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Circular Textiles

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Abstract

The mini-review focuses on solutions that would compel sustainable outcomes in the textile segment. The ideas of a plethora of surplus ecological material matrices, green technologies, and eco-friendly additives available in nature are put forth. It discusses the regeneration of the land, water, and energy that would contribute to carbon neutrality and higher value generation in the textile segment. Finally, the significance of sustainability credentials is given.

Keywords: Circular textiles; biomimicry; nature-based solutions; natural fibres; natural dyes

Introduction

Biomimicry, inspiration from nature, would assist in solving problems to meet the “needs” sustainably; it impels plant-based renewable sources to circumvent depleting fossil fuels creatively and harmoniously [1,2]. Implementing circular materials inspired by nature, in which the natural fibres and plant-based colours are the best examples of biomimicry in textiles and fashions, as reviewed further. The structural colours from nature, the colours from fungi and mushrooms for fabrics, are biomimicry.

Material matrix

The textile industry is demonstrating a paradigm shift towards alternative ecological materials such as seaweed, pineapple, lotus silk [3], coffee, hemp, abaca, ramie, bast, Icelandic eiderdown [4] and nettle fibres as prospective natural fibres that impels circularity. Similarly, cyclical colours are natural colours, and they are predominantly synthesised from natural fruits, flowers, stems, leaves, barks, grasses, seeds, roots, trees, and berries. The molecules of natural origin are biodegradable, whereas synthetic chemicals lack biodegradability, as they remain in the environment releasing toxic fumes [5]. The plant-based traditional colours are from indigo and manjistha; some of the innovative sources of natural colours are bilberry leaves, nettle leaves, hops flowers and violet herbs [6,7]. The structural colours, for instance, butterfly wings scales, peacocks’ tails, opal in beetles and iridescent spines in the sea mouse, are bioinspired and could be replicated on fabrics [8]. In the same vein, the additives in the form of mordants and surfactants are also available from nature. For example, the biomordants almond shells [9] and oak bark extracts [10] and several others likewise,

the significant source of saponins are areetha nut and shikkakai (Thakker, 2021) for application on cotton and wool fabrics. The natural material matrix presented from nature goes back to nature as they are inherently compatible thus cyclical.

Ecological technologies

Conventional surface modification techniques, implementing petroleum-based raw materials are high on global warming potential value [11]. Therefore, to combat the problem, environmentally-friendly surface modification methods ought to be encouraged, such as plasma surface treatment technology. The use of digital printing of textiles is the key to reducing chemical waste and combating the climate crisis. UK and EU support the industrial transformation to be sustainable by investing in digital innovations (European Commission, n.d.). Integrating digitisation into production processes is the key to combating the climate crisis. Digital micro-factory focuses on data-driven and digital products, including digital design, digital printing, digital processing, and digital finishing. It reinforces digital marketing and the entire digital platform for the future sustainable textile industry [12]. The existing literature recognizes the advantages of digital textile printing technology around its novelty, customized production, vast colour range, and applicability on the varied substrates. Digital textile printing contributes to sustainability as it is low on water and energy demand [13,14].

Best from waste

A Swedish paper giant Sodra aimed to process 25,000 tonnes of textile waste per year by 2025 to offer circular products to market.

It involves utilising 50,000 tonnes of pulp containing 50% wood and 50% post-consumer waste [15]. Similarly, a team of authors established a closed-loop fibre to fibre wet spun process to recycle cotton from waste denim. However, it is to rethink as the process designed implemented dimethyl sulfoxide as a cosolvent with ionic liquid 1-butyl-3-methylimidazolium acetate to dissolve the denim waste (Ma, Zeng, Wang, & Byrne, 2019). Jonsson et al. suggested biocatalysis for recycling synthetic polymers. For example, the *Clostridium thermocellum* bacteria and PET hydrolase could degrade the polyester-cotton blend. However, their environmental performance requires to be validated on Higg Index [16].

Nature-based business solutions

Business canvases inspired by nature are the future. Enterprises turn to nature-based solutions to make a paradigm shift from business as usual for enhanced value delivery, as displayed in Figure 1. By definition, it involves actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits [17] (Figure 1). Aiama et al. outlined the opportunities for the apparel sector to commit towards nature conservation in the following ways [18].



Figure 1: Nature-based enterprise value generation.

- a) Adopt a deforestation-free supply chain by sourcing plant fibres and colours from organically managed landscapes.
- b) Promote land restoration by planting trees by manifold to that consumed.
- c) Substitute more hazardous chemicals with less/no hazardous chemicals, for instance, performing the process of extraction from plants with pure water instead of solvents generating volatile organic compounds (VOCs), namely ethanol, methanol, and others.
- d) Monitor the water for dissolved oxygen levels (DO), oxidation-reduction potential levels (ORP), total dissolved solids (TDS) and others to maintain water sustainability.
- e) Contribute towards sustainable communities by cultivating good agricultural practices, water stewardship and others.

Sustainability credentials

Sustainability is not a fad; it is here to stay. Sustainability is not a trend but a way of life. However, professional accreditors would enable achieving the desired aim of sustainability. For example, the sustainability credentials could be acquired from the Testex of OEKO-TEX (Switzerland). It offers textile and leather testing and certification. Sustainability and transparency are their core values adhering to Sustainable Development Goals (SDGs) [19]. Likewise, accessibility to software, namely Higg Index [20] and OpenLCA [21], would facilitate the calculation of the environmental impacts of your projects. The Global Fibre Impact Explorer (GFIE) by Google,

in collaboration with Stella McCartney would pilot test its platform, to source materials responsibly [22].

Conclusions

The climate action initiates at the source of the materials; therefore, Google technology identifies the preferred materials associated with Textile Exchange and formulates a GFIE tool [22] that would propel accountable sourcing from make to finish. Circular transitions, a Mistra Future Fashion Conference on Textile Design and the Circular Economy aimed at "Materials, Models and Mindsets" [23] to compel carbon neutrality in the textile fashion industry. The reuse, recycle, regenerate, renovate, and rentals are

effective tools of today to circumvent landfills, emission and effluent disasters arising from the textile industry.

Future Recommendations

The crucial aspects that are essential for circular textiles outcomes and ought to be implemented in future fashion factories are depicted in Figure 2. Circular technology applies to each of the segments shown in Figure 2. It is suggested to apply ecological technology in creating circular materials, circular design, circular production, and circular disposal, contributing towards carbon neutrality by acquiring circular textiles (Figure 2).

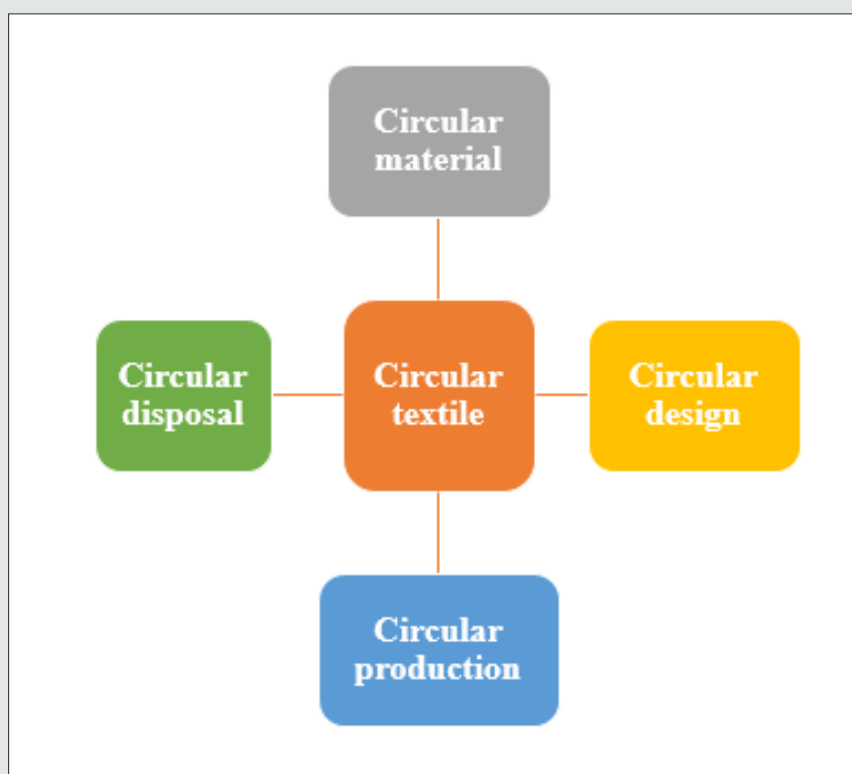


Figure 2: Circular textile outline for future fashion factories.

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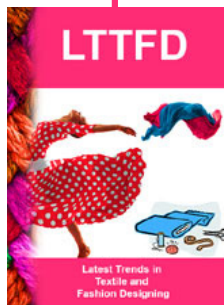
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