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REČ UREDNIKA

U ime Redakcionog odbora časopisa „Tekstilna industrija“, pozivamo sve čitaoce, autore, kolege, dugogodišnje saradnike i pretplatnike, sponzore i donatore da nam se pridruže u našim aktivnostima kako bi adekvatno obeležili jubilarnu godinu koja je pred nama.

Nadamo se da ćemo u ovoj jubilarnoj godini kada Savez inženjera i tehničara tekstilaca proslavlja 70 godina uspešnog rada i 70 godina neprekidnog publikovanja časopisa „Tekstilna industrija“, uspešno organizovati po peti put Međunarodnu konferenciju „Savremeni trendovi i inovacije u tekstilnoj industriji“.

Takođe, povodom obeležavanja Jubijela, planira se štampanje publikacije - Monografije pod naslovom „Tekstilna industrija Srbije-istorija, kulturno nasleđe, razvoj i obrazovanje kadrova“.

Cilj ove publikacije je da se prikaže istorijat i razvoj tekstilne industrije Srbije u periodu od kraja 19. veka do današnjih dana kroz ekonomske fenomene i pojave, tehnološki razvoj, tržište tekstilne industrije, radnu snagu i obrazovanje stručnih kadrova.

Takođe, cilj je da se kroz prikaz tradicionalnih proizvoda koji su okarakterisani kao nematerijalno kulturno nasleđe, čuva istorija, tradicija i kultura, a ujedno da se razvija i tekstilna i modna industrija Srbije.

Svakako, jedan od ciljeva izrade ove monografije je i da se mlade generacije kroz formalne i neformalne vidove obrazovanja upoznaju sa istorijatom i razvojem tekstilne industrije, kako bi na osnovu dugogodišnjeg iskustva mogli da je unaprede.

Kao jedan od značajnih poglavlja monografije biće posvećeno nematerijalnom kulturnom nasleđu. Istražiće se vrednost tekstilnih proizvoda, kao jednih od najznačajnijih elemenata nematerijalnog kulturnog nasleđa Republike Srbije. Analiziraće se i prisutnost tradicionalnih vizuelnih simbola u savremenom modnom dizajnu, posebno u oblasti primenjene umetnosti, kao i njihovoj upotrebi u tekstilnoj i modnoj industriji. Simboli proizašli iz naše folklorne tradicije važan su ključ u očuvanju identiteta, izvorno duhovno bogatstvo i potencijalna osnova za inspiraciju u novim modnim trendovima. Savremenom stilizacijom ti motivi postaju vrlo atraktivni u savremenom stvaralaštvu, pa i na polju modnog dizajna. Na taj način tekstilnoj i odevnoj industriji se pruža mnogo opcija za razvoj. Promovisanje i upotreba etno motiva u savremenom odevanju je šansa da tekstilna industrija Srbije postane prepoznatljiva na svetskom tržištu i tako poveća svoju konkurenstsku prednost.

Glavni i odgovorni urednik
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THE EFFECT OF FABRIC STRUCTURE PARAMETERS ON DIMENSIONAL STABILITY AFTER DOMESTIC WASHING

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Abstract: *The aim of this research was to study the effect of fabric structure parameters on dimensional stability of a woven 100% cotton fabric after five cycles of domestic washing. Ten cotton fabrics with different structure parameters (yarn density, linear yarn density, cover factor, weave pattern) were exposed to five cycles of a domestic washing process and dried hung in line position. The dimensional changes of fabrics were measured after each washing and drying cycle and then expressed as a percentage of the initial dimensions. The experimental results have shown that shrinkage occurs in all ten fabrics, and it is higher in warp than in weft direction. Statistical analysis was used to identify the relationships between fabric shrinkage and fabric structure parameters. The results have shown that fabric shrinkage is in linear correlation with the cover factor and the weave factor.*

Keywords: weave factor, cover factor, dimensional stability, shrinkage.

UTICAJ PARAMETARA STRUKTURE TKANINE NA DIMENZIONU STABILNOST NAKON KUĆNOG PRANJA

Apstrakt: *Cilj ovog istraživanja je bio da se ispita uticaj parametara strukture na dimenzionu stabilnost 100% pamučne tkanine nakon pet ciklusa kućnog pranja. Deset pamučnih tkanina sa različitim strukturnim parametrima (gustina, linearna gustina prediva, faktor pokrivanja, prepletaj) izloženo je na pet ciklusa procesa kućnog pranja i sušenja. Promene dimenzija tkanina merene su nakon svakog ciklusa pranja i sušenja, a zatim izražene kao procentat početnih dimenzija. Eksperimentalni rezultati pokazuju da se skupljanje dešava kod svih deset tkanina i da je veće u pravcu osnove nego potke. Statistička analiza je korišćena za identifikaciju odnosa između skupljanja tkanine i parametara strukture tkanine. Rezultati pokazuju da je skupljanje tkanine u linearnoj korelaciji sa faktorom pokrivanja i faktorom prepletaja.*

Ključne reči: faktor prepletaja, faktor pokrivanja, dimenziona stabilnost, skupljanje.

1. INTRODUCTION

Dimensional stability of the textile materials is the change of dimensions in textile products when they are washed or relaxed. The textile product with good dimensional stability is worn and washed several times, the initial shape is unchanged, and the dimensions do not shrink or elongate [1]. The main reason for dimensional changes of textile materials is the release of stresses and strains introduced in production processes.

When the products are immersed in water, the water acts as a soothing medium, and all stresses and strains are relaxed and therefore the fabric tries to return to its original state. For textile products, it is important to determine the linear dimensions, not only immediately after production, but also during their application. Even more important is the previous evaluation of the dimensional stability of products that may occur during washing, dry cleaning, and ironing [2].

Several authors have investigated the influence of the fabric structure parameters (pattern, yarn linear density, stitch lengths) on the dimensional stability of knitted fabrics after washing and drying in several positions [3-5]. Shrinkage is highest after the first cycle of washing and drying [6]. Stitch lengths and yarn linear density have a significant influence on the knitted fabric shrinkage. The factors most responsible for dimensional changes are known to be the swelling of yarn and the relaxation of internal stress to which yarns are subjected during the knitting process [6-8]. The investigation of the influence of fabric composition on shrinkage has shown that fabrics made of hydrophilic fibers (cotton, linen, viscose) are more prone to shrinkage because they absorb a larger amount of water, they swell and substantially change their dimensions. Fabrics made from hydrophobic fibers shrink less or do not shrink during the washing process. The results from studies have shown that with the increasing of the elastane or polyester percentage, the fabric shrinkage is decreasing [9, 10].

From the literature review it can be noted that the dimensional stability of fabrics after washing is investigated by several researchers, who focus mainly on knitted fabric shrinkage. A fewer number of studies focus on the dimensional stability of woven fabrics. Topalbekiroglu et al. investigated the effect of the weave type on the dimensional stability of woven fabrics, and the results have shown that the weave has a significant effect on the dimensional changes of fabric. Weaves with a high number of interlacings have lower shrinkage [11].

In this research we focused on the influence of structure fabric parameters such as weave factor and

cover factor on the dimensional stability of woven fabrics. The weave factor evaluates a single thread float and an interlacing of adjacent threads and can be calculated for all the types of the weaves. The cover factor is a scientific measurement of the percentage area of the fabric covered by the yarns and fibre [12].

2. EXPERIMENTAL PART

In this study, ten woven cotton fabrics were used. The characteristics of fabrics are given in Table 1. Fabrics' characteristics were measured in accordance with relevant standards: surface density MKS BS EN 12127: 1998 [13], yarn linear density ISO 7211-5:2020 [14] and yarn density MKS EN 1049-2: 2007 [15]. For all fabrics, weave and cover factors were calculated. The weave factor was calculated by the following equation [12]:

$$M_{1(2)} = \frac{N_{1(2)}}{i_{1(2)}} \quad (1)$$

Where:

$M_{1(2)}$ - weave factors in warp and weft direction, respectively;

$N_{1(2)}$ - repeats of warp and weft, respectively;

$i_{1(2)}$ - numbers of intersections of warp and weft, respectively.

The linear cover factor in warp and weft direction was calculated by the following equation [12]:

$$C_{1(2)} = d_{1(2)} \cdot g_{1(2)} \quad (2)$$

Where:

$C_{1(2)}$ - cover factors in warp and weft direction, respectively;

$d_{1(2)}$ - the diameters of warp and weft, respectively;

$g_{1(2)}$ - the yarn densities of warp and weft, respectively.

Table 1: Characteristics of fabrics used in test

Fabric	Composition	Weave	Weave factor		Yarn density (cm ⁻¹)		Linear yarn density (tex)		Cover factor			Surface density (g·m ⁻²)
			warp	weft	warp	weft	warp	weft	C ₁	C ₂	C _f	
A	cotton	plain	1	1	38	33	17	17	0.53	0.46	0.74	124
B	cotton	plain	1	1	40	28	14	14	0.52	0.36	0.69	98
C	cotton	plain	1	1	90	46	9	9	0.99	0.51	0.99	127
D	cotton	plain	1	1	34	22	25	25	0.61	0.40	0.77	140
E	cotton	Twill 2/1	1.5	1.5	46	32	12.5	12.5	0.60	0.42	0.77	98
F	cotton	Twill 2/1	1.5	1.5	45	23	17	17	0.63	0.33	0.75	117
G	cotton	Twill 2/1	1.5	1.5	50	31	12.5	12.5	0.65	0.40	0.79	103
H	cotton	Twill 3/1	2	2	56	27	14	14	0.73	0.35	0.82	117
I	cotton	Twill 3/1	2	2	32	23	20	20	0.51	0.37	0.70	111
J	cotton	Twill 3/1	2	2	42	30	12.5	12.5	0.55	0.39	0.72	92

C₁ – warp cover factor; C₂ – weft cover factor; C_f – fabric cover factor

The total fabric cover factor (was calculated according to the following equation:

$$C_f = C_1 + C_2 - C_1 \cdot C_2 \quad (3)$$

The dimensional stability of fabrics was examined according to the standard ISO 3759:2011 [16]. All fabrics were exposed to standard atmosphere, temperature 20 ± 2 °C, relative humidity 65% for 24h. The samples were washed and dried according to domestic washing and drying standard test procedures [17]. The samples were exposed to five washing and drying cycles. The samples were washed at the temperature of 40°C, rotation frequency of hydro extraction 800 min^{-1} and consumption of detergent 20 g. The samples drained hung in line in warp direction, at 22°C

until full drying. After that, fabric samples were relaxed for 12 hours on a flat, smooth surface.

Measurements of each washed and dried sample were taken in warp and weft directions. The dimensional stability in warp and weft directions of washed samples was calculated after each cycle of washing and drying. The dimensional stability in both directions was evaluated as growth (+) or shrinkage (-). Statistical analysis was used to identify the relationships between fabric shrinkage and fabric structure parameters.

3. RESULTS AND DISCUSSION

Ten cotton fabrics underwent washing and drying cycles five times repeatedly. In all ten fabrics, shrink-

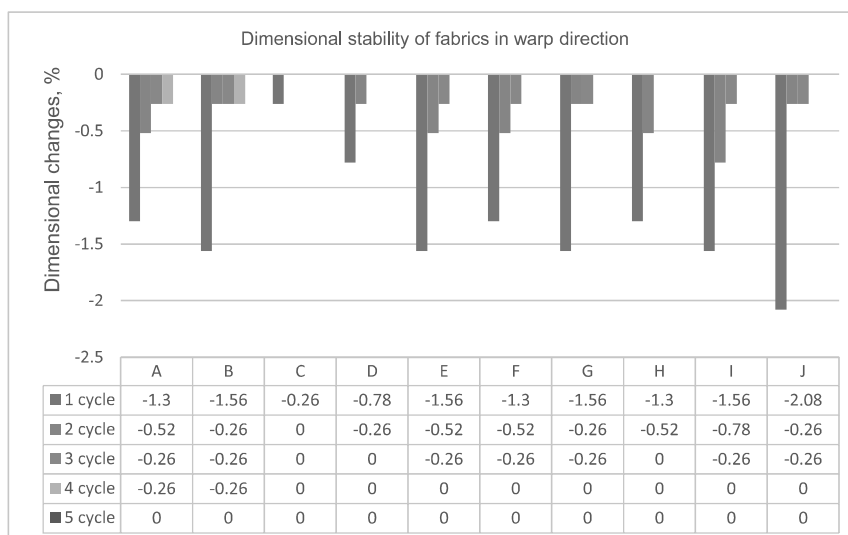


Figure 1: Dimensional stability of fabrics in warp direction after five cycles of washing and drying

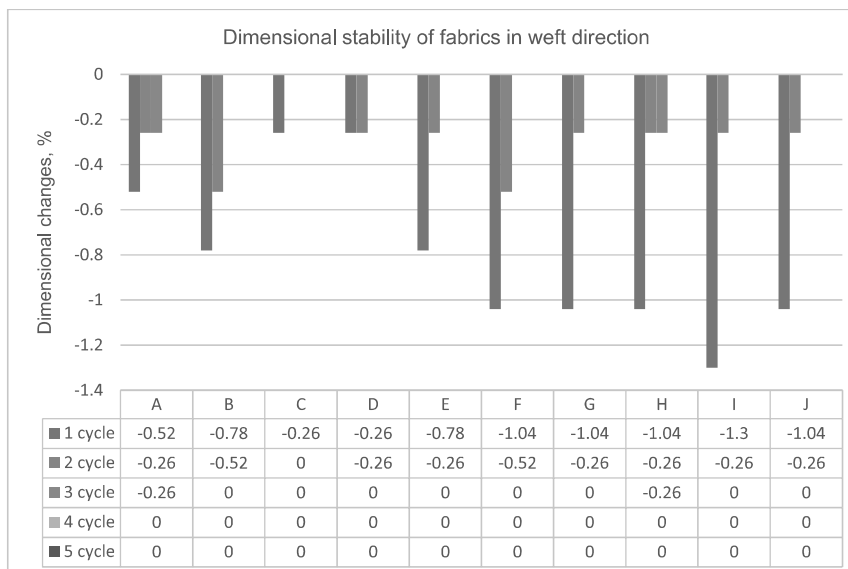


Figure 2: Dimensional stability of fabrics in weft direction after five cycles of washing and drying

Table 2: Total shrinkage of tested fabrics after domestic washing and drying

Fabric	Weave	Weave factor		Cover factor		Total Shrinkage, %	
		Warp	Weft	Warp	Weft	Warp	Weft
A	Plain	1	1	0.53	0.46	2.34	1.04
B	Plain	1	1	0.52	0.36	2.34	1.3
C	Plain	1	1	0.99	0.51	0.26	0.26
D	Plain	1	1	0.61	0.40	1.04	0.52
E	Twill 2/1	1.5	1.5	0.60	0.42	2.34	1.04
F	Twill 2/1	1.5	1.5	0.63	0.33	2.08	1.56
G	Twill 2/1	1.5	1.5	0.65	0.40	2.08	1.3
H	Twill 3/1	2	2	0.73	0.35	1.82	1.56
I	Twill 3/1	2	2	0.51	0.37	2.6	1.56
J	Twill 3/1	2	2	0.55	0.39	2.6	1.3

age was noted in both warp and weft direction. The obtained results from the test are shown in Fig. 1 and Fig. 2.

Shrinkage is highest after the first washing. In the subsequent washing cycles that percentage decreases. The same is observed in the direction of warp and in the weft direction.

The total shrinkage of tested fabrics is shown in Table 2. It was noted that shrinkage in the warp direction of all ten tested fabrics is higher than that in the weft direction. The estimated values of shrinkage in warp direction are between 0.26 – 2.6 %, and between 0.26 – 1.56 % in weft direction. In woven fabrics, the warp yarns are under much strain due to interlacement than the weft yarns. Hence, when a fabric is relaxing, the warp yarn shrinkage will be greater than that of weft yarns.

If we make a comparison between the total shrinkage values of the fabrics in the warp direction, it is noted that the fabrics with a higher cover factor have a smaller shrinkage value. Conversely, fabrics with a lower cover factor in warp direction have a higher shrinkage after five washing cycles. This correlation is statistically confirmed with a linear correlation coefficient $R = -0.85$ (Figure 3a). The same is observed in the weft direction. The coefficient of linear correlation between the weft cover factor and the dimensional shrinkage in the weft direction is $R = -0.81$ (Figure 3b). This is due to more open space between yarns in the fabric with a low cover factor. When the fabric has open space, the warp and weft yarn come much closer to each other after the washing process. The correlation coefficients are statistically confirmed by the t criterion at the level of significance of $\alpha = 5\%$.

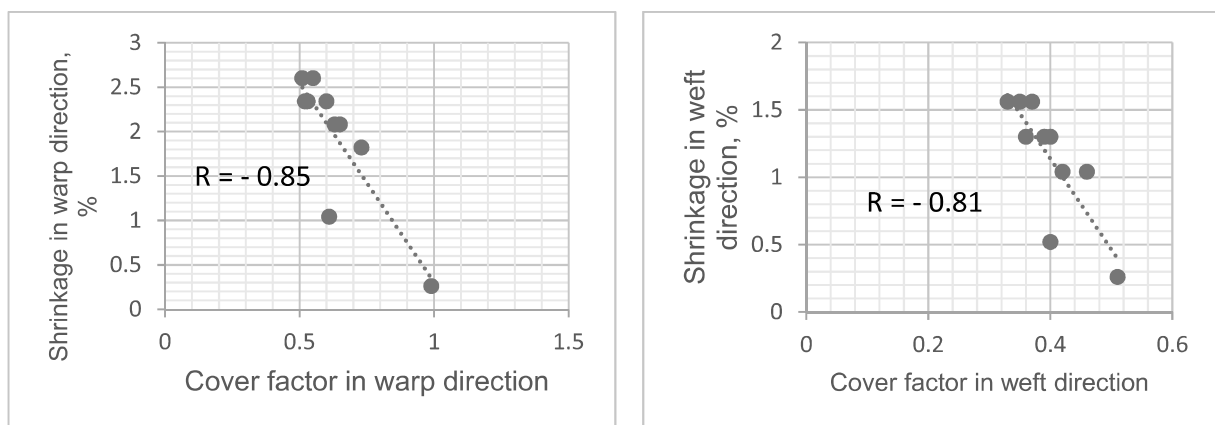


Figure 3: Linear correlation between cover factor and shrinkage: a) warp direction, b) weft direction

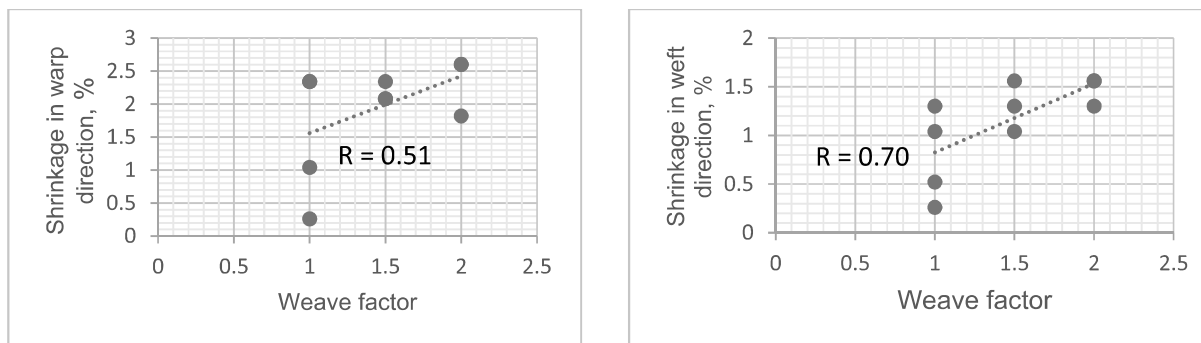


Figure 4: Linear correlation between weave factor and shrinkage: a) warp direction b) weft direction

The calculated t value is higher than the theoretical ($t_{\text{exp}} > t_{\text{theor.}(8,95\%)} = 2,31$).

The dimensional shrinkage in the warp direction of plain fabrics was estimated between 0.26- 2.34%, and in the weft direction between 0.26 – 1.3%. In the warp direction of the twill 2/1 fabrics, shrinkage was estimated between 2.08 – 2.34% and in the weft direction between 1.04-1.56%. The shrinkage in the warp direction of the twill 3/1 fabrics was calculated between 1.82 – 2.6% and in the weft direction between 1.3 -1.56%. It is noted that fabrics with a lower weave factor have lower shrinkage values (Table 2). The percentage of shrinkage is lower in plain fabrics that have a weave factor value 1 compared with twill fabrics. Higher weave factor means longer float of the fabric yarn which gives a higher shrinkage percentage. Plain fabrics have more closely packed yarns and shrink slightly less than twill fabrics (2/1 or 3/1) which are less compact and have a slightly bigger yarn float. The statistical analysis of the experimental results has shown a linear correlation between the weave factor and the dimensional shrinkage (Figure 4a and 4b). The coefficient of linear correlation (R) between the weave factor and the fabric shrinkage is 0.51 in warp direction, and 0.70 in weft direction.

4. CONCLUSION

The aim of this paper was to investigate the effect of fabric structure parameters on the dimensional stability of cotton fabrics after five cycles of washing and drying. Tests were performed according to ISO standards and changes in the dimensions were measured right after each cycle. In this study, all ten fabrics experience dimensional shrinkage which differs from fabric to fabric depending on the structure. Dimensional shrinkage is highest after the first washing and drying cycle, and shrinkage value is higher in warp than in weft direction. The estimated values of shrinkage in

warp direction are between 0.26 – 2.6 %, and in weft direction between 0.26 – 1.56 %.

The statistical analysis of the experimental results has shown that the weave and the cover factor of the fabric play an important role in the dimensional stability of the fabric. The dimensional shrinkage is in positive linear correlation with the weave factor, and in negative linear correlation with the cover factor.

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