The effect of preparation, dyeing and finishing treatments on the biodegradation of cellulosic microfibres

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Abstract

Considered as an emerging environmental pollutant, microfibres have been identified in numerous terrestrial and aquatic ecosystems. Previous research has held a perceived notion that those found in the environment are primarily synthetic, citing the ability of natural materials to readily biodegrade. However, recent studies analysing microfibres found in the environment have observed this to be incorrect, with 80% of fibres found in ocean samples reported as cellulosic. This subsequently poses the question – what factors are preventing these natural fibres from degrading in the environment?

This research aims to develop understanding of the effect of preparation, dyeing and finishing treatments on the biodegradation rates of cellulosic microfibres in various environments. Cotton fibres that have received differing chemical treatments including mercerization, reactive dye application and easy-care finishes were exposed to an environmentally representative freshwater and marine water matrix. The biodegradation of these fibres was measured using biological oxygen demand and fibre analytical data. Results have identified early stages of biodegradation in fibres from a loomstate cotton, following exposure in a freshwater matrix for up to 252 days. This was identified through significant increases in fracture length and width with increased environmental exposure time, however at slower rates than previously reported in the literature. Significant differences were measured between surface topographic changes between unaltered loomstate cotton, cotton prepared for dyeing, and indigo dyed denim cotton fibres. Lowest level of fragmentation were measured on vat dyed indigo denim fibres in comparison to other tested fibres suggesting that the presence of dye may impede biodegradation of these fibres. The results form this study raise concerns surrounding the biodegradation and environmental fates of cellulosic microfibres suggesting that these microfibres may be more persistent in the environment than previously assumed. Due to the high level of chemical alteration that these fibres undergo during textile manufacturing, it should be considered that these microfibres are not naturally occurring and should therefore be referred as synthetic.