DEGRADATION OF NONWOVEN FABRICS SUITABLE FOR WET WIPES BURIED IN SOIL

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Abstract: *In this research, biodegradation behaviour of nonwoven fabrics suitable for wet wipes having different fibre types such as regenerated cellulose (viscose and Tencel), polyethylene terephthalate (PET) and their blends were investigated. Each nonwoven fabric was buried in soil and test samples were controlled in regular periods. Visual appearance was reported and examined by photographs and microscopic views. According to the changes in visual appearance and weight loss, biodegradation was examined in a systematic way. It has been observed that regenerated cellulose nonwoven fabrics and the PET nonwoven fabrics show big difference under the same degradation conditions. PET fibre content delays biodegradation in the soil and degradation behaviour is similar the content of PET fibre in fabric structure. The higher PET, lower degradation, and the higher cellulosic fibre, the higher degradation was determined for nonwoven fabrics suitable for wet wipes.*

Keywords: *degradation, nonwoven, soil burial, wet wipes*

1. INTRODUCTION

Nonwoven products, which are increasingly attracted by both manufacturers and consumers as faster and cheaper production, continue to be used in new areas every day. In particular, the ease of use of disposable products has created dynamism in the nonwoven sector and caused the sector to grow. Important developments are taking place in the disposable care and hygiene products market, which has an important place in daily life [1]. Most of these developments are aimed at increasing the qualities of disposable textile products. Wet wipes belonging to the care and hygiene products group meet the expectations of consumers in terms of both hygiene and ease of use.

In recent years, non-biodegradable materials have been a subject of discussion due to the damage they cause in the environment and their waste loads, and many studies have been initiated accordingly. Environmentally friendly products have started to be produced with appropriate technology. The need for environmentally friendly applications in frequently encountered products clearly reveals the importance of biodegradation in the textile industry. Biodegradation is the breakdown of organic materials by microorganisms such as bacteria and fungi. In last decade, there are many studies on biodegradation and new biodegradable fibres. Many researches were conducted on biodegradability of different materials and also textiles for different degradability conditions [2-8,10-11]. While the efforts to create new biodegradable nonwovens are continuing, the post-use journeys and waste load of wet wipes,

which are consumed every day in the market were studied [9]. In the context of this study, nonwoven fabrics suitable for wet wipes in landfill environment conditions is examined.

By the increasing consumption of wet wipes in daily life and getting higher with day by day with continuing Covid 19 pandemic, the researches on degradation of single use nonwoven fabrics is getting importance.

2. MATERIAL AND METHOD

In this research, nonwoven fabric suitable for commercial wet wipes were supplied from a producer company and analysed before degradation tests. Six nonwoven fabrics by different raw materials having different fibre contents were selected to examine the differences in biodegradation behaviour. The properties of the fabrics are shown in table 1. As can be seen in table 1, selected fabrics consist of different contents of viscose, Tencel and PET fibres.

Table 1. Structural parameters of nonwoven test fabrics

Fabric No	Raw material	Mass per unit area(g/m ²)	Thickness (mm)	Density (g/cm ³)
1K	100% Tencel	73.2	0.68	0.093
2K	70/30% Tencel/CV	66.0	0.60	0.088
3K	50/50% PET/CV	48.9	0.55	0.084
4K	60/40% PET/CV	70.4	0.38	0.089
5K	80/20% PET/CV	54.4	0.71	0.100
6K	100% PET	42.4	0.57	0.094

All samples were conditioned in the Physical Textile Testing Laboratory of Dokuz Eylül University Textile Engineering Department under standard atmospheric conditions before mass per unit area and thickness measurements. Samples were prepared in a square shape to be buried for 1 month and 2 months period and were weighed to make comparisons before and after burial period. The test samples for soil burial test were shown in figure 1. After that stage all samples were covered with soil. During the degradation process, relative humidity measurements were made in soil and water was sprayed to protect the moisture of the soil in constant such as 95% RH.

Figure 1. The test samples in plexiglass boxes for soil burial test

3. RESULTS

After the burial period completed, test samples were taken from soil and rinsed with ethanol/water solution and dried at room temperature. Weight loss (%) values were calculated after measuring the mass of samples under standard atmospheric conditions. Besides visual appearance of buried test samples was examined and recorded for two different burial periods. These visual examinations were given in table 2 and figure 2.

Table 2. Visual observation results of test samples for two different burial periods

Sample code	Visual appearance after 1 month soil burial	Visual appearance after 2 months soil burial
1K	Hard, brittle, dark spotting, hole and tear occurred	Completely disintegrated
2K	Completely disintegrated	-
3K	Yellow spotting, thinner areas were seen	Increased yellow staining, very thin areas were seen
4K	Yellow spotting, thinner areas were seen	Yellow staining and thinner areas were observed.
5K	Light spotting was observed	Yellow spotting increased
6K	No obvious change	Yellow spotting was seen

Figure 2. The test samples after two months soil burial period

As seen in table 2 and figure 2, Tencel/viscose nonwoven fabric was degraded in the first month. Pure Tencel nonwoven fabric was degraded after the second month burial period. For fabrics 3K-5K, some thinner places were observed and colour change was seen. Fabric coded 6K (100 PET %) was the test sample having least changing after two months.

According to weight loss values, it has been observed that regenerated cellulose nonwoven fabrics and the PET nonwoven fabrics show big difference under the same degradation conditions. PET fibre content delays biodegradation in the soil and degradation behaviour is similar the content of PET fibre in fabric structure (figure 3).

Figure 3. Weight loss values (%) after one month and two months soil burial periods

4. CONCLUSION

In this research, the biodegradability behaviours of nonwoven fabrics suitable for wet wipes and having different fibre types, such as viscose, Tencel, polyethylene terephthalate (PET) and its blends were studied in soil burial tests. Degradation of nonwoven fabrics suitable for wet wipes were evaluated by examining the changes in the fabrics.

Having higher cellulosic fibre in its content supplies relatively faster degradation of nonwoven fabrics in comparison to the other fabrics used in the study. As a general view, nonwoven fabrics having cellulosic fibres in its structure have shown good degradation behaviour. It is possible to conclude that to bury wet wipes is a good idea to decrease the waste load of wet wipes and to make disposing these materials easier if the fabrics have no virus, no microbial contamination and etc.

For further studies, it will be better to simulate soil degradation of wet wipes having different fibre content and carrying different wetting solutions.

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REFERENCES

- [1] European Disposables and Nonwovens Association, EDANA publications, *Worldwide Outlook for the Nonwovens Industry 2018-2023*, Brussels, Belgium: EDANA, Available at: <https://www.edana.org/publications/statistics-nonwovens-report> [Accessed on June 2021]
- [2] Alimuzzaman, S., Gong, R.H., Akonda, M., *Biodegradability of Nonwoven Flax Fiber Reinforced Polylactic Acid Biocomposites*, In: *Polymer Composites*, 2014, 2094-2102
- [3] Alshehrei, F., *Biodegradation of Synthetic and Natural Plastic by Microorganisms* In: *Journal of Applied & Environmental Microbiology*, 2017, 5 1, 8-19
- [4] Chee, S.S., Jawaida, M., Sultan, M.T.H., Alothman, O. Y., Abdullah, L.C., *Accelerated weathering and soil burial effects on colour, biodegradability and thermal properties of bamboo/kenaf/epoxy hybrid composites*, In: *Polymer Testing*, 2019, 79, 106054
- [5] Sölar, V., Devrim, G., *Biodegradation Behaviour of Different Textile Fibres: Visual, Morphological, Structural Properties and Soil Analyses*, In: *Fibres and Textiles in Eastern Europe*, 2019, 1, 133
- [6] Choi, S., Jeon, H., Jang, M., Kim, H., Shin, G., Koo, J.M., Lee, M., Sung, H.G., Eom, Y., Yang, H.S., Jegal, J., Park, J., Oh, D. X., Hwang, S. Y., *Biodegradable, efficient, and breathable Multi-Use Face Mask Filter*, In: *Advance Science*, 2021, 8, 2003155
- [7] Gregorich, E.G., Carter, M.R., Angers, D.A., Monreal, C.M., Ellert, B.H., *Towards a minimum data set to assess soil organic matter quality in agricultural soils*, In: *Can. J. Soil Sci.*, 1994, 74, 367-385
- [8] ISO 11721-1:2001. Textiles – Determination of resistance of cellulose-containing textiles to micro-organisms – Soil burial test – Part 1: Assessment of rot-retardant finishing
- [9] Klug, P., *Clariant product for wet wipes*, Clariant R & D Personal Care Report, 2008
- [10] Miros-Kudra, P., Gzyra-Jagiela, K., Kudra, M., *Physicochemical Assessment of the Biodegradability of Agricultural Nonwovens Made of PLA*, In: *Fibres and Textiles in Eastern Europe*, 2021, 29, 1, 145, 26-34
- [11] Park, C.H., Kyung, Y., Seung, K., Im, S., *Biodegradability of cellulose fabrics*, In: *Journal of Applied Polymer Science*, 2004, 94, 1, 248-253