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EFFECTS OF YARN SPINNING SYSTEMS AND TWIST DIRECTION ON SOME PROPERTIES OF VISCOSE INTERLOCK FABRICS

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Abstract: In this study, it was intended to investigate the effects of yarn spinning systems as well as yarn twist direction on some comfort and spirality performance properties of the fabrics. For this aim, interlock knitted fabrics made of 100% viscose yarns were produced with different spinning systems namely, ring, compact and siro at two twist directions; S and Z. The results indicate that the fabrics made of compact yarn possessed high water vapor and high air permeability values, but lesser vertical wicking values than ring yarn fabrics. However, both of the permeability values of the compact yarn fabrics markedly reduced when yarn twist direction was S. Generally, irrespective of yarn twist direction, the siro yarn fabrics exhibited better permeability but lesser wickability values as compared to ring yarn fabrics. Ring yarn fabrics displayed relatively highest wickability values and spirality percentages as compared to made from siro and compact yarns. In addition, samples produced from Z-twist yarn had higher air permeability values as well as water vapor permeability values but their vertical wicking values and spirality percentages were lesser than that of S-twisted ones. To sum up, it can be inferred that the spinning system has a profound influence on structural parameters of spun yarns.

Keywords: viscose, interlock, comfort, packing density, compact, siro, yarn

İplik Tipi ve Büküm Yönünün Viskon Interlok Kumaşlarin Bazi Özelliklerine Etkisi

Öz: Bu çalışmada, iplik eğirme sisteminin yanı sıra iplik büküm yönünün kumaşların bazı konfor ve may dönmesi özellikleri üzerindeki etkileri araştırılmıştır. Bu amaçla, % 100 viskon elyafından üretilmiş interlok örme kumaşlar; ring, kompakt ve siro olmak üzere üç farklı eğirme sisteminde ve S ile Z olmak üzere iki farklı büküm yönünde üretilmişlerdir. Elde edilen sonuçlar, kompakt iplikten yapılan kumaşların su buharı ve hava geçirgenlik değerlerinin yüksek olduğunu, fakat kılcal ıslanma değerlerinin ise ring iplik sistemi ile üretilenlere kıyasla daha düşük olduğunu göstermiştir. Ayrıca, S büküm yönüne sahip kompak iplikten üretilmiş kumaşların hava ve su buharı geçirgenlik değerlerinin Z yönünde üretilmiş olanlara nazaran ciddi bir düşüş sergiledikleri görülmüştür. Genel olarak, iplik büküm yönüne bakılmaksızın, siro iplikten üretilmiş kumaşların geçirgenlik özelliklerinin ring iplik ile üretilenlere göre daha yüksek olduğu gözlenmiştir. Diğer taraftan, ring iplikten üretilmiş kumaşlar, siro ve kompakt ipliklerden yapılanlara göre nispeten en yüksek kılcal ıslanma ve may dönmesi sergilemişlerdir. Ayrıca, Z bükümlü iplikten üretilen numuneler daha yüksek hava ve su buharı geçirgenlik değerlerine sahipken, dikey kılcal ıslanma değerleri ve may dönmesi yüzdeleri S bükülmüş olanlardan daha düşüktür. Özetle, eğirme sisteminin ipliklerin yapısal parametreleri üzerinde derin bir etkiye sahip olduğu sonucuna varılmıştır.

Anahtar Kelimeler: viskon, interlok, konfor, paketleme faktörü, kompakt, siro, iplik

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1. INTRODUCTION

Expectations from fabrics and clothes go up due to the increase of life standard. Feeling comfortable both at working as well as free times is very important due to the expectations of the people and this influences the shopping choices of the people. Thus, last decade objective assessment of feeling comfortable is very effective. Thermal comfort which is the one of the very essential contributing property to clothing comfort is affected by the thermal and water vapor as well as air permeability properties of the fabrics (Ozdemir, 2017). As a result of body activity, the wearer perspires so the garment which contacts with the skin becomes wet which decreases the body heat and the wearer feel tired. Thus, moisture release to the atmosphere must be quickly which is governed by the garment (Das, Kothari and Sadachar, 2007). The thermal and humidity balance of the human body at different environmental conditions and activities is maintained by the garments with better thermal comfort properties by transferring human body's heat and moisture (Ozdemir, 2017). For feeling comfortable, to evaporate perspiration from the skin and transfer the moisture to the atmosphere are the two major parameters. The moisture is transferred to the atmosphere by diffusion and wicking. Faster liquid transfer through fabric as well as more uniform moisture distribution over the fabric surface are achieved with better wicking ability of the fabrics (Das, Kothari and Sadachar, 2007). Furthermore, (1) the microscopic level (chemical composition, morphological characteristics, fineness, cross section, porosity and water content of component fibres), (2) the mesoscopic level (yarn structure and properties), and (3) the macroscopic level (the fabric's physical and structural characteristics and finishing treatments) are the three levels which affects the thermal properties of fabrics (Karaca et al, 2012).

Knitted fabrics are an important part of the textile sector owing to having an elastic and light structure, producing single jersey fabrics easily and quickly, having a lighter weight and lower production cost, suitable for printing. On the other hand, in addition to their advantages, these fabrics have some quality problems such as dimensional change and deformation (Değirmenci and Topalbekiroğlu, 2010). As a result, both the aesthetic and functional performances of knitted fabrics like displacement or shifting of seams, mismatched patterns, sewing difficulties, etc. are affected by spirality so it is tried to be avoided by different kinds of yarn-related methods (Tao et al, 1997). Low-twist-lively yarns, balanced plied yarns and using S-twist and Z-twist yarns respectively at feeders are some examples of avoiding these problems (Değirmenci and Topalbekiroğlu, 2010). Also, the twist amount of the yarn is influenced by the arrangement of the fibers in the yarn and it changes depending to yarn spinning type.

Spinning is the conversion of the textile fibers to yarn structure and the main aim of the spinning is to obtain higher production with adequate yarn quality (Khurshid et al, 2013). The arrangement of the fibers as well as the quality of the yarn are influenced by the mode of packing. Staple yarn properties are depended on both the arrangement and configuration of constituent fibers. Fiber packing density in the yarn cross-section give an important information about the yarn internal structure (Regar, Sinha and Chattopadhyay, 2018a; Guo and Tao, 2018). Both physical and mechanical properties as well as heat and moisture transmission characteristics are affected by the degree of packing of the fibers in a yarn so the arrangement of the fibers in a yarn can be used as a tool for its qualitative assessment of performance (Regar, Sinha and Chattopadhyay, 2018a). Ring spinning is the leading spinning technology but its production capacity is low due to many limitations like traveler speed, balloon tension, spindle speed and the spinning triangle. From this point of view, researchers tried to develop new spinning systems with the aim of producing high quality yarns with lower cost (Khurshid et al, 2013; Regar, Sinha and Chattopadhyay, 2018b). The newly developed spinning systems are varied from one another in respect to their structure and also their bulk, mechanical as well as surface properties are distinct (Kaynak and Çelik, 2018; Kane et al, 2007). Both physical properties of the constituent fibers and the yarn structure characterized by the arrangement of the individual fibers in yarn cross-section have a major effect on the yarn properties. Figure 1 represents the process of fiber integration in the yarn formation zone in three spinning systems namely ring, compact and siro.

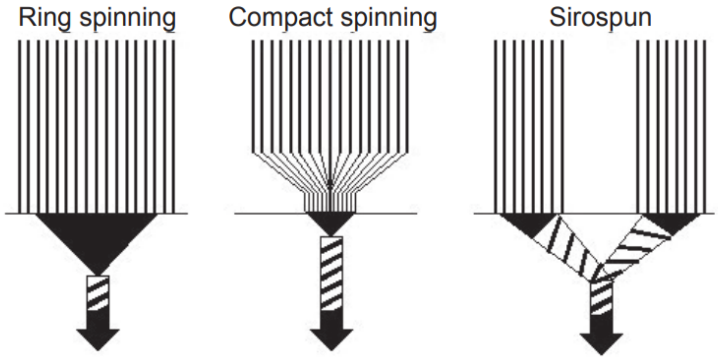

Figure 1:
Spinning triangle for different spinning systems (Buharali, Omeroglu, 2019b)

Compact spinning is a kind of modified ring spinning which preserves fiber alignment and parallelization up to the point of twist insertion. The packing density of this yarn is higher than ring yarn because the edge fibers are incorporated into the yarn as the spinning triangle is eliminated (Das, Kothari and Sadachar, 2007). Compact yarns display significantly smaller mean fiber position, helix angle and helix diameter; on the other hand, mean migration intensity, equivalent migration frequency and migration factor values are higher than that of ring yarns (Tyagi and Kuma, 2009). In addition, the strength of compact yarn is improved 15–20 % (Regar, Sinha and Chattopadhyay, 2018b; Kane et al, 2007) and elongation is higher approximately 20% and hairiness is lowered by as much as 50 %. Owing to having less hairiness structure, there is no need to use wax during knitting (Kane et al, 2007).

In order to improve the strength and irregularity properties of yarn, the plying process is generally used in short staple spinning. As an alternative to the conventional plying of short staple yarns, two-strand spinning has been started to be used by many producers. The name of the modified ring spinning system is siro-spinning (Regar, Sinha and Chattopadhyay, 2018b). Although first of all it was exhibited for long staple spinning, it can be also used for the production of the short staple spinning (Soltani and Johari, 2012). In this system two rovings are fed to a ring frame, with separators to ensure that each roving is drafted individually. Emerging from the nip point of the front rollers of the drafting system, the two strands are twisted together at a convergence point and by doing so a plied yarn could be produced before the pigtail guide (Regar, Sinha and Chattopadhyay, 2018b). Due to this production process, siro-spinning combines spinning and doubling at the same time which explains the huge amount of using this spinning system in the textile industry (Yılmaz and Usal, 2012). The siro yarns are superior to the conventional ring yarns and quite comparable to the conventional two-ply yarns. Different from the ring yarns, which get their strength from twist and fiber migration, these yarns gain strength by winding individual strands around each other (Salhotra, 1990). In addition, as yarn hairiness values are low due to having a circular cross-sectional shape instead of oval shape for two-plied yarns (Zhigang and Xu, 2013), yarn surface is smooth and have better abrasion resistance (Soltani and Johari, 2012) as well as frictional property than that of conventional ring staple yarns (Zhigang and Xu, 2013). Also, its tenacity value is higher than single yarn for all twist multipliers as well as two plied yarn (Kireçci, Kaynak and Ince, 2011). Furthermore, fabrics produced by siro yarn have higher pilling resistance, abrasion resistance and thermal conductivity than two-fold yarn fabrics while their bursting strength is low. Also, their crease recovery value is almost the same with two ply yarn fabric but higher than that of single yarn fabric (Kireçci, Kaynak and Ince, 2011).

By changing the fibers, yarns as well as knitting parameters and post knitting finishes, it is tried to produce a knitted fabric with better comfort properties and physical performances (Kane et al, 2007). As the yarn structure changes, various types of external and internal changes take place in resultant yarns. Fiber configurations remain different in ring, siro and compact yarns. Hence, a systematic research is required in this field to understand the role of yarn structure on fabric comfort. Many studies are available on the performance of knitted fabric made of different spinning systems (Beceren, Nergis, 2008; Altas, Kadoğlu, 2012; Çeken, Göktepe, 2005, Kane, Patil, Sudhakar, Sudhakar, 2007; Özgüney, Kretzschmar , Özçelik, Özerdem, 2008; Beceren, Candan, Duru, Ülger, 2010). However, different from the previous studies, the present investigation is aimed to find out the effect of both spinning type and twist direction on thermal comfort properties as well as spirality of interlock fabrics made of viscose fiber.

2. EXPERIMENTAL STUDY

2.1. Materials

In the study, 100% viscose fiber was used which was 1,3 dtex fineness and 38 mm length. For the production of yarns samples, ring, siro and compact yarn spinning processes were selected. Also, each yarn type was produced at two twist direction. By this way, both effect of yarn type as well as twist direction on some comfort properties of the viscose fabrics could be investigated.

For this work, interlock fabrics of 30’’ diameter were knitted on a 24 gauge Mayer&Cie circular knitting machine. After the production, the knitted fabrics were washed at 40 ^{0}C for 40 minutes using domestic type laundering machine for removing the impurities. After that, they were line dried and conditioned under the standard atmosphere conditions (20 °C, 65% relative humidity) for one day.

2.2. Test methods

Yarn linear density, yarn twist, tensile strength and elongation, yarn evenness, tests were conducted in accordance with the standards TS 244 EN ISO 2060 (1999), ASTM D1422-99 (2006), TS EN ISO 2062 (2010) and TS 7123 (1989), in turn. Twist of the yarns spun on each spinning system was tested on a Zweigle D301 tester, Uster evenness tester was used for the measurement of evenness of the yarns. Tensile strength and elongation at break of the yarns were determined on a Titan 2 machine. The average values of 20 test results were presented in Table 1 for the yarn linear density, twist, evenness, imperfections as well as tensile properties.

Table 1. Yarn properties

Yarn Properties	S-Ring	Z-Ring	S-Siro	Z-Siro	S-Compact	Z-Compact
Count (Ne)	30,15	29,76	30,15	29,62	28,97	28,95
Count(CV%)	3,2	2,6	2,1	0,3	1,7	1,2
Twist (tour/m)	710,5	675	647,5	757,5	696,5	646,5
Twist(CV%)	7,3	4,5	7,4	7,2	5,2	4,4
Twist factor (α_e)	3,29	3,14	3,00	3,54	3,29	3,05
Evenness (CV%)	12,07	13,94	14,36	12,68	11,66	12,46
Thin Place ((-50%)/ 1000m)	0	4	15	1	0	2
Thick Place ((-50%)/ 1000m)	12	59	45	17	11	16
Neps ((+200)/ 1000m)	70	72	62	91	64	88
Tensile Strenght (cN/tex)	19,59	19,85	19,59	19,94	20,39	20,40
Tensile Strenght (CV%)	6,62	7,1	10,67	8,47	8,6	8,14
Elongation %	12,87	13,75	12,27	13,14	12,61	12,27
Elongation (CV%)	6,85	6,7	12,1	11,9	9,96	8,39

Water vapor permeability (ASTM E96-00, 2000), air permeability (TS 391 EN ISO 9237, 1999), vertical wicking (DIN 53924, 1997), weight (ASTM D3776, 2017) and spirality (AATCC 179, 2019) of the samples were measured in accordance with the relevant standards. All the tests were repeated five times and their average values were shown either in the Tables or Figures. The overall porosity defined as the ratio of the open space to the total volume of the porous material was calculated from the measured thickness and the weight per unit area values according to the equations previously reported (Mukhopadhyay, Ishtiaque and Uttam, 2011). Table 2 shows the average values of the fabric properties.

Table 2. Fabric properties

Fabric Samples	Weight (g/m^2)	Thickness (mm)	Stitch Density ($loops/cm^2$)	Spirality (%)	Porosity (%)
S-RING	250,27	0,77	199,20	8,60	78,51
Z-RING	246,67	0,74	206,25	7,80	77,92
S-SIRO	251,13	0,79	220,00	7,40	78,98
Z-SIRO	261,03	0,75	222,86	6,20	77,20
S-COMPACT	257,93	0,77	206,70	5,00	77,96
Z-COMPACT	273,23	0,81	216,37	4,20	77,71

Analysis of variance (ANOVA) and paired t-test were used to analyze the test results for significance in differences of the mean values of the measured properties. All the statistical tests were established at the 0.05 significance interval using SPSS 25 statistical software.

3. RESULTS AND DISCUSSION

3.1. Air permeability test results

Volumetric rate per unit area of the textile at a certain pressure difference is air permeability (ASTM D6476,2017; ASTM D 737, 2018) and it affects the thermal regulation of the human body as well as comfort during wearing (Veselá and Kus, 2016). Both natural and forced convective air pass through the fabric is impressed by the fabric ventilation capacity or its breathability (Tyagi et al, 2010). In this study, air permeability values of the fabrics were recorded to be in the range of 356,33 to 465 ($l/m^2/s$) (Figure 2). Fabrics made of compact-Z yarn had the highest air permeability values whereas fabrics made of ring-S yarn were the lowest.

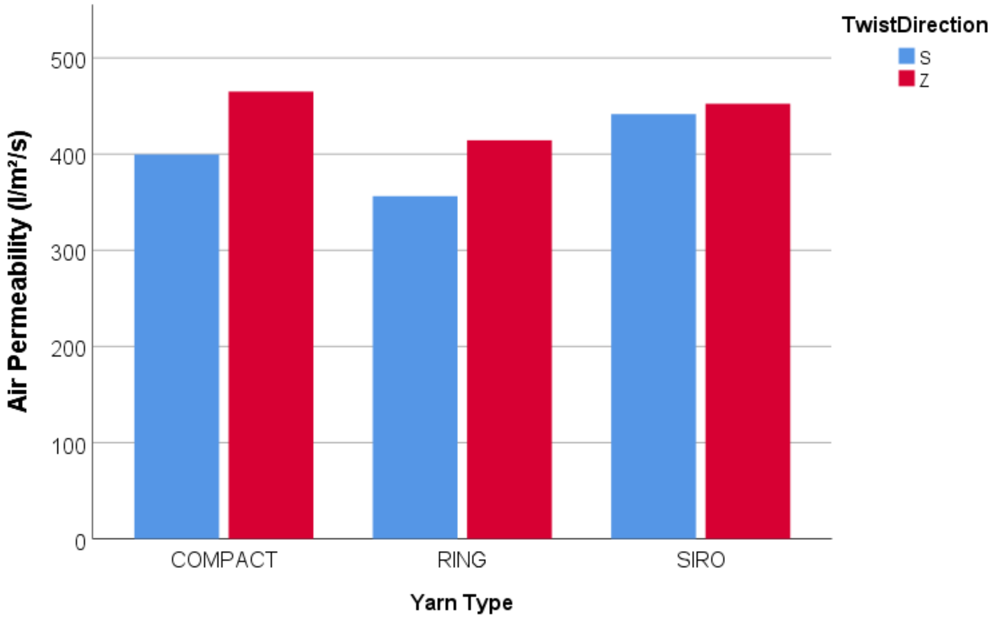

Figure 2:
Air permeability values of the fabrics

As it is seen from Figure 2, the fabrics produced from the yarns with different spinning systems have different air permeability values and also the air permeability values of the fabrics were strongly related to yarn twist direction. The results indicate that the air permeability values of the fabrics made of Z twisted yarn were increased in the order of ring, siro and compact yarns respectively. At compact spinning by the help of pneumatic compression, fibers in the spinning zone are controlled which cause less protruding fibres on the outer surface of the yarn. Thus, the hairiness of this yarn is reduced (Khurshid et al, 2013; Tyagi and Kumar, 2009). On the other hand, according to literature survey, the ring yarn has the highest hairiness values compared to compact and siro yarns because of its production process (Kaynak and Celik, 2018; Kane et al, 2007; Wu et al, 2009). Also, the fabrics with compact yarn has clearer spaces between stitch loops than fabric samples with ring and siro yarns by the way the air got easy passage into the loop without any restriction which explains the highest air permeability values of fabrics made of compact yarn. This result is compatible with the literature (Kaynak and Celik, 2018). Regarding to yarn structure, siro yarns are less hairy and more compacted and tightly condensed compared to ring yarn. This means the existence of more space between the adjacent yarns. As a result, their air permeability was higher than ring one. Also, according to ANOVA statistical analyses, yarn type was found to affect air permeability of the fabrics (F=8,029 sig.0,004).

The results also showed that the permeability values of Z yarn fabrics were higher than those of S yarn fabrics for all yarn types. In addition, yarn twist direction was also found to be influential on air permeability (t=-3,084 sig. 0,007). This situation is due to the relationship between the yarn twist direction and the machine rotation direction. The interlock fabrics in this study were manufactured on a Mayer &Cie machine which rotates in the S-direction. There are two types of porosity. First one is the inter-yarn porosity which is also known as macro porosity and includes the pores between the yarns from which the fabric is made. The other one is the intra-yarn porosity also known as micro porosity which comprises pores inside the yarns and are formed between the fibers (Havlová and Špánková, 2017). As can be seen from the Table 2, in this study the inter-yarn porosity values of the fabrics were almost the same. Yarn twist affects the fiber distribution, yarn alignment and its compactness, and these properties in turn control the inter-fiber space which also influences the fabric permeability. The packing density of compact yarn is greater than that of ring and siro yarns ones. When both twist direction and machine rotations were at the same way, the smooth and less hairy structure of compact yarn was affected overmuch such that intra-yarn porosity structure of the fabrics were influenced negatively with this two-way interaction and thus air permeability of fabrics made of compact yarn was decreased and the permeability of fabrics made of S-compact yarn were lower than siro ones.

3.2. Water vapor permeability test results

The ability of a fabric to allow moisture vapor to be transferred through the material is defined as water vapor permeability and it has an important effect on thermal and physiological comfort of clothing. Diffusion through the air spaces between the fibers and diffusion through the yarns and along the fibers are the ways which water vapor can diffuse through the fabric structure (Kaynak and Celik, 2018). Due to having different yarn structure, fiber distribution and packing density properties, each yarn sample has different water vapor performance for both yarn twist directions. In this study, the results presented in Figure 3 shows that all among the samples the water vapor permeability of the fabric made of compact Z-twist yarn was the highest whilst ring S-twist sample performed the worst one which was similar with air permeability results. As shown in Figure 3, the water vapor permeability values were changed between 778,6 and 898,38 (g/m^2/day).

The relative water vapor permeability data of the Z-twist yarn fabrics showed that compact yarn fabrics, in general, exhibit significantly higher water vapor permeability than their siro and ring yarns counterparts respectively. Since compact yarn has lowest hairiness and the ring sample has the highest hairiness among three yarn samples, the fabrics with compact yarn has clearer spaces between stitch loops than fabric samples with ring and siro yarns (Kaynak and Celik, 2018) which leading to easy passage of vapor and hence higher water vapor permeability. This finding is also comparable with the literature (Tyagi et al, 2010). Packing density which influences fiber distribution along yarn cross-section have an impact on yarn hairiness, strength, compactness as well as uniformity of the structure (Yılmaz et al, 2007). The packing density of siro yarn is greater than that of ring spun yarn (Ishtiaque et al, 1993), which is one of the causes for the higher water vapor permeability of siro yarn than ring ones. This point was actually confirmed with the results of ANOVA stating that yarn type was an influential factor for water vapor permeability (F=5,950 sig. 0.013)

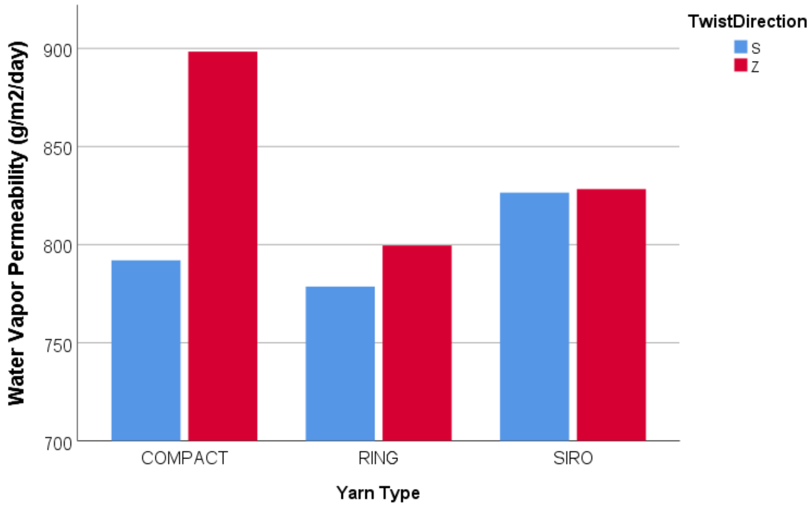

Figure 3:
Water vapor permeability values of the fabrics

In addition, experimental data revealed that the water vapor permeability of the fabrics made of compact and ring spinning systems depends on twist direction. Also, the influence of yarn twist direction on water vapor permeability of fabrics were evaluated with paired t-test and it was observed that it was an important parameter for the fabrics made of ring and compact yarn (ring t=-1243,817 sig. 0,000 compact: t=-130,276 sig. 0,000). Water vapor permeability values of these fabrics made of Z-twist direction showed superior performance comparing to their counterpart S-twist ones and this difference was more evident for the fabrics made of compact yarn. The machine's rotation has an effect on the yarn tensional force and thus yarn compactness which explains the lesser permeability values of the fabrics made of S twisted yarns. The same machine rotation and yarn twist cause these fabrics too dense which blocks the passage of water vapor into the loop. However, as can be seen from Figure 3, the water vapor permeability values of fabrics made of S and Z yarn twist directions almost have the same values (t=-2,168 sig. 0,096).

3.3. Vertical wicking test results

Wicking which is an essential contribution parameter for feeling comfortable is the spontaneous transportation of liquid to the porous structure by capillary forces. The ability of transportation liquid moisture from body to outer surface shows the wicking performance of the fabric (Tyagi, 2010). Ideally wicking should promote quick drying and faster cooling in the hot environments or where the perspiration is present on the skin (Das, Kothari and Sadachar, 2007). In this study, vertical wicking values of the samples were changed between 5.5 and 7.2 cm range (Figure 4).

According to the results and as shown in Figure 4, when the fabrics were produced by yarns with Z twist direction, fabric made of ring yarn had the highest wicking value and compact and siro ones had the same values. Wicking rate depends upon the type of yarn structure in other words the separation between fibers in the yarn because this determines the number of capillaries, size of capillary, and size distribution. All these factors are influenced by packing of fibers in the yarn body (Singh and Nigam, 2013). According to the Yılmaz et al (2007) compact yarns had nearly 15–30% higher packing density values compared to that of the conventional ring spun yarns and the packing density of ring yarn is less than that of the siro yarn (Ishtiaque et al, 1993). The reason why fabrics made of ring yarn exhibited higher wickability than compact and siro ones is having lower packing density which in turn leads to formation of larger capillary size as well as improved interconnectivity of capillaries within the yarn structure and thus results in higher wickability. This finding is also comparative with literature (Singh and Nigam, 2013). Relatively higher thickness values of the fabrics made of compact yarn as shown in Table 2 caused these fabrics to have equal wickability values with siro ones. However, ANOVA results implied that there was no significant difference between the vertical wicking values of the fabrics made of different spinning systems whose yarn twist direction was Z (F= 0,325 sig. 0,728).

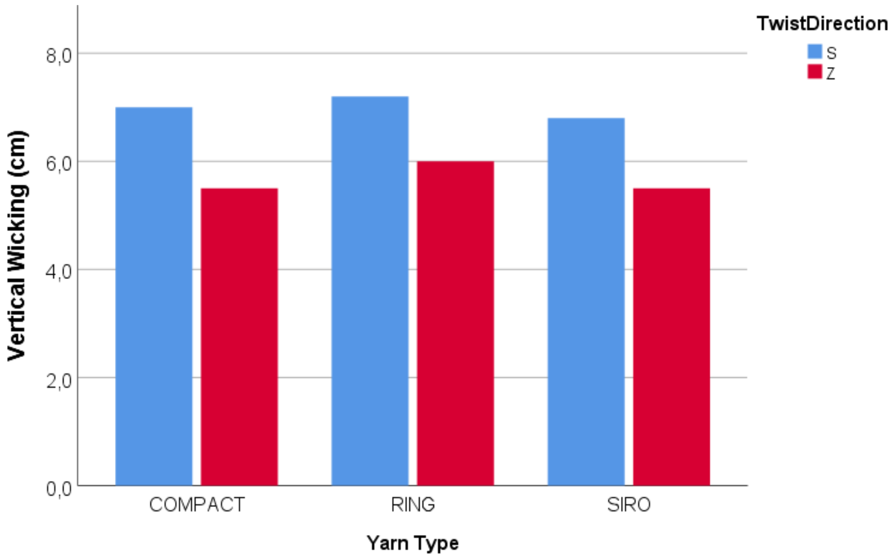

Figure 4:
Vertical wicking height values of the fabrics

In yarns the way in which individual filaments pack together determines the amount of void space between the fibers and an increase in the number of fibers, yarn tension and twist had a significant effect on the yarn wicking performance (Nyoni and Brook, 2006). In this study, although the twist level stayed the same but yarn twist direction was changed, it was observed that wickability of the fabrics were affected irrespective of yarn type such that S-twisted yarn fabrics were superior to Z- twisted ones. However, paired t-test implied that this decline was not statistically important (t=1,369 sig. 0,190). When machine rotation and yarn twist direction were the same may cause to formation of wedge shape capillaries at the interface and also increased capillary connectivity which enhanced the wickability of the fabrics.

3.4. Spirality test results

Interlock fabrics are manufactured on circular knitting which has a rotational movement and it is in a tubular form which makes the fabric tend to slide. Due to this slide formation, wales and courses are angularly distorted from their ideal right angle (Değirmenci and Topalbekiroğlu, 2010). The main reason of spirality is the unbalanced and the residual torque in the yarn. Spirality percentages of interlock viscose fabrics are illustrated in the Figure 5 and it is seen that the percentage of spirality changed between 4.2% to 8.6%.

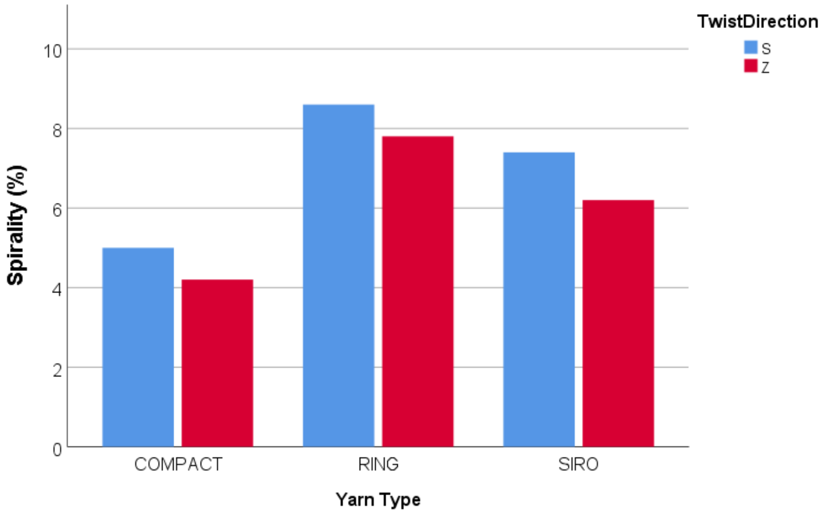

Figure 5:
Spirality values of the fabrics

The results in Figure 5 showed that spirality of all experimental fabrics is directly proportional to yarn type. Furthermore, this finding was supported with ANOVA evaluation (F=25.395 sig. 0,000). According to the literature, variance of the fibers per cross section, variance of the mean local fineness and the mean parameter of fiber inclination relative to yarn axis affects the linear density of the yarn (Zeidman, Suh and Batra, 1990) and by the help of it the degree of freedom of yarn movement in the fabric structure which contributes significantly to the rise of spirality could be reduced (Primentas, 2003). This information explains why fabrics made of viscose compact yarn which performs the highest inclination to yarn axis due to having highest yarn packing density showed the lowest spirality values. On the other hand, the fabrics made of viscose ring yarn had the highest spirality percentage values. In addition, as can be seen from Table 1, while the twist factors of ring and compact yarns were almost the same, but siro ones were a bit different which may be due to the difficulty of measuring yarn twist as it is known. The similarity of twist factors of yarns emphasizes the effect of yarn type on fabric spirality.

According to literature yarn twist direction is an important variable influencing fabric spirality (Chen, Au, Yuen, Yeung, 2003). In our study, it was found that yarns made using Z-twist direction yielded fabric having lower spirality than those made using S direction. However, this decrease was not statistically important according to paired t-test (t=0,422 sig.0,678). Mayer&Cie machine rotates in a counterclockwise direction and the combine effect of the machine rotational direction and S-twist direction is the main reason of this result which is supported with literature (Değirmenci and Topalbekiroğlu, 2010; Au, 2011).

4. CONCLUSION

Studies conducted before generally examined on some comfort properties of plain jersey fabrics and also they investigated fabrics made of either cotton or man-made synthetic fibers. However, different from them, this study focused on the effects of spinning systems namely; ring, compact and siro on some comfort and spirality properties of interlock knitted fabric made of 100% viscose fiber. In addition, to analyze the effect of the twist direction on these properties versus the machine rotational direction, yarns were produced both Z and S twist directions and viscose interlock knit fabrics were manufactured on a Mayer&Cie circular knitting machine that rotates in the S-direction.

Analysis of the results from the interlock fabrics with the different yarn types showed that both yarn structure and twist direction are important factors in controlling characteristics of knitted viscose fabrics. Invariably, compact Z-yarn fabrics exhibited higher air and water vapor permeability values but lower vertical wicking values than ring and siro yarns. It was also inferred from the results that both water vapor and air permeabilities showed descending, on the other hand, the vertical wicking values ascending relationships when yarn twist direction was S. Moreover, irrespective of yarn type, the results showed that fabrics made of S twisted yarns had higher spirality percentages and it was seen that the lowest spirality values belonged to compact Z yarn fabric, whereas the highest belonged to ring S yarn fabric.

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