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Decomposition of Nanoparticle Finished Textiles: A Brief Overview

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Abstract:

Textiles go through a variety of dyes and chemicals to their final destination. Textiles have non/and biodegradable substances, which decompose with time. The chemicals on them may not decompose and might be toxic to microorganisms present in ground. At present, a lot of research is performed on the decomposition of textile materials in natural soil, converting into biomass, water and carbon dioxide, posing no harm to the environment. In this respect, this research work aimed to see the decomposition of chemicals present on textiles, in order to understand the biodegradation phenomenon of textile materials and chemicals when buried in soil. The visual observations revealed that the decomposition or degradation of cellulose textile materials proceeded earlier than the one with functionality substance present on the cellulosic textiles.

Keywords: Textile; waste; decomposition; Silver nano finishes; degradation

Introduction:

Like every single natural material, textile materials will decay or decompose affected by water and microorganisms present in the ground, under practically identical natural conditions. However, the time of decomposition is predominantly depends on the raw materials utilized, some materials decompose in months, years, decades or even hundreds of years (1,2). Recent studies on the degradation of textile materials didn't carried out the decomposition of functional chemicals or substance on it in real soil or soil-like atmosphere. Degradation of permanent flame retardant finish from textiles (3) and its kinetics (4). However, the assessments of decomposition depend on institutionalized soil entombment tests as indicated by International Organization of Standards (ISO), such as ISO 11721-1:2001 (5) etc., which are utilized to decide the decomposition or decay of textile materials. Resulting ecotoxicological examinations enables the researchers to make determinations of hazard assessment and environmental compatibility. Moreover, substitute disposals are suggested for textiles with functionalities, for instance gasification and oxidation processes (6–8). In similar context, there was a need of work comparing textile materials with functional substances to non-functional textile materials in natural degradation environment in soil.

Experimental:

100% cellulosic woven fabric having a mass of 150 g/m² was used in the experiments. For cellulosic textile with functionality, antimicrobial finishes based on silver (Ag) was used, the fabric was finished with silver nano powder NP-30 (Ames Goldsmith Corp., USA). Decomposition of finished and unfinished and finished cotton fabric was determined with soil microflora using soil burial test according to ISO 11721-1:2001 and ISO 11721:2003 standards. This process consists of a container filled with commercial grade compost

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having soil with $60 \pm 5\%$ water content for determined moisture retention capacity. pH of the soil was kept between 4 to 7.5. The textile samples were buried in the soil over a period of 3 and 12 days. To find the decomposition phenomena on textile samples, degree of polymerization was carried out. The samples were dissolved in Cuoxam, which is a solution of cupric hydroxide in ammonia (aq.) $[\text{Cu}(\text{NH}_3)_4](\text{OH})_2$. The degree of polymerization was determined viscosimetrically with Oswald shear dilution viscometer.

Results and Discussion:

Chemicals added to textiles for functionalization, potentially decompose later than the textiles itself, making it unsafe for to future varied vegetation. Despite the field of utilization of the textile materials, the necessities concerning textile or/and chemical decomposition in the ground can vary significantly now and then. Like, the general textile items used in daily life, like apparel or home textiles decompose faster as would be prudent and with no buildups which could be unsafe to the environment.

Table 1. Degree of polymerization of samples

Sample	Unfinished cellulose	Finished cellulose
0 day burial	1600	1620
3 days burial	1570	1600
12 days burial	1250	1440

The results of degree of polymerization in Table 1 shows that with time interval of 3 days, the degradation or decomposition of cellulosic material started in both samples. The degree of polymerization of both samples decreased with increasing time of burial. However, the degree of polymerization of finished cellulosic material decrease slowly compare to the unfished sample. This slow drop of degree of polymerization shows an influence of functionality substance present on textile.

Since all natural materials have a frame of carbon atoms, for instance materials with organic molecules (sugar, fats, proteins, nucleic acids). These carbon chains are broken during decomposition in the soil by fungi and bacteria and splitting the molecules. The time of breaking such chains is dependent to the building blocks of the atoms. The natural polymers having alcohols, acids or similar molecules are connected normally via reacting oxygen groups at their ends which sometimes contain other carbon and oxygen atoms. The cellulosic structure having the formula $(\text{C}_6\text{H}_{10}\text{O}_5)_n$, is a polysaccharide consists of a linear chain of hundred to thousands of $\beta(1\rightarrow4)$ linked D-glucose units. Such chains and units are readily utilized by microbes. On the other hand, the Ag finished cellulose material, makes it difficult to decompose by these same microbes. Mainly, the decomposition of such materials in the soil generate carbon dioxide as a waste product (9).

Conclusions and Future Perspectives:

The decomposition of finish chemicals present on textiles are influence by their particle size and types and degree of cellulose biodegradation itself. From this study, it was found that, even the degree of polymerization of both samples, finished with Ag and unfished textile, started with few days of burial. However, the use of Ag for cellulosic materials functionalization, delay the decomposition in soil compared to the unfished cellulosic textile.

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