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## SOIL DEGRADATION OF DENIM FABRICS PRODUCED BY DIFFERENT FINISHING TREATMENTS

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**ABSTRACT:** *This study investigates the effects of some washings and special treatment processes on the biodegradation of denim fabrics. Finishing treatments and special processes were applied systematically on a raw denim fabric to evaluate the effect of individual applications on biodegradation. According to the results, all the finishing processes applied to obtain a worn appearance influence denim fabrics' mechanical and biodegradation properties. Stone washing and its combination with bleaching were determined as the most aggressive applications for denim fabrics. Although a significant decrease was observed, three months of biodegradation is enough to obtain nearly fully damaged fabrics.*

**Keywords:** *Biodegradation, denim fabric, finishing, soil, weight loss.*

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## DEGRADACIJA TKANINA OD TEKSASA PROIZVODENA RAZLIČITIM ZAVRŠNIM TRETMANIMA

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**APSTRAKT:** *Ova studija istražuje uticaj nekih pranja i procesa specijalnog tretmana na biorazgradnju teksas tkanina. Završni tretmani i specijalni procesi su sistematski primenjeni na sirovu teksas tkaninu da bi se procenio efekat pojedinačnih aplikacija na biorazgradnju. Prema rezultatima, svi procesi završne obrade koji se primenjuju da bi se dobio pohabani izgled utiču na mehanička i biodegradirajuća svojstva teksasa. Pranje kamena i njegova kombinacija sa beljenjem utvrđeni su kao najagresivnije primene za teksas tkanine. Iako je primećeno značajno smanjenje, tri meseca biorazgradnje su dovoljna da se dobiju skoro potpuno oštećene tkanine.*

**Ključne reči:** *biorazgradnja, teksas tkanina, završna obrada, zemlja, gubitak težine.*

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### 1. INTRODUCTION

Jeanswear is becoming more and more popular all over the world. However, many non-biodegradable and environmentally harmful wastewater is produced during jeanswear production. Although durability is not one of the main concerns of denim product

consumers, wear on fabric because of previously mentioned chemical and mechanical applications may decrease the necessary performance properties of denim products. There are many studies conducted on the effects of different mechanical and chemical finishing processes on the physical and mechanical properties of denim fabric. To the increasing trend in sustainability, studies using recycled fiber, fewer chemicals, and less water in denim production is the new concept in research [1-6].

Sandin and Peters (2018) This paper comprehensively reviews studies of the environmental impact of textile reuse and recycling, to provide a summary of the current knowledge and point out areas for further research [7].

When previous studies were evaluated, it was obvious that there were limited studies about the degradation behavior of denim fabrics. For this purpose, this current research investigates the effect of common treatments on the degradation behavior of denim fabrics.

## 2. MATERIALS and METHODS

### 2.1. Materials

There is a systematic experimental plan for the research. The same raw fabric was used and application of different washing/finishing procedures were, eight denim fabrics having different looks and different properties were handled.

One type of denim fabric made of 100% cotton having 3/1 twill weave was used in the research as a raw fabric. Linear density values of the warp and weft yarns were Ne 6 (10,2 tex) and Ne 12 (20,3 tex), fabric setting was 24 and 20 cm-1 for warp and weft directions, and mass per unit area of the raw fabric was 13,1 ons/yd<sup>2</sup>. Seven different washing and fading procedures were applied and eight fabric types were evaluated in terms of degradation behavior for three soil burial periods. Table 1 summarizes the applied finishing processes and shows fabric codes.

**Table 1:** Washing and special treatment applied on denim fabrics

Fabric code	Explanation of denim fabrics
<b>H</b>	Raw fabric
<b>R</b>	Rinse washed
<b>E</b>	Enzyme treated
<b>T</b>	Stone-washed
<b>TE</b>	Stone-washed, Enzyme treated
<b>TH</b>	Stone-washed, Bleached
<b>TK</b>	Stone-washed, Ice-bleached
<b>OZ</b>	Ozone treated

## 2.2. Methods

The degradation behavior of fabrics was investigated by soil burial method for different periods. After the last burial period, the soil samples were also examined besides the fabric samples to evaluate the harmful effect in the soil during degradation. Thus, the method part contains two main sections such as the fabric tests before and after the burial period and the soil tests.

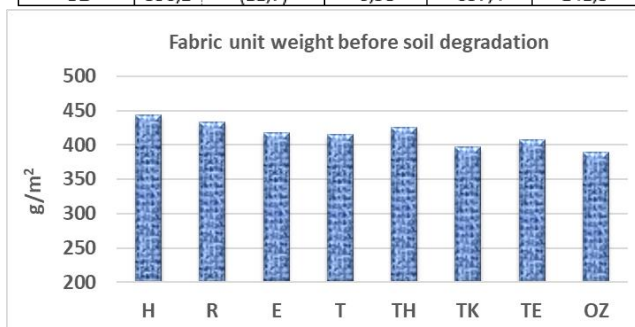
Before the soil burial process, fabric thickness, and weight per unit area values (Figure 1) were determined. Photographic and microscopic views of the test samples were taken. Three burial periods were followed such as 1 month, 2 months, and 3 months. After every soil burial period, the visual examination was recorded, and microscopic view and weight loss were determined.

## 3. CONCLUSIONS

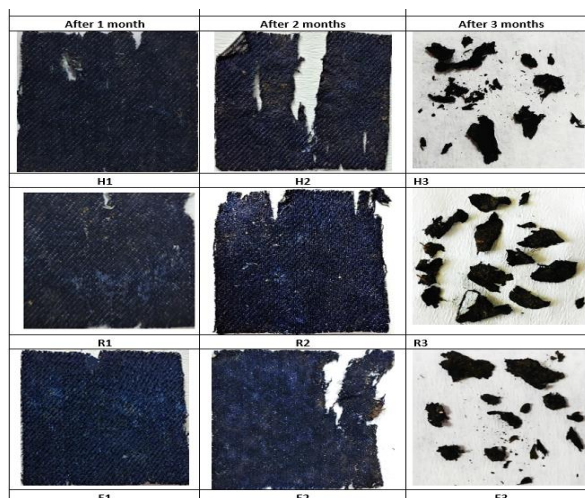
Fabric-breaking strength properties were determined to have a better understanding of the effects of applied treatments and to evaluate biodegradation better. Table 2 shows the results of basic structural properties and breaking strength values. As seen in Table 2, especially stone washing and the processes combined with stone washing destroyed the fabric in a high amount both in warp and weft directions. Besides the most dramatic decrease is obtained for the weft direction of ozone-treated denim fabric. These results were utilized to comment clearly on the biodegradation results. Figure 2 and 3 show the results of soil degraded fabrics..

**Table 2:** Basic structural and mechanical results of denim fabrics

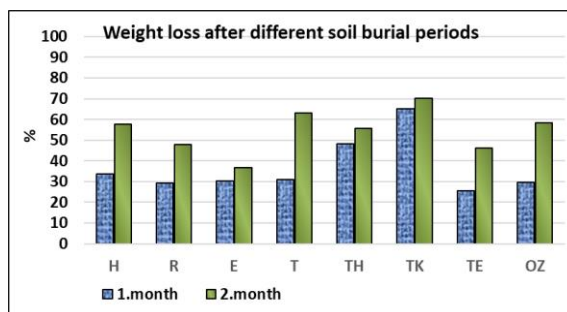
Denim fabric code	Mass per unit area		Thickness (mm)	Breaking strength (N)	
	g/m <sup>2</sup>	(oz/yd <sup>2</sup> )		Warp	Weft
H	442,8	(13,1)	0,89	843,5	319,5
R	433,1	(12,8)	1,00	834,6	270,1
E	414,3	(12,2)	1,06	729,6	259,6
T	408,2	(12,0)	1,06	613,2	255,8
TH	423,8	(12,5)	1,00	645,4	233,8
TK	396,8	(11,7)	0,99	639,7	189,7
TE	408,1	(12,0)	0,97	544,4	182,0
OZ	396,2	(11,7)	0,98	657,4	141,3



**Figure 1:** Fabric unit weight before the soil degradation period



**Figure 2:** Figure. Photographic views of the H, R, E coded denim fabrics after different soil burial periods (1, 2, 3 months)



**Figure 3:** Figure. Weight loss of the denim fabrics after different soil burial periods (1, and 2 months)

The weight loss values of all the test samples were summarized first and illustrated in Figure 3. As seen in Figure 3, the highest degradation was obtained in TK samples for 1 month of buried denim fabrics. Acceleration in degradation was seen for all denim samples. For a two-month burial period, only stone-washed and stone-washed-ice bleached denim fabrics lost their weight by more than 60%. After a three-month degradation period, except for two test fabrics (R, E coded fabrics), all denim fabrics used in the research have lost their weights higher than 80%. The results indicate that the denim fabrics used in the research present good soil biodegradation. Besides this does not mean denim fabrics are not harmful to the environment, As it is well known, the most harmful processes during textile production are dyeing, drying, and finishing processes, and also denim production has a very big negative effect on soil and marine pollution. With the



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help of this study, denim garment producers may find a new solution to garment industry tails.

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