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Full Length Research Paper

Investigation of water absorbency and color fastness of modal woven towels

Filiz SEKERDEN

Textile, Clothing, Footwear and Leather Department, Iskenderun Vocational Schools, Mustafa Kemal University, İskenderun, Hatay, Turkey. E-mail: filizsekerden@yahoo.com. Tel: + 90 326 613 70 80. Fax: + 90 326 613 56 13.

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Water absorbency and color fastness to perspiration, seawater and washing of modal terry woven fabrics were studied in this research. Weft and warp yarns were produced from 100% cotton and pile yarns were produced from 50/50% modal/cotton blended yarn. Terry woven fabrics were produced in five different pile heights. Water absorbency and color fastness tests were carried out on fabrics. It was determined that sinking time of the terry woven fabrics decreased with the increase in pile height. It was observed that wicking height of terry woven fabrics increase by decreasing the weft density of fabrics. It was established that modal towels dyed with reactive dyestuff showed high levels of color fastness.

Key words: Modal terry fabric, water absorbency, color fastness.

INTRODUCTION

Terry towels are produced using weft, ground and pile warp yarns. Terry towel fabrics should have high water absorption, good color fastness and dimensional stability properties (Schramek, 2009). Pile structure, pile, warp and weft yarn materials have an important effect on the usage properties of terry fabrics. Recent studies have shown that the the water absorption capacity of a terry fabric is dependent on yarn material, yarn type and fabric construction. An increase in weft and/or warp density reduced the percentage of static water absorption and an increase in pile height increased the percentage static water absorption of terry fabrics. The effect of pile height on static water absorption was found to be more pronounced compared to warp and weft density (Karahan and Eren, 2006; Petrulyte and Baltakyte, 2009). Swani et al. (1984) conducted a study on functional properties of terry towels produced by using the ring and the OE yarn in pile warp. They observed that there was no difference in water absorption rate in towels made out of OE yarn and ring yarn but the maximum absorption of water for OE towels was better than that of ring towels. Water absorption levels depend on fabric type and applied finishing procedure as much as the characteristics of the fabrics (Petrulyte and Baltakyte, 2009). Retention of color is important to consumers and is often a determining factor in the serviceability of a textile item. A textile that resists loss of color is said to be colorfast. The word 'fast' means firmly fixed; in other words, the dye holds 'fast' to the fiber. The resistance of a material to any change in any of its color characteristics, to transfer its colorants to adjacent materials (Hargrave, 1997).

Fastness tests are important tools for assessing the quality and the stability of dyeing. In many cases, the fastness properties are strongly related to the substrate type and mordant used for dyestuff fixation. There are many factors that influence the fastness such as the substrate, the surrounding conditions (water, solvent, chemicals, temperature, humudity, light intensity and light source etc) pre-and after- treatments, as well as dyestuff distribution in the fibers, textile and also the amount of dyestuff fixed on the goods (Bechtold and Mussak, 2009). Modal terry woven fabrics that have recently become common in the textile sector were studied in the present research. Modal is a regenerated cellulose fiber manufactured through processes that provide the fibers with high strength and high elasticity modulus in wet conditions (Yakartepe and Yakartepe, 1995; Cook, 1984). Modal can also be defined as a high wet modulus regenerated cellulosic fiber (Agarwal et al., 2011). In previous studies, research authors focused on water

Table 1. Irregularity and strength features of yarns.

	Yarn number (Tex)	*U%	*Thin places/km (-50%)	*Thick places/km (+50 %/km)	*Neps/km (+ 200 %/km)	*Rkm (g/tex)
Pile	36.9	7.5	0	6	12	18.5
Warp	30x2	8.4	0	3	6	14.2
Weft	49.2	9.8	0	15	28	13.5

Table 2. Some physical characteristics of terry fabrics.

Fabrics	Warp density (ends/cm)	Weft density (picks/cm)	Pile height (mm)	Areal density (g/m^2)	Pile/ground weight ratio
1	13	20	10.8	582.8	1.95
2	13	20	8.8	599.3	2.31
3	13	16	9.5	618	2.09
4	13	19	9.1	639.5	2.28
5	13	20	8.1	649	1.94

absorption properties of cotton or linen terry fabrics. There are no sufficient studies of the hydrophilicity, water absorption, wicking height and color fastness of modal terry woven fabrics in the literature. This study examined the water absorption, wicking height and washing, seawater and perspiration fastness of modal towels with different pile heights.

MATERIALS AND METHODS

Weft and warp yarns were produced from 100% cotton yarn and pile yarns were produced from 50/50% modal/cotton mixture. Towel fabrics were woven by a gripper weaving machine. Modal fibers are obtained from the plant in fiber form and woven after transforming into yarn. All of the fabrics were dyed with reactive dyestuff in the same conditions. Table 1 shows irregularity and strength characteristics of modal yarns used in terry fabrics and Table 2 shows some physical characteristics of terry fabrics. The means of values that were seen in Table 1 can be explained as; U%, thin and thick places, neps, Rkm values of pile, warp and weft yarns are shown in Table 1. U% is the percentage mass deviation of unit length of yarn, thin places are places in the yarn, that are thinner than -50% of the yarn diameter, thick places are places in the yarn that are thicker than +50% of yarn diameter, Neps are places in the yarn that are thicker than +200% of the average yarn diameter. Rkm can be expressed by the "length of yarn in kilometer" at which yarn will break off its own weight. All characteristics of the fabrics were calculated according to the recognized standards. The areal densities of the fabrics, pile heights, water absorbency, wicking height level of water, color fastness to sea water, color fastness to perspiration, color fastness to washing was in accordance and was determined according to TS 251 (1991), TS 629 (2007), TS EN 14697 (2007), DIN 53924 (1997), TS 397 EN ISO 105-E02 (2002), TS EN ISO 105-E04 (2010) and TS EN ISO 105-C06 (2010) standards respectively. Specimens of the textile in contact with adjacent fabrics are immersed in 30 g/L aqueous sodium chloride solution, then drained and placed between two plates under a specified pressure in a test device for 4 h at 37℃.

The specimens and the adjacent fabrics are dried separately. The change in color of each specimen and the staining of the adjacent fabrics are assessed with the grey scales (TS EN ISO 105-E02, 2010, Ullman, 2008). Specimens of the textile in contact with adjacent fabrics are treated in two different solutions histidine, then drained and placed between two plates under a specified pressure in a test device for 4 h at 37℃. The specimens and the adjacent fabrics are dried separately. The change in color of each specimen and the staining of the adjacent fabrics are assessed with the grey scales (TS EN ISO 105-E04, 2010, Ullman, 2008).

RESULTS

Water absorbency test

Figure 1 shows the water absorbency test results of terry towel fabrics and their areal densities. The sample with highest pile height had the shortest sinking time (Figure 1).

Wicking height of water

Figure 2 shows the test results of the wicking height of water in accordance with DIN 53924 standards. The fabric samples (250 mm in length and 30 mm in width) were cut along the warp direction and were vertically immersed so that the lower end will contact the water (15 mm from the lower end). Wicking heights (cm) were measured at 10, 30, 60 and 300 s.

Color fastness

The washing, seawater and perspiration fastness of sample fabrics were examined. It was determined that fastness values of all the samples were equivalent and multi-fiber staining results are shown in Table 3. It was established that the color change of all fabrics according

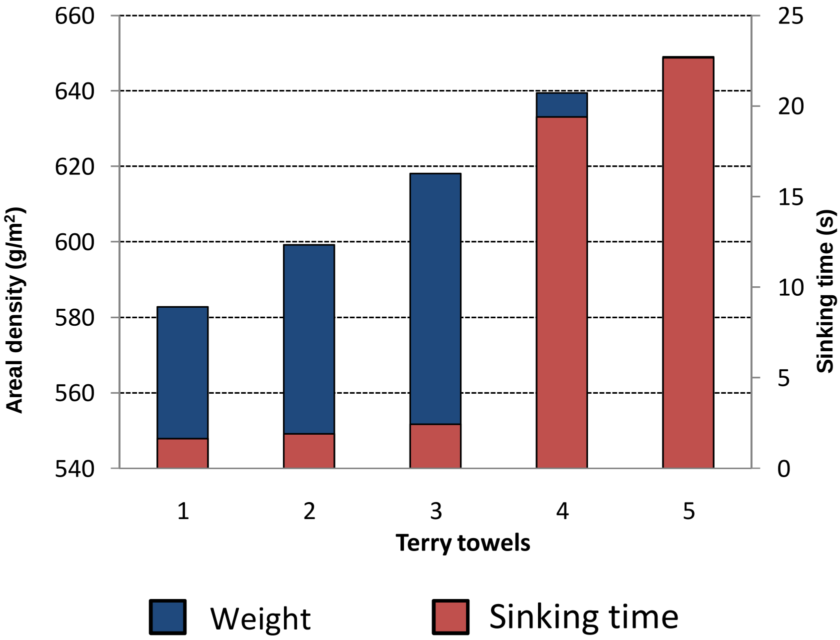

Figure 1. Sinking time –areal density variations of fabrics.

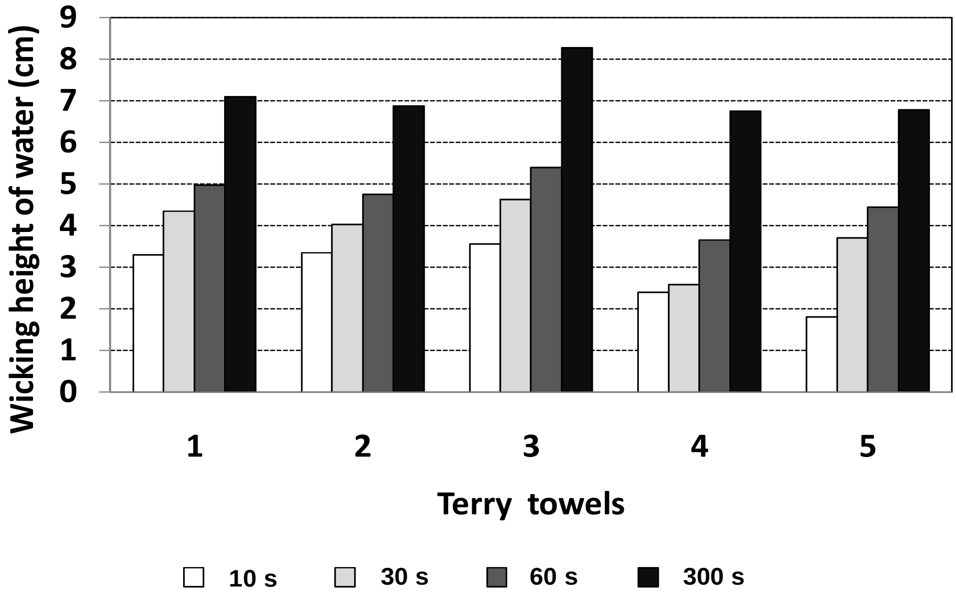

Figure 2. Wicking height levels of water of the fabrics at 10, 30, 60 and 300 s.

to washing, seawater and perspiration fastness is between 4 and 5 on the grey scale.

DISCUSSION

The sample with highest pile height had the shortest sinking time (Figure 1). Pile height decreases the sinking time. This agrees with the findings of previous study (Zervent and Koc, 2006). Surface area to absorb water increases with increasing pile height and decreases the sinking time. Vertical transportation of water depends on size of capillary and availability of surface are to absorb water. The reason for more wicking height of towels with

Table 3. Color fastness of fabrics to washing, seawater and perspiration.

Fabrics	Multifiber	Color fastness to washing	Color fastness to sea water	Color fastness to perspiration	
				Acidic	Alkaline
1, 2, 3, 4, 5	Acetate	4/5	4/5	4/5	4/5
	Cotton	4/5	4/5	4/5	4/5
	Nylon 6,6	4/5	4/5	4/5	4/5
	Polyester	4/5	4/5	4/5	4/5
	Acrylic	4/5	4/5	4/5	4/5
	Wool	4/5	4/5	4/5	4/5

greater pile ratio may be attributed to the fact that area of contact of towels increases with the increase of pile ratio (Sharma and Madhusoothanan, 2007). Although pile/ground weight ratio of second and fourth fabrics is greater than third fabric, wicking height of third fabric is greater than the others (Figure 2). It can be the reason for this, the weft density of third towel is lower than the others. The results are consistent with previous study (Ramesh et al., 2011).

Conclusions

The conclusions of this study are as follows:

i) Sinking time decreases with increasing pile height.
ii) Wicking height increase by decreasing the weft density of terry fabrics. It was observed that wicking height is rapid in the first 60 s, but then it shows a tendency to slow down.
iii) Modal towels dyed with reactive dyestuff have good color fastness to washing, seawater and perspiration and pile height and towel areal densities do not have an effect on color fastness.

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