(REFEREED RESEARCH)

THE AVAILABILITY OF MICROFIBER TEXTILE MATERIAL IN THE TEXTILE ARCHITECTURE - THE EFFECT OF UV ABSORBER ON MATERIAL TENSILE STRENGTH

MİKROLİF TEKSTİL MALZEMESİNİN TEKSTİL MİMARİSİNDE KULLANILABİLİRLİĞİ - UV ABSORBANLARIN MALZEME ÇEKME DAYANIMINA ETKİSİ

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ABSTRACT

Günümüzde, yapı malzeme gruplarına polimer lifler içeren kompozitlerin üretilmesiyle yeni alternatifler katılmıştır. Çeşitlilik gösteren bu lifler "Teknik Tekstiller" şeklinde, "Tekstil Mimarisinde" çağdaş strüktür sistemlerinin hızla yayılmasını sağlamıştır. Tekstil mimarisinde kullanılan lifler ağırlıklı olarak polyester, polipropilen ve poliamid liflerdir. Bu lifler arasında, özellikle mikrolif şeklinde olanlar iklim koşullarına karşı dayanıklılık göstermeleri nedeniyle öne çıkmaktadır. Mikrolif tekstil yüzeyleri hava ve su buharı geçirgenliğine sahipken, dış yüzey malzemesinden istenen dayanıklılık koşullarını sağlamaktadır. Bu araştırmada, tekstil sektöründe kullanılan polyester mikrolif malzemenin dış ortam koşullarına maruz kaldıktan sonra çekme dayanımı gibi mekanik özellikleri araştırılmıştır. Dış ortam koşulları arasında, özellikle UV radyasyon faktörü malzeme yüzeyinde etkili olmaktadır. Bu nedenle, farklı konsantrasyonlarda UV absorbanlar, mikrolif tekstil üzerine uygulanmıştır. Boyanmamış mikrolif tekstil malzemesi %0, %1, %2, %3 ve %4 UV absorban konsantrasyonları ile işlemden geçirilmiştir. Numuneler, gün ışığı ve UV radyasyonu 300-400 nm ile sınırlandırılarak, mavi yün 7-L8 derece referansa eşdeğer olacak şekilde 320 saat hızlandırılmış yaşlanma deneylerine maruz bırakılmıştır. Deney sonuçları incelendiğinde; UV absorbanın malzeme üzerinde olumlu etkisi olduğu; ancak, farklı konsantrasyon yüzdelerinin malzemenin dayanıklılığı üzerinde herhangi bir etkisinin olmadığı tespit edilmiştir.

Key Words: Mikrolif, Yaşlanma deneyi, UV absorban, Çekme dayanımı, Tekstil mimarisi.

ÖZET

Recently, new alternative materials are participated by the production of composites which includes polymer fibers. The fibers in the form of "Technical Textiles" show variety and provide spreading the modern structure systems in "Textile Architecture". The fibers used in textile architectures are mainly polyester, polypropylene and polyamide fibers. Especially the fibers in the form of microfibers come forward because of the endurance against the climatic conditions. Microfiber textile surfaces has the air and water vapour permeability which is demanded for exterior coating, can also be used as exterior surface material when durability conditions were provided. In this research, the tensile strength of polyester microfiber material, used in textile industry, was researched under external conditions. Among these external conditions, especially UV radiation was an effective factor on the material surface. Due to this factor, different concentrations of UV absorbers were applied on microfiber. Undyed microfiber textile material was treated with 0%, 1%, 2%, 3% and 4% UV absorber concentrations. UV radiation of daylight was limited in 300-400 nm and material was exposed to accelerated aging experiment for 320 hours, which was equivalent to blue wool 7-l8 degree reference. The experimental results showed that UV absorber has a positive effect on aged material; however, concentration percentage differences do not provide any annex to endurance of material.

Anahtar Kelimeler: Microfiber, Aging experiment, UV absorber, Tensile strength, Textile architecture.

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1. INTRODUCTION

Nowadays, textile offers new approaches to architecture with its technology and material properties. While making it possible to design very complex structures by the means of availability, especially technical textile group also attains many application fields by the way of functionality (1).

Technical textiles which were used as structure textiles besides geo textiles, take part in applications known as "Textile Architecture". Textile architecture has included different fibers like polypropylene, polyester and polyamide. These textile surfaces were strengthened against climatic conditions using different coating materials like PU, PVC, and PTFE.

Especially the fibers in the form of microfibers come forward because of the endurance against the climatic conditions. In this research, microfiber fabric which was lighter than membranes whether can be used in architecture. Microfibers were usually produced from polyester and polyamide polymers. Microfibers were finer (<1.0 dtex) than any other natural and conventional synthetic fibres. This property provides air and vapour permeability, but on the other hand it has a waterproof property. A microfiber textile surface has a wider surface area than a conventional textile surface.

Having hollows in their structure, microfibers have resistance to climatic conditions. Due to this property and their light weight, microfibers were chosen in this research. UV absorber was used against the harmful effects of UV radiation. The effectiveness of different concentrations on tensile strength and elongation ratio were examined.

In this research, UV radiation effect was limited between 290 - 400 nm.

UV radiation causes harmful effects on material structure such as, due to the increasing of the surface temperature, decomposition of micro-structure was occurred (2). Oxygen, in the environment can interact with other chemical groups and can accelerate reactions (3).

UV absorbers have an ability to decrease the UV transmittance degree on fabrics and provide solar protection (4- 7). UV absorbers have organic (o-hydroxybenzophenone; o- hydroxy-phenylbenzotriazole; o-hydroxyphenyl-triazine) and inorganic (titanium dioxide) structures which absorbs and reflects the excited energy without harming the environment (6). UV absorbers were applied in textile industry in wet processes. Effect mechanism of UV absorbers against UV radiation on different polymers can be found in many references. Many references on effects of UV absorbers, which was a derivate of Benzotriazole, were researched (8, 9, 10), the effects of ultraviolet (11, 12), humidity and heat were examined (13, 14), the characteristics of light fastness were subjected (10, 15, 16) and the UV transmittance effects on polyester were examined (17).

In previous research, on undyed microfiber textile, UV absorbers were applied in concentration percentages of 1 %, 2 %, 3 % and 4 %. The effects of UV absorbers colour changes on aged material were examined by comparing (18).

In this research, same UV absorber in different concentrations was used and after aging the fabric; UV absorber's effect on tensile strength and elongation values were compared.

2. MATERIALS AND METHODS

2.1. Material

Scoured 100 % polyester microfiber fabrics without fluorescent brighteners were used.

Fabric construction: Yarn counts: Warp: 70 Td, Weft: 72 Td (a unit of measure of linear density of fibre mass- The weight in grams of 9000 meters of a fibre or yarn), fabric I: twill weave 2/1 Z, warp/cm: 40, weft/cm: 36, fabric weight: 115g/m²

UV Absorber**:** Benzotriazole derivate

Dispersing agent: A dispersing assistant in order to allow the non-soluble UV absorber to disperse in the liquid.

Acid buffer: For the adjustment of Ph value bath.

2.2. Equipment Used

Laboratory HT Dyeing machine (Roaches Brand-MB)

Mechanical testing apparatus: Instron 4411(100± mm/min)

Weatherometer: Xenotest 150 S- Atlas (air cooler xenon arch lamp with 2200 W power, filter system, simulating sun light or open air conditions behind SPD glass, turning example shelf with capacity of 1320 cm^2, rain spraying system, black standard thermometer which was able to make heat control of test capacity, ultrasonic moisture system).

2.3. Method

2.3.1. Preparing Experiment Samples

In this study, UV absorber was applied to 1.9 g undyed microfiber material by the concentrations of 0 % and 1 %, 2 %, 3 % and 4 %. Applications were examined in bath ratio 20:1 (20 mL solution for 1 g material) by exhaustion method. 0.8 g/L dispersing agent and 0.5 g/L buffer (pH 5.5) was added to the bath at the beginning of the process. The UV absorber was applied by exhaust method. Process was started at 30 ºC and the heat was raised to 130 ºC with 1.5 C/min gradient and worked at this degree for 30 minutes. Then, the samples were rinsed in the dyeing machine with a bath ratio of 50:1 at 30 C for 5 minutes, after dried in open air without tension. Every application was applied five times.

2.3.2. Accelerated Aging Experiments

Every undyed microfiber sample was conditioned according to TS EN ISO 139:2006. Determining the materials' endurance ASTM E 632-82 was used. Determining the effects of UV radiation, heat and water on samples EN ISO 105-B04:1997 was used.

Experiments in the accelerated aging equipment, were made with xenon arch distribution was 300-400 nm and their radiation radiance 42 W/m^2. Required equations for equipment conditions of open air simulation and year based average radiation ratios were given in (Table1, Formula 2.1).

Among the adapted programmed climatic conditions, South France values were chosen which have good agreement with Turkey's climatic condition. Calculation method developed by Atlas Company was used.

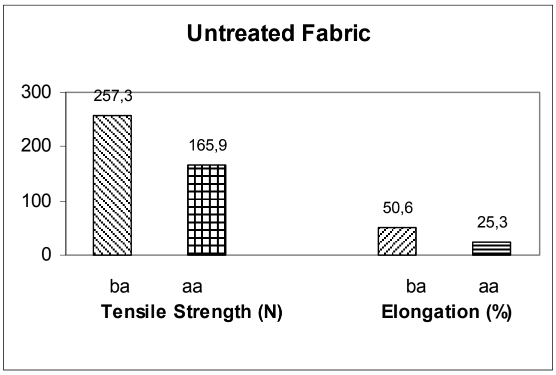
Table 1. Year based average radiation circulation ratio (Atlas Weather Testing Guide.2001)

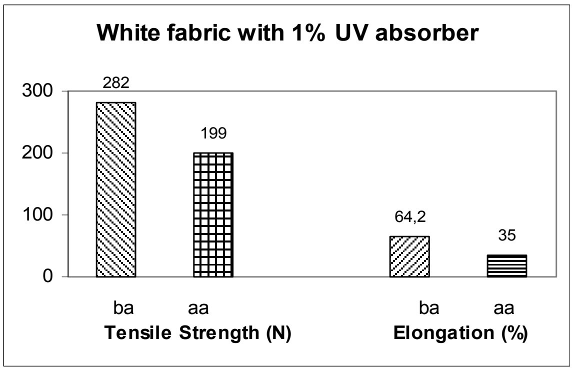
Region	**295-3000nm Global, MJ/m^2**	**295-800 nm UV+ Visible, MJ/m^2**	**295-400 nm UV MJ/m^2**
Florida	5850	3400	355
Arizona	8000	4600	485
Central Europe	3550	2050	215
South France	5000	2900	300

$$t(s)=\frac{\text{Radiation } H\ (Ws/m^2)}{\text{Radiation } E\ W/m^2} \qquad t(h)=\frac{H\ (Ws/m^2)}{E\ W/m^2 .3600\ s/h}=\frac{300.10^6}{42.\ 3600}=1984\text{ h} \quad (2.1)$$

Table 2. (1-8/ L2-L9) Light Exposure Conditions for Blue Wool Reference (1-8/ L2-L9)

Fastness values / Reference values	**Assessment**	**Colour Index No**	**Colour Fading Period (**hour)
1 – L2	very poor	C.I.Acid Blue 104	5
2- L3	poor	C.I.Acid Blue 109	10
3- L4	fair	C.I.Acid Blue 83	20
4- L5	average	C.I.Acid Blue 121	40
5- L6	good	C.I.Acid Blue 47	80
6- L7	very good	C.I.Acid Blue 23	160
7- L8	excellent	C.I.Sol.Vat Blue 5	320
8- L9	outstanding	C.I.Sol. Vat Blue 8	640





ba: before aging **aa:** after aging

Figure 1. Comparison of tensile strength and elongation of undyed sample without UV absorber

Figure 2. Comparison of tensile strength and elongation of undyed samples with 1 % UV absorber

Experiment samples were exposed to 40 ºC temperature in atmosphere of 40 % humidity, and exposed to 1 minute irrigating by rainspraying water and 29 minutes drying period. Samples were placed with the angle of 90º and 100 mm away from the source of light. The conditions of exposing light of blue wool reference was demonstrated (Table 2).

Blue wool standard was taken for aging experiments to determine the textile material's usage in exterior surface. According to blue wool standard, 640 hour was taken as exposing time which is required for maximum colour fading. However, the angle of sun light on to the exterior surface never can be 90º therefore exposing time was reduced by half to 320 hours (45 instead of 90º) (19).

To relate the accelerated experiments' to open air conditions, 1984 hours (Formula 2.1) was taken as one year. Related to proportional value of exposing time; 1984/640=3.1 was taken. Depending on this result; 12 month/3=4 month exposing times were obtained.

It was observed that at the end of 4th month, colour fading was stabilized. Colour fading degree reached 7 at the end of 320 hours and its light fastness is perfect.

2.3.3. Tensile Strength and Elongation

Five measurements for each warp's direction according to ASTM D5035-1995 has been made.

3. RESULTS AND DISCUSSION

Experiment samples were exposed in aging machine, programmed according to ISO 105-B04, for 320 hours. This time period is required to obtain for colour fading degree of 7.

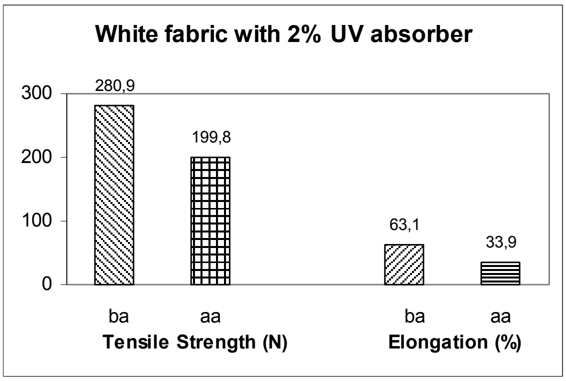
The results of tensile strength and elongation of fabrics were given in 'Fig. 1, 2, 3, 4, 5'.

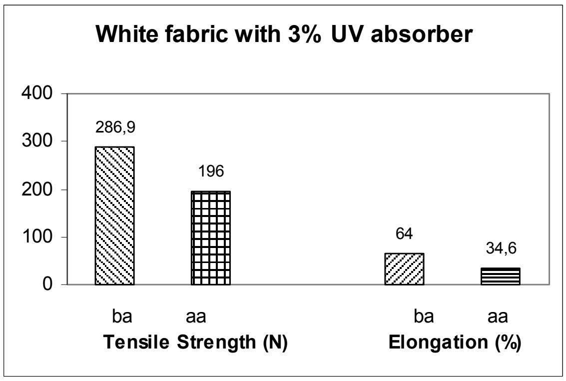
The tensile strength values of the untreated fabric decreased approximately 35 %. The elongation percent ratio decreased 50 % (Figure 1).

The tensile strength of the undyed sample applied with 1% UV absorber decreased about 29 % and elongation values decreased 45 % after aging (Figure 2).

The tensile strength of the undyed sample applied with 2 % UV absorber decreased about 29 % and % elongation values decreased 46% after aging (Figure 3).

The tensile strength of the undyed sample applied with 3 % UV absorber decreased about 31 % and % elongation values decreased 46 % after aging (Figure 4).





ba: before aging **aa:** after aging

Figure 3. Comparison of tensile strength and elongation of undyed sample with 2 % UV absorber

Figure 4. Comparison of tensile strength and elongation of undyed sample with 3 % UV absorber

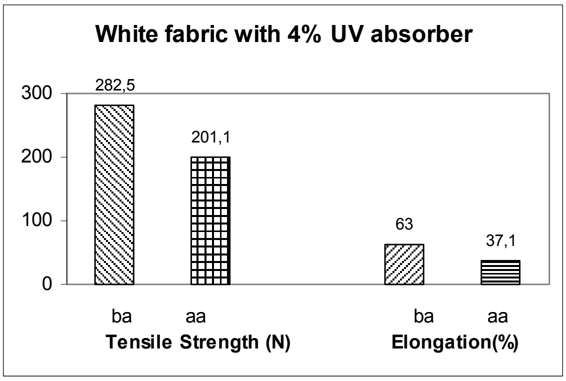
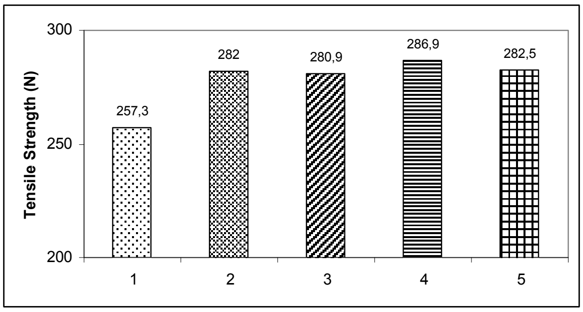
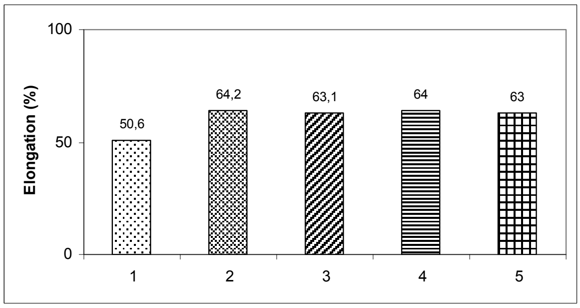


Figure 5. Comparison of tensile strength and elongation of undyed sample with 4 % UV absorber





1: untreated fabric **2:** undyed fabric with 1% UV absorber **3:** undyed fabric with 2% UV absorber **4:** undyed fabric with 3% UV absorber **5:** undyed fabric with 4% UV absorber

Figure 6. Comparison of tensile strength of samples before aging

Figure 7. Comparison of elongation break of samples before aging

The tensile strength of the undyed sample applied with 4 % UV absorber increased about 30 % and % elongation values increased 32 % after aging (Figure 5)

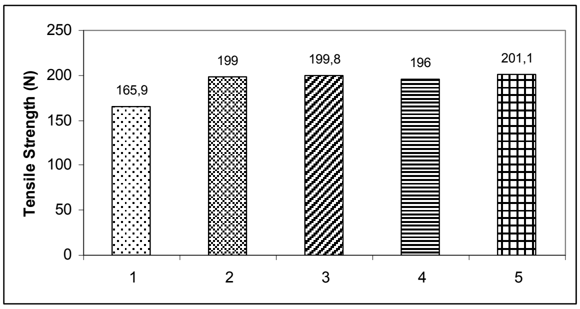
4.1. Comparison of Tensile Strength and Elongation Break of Fabrics Before Aging

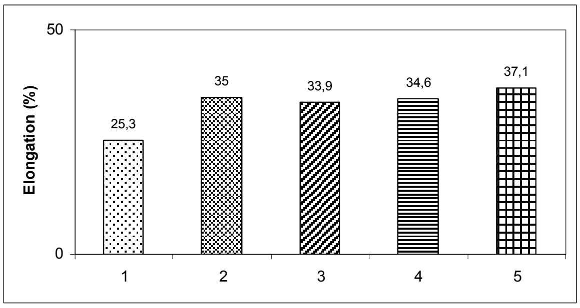
Comparison of tensile strength and elongation break of fabrics before aging were given (Figure 6 and Figure 7).

As seen in Figure 6 and Figure 7, UV absorber has a positive effect on material. However, percentage differences in concentrations does not provide any annex to both tensile strength and elongation break of material. Comparing between values, UV absorber applied samples' tensile strength increased approximately 10% and elongation break values increased approximately 25 %.

4.2. Comparison of Tensile Strength and Elongation Break of Fabrics after Aging

The Comparison of tensile strength and elongation break of fabrics before aging were given in (Figure 8 and Figure 9).

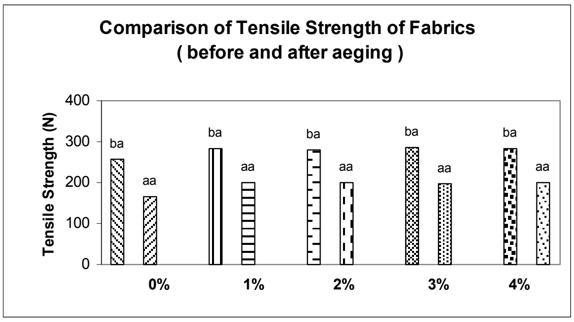




1: untreated fabric **2:** undyed fabric with 1% UV absorber **3:** undyed fabric with 2 % UV absorber
4: undyed fabric with 3 % UV absorber **5:** undyed fabric with 4% UV absorber

Figure 8. Comparison of tensile strength of samples after aging

Figure 9. Comparison of elongation break of fabrics after aging



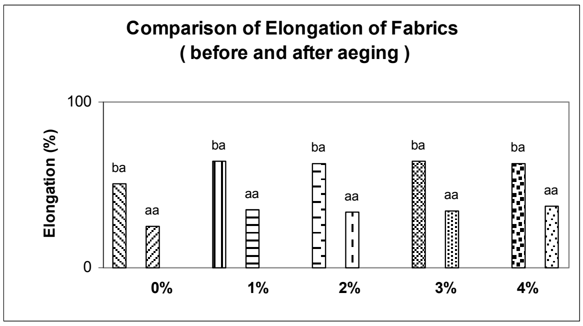


Figure 10. Comparison of tensile strength of samples before/after aging

Figure 11. Comparison of elongation % of samples before/after aging

As seen in Figure 8 and Figure 9, values of UV absorber applied samples' tensile strength increased approximately 20% and elongation break values increased approximately 38 %. However, concentration percentage differences do not provide any annex to the endurance of material.

When the values of tensile strength on before aging and after aging were compared; it is observed that, after aging, material without UV absorber decreased approximately 35%, material with UV absorber decreased approximately 29%. When the values of elongation break on before aging and after aging were compared; it is observed that, after aging, material without UV absorber decreased approximately 50%, material with UV absorber decreased approximately 45%.

As a result, usage of UV absorber, in after aging, has a positive effect on tensile strength and elongation break respectively 6% and 5%.

5. CONCLUSIONS

The application of UV absorber has a positive effect on tensile strength and elongation break properties of aged and unaged material. However, concentration percentage differences do not provide any annex to the endurance of material.

It is observed that, by using UV absorber, loss of tensile strength and elongation break, caused by aging, was lower.

We believe that using microfiber textile material applied with UV absorber suitable for exterior surface and demonstrates potential in use.

When the researched microfiber material is positioned vertically on extrerior surfaces, the angle of the radiation will change (45° instead of 90°). For this reason, "exposure period" is taken as twice (640 hours) the period of staying in machine (320 hours) in calculations (18). In relating accelerated experiments to external temperature conditions, when 1984 hours (Formula 2.1), equivalent of *one year*, connection (1984 / 640 = 3.1) is made, it is seen that discoloration is stabilized at the end of "fourth" month.

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Bu araştırma, Bilim Kurulumuz tarafından incelendikten sonra, oylama ile saptanan iki hakemin görüşüne sunulmuştur. Her iki hakem yaptıkları incelemeler sonucunda araştırmanın bilimselliği ve sunumu olarak ***“Hakem Onaylı Araştırma”*** *vasfıyla yayımlanabileceğine karar vermişlerdir.*
