellulase, and the product was glucose.

✓ Another method uses NaOH and ethanol to pre-treatment of textile waste based on blending cotton with PET (polyethylene terephthalate). The cotton and PET blend textile wastes were treated with NaOH and ethanol solution, then the mixture was filtered and the filtrate was treated with H_2SO_4 for precipitation, followed by filtration to obtain terephthalic acid and ethylene glycol. Another step is enzymatic hydrolysis in the presence of cellulase and recombinant WCCG gene, resulting in glucose. The resulting glucose from the previously presented methods is subjected to the fermentation step to obtain lactic acid and the reduction step to obtain sorbitol. Fermentation occurs in the presence of yeast extract and solutions of KH_2PO_4, K_2HPO_4, $(NH_4)2PO_4$, NaCl, $MnCl_2 \cdot 6H_2O$, $CaCl_2 \cdot 2H_2O$. To maintain an anaerobic environment, $MgCO_3$ is added. Reduction takes place by subjecting glucose to catalytic hydrogenation with the addition of sodium borohydride. Finally, to remove excess sodium borohydride, the product resulting from catalytic hydrogenation was treated with HCl, followed by evaporation in vacuum drying steps. In Figure 1, chemical procedures for obtained lactic acid and sorbitol from cotton textile waste are presented.

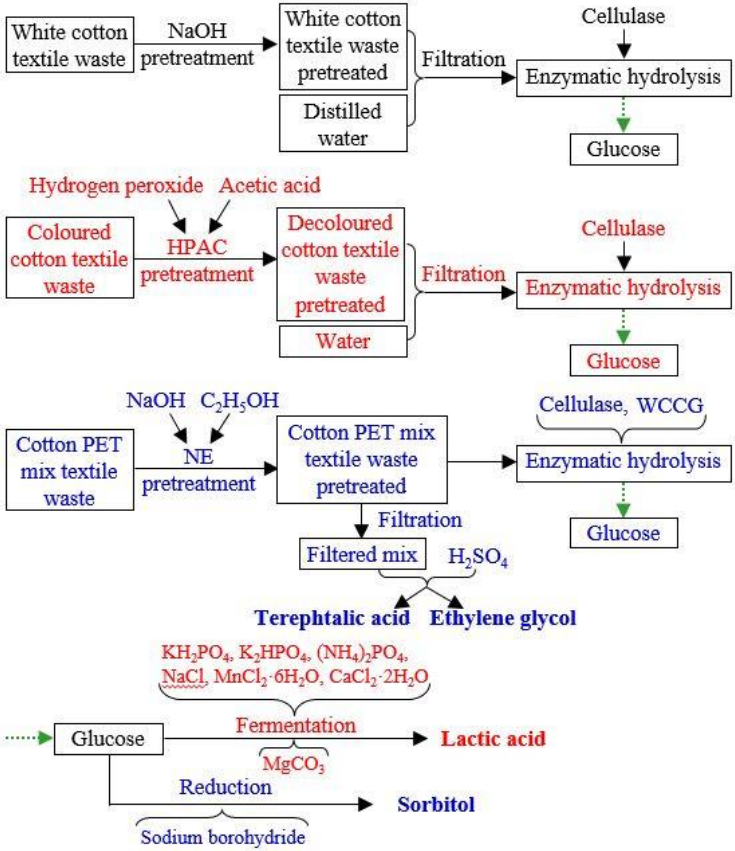

Fig.1. Chemical procedures for obtained-value added products from cotton textile waste

Results and conclusions

Currently different chemical methods have been developed to convert textile waste from cotton processing into valuable products. For this purpose, a biorefining process is required, sorting them into (i) coloured cotton, (ii) uncoloured cotton and (iii) cotton mixed with PET. Various chemical processes can be obtained from the sorting of these wastes, such as lactic acid, sorbitol, terephthalic acid and ethylene glycol. This process can thus be an important step towards a more efficient management of textile waste, based on the principle of a circular economy that relies the converting and recycling this waste into value-added products. In conclusion, after the sorting and valorisation processes, the two useful constituents are obtained which can have different practical applications.

Following the application of the previously mentioned chemical methods, it can be concluded that the yield of enzymatic hydrolysis (obtaining glucose) is higher in the case of textile waste based on undyed cotton.

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