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Effect of Loop Length On Thermal Comfort Properties of Mesh Knitted Fabrics

File Örme Kumaşlarda İlmek İplik Uzunluğunun Isıl Konfor Özelliklerine Etkisi

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EFFECT OF LOOP LENGTH ON THERMAL COMFORT PROPERTIES OF MESH KNITTED FABRICS

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ABSTRACT: In this study, it is aimed to change the loop length of knitted fabrics with a mesh structure and to investigate the effect of loop length differences on thermal and moisture transmission properties. For this purpose, six fabrics with different loop lengths were produced in two different knittings and yarn types. Thermal conductivity, thermal absorptivity, thermal resistance, air permeability and moisture management properties of these fabrics were measured according to standard test methods. The results showed that as the yarn gets finer and loop length increases, the air permeability values will increase. It was observed that as the loop length increase, the overall moisture management capacity (OMMC) and thermal absorptivity of the fabrics will decrease. The thermal resistance values of two ply textured polyester mesh knitted fabrics decreased with increasing density and the highest loop length two ply textured polyester mesh knitted fabric showed the highest thermal resistance value.

Keywords: thermal comfort, mesh knitting, moisture comfort, loop length

FİLE ÖRME KUMAŞLARDA İLMEK İPLİK UZUNLUĞUNUN ISIL KONFOR ÖZELLİKLERİNE ETKİSİ

ÖZET: Bu çalışmada file örgü yapısına sahip örme kumaşların ilmek iplik uzunluğunu değiştirmek ve bunun sonucunda oluşan ilmek boyu farklılığının ısı ve nem iletimi özelliklerine etkilerini incelemek amaçlanmıştır. Bunun için iki farklı örgü ve iplik yapısında ilmek iplik uzunlukları birbirinden farklı altı adet kumaş ürettirilmiştir. Bu kumaşların ısıl iletkenlik, ısıl soğurganlık, ısıl direnç, hava geçirgenliği ve nem yönetimi özellikleri standart test metodlarıyla ölçülmüştür. Sonuçlar iplik numarası inceldikçe ve ilmek iplik uzunluğu arttıkça hava geçirgenliği değerinin arttığını göstermiştir. İlmek iplik uzunluğu arttıkça kumaşların genel nem yönetimi özelliği (OMMC) ve ısıl soğurganlık değerinin düştüğü görülmüştür. Çift kat iplikten üretilen tekstüre polyester file örgü kumaşların ısıl direnç değerinin yoğunluk değerinin artışıyla düştüğü ve en yüksek ilmek iplik uzunluğu değerine sahip çift katlı iplikten yapılan tekstüre polyester file örme kumaşın en yüksek ısıl direnç değeri gösterdiği gözlemlenmiştir.

Anahtar Kelimeler: ısıl konfor, file örgü, nem iletimi, ilmek iplik uzunluğu

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1. INTRODUCTION

Comfort is the state of being in harmony with the thermal environment in which the person living. Properties like thermal resistance, air permeability, water vapour permeability and liquid water permeability are critical for the thermal comfort of a clothed body [1]. Knitted fabrics are preferred in daily wear and sportswear because of their flexibility and comfort properties. Loop (stitch) length is a length of yarn which includes the needle loop and half the sinker loop on either side of it. Generally, the larger the stitch length, the more extensible and lighter the fabric and the poorer the cover, opacity and bursting strength [2].

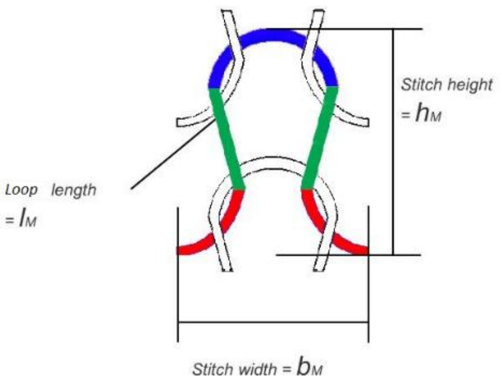


Figure 1. Loop length and intermeshing points of a needle loop

Especially mesh knitted fabrics allow heat and moisture transfer due to their high air permeability properties. These fabrics were more convenient for sports clothes because these fabrics enable air circulation during high activity levels. Extensive research has been carried out to investigate the thermal comfort behaviour of knitted fabrics. Özdil et all. investigated thermal properties of different yarn knitted 1x1 rib fabrics. Alambeta test device was used for thermal resistance, thermal absorptivity and thermal conductivity measurements. The results showed that If yarn count and yarn twist increase, thermal resistance will decrease [3]. Öner et al. investigated effect of raw material, weave type and tightness on liquid absorption and transmission of knitted fabrics made of cotton, viscose and polyester yarns. The results showed that polyester fabrics have good moisture management property and quick water transfer ability compared to others [4]. Çoruh investigated the effect of knitting structure, loop length, tightness factor, fibre type and yarn properties on the mechanical and comfort properties of single jersey knitted fabrics. They declared that increasing loop length of fabrics increases fabrics water vapour permeability properties. On the other hand, an increase in the linear density of yarns decreases the water vapour permeability of the knits [5]. Özkan and Kaplangiray investigated thermophysiological comfort properties of polyester knitted fabrics. They founded that textured polyester yarn knitted fabrics were showed the highest air permeability properties than moisture management polyester knitted fabrics in same yarn count and knit structure [6].

Varshney et al. studied the effect of linear densities and profiles of polyester fibres on the physiological properties of their fabrics. For these reason comfort, heat, air and moisture transmission properties of fabrics were investigated. The results showed that coarser and modified profiles of polyester are comparatively more comfortable due to their high porosity since the pore structure of the fabrics has considerable influence on their wickability and water vapour permeability [7]. Manshahia and Das studied thermophysiological comfort properties of different filament shape factor, elastane linear density and fabric loop length polyester elastane plated fabrics. The results showed that fabric loop length played a vital role in determining heat and mass transmission because of changing fabric tightness. They evaluated that fabric knitted at longer loop length make the fabric more permeable to air and moisture vapours [8]. Sampath et al. studied the effect of filament fineness on comfort characteristics of moisture management finished polyester knitted fabrics. Moisture management finish applied five different types of single jersey knitted fabric were used in the experiments. They introduced a new test method for measuring traverse wicking properties of the fabric. They also declared that filament fineness and surface area of yarn crucial parameters in deciding the comfort characteristics of the fabrics [9].

Jhanji et al. investigated the effect of fibre type and yarn linear density on the thermal properties like thermal resistance, thermal conductivity and thermal absorptivity of single jersey plated fabrics. The results showed that thermal conductivity, thermal absorptivity and air permeability affected by face yarn linear density and back layer fibre type [10]. Chidambaram et al. investigated the effects of stitch length and yarn linear density on fabric properties like air permeability, thermal conductivity, thermal resistance and relative water vapour permeability. They declared that the increase of linear density and stitch length affects the thermal comfort properties. Also showed that, If the yarn gets finer the thermal resistance and thermal conductivity decrease [1].

Mesh knitted fabrics allow heat and moisture transfer due to their porous structure, so they are especially preferred for sportswear. In this study thermal and moisture comfort properties of different loop length, single and two ply yarn mesh knitted fabrics were investigated. The aim of the study is to change loop length and seeing the effect of loop length changes on the comfort of the mesh knitted fabrics. Because there are not many studies on the effect of loop length change of mesh knitted fabrics on thermal comfort properties.

2. MATERIALS AND METHODS

Six types of knitted fabric with two different knit structures and different loop lengths were supplied from a manufacturer. Mesh rib knitted fabrics were produced 34'' 20 gg and mesh knitted fabrics were produced 34" 18 gg circular knitting machine. The loop length is considered to be primary knitted structure parameter [11]. The loop length is the measurement of yarn length on the yarn axis in a loop. There are many formulas related to loop length measurement are used in the literature [12,13,14]. However, the loop length is set on the machine and no calculation is used in this study. Because the change in the length of the loop thread is negligible in the measurements made before and after relaxation [15]. The fabric specification is shown in Table 1and photos of fabric knits were given in Table 2. The fabrics were produced with two different types of knit structure and different loop length. All these samples were conditioned in an atmosphere at 21 ± 1 °C and 65 ± 2% RH for 24 h before testing. Air permeability measurements were made SDL Atlas Air permeability instrument according to EN ISO 9237 standards with 100Pa air pressure and 20 mm^2 test area with three repeats. Alambeta test device measures thermal conductivity, thermal resistance, qmax and thickness of the textile structures. Also, the objective measurement of the warm–cool feeling of fabrics, so-called thermal absorptivity is possible with Alambeta test device [16]. Average of five measurements were taken from Alambeta test device.

According to AATCC test method 195-2009, wetting time (top-bottom), absorption rate (top-bottom), maximum wetted radius (top-bottom), spreading speed (top-bottom), accumulative one-way transport capacity index and overall moisture management capability of fabrics were measured by MMT with five repeats, which was used to determine liquid moisture transport properties in multi-dimensions. The top surface of the device is simulated the surface in contact with the skin and the bottom surface is simulated exposing to the atmosphere.

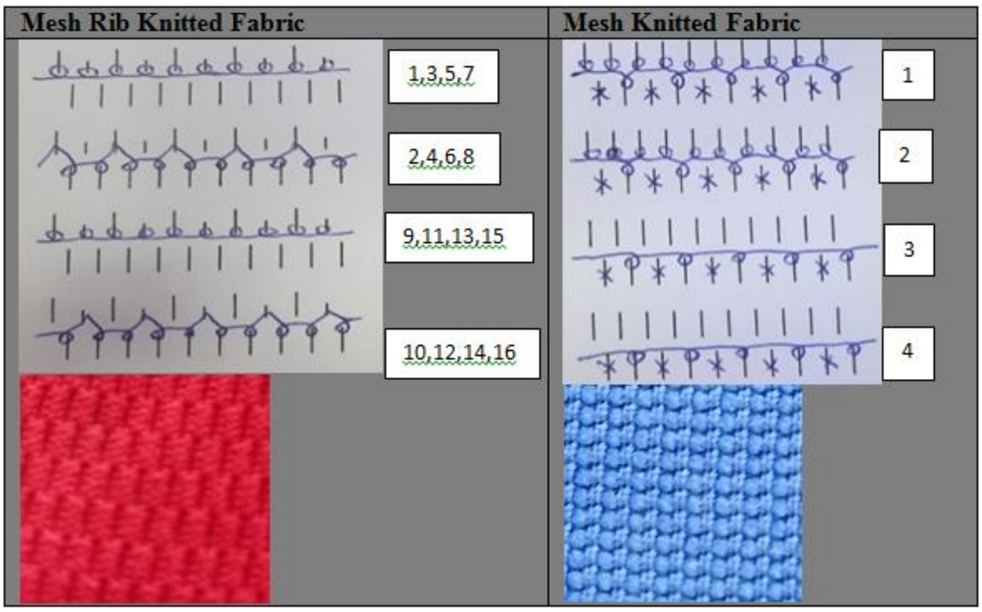
Single factor variance (ANOVA) analyses were used to determine the statistical significance of the variations. The fabrics used in the experiment were not produced in a controlled chamber. To deduce whether the parameters were significant or not, the p values were examined. If the p-value of a parameter was greater than 0.05 (p>0.05), the parameter was not investigated further.

Table 1. The properties of fabrics used in the experiment

Fabric Code	Yarn Count	Weave	Weight (g/m^2)	Finish Length (cm)	Thickness (mm)	Density g/cm^3	Loop Length (mm)
F1	75 Denier 72 Filament Textured Polyester	Mesh Rib	142	153	0,65	0,21	2,5
F2	75 Denier 72 Filament Textured Polyester	Mesh Rib	125	160	0,66	0,18	2,8
F3	75 Denier 72 Filament Textured Polyester	Mesh Rib	128	160	0,68	0,18	3,1
F4	75 Denier 72 Filament Textured Polyester X2	Mesh	237	139	0,85	0,27	2,4
F5	75 Denier 72 Filament Textured Polyester X2	Mesh	214	148	0,87	0,24	2,6
F6	75 Denier 72 Filament Textured Polyester X2	Mesh	183	158	0,84	0,21	3,0

- X2 means double yarn twisted to each other.

Table 2. The photos and knitting diagrams of fabrics used in the experiment



3. RESULTS AND DISCUSSION

3.1. Air Permeability Test Results

Air permeability one of the important factors that affects the heat and water transfer rates in fabrics. Air permeability is defined as the volume of air in litres which is passed through 100 cm^2 (10 cm × 10 cm) of the fabric in one minute at a pressure difference of 10 mm head of water [17]. Higher air permeability will help to evaporate water and air ventilation due to air movements of whole garment microclimate. The air permeability values of fabrics were given in *Figure 2*. When we compare two ply yarn textured polyester mesh knitted fabrics, the highest air permeability value was observed the highest loop length fabric (F6). Because increasing loop length increases the porosity of fabrics and porosity is one of the important parameters for air permeability. Single yarn textured polyester mesh rib knitted fabrics were observed the higher air permeability values than two ply textured polyester mesh knitted fabrics. Air permeability is related to fabric weight, thickness, pore size and knitting structure. In this study, the highest loop length value single yarn knitted fabric was showed the highest air permeability value (F3). The results showed that for a fabric of given knit type, the air permeability increases as the loop length increases. This supports previous work, increasing the loop length produced a looser surface in the fabric and increased air permeability [18]. As a result, mesh knitted fabrics were observed lower air permeability values than mesh rib knitted fabrics because of the weight and thickness of these fabrics higher. Also, the ANOVA test results supported that fabric type had an important effect on air permeability values of fabrics (Table 3).

3.2. MMT Test Results

MMT test device was used for measuring moisture management properties of fabrics. The measurement principle is based on the transfer of the test solution which simulates perspiration (AATCC 15), by the time that test solution was dropped on the fabric's top surface. MMT measures the transfer of sweat in three directions such as spreading outwards on the top surface, transmission through the top surface to the bottom surface, spreading outwards on the bottom surface of the fabric and then the evaporation performance [19]. Top fabric surface refers to that side of the fabric which initially comes in contact with the test-water drop and represents the side that would come in contact with the skin of a wearer and first encounter the wearer's perspiration [20]. MMT grading scale was given in Table 4.

The ANOVA test suggested that there was significant difference among the six fabrics as shown in Table 3 ($F = 661.34$, $p = 0.000 < 0.05$).

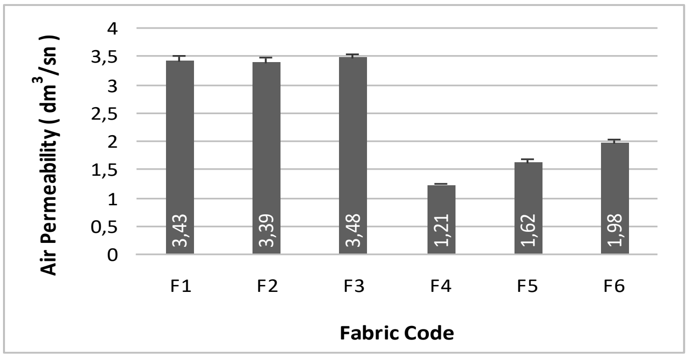


Figure 2. Air permeability values of tested fabrics

Table 3. ANOVA table for air permeability

	df	SS	MS	Fs	Ftable
Fabric Type	5	15,959	3,191	661,34	3,11
Error	12	0,0579	0,004825		
Total	17	16,017			

Table 4. MMT grading scale

Index	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
Wetting Time (s)	≥120 No wetting	20-119 Slow	5-19 Medium	3-5 Fast	<3 Very Fast
Absorption Rate (%/s)	0-10 Very slow	10-30 Slow	30-50 Medium	50-100 Fast	>100 Very Fast
Max Wetted Radius (mm)	0-7 No wetting	7-12 Small	12-17 Medium	17-22 Large	>22 Very large
Spreading Speed (mm/s)	0-1 Very slow	1-2 Slow	2-3 Medium	3-4 Fast	>4 Very fast
OWTC (%)	<-50 Poor	-50 to 100 Fair	100-200 Good	200-400 Very good	>400 Excellent
OMMC	0-0,2 Poor	0,2-0,4 Fair	0,4-0,6 Good	0,6-0,8 Very good	>0,8 Excellent

The liquid transport properties of six different types of knitted fabrics differing in the knitting structure, yarn count and loop length were investigated. Top and bottom wetting time values of tested fabrics were shown in Figure 3. The wetting of a fabric depends upon the nature of the wetting liquid and the surface energy of the textile substrate, which is largely dependent upon the structure, perimeter, surface purity and molecular orientation of the fibre, yarn, fabric, capillary forces, cover factor, area density and surface roughness [21]. The water molecules are not absorbed by the polyester fibers because of their hydrophobic characteristics although they contribute to the wetness comfort by transporting the liquid quickly by capillary forces. The wetting time of the top and bottom surface increased with an increase in weight of the samples tested. As you have seen from Figure 3, the highest yarn count (75/72x2 two ply yarn) and weight mesh knitted fabrics were observed the highest wetting time values. Which means these fabrics wetted longer time than mesh rib knitted fabrics. Single yarn textured polyester mesh rib knitted fabrics were observed the fast wetting time values according to MMT grading scale. Two ply yarn mesh knitted fabrics were observed medium wetting time values according to MMT grading scale (Table 4). The wetting time values of two ply yarn knitted fabrics increase because the fabric thickness increases, too. The results indicated that the wetting time of the bottom surface is in general higher than that the top surface for all the fabric like previous studies. [22]. In terms of wetting time index, the fact that the bottom surface becomes wet in a longer time than the upper surface (which contact the skin) shows that liquid is transported from one side to other slowly [23]. It was seen that the wetting time values of single-ply yarn knitted fabrics changed in a wider range than two ply yarn knitted fabrics at the error bar graphs.

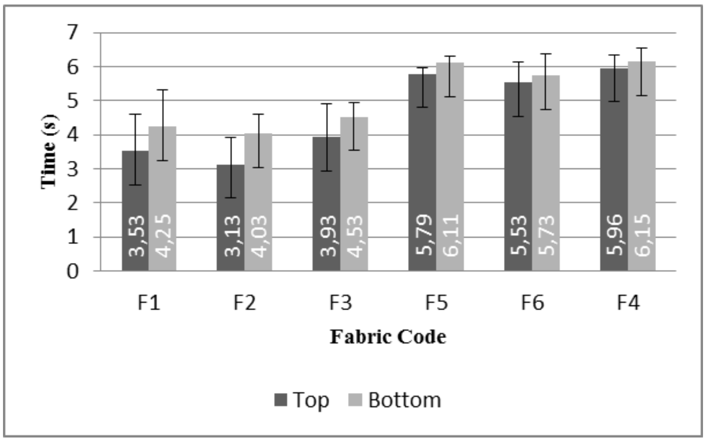


Figure 3. Top and bottom wetting time values of fabrics

Absorption rate is the average speed of liquid moisture absorption for the top and bottom surfaces of the specimen during the initial change of water content during a test. As is seen from Figure 4, the top absorption rate of two ply (75/2 x2) yarn textured polyester knitted fabrics increases with an increase in the loop length of the samples tested, whereas that of the bottom surface of the fabrics decreased with an increase in the loop length. Single yarn textured polyester mesh rib knitted fabrics showed higher absorption rate values than two ply textured polyester yarn knitted fabrics. It was concluded that the higher the yarn count and weight of the fabric, the lower the absorption rate. Which supports previous studies as the yarn gets finer, the thickness of the fabric decreases. Therefore the absorption rate values of the thinner fabrics become higher [24]. In terms of absorption rate indices, it was seen that all tested fabrics had medium absorption rate values for the top surface and slow absorption rate for the bottom surface according to MMT grading scale.

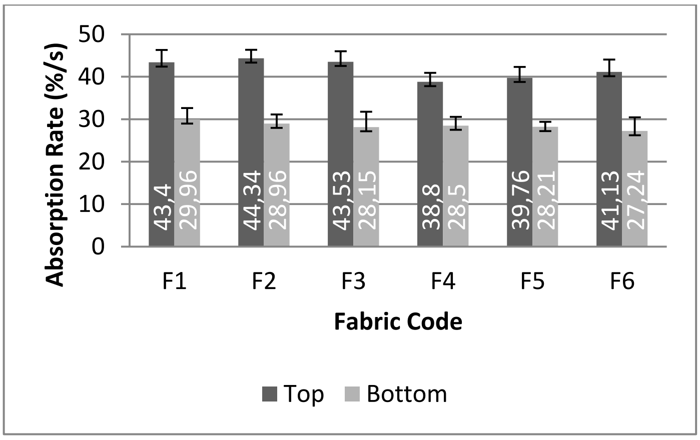


Figure 4. Top and bottom absorption rates of fabrics

Spreading Speed (SSi) is the accumulated rate of surface wetting from the centre of the specimen, where the test solution is dropped to the maximum wetted radius. As is seen from Figure 5, the lowest loop length value single yarn knitted F1 coded fabric was observed very fast spreading speed value according to MMT grading scale. The single yarn knitted 75/72 denier textured polyester mesh rib fabrics were observed very fast spreading speed values, especially in the top surface. Two ply yarn knitted fabrics (75/72x2 denier) were observed fast spreading speed values according to MMT grading scale. If the yarn count and weight of the fabric increased, spreading speed would decrease. Besides, as the loop length of the mesh rib knitted fabrics increased, the spreading speed value decreased. However, in fabrics made with folded yarn, only a decrease in the bottom spreading speed was observed with the increase of the loop length.

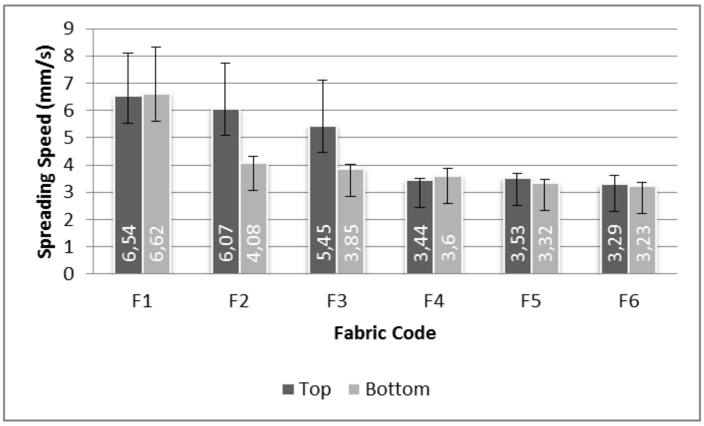


Figure 5. Top and bottom spreading speed values of fabrics

Figure 6 shows the mean grades of the maximum wetted radius of the top and bottom of the sample fabrics tested. Maximum wetted radius is defined as the greatest wetted ring radius on the top and bottom surfaces, respectively. The single yarn textured polyester mesh rib knitted samples were observed very largely spreading speed values in the top surface indicating that liquid sweat can be easily transported with a large wetted area by capillary forces. The two ply yarn textured polyester mesh knitted fabrics were showed large spreading speed values. This is most probably the thickness of yarn when the yarn number and fabric weight increased maximum wetted radius will decrease for the same type of yarns. So, mesh rib knitted fabrics were observed highest maximum wetted radius values especially in the top surface which contact to the skin. The lower value of maximum wetted radius for the top surface of the fabric means less damp touch and less cool sensation, providing better comfort to the wearer [25]. It was observed that the loop length changes for both knitting types did not affect on the maximum wetted radius value.

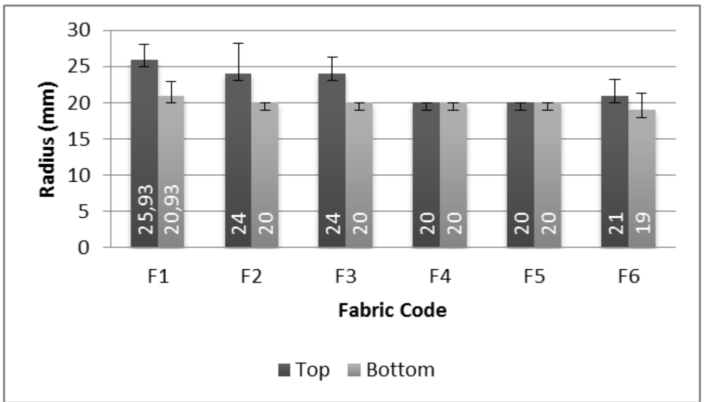


Figure 6. Top and bottom maximum wetted radius of fabrics

OWTC exhibits the liquid transport from the top surface to bottom surface of the fabric. If the OWTC value of one fabric is between 200 and 400 it means that one-way transport is very good. Also, the fabric has a value higher than 400, one-way transport is defined as excellent [26]. A comparison of the accumulative one-way transport index (OWTC) of all kinds of fabric is shown in *Figure 7*, indicating that the OWTC of single yarn textured polyester knitted fabrics (except fabric F1) was higher than that of the two ply textured polyester yarn knitted fabrics. It was seen the effect of the yarn count difference on the OWTC value of fabrics. Two ply yarn mesh knitted fabrics were showed the lowest OWTC values. It was observed that the one-way transport index value increased with the increase of the loop length in the fabrics produced from single yarn. Also, all the fabrics were showed perfect one-way transport index value according to MMT grading scale.

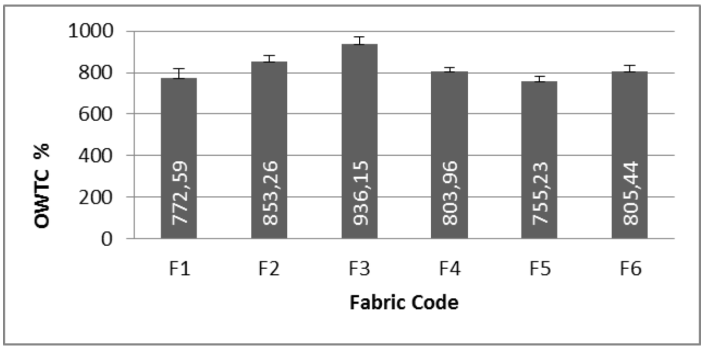


Figure 7. OWTC values of fabrics

Moisture management capacity of a fabric defined as simulating the liquid sweat on the skin absorbed and transferred to the outside of clothing through the fabric by pumping a preset volume of the liquid solution onto the upper surface of the fabric. The larger the OMMC is, the higher the overall moisture management capability of the fabric. Figure 8 shows that fabrics F1 and F2 have the highest liquid moisture management capacity (OMMC is very good). Also, all the fabrics were observed very good moisture management properties according to MMT grading scale. The lowest moisture management capacity was observed the highest loop length of two ply yarn knitted fabric (F6). It was seen that the effect of loop length differences for two different yarn count of fabric. If the loop length of fabrics increased, OMMC value would decrease for both two knit type. Also, the ANOVA test results supported that fabric type had an important effect on OMMC values of fabrics (Table 5).

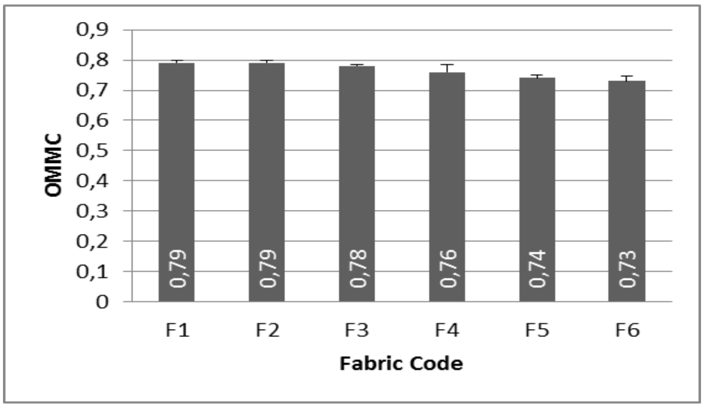


Figure 8. OMMC values of fabrics

The ANOVA test suggested that there was significant difference among the six fabrics as shown in Table 5 ($F = 21.09$, $p = 0.000 < 0.05$).

Table 5. ANOVA table for OMMC value

	df	SS	MS	Fs	Ftable
Fabric Type	5	0,01951	0,003902	21,09	2,62
Error	24	0,00444	0,000185		
Total	29				

3.3. Alambeta Test Results

3.3.1 Thermal Conductivity

Thermal conductivity is an intensive property of a material that indicates its ability to conduct heat. Thermal conductivity value of tested fabrics was compared in *Figure 9*. Thermal conductivity values of mesh knitted fabrics are higher than mesh rib knitted fabrics. Which means for the same loop length, single yarn knitted fabrics show lower thermal conductivity.

The highest thermal conductivity value was seen for F4, the fabric having the lowest loop length. For mesh rib knitted fabrics, the highest thermal conductivity value was seen F1 the lowest loop length value fabric. Also, these fabrics were the highest density fabrics among their groups. This can be explained with the entrapped air in the fabric structure. As the amount of fibre in the unit area increases and the amount of air layer decreases as the weight increases. As it was known, thermal conductivity values of fibres are higher than the thermal conductivity of entrapped air [27]. The heavier fabrics which contain less entrapped air (two ply yarn knitted) had higher thermal conductivity values. Also, the ANOVA test results supported that fabric type had an important effect on thermal conductivity values of fabrics (Table 6).

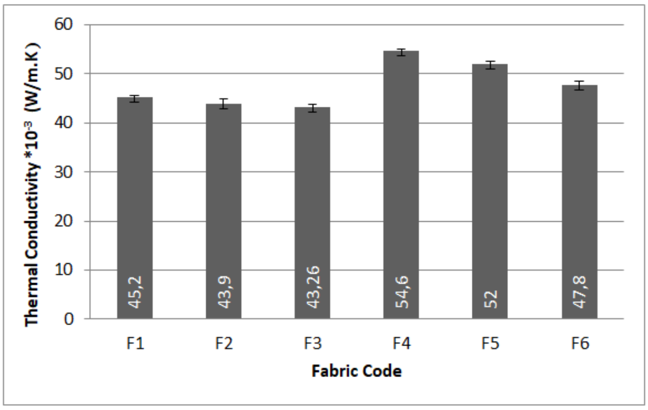


Figure 9: Thermal conductivity values of fabrics

The ANOVA test suggested that there was significant difference among the six fabrics as shown in Table 6 ($F = 295.05$, $p = 0.000 < 0.05$).

3.3.2. Thermal Absorptivity

Thermal absorptivity is the objective measurement of the warm-cool feeling of fabrics [28]. Thermal absorption can be calculated according to:

$$b = \sqrt{\lambda.\rho.c}\ \mathrm{W.\,s^{1/2}.\,m^{-2}\,K^{-1}} \tag{1}$$

Where: λ thermal conductivity, ρ fabric density and c the specific heat of fabric [29]. When a human touch a garment that has a different temperature than the skin, heat exchange occurs between the hand and the fabric. If the thermal absorptivity of clothing is high, it gives a cooler feeling at first contact. Also, fabrics knitted with finer yarns on the same machine give slacker constructions and these fabrics give a warmer feeling as the first contact [30]. Increase in yarn linear density increases thermal absorptivity, suggesting that the fabrics knitted with coarser yarns would be perceived cooler on initial skin contact, irrespective of the fibre types [10]. Fabrics knitted with coarser yarns give tighter constructions give a cool feeling. The highest thermal absorptivity value was seen in F4 coded fabric which has the highest density and thermal conductivity value too. Thermal absorptivity values of the two ply yarn knitted fabrics were higher than the single yarn knitted fabrics like thermal conductivity value (Figure 10). The highest thermal absorptivity values were seen in the lowest loop length and highest density value fabrics for both knit type. The higher thermal absorptivity of denser fabrics is related to their effect on surface contact area for heat transfer. This feature is affected by the mentioned parameters by their indirect effect on the surface contact area. Also, the ANOVA test results supported that fabric type had an important effect on thermal absorptivity values of fabrics (Table 7).

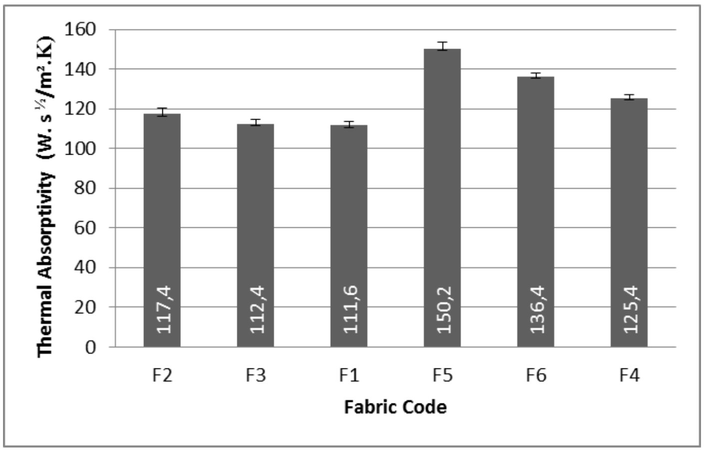


Figure 10: Thermal absorptivity values of fabrics

The ANOVA test suggested that there was a significant difference among the six fabrics as shown in Table 7 ($F = 184.6$, $p = 0.000 < 0.05$).

Table 6. ANOVA table for thermal conductivity

	df	SS	MS	Fs	Ftable
Fabric Type	5	537,003	107,4	295,05	2,62
Error	24	8,74	0,364		
Total	29	545,743			

Table 7. ANOVA table for thermal absorptivity

	df	SS	MS	Fs	Ftable
Fabric Type	5	5796,568	1159,31	184,6	2,62
Error	24	150,8	6,28		
Total	29	5947,68			

3.3.3. Thermal Resistance

Thermal resistance is a measure of the body's ability to prevent heat from flowing through it. Under a certain condition of climate, if the thermal resistance of clothing is small, the heat energy will gradually reduce with a sense of coolness [31]. Thermal resistance values of fabrics were given in Figure 11.

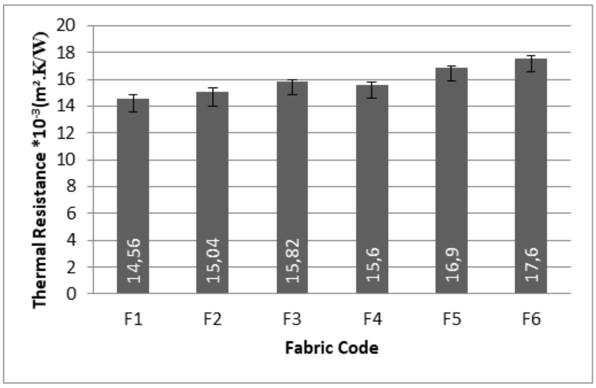


Figure 11. Thermal resistance values of fabrics

The highest thermal resistance value was seen the highest loop length two ply yarn knitted textured polyester mesh knitted fabric (F6). The lowest thermal resistance value was seen the lowest loop length single yarn knitted textured polyester mesh rib knitted fabric (F1). Two ply yarn knitted mesh knitted fabrics were observed higher thermal resistance values than 75/72 denier mesh rib knitted fabrics. The highest thermal conductivity value fabrics were observed the lowest thermal resistance values (F1 and F4) in same knit type. Oğlakçıoğlu and Marmaralı (2007), declared that there is an inverse relationship between thermal resistance and thermal conductivity [32]. It was observed that the thermal resistance value of two ply textured polyester mesh knitted fabrics decreased with increasing density. Thus, if the fabric density increases, the thermal resistance will decrease [33]. Cubric et al. (2013), reported that air entrapped in the knitted fabric structure plays a prevalent role in the thermal resistance of knitted fabrics [34]. If the amount of entrapped air in the fabric increase, the thermal resistance of fabric will increase because of the thermal conductivity of air lower than the fibres (25 mW/mK). Also, the ANOVA test results supported that fabric type had an important effect on thermal resistance values of fabrics (Table 8).

The ANOVA test suggested that there was significant difference among the six fabrics as shown in Table 8 ($F = 139.57$, $p = 0.000 < 0.05$).

4. CONCLUSIONS

In this study, the effect of loop length changes on heat and moisture transmission properties of mesh knitted fabrics was investigated. For this purpose, thermal conductivity, thermal absorptivity, thermal resistance, air permeability and moisture management properties of fabrics were measured according to standard test methods. The results showed that as the yarn gets finer and loop length increases, the air permeability will increase. The lowest yarn count and highest loop length single yarn mesh rib knitted fabric showed the highest air permeability value. The single yarn textured polyester mesh rib knitted fabrics showed highest absorption rate and very fast spreading speed values than two ply yarn knitted fabrics. The OWTC of single yarn textured polyester knitted fabrics (except fabric F1) was higher than that of the two ply textured polyester yarn knitted fabrics. It was observed that the one-way transport index value increased with the increase of the loop length in the fabrics produced from single yarn. All the fabrics were observed very good moisture management properties. It was seen the effect of loop length differences for two different yarn count of fabric. If the loop length of fabrics increased, OMMC value would decrease for both two knit type. For the same loop length, single yarn knitted fabrics showed lower thermal conductivity values. The highest thermal absorptivity values were seen in the lowest loop length and highest density value fabrics for both knit type. This is most probably due to mesh knit which contain less entrapped air. On the other hand, the highest thermal resistance value was seen in the highest loop length of two folded yarn knitted fabric (F6) which contains more entrapped air.

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Table 8. ANOVA table for thermal resistance

	df	SS	MS	Fs	Ftable
Fabric Type	5	32,811	6,56	139,57	2,62
Error	24	1,132	0,047		
Total	29	33,94			

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