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Makale / Research Paper

# The Effect of Softener on the Performance and Thermal Comfort Properties of Warp Knitted Acrylic Blankets

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**Abstract:**In this study, the performance properties of blankets produced by acrylic pile yarn via Raschel warp knitting machine are investigated. Two different yarn counts and three different densities are used for the pile yarns of the sample blankets. In addition, the blankets are treated with three different softeners. The structural properties, thermal comfort, softness and durability of the eighteen samples are tested according to international standards. The aim of the study is to select the optimum softener type for the blankets which is convenient to the winter season. Therefore, the study data are analyzed by both graphs and statistical methods. Then the best convenient blanket is selected by optimization technique with statistical package program. The lack of detailed studies on warp knitted blankets in the literature is the primary feature of this study.

**Keywords:** warp knitted, blanket, thermal related terms, bursting strength, softener

# Çözgülü Örme Akrilik Battaniyelerin Performans ve Termal Konfor Özelliklerine Yumuşatıcının Etkisi

**Öz:** Bu çalışmada, Raschel çözgülü örme makinesi ile akrilik hav ipliği ile üretilen battaniyelerin performans özellikleri araştırılmıştır. Örnek battaniyelerin hav iplikleri için iki farklı iplik numarası ve üç farklı yoğunluk kullanılmıştır. Ayrıca battaniyeler üç farklı yumuşatıcı ile işlem görmektedir. On sekiz numunenin yapısal özellikleri, termal konforu, yumuşaklığı ve dayanıklılığı uluslararası standartlara göre test edilmiştir. Çalışmanın amacı, kış mevsimine uygun battaniyeler için optimum yumuşatıcı tipinin seçilmesidir. Bu nedenle, çalışma verileri hem grafikler hem de istatistiksel yöntemlerle analiz edilir. Daha sonra istatistiksel paket programı ile optimizasyon tekniği ile en uygun battaniye seçilir. Literatürde çözgülü örme battaniyeler ile ilgili detaylı çalışmaların olmaması bu çalışmanın en önemli özelliğidir

**Anahtar kelimeler:** Çözgülü örme, battaniye, ısıl konfor, patlama mukavemeti, yumuşatıcı

## 1. Introduction

The blanket is a soft textured textile product that can be produced mostly by wool or similar fibers as a covering material from cold weather or an accessory. Blankets can be classified as woven blankets and knitted blankets according to their production technologies. Blankets are produced by using different raw materials according to their using purpose. Although the type of fiber known for the blanket is the most wool, it can be said that acrylic, polyester, and cotton fibers are widely used in the blanket making due to the fact that wool fiber is rather expensive and its maintenance is not easy. Knitted blankets can be produced by warp and/or weft knitting methods. In this paper, samples were obtained by warp knitting technique.

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In warp knitted blanket samples, there are three different types of yarns as warp yarns, pile yarns, and binding yarns. The sample product is manufactured by the machine in three dimensions. The end product comes out of the machine is shown in Figure 1.

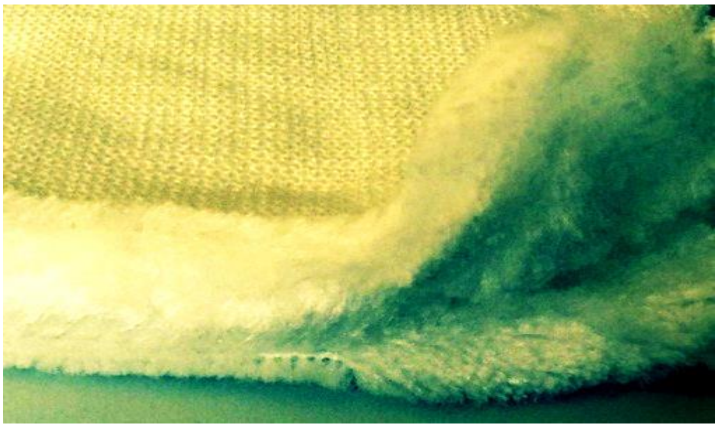

**Figure 1.** 3 D double layered fabric

While the warp and binding yarns of the products are generally polyesters, the pile yarns can be acrylic, cotton, or polyester. Acrylic is chosen as pile yarn in this study. The reasons for this is acrylic touch and view resemble wool. It can be washed easily. Acrylic's ability to protect the shape is high. Its resistance to oil and chemicals are high. It can be colored in bright colors with excellent fastness. Acrylic has high resistance to sunlight.

Fabrics extracted from the knitting machine are divided into two by the cutting machine. Piled fabrics with a cut face are colored with the help of a printing machine, the desired patterns are printed on and the colors of the fabrics are stationed by fixation. Then the excess dye and chemicals on the fabrics are removed. The resulting fabrics come to the smoothing boat and are softened with different chemicals.

Softening agents are products that are intended to impart a soft handle to textiles. As a result of the different structures of the products handle modifications such as smooth, fully fluffy, softness are possible. Many softening agents are moreover influencing the hydrophilic and hydrophobic properties, elastic resilience, sewing properties, and creasing behavior. Softening agents are generally preparations of fats, waxes, paraffin, silicones, and their derivatives [1].

After softening, the fabrics pass to final drying. Dried fabrics pass through the ram machine to fix the width and length. Then the brush machine opens the piles. Then, both sides of the fabric are raised. The pile heights are adjusted to a fixed height with the help of scissors. The fabrics coming out of the scissors are laid in the paving machines and ready for sewing. After the size measurement blankets are placed at cutting tables to adjust them as determined blanket size [2].

In general, warp knitted spacer fabrics, due to their three-dimensional structure cannot be produced by the classic textiles [3,4]. The specific properties of these textile structures are as follows; air permeability and breathability, moisture, heat permeability and absorption, excellent physiological and climatic comfort, compressibility strength, ability to be combined with functional materials, good surface strength and light weight [5]. The heat and air flow of these structures are also very different. Another characteristic feature of this structure is the ability to minimize the point effects by spreading the pressure on the surface to a lesser extent and to pass the liquid coming from the floor to the middle part immediately. It has been determined that they have been used as a cover in the operating rooms, have slowed down the decrease in body temperatures. Especially for applications in medical areas where sweat absorption, air, and heat transfer are necessary, they have the potential to be used as an alternative to the sponge. The pile area forms a kind of microclimate environment between the body and the surface. It is an important advantage that each unit forming the fabric can be produced using different yarns. When the fabric is fabricated, the part contacting the skin is made of synthetic yarn, allowing the moisture to flow from this inner surface rapidly into the middle pile area. If the pile yarn with moisture-conducting properties is used, the incoming moisture is absorbed by the natural fiber on the outer surface to prevent wetness of the skin. Pile height is important in this context [2].

In the literature, a detailed study on the performance and thermal properties of warp knitted blankets has not been found. The aim of the study is to find the most suitable sample type as a winter blanket and besides this, the results of the study will be a source for the researchers.

## 2. Experimental Study

### 2.1. Material

In this study, 18 warp knitted blankets were produced. The produced blankets are varied with the used yarn count, pile yarn density, and applied softeners. Since the blankets produced in the study are produced in the form of spacer fabric, there are binding yarns, ground yarns, and pile yarns in them. Binding and ground yarns are 150D / 48 F FDY polyester yarn and are the same in all samples.
In this study, three different softeners were used as Tubingal WES, Tubingal KND, and Aksoft SD. TUBINGAL WES is a multifunctional softener for all textile substrates. It can be applied on woven and knitwear of cellulose fibers, on pure woolen cloth, polyamide articles for bathing suits, sportswear, corduroy, microfiber textiles, etc. The product gives an excellent soft handle together with high resiliency, good decreasing behavior, and very good sewability. The product is sensitive to alkali [6].

**Table 1.** Samples were coded according to the pile yarn number, density and softener

| Samples | Pile Yarn Count | Pile yarn density | Applied softener | Samples | Pile Yarn Count | Pile yarn density | Applied softener |
|---|---|---|---|---|---|---|---|
| A18-629-W | Nm 18/1 | 6.29/cm | Tubingal WES | A30-629-W | Nm 30/1 | 6.29/cm | Tubingal WES |
| A18-629-KN | Nm 18/1 | 6.29/cm | Tubingal KND | A30-629-KN | Nm 30/1 | 6.29/cm | Tubingal KND |
| A18-629-SD | Nm 18/1 | 6.29/cm | AKSOFT SD | A30-629-SD | Nm 30/1 | 6.29/cm | AKSOFT SD |
| A18-760-W | Nm 18/1 | 7.60/cm | Tubingal WES | A30-760-W | Nm 30/1 | 7.60/cm | Tubingal WES |
| A18-760-KN | Nm 18/1 | 7.60/cm | Tubingal KND | A30-760-KN | Nm 30/1 | 7.60/cm | Tubingal KND |
| A18-760-SD | Nm 18/1 | 7.60/cm | AKSOFT SD | A30-760-SD | Nm 30/1 | 7.60/cm | AKSOFT SD |
| nA18-1082-W | Nm 18/1 | 10.82/cm | Tubingal WES | A30-1082-W | Nm 30/1 | 10.82/cm | Tubingal WES |
| A18-1082-KN | Nm 18/1 | 10.82/cm | Tubingal KND | A30-1082-KN | Nm 30/1 | 10.82/cm | Tubingal KND |
| A18-1082-SD | Nm 18/1 | 10.82/cm | AKSOFT SD | A30-1082-SD | Nm 30/1 | 10.82/cm | AKSOFT SD |

TUBINGAL KND is a hydrophilic, weakly cationic terry cloth softener based on fatty acid condensation products and special smoothening agents, free of silicone. It is universally applicable and supports pile resiliency in combination with tumble processes. In this way, the product imparts a pleasant, soft, voluminous handle. The fabric stays hydrophilic even after higher drying temperatures [7].

AKSOFT-SD is a cation-active softener with antistatic properties that produces excellent soft finishes on a wide range of textile materials including those of cotton, wool viscose rayon, polyamide, polyester and polyacrylic. AKSOFT-SD is a highly effective softening agent for all acrylic and mod-acrylic fibers. The effectiveness varies according to the conditions but as a general guide the softening increases when the temperature and pH of application increase. Strongly alkaline solutions can cause precipitation and pH above of “7” is not recommended without laboratory tests to confirm the stability of the system. Softness increases with increasing amounts of softener up to an optimum concentration. These recommendations apply to all acrylic fibers but the effect will vary from one fiber to another [8].

After the fabrics were cut, raised, shaved, brushed and softened, they came to the sample preparation unit. Unit weights and unit thicknesses below 2 kPa were measured for 24 hours in laboratory conditions. The fabrics were coded according to the pile yarn number, density and softener used for clarity of the study and presented in Table 1.

### 2.2. Method

#### 2.2.1 Structure-Related Tests

Structural changes were the parameters that directly affect the performance test results of knitted fabrics. For this reason the unit weights of the samples were calculated according to ISO 12127: 1999. The unit thickness of the fabric was measured with a Wira tester under the pressure of 2 kPa with the help of a digital thickness gauge tester and the results are given in Table 2.

**Table 2.** Structural test results of sample fabrics

| Samples | Thickness(mm) | Unit Weight (g/m$^2$) | Samples | Thickness (mm) | Unit Weight (g/m$^2$) |
|---|---|---|---|---|---|
| A18-629-W | 6,9 | 650 | A30-629-W | 5,9 | 560 |
| A18-629-KN | 6,7 | 650 | A30-629-KN | 6,0 | 560 |
| A18-629-SD | 5,9 | 630 | A30-629-SD | 5,0 | 560 |
| A18-760-W | 7,0 | 710 | A30-760-W | 7,8 | 590 |
| A18-760-KN | 5,3 | 720 | A30-760-KN | 8,8 | 590 |
| A18-760-SD | 6,2 | 710 | A30-760-SD | 6,2 | 660 |
| A18-1082-W | 7,3 | 720 | A30-1082-W | 8,0 | 620 |
| A18-1082-KN | 7,8 | 720 | A30-1082-KN | 9,2 | 620 |
| A18-1082-SD | 8,5 | 710 | A30-1082-SD | 8,2 | 620 |

#### 2.2.2 Comfort-Related Tests

The air permeability of the samples was tested according to ISO 9237 standard by means of SDL Atlas air permeability tester. The tests were completed by taking measurements from 10 different locations of the fabric with the head of 20 cm2 and a pressure difference of 100 kPa. Thermal conductivity and water vapor resistance tests of the samples were carried out according to ISO 31092: 2000 standard with a Hotplate tester. During the test, the ambient conditions were kept constant at 40% humidity and 1 m/s air velocity.

#### 2.2.3 Performance-Related Tests

In order to test the durability of the sample fabrics, the fabrics were subjected to the bursting strength test with the TRUBURST 2 tester according to the BS EN ISO 13938-2 standard. The tests were carried out at 5 different locations of the sample fabrics by adjusting the inflation rate and fixing the time. The diaphragm corrected strength test results of the fabrics were averaged and comparisons were made.

In order to determine the softness of the sample fabrics, drapeability and bending rigidity tests were applied. Cusick drapeability test device was used to measure the drapeability of the blankets. The test was based on the determination of the shadow of the fabric, which was formed by its own weight, with the help of a mirror, the shadow on the paper, and then the shaded parts on the paper and the mathematical expression of the cast.

Determination of the bending rigidity of sample fabrics was done according to ASTM D1388 – 18-standard test method for stiffness of fabrics. The bending rigidity is the resistance of the textile sample, which is cut in certain rectangular shapes, against the bending under its own weight. The bending length and bending strength of fabrics is determined by the bending rigidity test.

## 3. Results and Discussion

### 3.1 Comfort-related tests

Each season's clothing is different depending on changing weather conditions. Winter clothing must have a high thermal resistance. At the same time, moisture and air permeability should be lower in order to provide the thermal insulation of the fabric structure. The thermal resistance of summer clothes should be low, moisture and air permeability should be high [9-11]. As a result, the main function of the garments is to keep the body temperature at an average value (37° C) even when external atmospheric conditions or physical activity change. That is, when the body temperature rises, the body must expel the appropriate amount of heat to maintain the thermal balance. Therefore, the thermal balance between gained and lost heat must be sustained in order to make one feel comfortable. This balance is also possible with perspiration [12]. Since the blankets chosen as a sample of the study should be suitable for winter use, their air permeability should be lower [5]. Then thermal resistance and water vapor permeability should be high.

### 3.2.1 Air permeability

Blankets are generally used to prevent heat transfer and protect the wearer from the passage of cold air. Therefore, it can be said that the sample with the lowest air permeability is more suitable for the blanket. Therefore, increasing the frequency of pile yarn seems to be quite effective. According to the results, the effect of pile yarn on permeability was remarkable. Of course, using fine pile yarn had reduced the air permeability. It was observed that the increase in pile density further decreased the permeability in blankets with fine pile yarns. Softeners did not have a significant effect. As a result, it was clear that it was more appropriate to use high pile density, fine pile yarn, and TUBINGAL-WES for winter blankets.

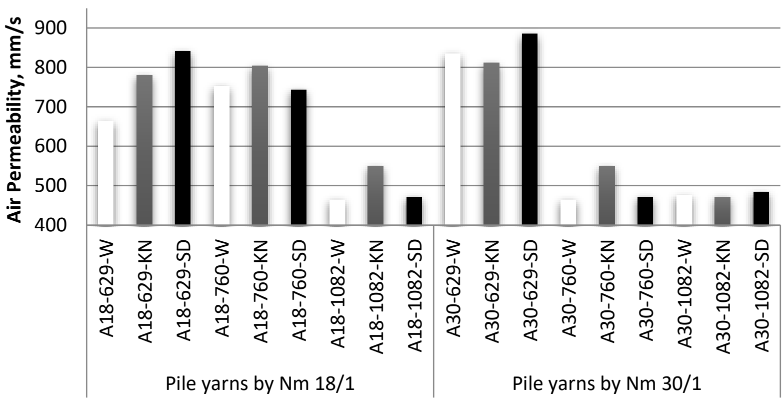


**Figure 2.** Air permeability test results of blankets

### 3.2.2 Thermal Resistance

Thermal resistance is defined as the temperature difference between two sections of a material divided by the heat flow velocity between the sections and resisting to heat transfer in the stable state [13]. Thermal resistance is found by dividing the thickness of the fabric by thermal conductivity. Material thickness is inversely proportional to thermal conductivity. In other words, the lower the thermal conductivity of a material and the higher its thickness, the higher its thermal resistance. The thermal conductivity of the fibers in the fabric is low, and the thermal conductivity of the air in the fabric pores is low 1and the thermal resistance of the fabric is high. High thermal resistance in cold weather conditions means high thermal insulation. Test results for sample blankets are given in Figure 3.

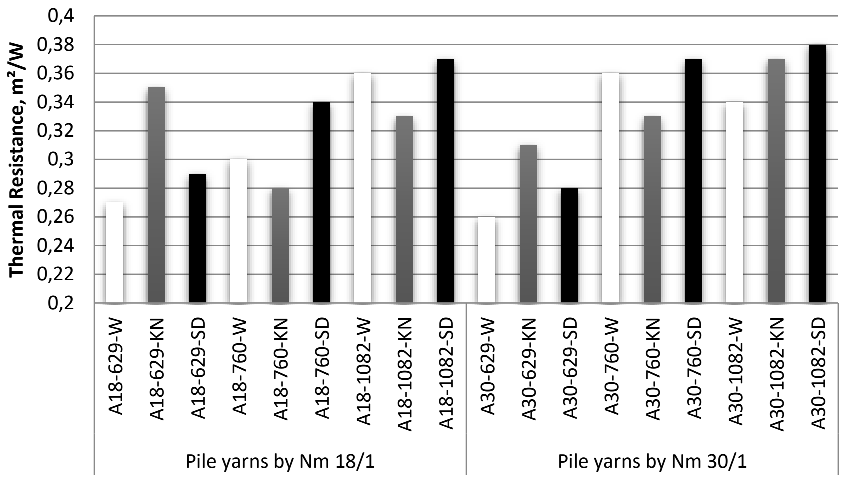


**Figure 3**. Thermal resistance test results of blankets

Normally, thermal resistance should decrease as thermal conductivity increases. However, if the raw material was stable, this relationship changed to thermal resistance as the thickness increases. The results were consistent with the thickness change. According to the results, the pile yarn count did not cause a noticeable effect on the thermal resistance. The increase in the frequency of pile yarn significantly increased the resistance. On the other hand, it was clear that softeners caused different resistances for each sample, but this was not been classified. It was considered that the samples with the highest density of pile yarns were the best samples regardless of the pile yarn number and softener.

### 3.2.3 Water Vapor Resistance

The clothing should help the body's temperature control function under changing physical conditions. Thus, the body's heat and moisture production is balanced and the microclimate occurs in the area close to the skin. As a result of each activity in the human body, due to its metabolism, some heat is produced. When this heat level increases, the heat transfer through the garment and the energy balance of the body are insufficient. As a result, sweating occurs and the body can cool down again. Moisture absorption is the ability to retain fluid in a material and in its pores. Clothes with high liquid absorption can be used in contact with the body because they absorb very well sweat [14]. The hotplate test uses the protected hotplate method to sweat because it measures at a temperature that is closest to the body temperature (37℃ ). In this test method, the water vapor resistance is the ratio of the water vapor pressure difference between the two surfaces of a material to the evaporation heat flow in the unit area in the direction of the pressure change.

$$W_d=1 / (Ret * QTM) \quad (1)$$

QTM is the heating temperature of the measuring unit which allows the water to evaporate at the TM temperature. For 35℃, QTM is equal to 0.672 W/g. Wd; the water vapor permeability is the amount of water vapor in grams per one square meter per hour and 1 Pascal pressure depending on the water vapor resistance of the material and the temperature. The low water vapor permeability causes the water vapor to become liquid and the clothes and body surface becomes wet. This means that the water vapor permeability in a comfortable suit should be high. Test results for sample blankets are given in Figure 4.

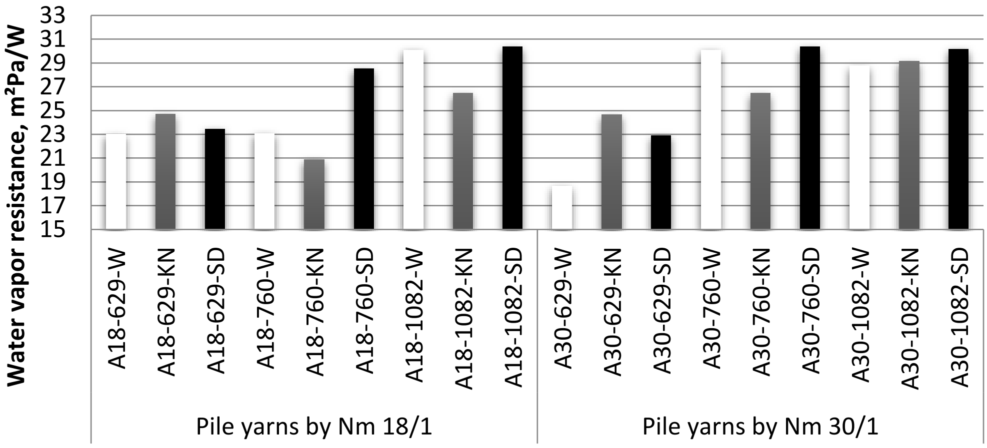


**Figure 4.** Water vapor resistance test results of blankets

According to the water vapor test results given in Figure 4, density is an important parameter on water vapor penetration resistance. When the graph is examined, it is concluded that the pile yarn number is not effective on the water vapor resistance. When the softeners applied to the sample fabrics were compared, the highest resistance was observed when cationic softeners were applied. For the blankets, the water vapor transmission resistance should be low, so the blanket should be able to remove the water vapor from the body as quickly as possible. Compared to the results; it is concluded that it is more suitable to use frequency low acrylic blankets for the winter season.

### 3.3 Performance-Related Tests

#### 3.3.1 Bursting Resistance Test

Bursting resistance means the resistance of fabrics with the multi-directional stretching capacity to the pressure produced by knitting technology. Although the warp knitted fabrics are similar to the woven fabrics by the structure, it is more convenient to perform the strength measurements with the bursting strength tester. Test results for sample blankets are given in Figure 5. Test results for sample blankets are given in Figure 5.

#### 3.3.2 Drapeability

Drapeability is one of the important characteristics affecting the appearance of the fabric and it can be defined as the deformation behavior of the fabric under its own weight. It emerges as an important parameter for predicting the appearance of the fabric during use [15]. It is expected that the drape is high because the blanket also has the meaning of how the blanket will wear the user. The drapeability test results applied to the sample fabrics are given in Figure 6.

Figure 6 shows that all samples produced with selected parameters exhibited near-drapeability results. It cannot be said that the selected parameters had significant and consistent effects on the drapeability.

According to the results, it was clear that the pile yarn on the drape was more effective. Because, as the pile yarn became thicker, the unit weight of the fabric increased and this increased the drapeability.

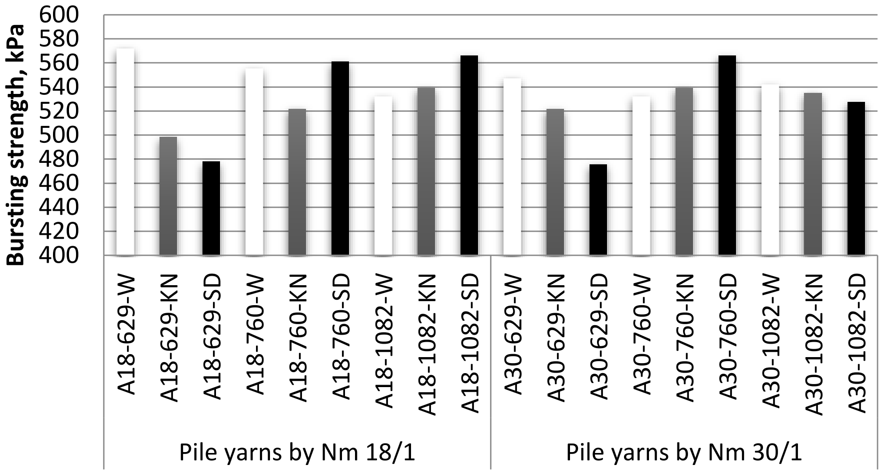


**Figure 5.** Bursting strength test results of blankets

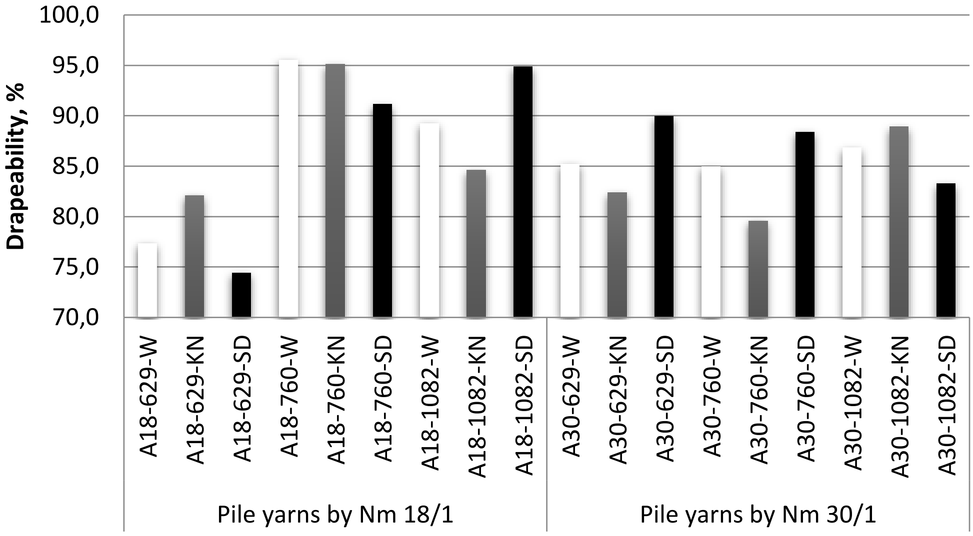


**Figure 6.** Drapeability test results of blankets

The increase in density was also one of the factors that increased drapeability, however, both thickening the pile yarn and increasing the density caused the fabric to harden when it exceeded the optimum level. This approach explained that the 18 Nm and 7.60 often had the highest drapeability value of produced blankets.

### 3.3.3 Bending Rigidity

Bending rigidity is a parameter that is very closely related to fabric drape. Bending is defined as a horizontal deviation of a rectangular fabric, whose horizontal end is fixed horizontally. When evaluated especially in terms of fabric comfort, draping and bending properties stand out as the main parameters affecting the selection, design, and appearance of textile materials [15]. Since the bending rigidity is high, the softness of the fabric is high and it can be said that the fabrics with low bending resistance are softer. A bending resistance test was applied to the sample fabrics in width and length direction and the total resistance of the fabric was calculated by using the formula. Here; G = bending strength, M = fabric weight and C = average droop length. The results of the sample blankets are presented in Figure 7.

$$G = 0.10MC^3 \quad (2)$$

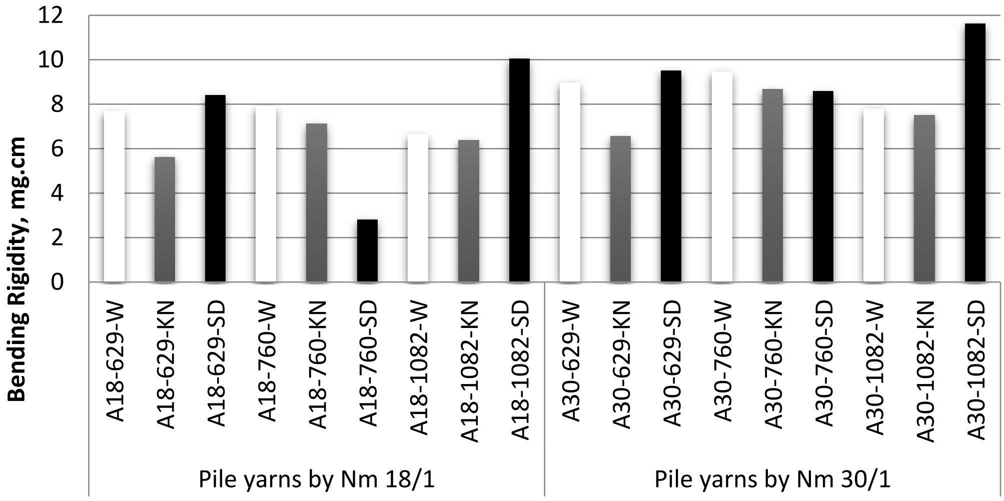


**Figure 7.** Bending rigidity test results of blankets

Figure 7 showed that the type of softener applied was a parameter that affects the bending behavior. As the pile yarn became thinner, the increase in strength could be mentioned. As the yarn density increased, an uneven reduction in bending strength occurred. All the fabrics had adequate softness for being blanket.

### 3.4 Statistical Analyses

#### 3.4.1 Variation Analyses Test: ANOVA

The statistical analysis of the test results obtained from the study was performed by using the Design Expert package program. The number and density of the used pile yarns and the softeners applied were selected as dependent variables. Of these, the density and number are limited numerical variables; softener was determined as a categorical variable. Since the program used determines the model type linearly, the analyzes were made on this type. As the confidence interval was considered as 95% when analyzing the results, p> 0.05 values in ANOVA test results showed that the variables had no significant effect on the result whereas p <0.5 values were the opposite. The results of ANOVA analysis as a result of this information are summarized in Table 3.

**Table 3.** Statistical analysis of applied test results-ANOVA test results

| **General Factorial, Linear Model** | | **Dependent variables; Prob>F** | | | |
|---|---|---|---|---|---|
| | | **Model** | **Pile Density** | **Softener** | **Pile yarn count** |
| Applied Tests | Thickness, mm | 0.0150 | 0.0014 | 0.4810 | 0.3810 |
| | Unit weight, g/m$^2$ | <0.0001 | 0.0042 | 0.9626 | <0.0001 |
| | Air Permeability, mm/s | 0.0034 | 0.0003 | 0.6855 | 0.1892 |
| | Bursting Strength, kpa | 0.2595 | 0.4133 | 0.7604 | 0.5212 |
| | Thermal Resistance, | 0.0038 | 0.4370 | 0.4109 | 0.0314 |
| | Water vapor resistance | 0.0025 | 0.333 | 0.3781 | 0.0199 |
| | Drapeability, % | 0.2166 | 0.9078 | 0.5892 | 0.7045 |
| | Bending Rigidity, mg.cm | 0.4455 | 0.4727 | 0.5807 | 0.1539 |

Table 3 showed that the density was a significant factor on thickness; softener and number were not important factors. On unit weight, density and yarn number were significant variables. The determining factors had no statistically significant effects on air permeability, bursting strength, drapeability, and bending rigidity. The density had a significant effect on thermal resistance and water vapor resistance. As a result, it can be said that the statistically significant parameter for the blankets produced with the same parameters is the density.

### 3.4.2 Numerical Optimization

Various tests were applied to 18 warp knitted blankets produced within the scope of the project. Since the mentioned blankets are considered as winter, the properties that these fabrics should have were chosen as the target and it was decided which blanket properties would be achieved. In order to achieve this result, the numerical optimization menu of the Design Expert 8.0 package program has been used. Firstly, yarn count, pile yarn frequency, and softeners applied to blankets were introduced as variables. The test results of the blankets were entered as data. As a result of the study, the most suitable blanket for their use in winter was determined by the limitations and grading of these constraints. The results of the first three optimizations chosen from the optimizations are given in Table 4.

**Tablo 4.** The results of the first three optimizations chosen from the optimizations

| Number | 1 | 2 | 3 |
|---|---|---|---|
| **Tightness** | 629 | 629 | 679 |
| **Softener** | KN | SD | W |
| **Pile Yarn count** | 30 | 30 | 30 |
| **Air Permeability** | 822 | 811 | 739 |
| **Bursting Strength** | 533 | 533 | 533 |
| **Thermal Resistance** | 0,308 | 0,316 | 0,316 |
| **Water Vapor Resistance** | 22,3 | 24,1 | 23,1 |
| **Drapeability** | 86,3 | 86,3 | 86,3 |
| **Bending Rigidity** | 8,88 | 6,9 | 8,09 |
| **Desirability** | 0,553 | 0,549 | 0,549 |

According to Table 4, the most suitable blanket for the winter season should be from 30 Nm pile yarn, the density should be 6.29 and the KN softener should be applied.

## 4. Conclusion

This paper investigates warp knitted blankets which are known as “plush blankets” in our daily life. This type of blanket had a high market share, the enterprise where the samples were supplied received a considerable share of the cake. The aim of the study was to determine the thermal comfort and performance characteristics of the blankets which were actively used for both adults and children in winter months for their colors, softness, and aesthetic characteristics.

Therefore, the characteristics of the blankets were determined before the study. The users want the blankets to be soft and draped and they must be intact. They were particularly suitable for winter and they should be thermally comfortable. The pile yarns of the samples used differ in numbers and densities. In addition, the samples produced were also varied using different softeners. Tests were carried out on whether the produced samples had the expected properties. The test results were analyzed by means of graphs and statistical analyzes. The results are summarized as follows:

In terms of drapeability, it was found that all samples had a close degree of drape but the blankets produced by 18 Nm pile yarn with 7.60 density have optimum drapeability values. All of the samples had very high strength values. In addition, it was determined that the selected parameters had no distinctive effects on strength. According to the results of the water vapor resistance test, low-density blankets could be preferred because their users would be less sweating than other samples. The softeners applied to affect the thermal resistance of the samples, but since no change was shown in the same way for each density, this change was seen as a chance change, not a cause. The yarn count did not cause a significant difference in thermal resistance. According to the results of air permeability, samples with medium density were more suitable for the use of blankets. In accordance with the one-way ANOVA test applied to the sample fabrics, the only determinant factor on the performance and comfort characteristics of the sample fabrics at 0.05 significance level was the pile yarn density. Numerical optimization test results were applied to the sample fabric according to the specified constraints of 30 Nm acrylic pile yarn and 6.29 often produced and the KN softener applied blankets were the most appropriate warp knitted blankets for the winter season.

## Acknowledgments

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## Authors' Contribution

ZD and MT made the experimental design and ZD made the experiments and completed the project. MT and ZD analyzed the results and wrote the paper. Both authors read and proved the last version of the paper.

## Conflict of Interest

There is no conflict of interest.

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