Agro-industrial waste: raw material for textiles

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Abstract:

In recent years, the textile industry has been looking to develop new processing possibilities in order to reduce the environmental impacts generated along the production chain. Among these, the search for alternative fibers from biodegradable residues stands out, as well as a reduction in the consumption of water and chemical reagents, the replacement of chemical by enzymatic processes, the use of natural dyes and treatment of effluents. Thinking about these issues, the BR-UK Network was created, which aims to map agricultural industry by-products with the potential to develop textile processes and products for conscious consumption and production within the context of the circular economy. This paper presents straw an abundant agricultural by-product of sugar cane in Brazil and wheat in the UK.
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Keywords: biomaterials, sugar cane straw, wheat straw, circular economy, textile processes

1. Introduction

In recent years, the fashion industry has focused on the environmental problems of its processes and industry, however global challenges highlight the importance of using industrial and agro-industrial waste as raw materials in production processes. In Brazil, sugarcane is one of the largest agricultural monocultures, with an estimated productivity for the 2019-2020 harvest of 642.7 million tons [1]. With the mechanization of the sugarcane harvest, the straw that was previously burned in the field, became a waste available to be used [2-3]. Similarly, wheat is one of the most common crops grown in the UK, alongside sugar beet and potatoes [4]. The UK produces over 20Mt of crop residues (including 12Mt of wheat straw) per year, and sends around 40 Mt of biological material to landfill and incineration in municipal and industrial waste [5].

2. Theoretical Approach

With the search for cleaner processes and the valorization of new materials that are less impactful to the environment and to human health, the use of raw materials from agricultural by-products from waste is presented as an alternative. The valorization of these by-products, associated with the understanding of a circular economy, is important. As a result, the following research problem was defined for this study: “What possibilities of agricultural by-products can the BR-UK Network map to study their potential for textile processing, with the aim to minimize environmental impacts and add societal values?”. Sugar cane straw and wheat straw were previously selected in the research by the authors and are here compared to demonstrate the possibilities for local biomaterials development in different contexts that build on similar natural polymers, namely mainly cellulose, polyoses and lignin.

3. Research Done

The research done consists of a literature review and from the data resulting from projects carried out by the BR-UK Network carried from a previous selection of sugarcane and feasibility studies of wheat straw for textiles development. The objective is to conduct a survey of the potential of sugar cane straw and straw wheat for the textile industry with the aim to study sustainable routes for textile processing in Brazil and parallel methods with wheat straw

in the UK. In response to the composition shown in Table 1, the BR-UK Network mapped the application possibilities of sugar cane straw in the textile and apparel industry, and of which some applications have already been studied by the researchers of the network and others have been found in the literature, including the use others lignocellulosic materials such as wood and bagasse according to Table 2.

Tabela 1. Chemical composition of *in natura* straw (% m/m, dry basis)

Straw	Cellulose	Polyoses	Lignin	Extractives	Ash	References
Cane	33.5 ± 0.3	27.1 ± 0.3	25.8 ± 0.5	-	2.5± 0.2	[2]
wheat	31.0 ± 1.0	43 ± 3.0	22.0 ± 5.0	-	4.0± 1.0	[6]

Table 2. Application of all straw fractions

Raw material	Application suggestions	Examples with other lignocellulosic materials	References
Straw	Composites for accessories	Bagasse polypropylene composites	[7]
	Cultivation of microorganisms for the production of enzymes: cellulases and xylanases	Semi-solid fermentation of sugarcane bagasse with the fungus *Ceriporiopsis subvermispora*	[8]
Liquid residue from the steam explosion process	Textile dyeing and UV protection properties	Colored liquid residues produced in the steam treatment of eucalyptus wood as a natural fabric dye	[9]
Lignin	Coatings with UV absorption properties	Lignin was used as a UV protector in packaging films	[10]
Cellulose	Textile fibers		[2 - 3]
	Cellulose derivatives, eg acetate and CMC	Nanomembranes obtained from sugar cane acetate (non-woven).	[3 - 11]

	Nanocrystals for textile functionalization	Agro-industrial residue for nanocellulose	[12]

3. Analysis and Conclusion

The use of agro-industrial waste can be a promising alternative, because, in addition to the large quantities available, the use of this raw material can bring economic, environmental and social benefits.

5. Recognition and thanks

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