Textile & Leather Review

ISSN 2623-6281 | www.tlr-journal.com | 10.31881/TLR

Investigation of the Effect of Using Different Interlinings on the Comfort Properties of the Embroidered Surface

Zümrüt Bahadir Ünal, Eda Acar

How to cite: Bahadir Ünal Z, Acar E. Investigation of the Effect of Using Different Interlinings on the Comfort Properties of the Embroidered Surface. Textile & Leather Review. 2022; 5:165-179. https://doi.org/10.31881/TLR.2022.20

How to link: https://doi.org/10.31881/TLR.2022.20

Published: 26 April 2022

Investigation of the Effect of Using Different Interlinings on the Comfort Properties of the Embroidered Surface

Zümrüt BAHADIR ÜNAL, Eda ACAR*

Textile Engineering Department, Faculty of Engineering, Ege University, İzmir, Turkey

*eda.acar@ege.edu.tr

Article

https://doi.org/10.31881/TLR.2022.20

Received 11 March 2022; Accepted 20 April 2022; Published 26 April 2022

ABSTRACT

Embroidery is a form of embellishment obtained by processing the figures on various surfaces. It has been done as multi-needle and computer-aided since the 1990s. Embroidery practice is applied with the aim of improving the appearance of the product and separating the product from similar ones. The embroidery process has direct effect on the cost and sale of the product and is used widely in the garment industry. Embroidery applied on the surface is supported by interlining in order to have better quality of the embroidery. In this research, all parameters intended for obtaining embroidered surface were kept constant and five different interlining types were applied as variables. Physical and comfort tests were performed for evaluating the comfort features of the embroidered surface. According to the findings obtained from the study, the use of water-soluble interlining was found to be appropriate in places that were in direct contact with the skin.

KEYWORDS

embroidery, interlining types, clothing comfort, friction

INTRODUCTION

Embellishment art is a name given to all arts which give an object or a building a better appearance, to give appreciation and to increase its value [1]. Embroidery is one form of embellishment produced by processing alive, lifeless or geometrical figures with the intention of embellishment on the base of different goods [2].

While traditional embroidery uses needles or a crochet needle on various fabrics that are stretched on the embroidery frame, embroidery machines have been manufactured with the development of the industry. Different patterns designed in the computer are transferred to the fabrics to be used in various areas with the help of a computer.

The area of use of embroidery is highly extensive. It is used in clothing accessories, home textile and many decorative products, especially in underwear and outerwear. Embroidery processing profession is an industry in itself all over the world and it is also a sub-sector of the textile sector. Although it is not very high in cost, it provides a high added value to textile products.

Suitable machine, an embroidery needle suitable for the fabric structure, a quality embroidery thread suitable for the product and the needle, a suitable interlining, an experienced operator, the embroidery frequency suitable for the coverage of the thread and a suitable fabric surface to be embroidered are the parameters required for a quality embroidery [3,4]. All of these parameters must be selected correctly for a good embroidery quality.

Most of the study on embroidery generally focus on tools, techniques, and technologies about embroidery machines [5,6], the influence of the properties of embroidery threads on fabric [7], fashion embroidery design [8], the effect of embroidery process on physical properties of fabric like tensile strength, bending stiffness and elongation [9], developing prediction model for the prediction of the longitudinal shrinkage of the embroidered fabric, machine embroidery stitches types classification [10], recognition and classification of embroidered textile defects in manufacturing defects [11], technical embroidery for smart textiles [12].

Studies on determining the comfort properties of interlining used for changing purposes in various parts of clothing are limited [13]. The effects of embroidery stitch length and the weight of fusing paper on physical properties and thermal comfort by using the same yarns on two types of fabric, single jersey and pique were investigated. Super-tear air-laid embroidery fusing papers with three different weights were preferred. Embroidery has been found to have a significant effect on wearing comfort. Therefore, it is recommended to be applied to a small area on the clothing and to be used especially far from the sweating areas of the body [13].

The effects of the interlining on the air permeability, thermal conductivity, and crease recovery angle properties of wool fabrics were investigated. Two different interlinings (58 g/m^2, 100% PES; 43 g/m^2, 100% PES) were fixed onto four different blends of wool/fabrics (50-50% PES-Wool, 30-70% PES-Wool, 21-79% SE-Wool, 100% Wool) in three different conditions. According to the results, the interlining decreased air permeability values of the fabrics and there was an increase in thermal conductivity values for all types and conditions [14]. The effect of sewing and fusing of the interlining on the drape behaviour of men's suiting fabrics was investigated. It was stated that the drape coefficient changed depending on the types of seams, stitches and also the interlining used [15]. Effects of 6 different woven interlinings on the handle properties of shirt fabric were examined. The fabrics fused with interlinings with thinner warp and weft yarn and higher fabric density were found softer and thinner and these fused panels had better drapeability and were more compressible [16].

In this study, all parameters affecting embroidery quality were kept constant and embroidery was made using five different interlinings that could be suitable for the base fabric. Then, the effects of different interlining types on physical and comfort properties of embroidered surface were evaluated by applying weight, thickness, circular bending, air permeability, moisture transmission and roughness tests. There are not enough studies in the literature that investigate the comfort properties of embroidered surfaces depending on the use of different interlinings. It is thought that the results obtained in this study will contribute to this field.

INTERLINING TYPES USED IN EMBROIDERY MACHINES AND USAGE PURPOSES

The materials used to increase the resistance of the stitched material during sewing as well as the quality of sewing are called interlinings. An interlining is an intermediate layer attached to the fabric in different ways in accordance with the appearance, quality and the intended use of the garment. The colour and the thickness of the fabric and the next operations on the product must be taken into consideration when selecting the interlining.

Interlining can be grouped into three categories: weaving, knitting and non-woven, according to production methods. Nonwoven interlinings are mostly used because they give better results on embroidered surfaces, are easy to clean and are economical. Nonwoven interlinings are easy to tear. The lower surfaces of all interlinings are covered with a material that melts with heat and allows it to adhere to the fabric. These interlinings are fixed to the fabric so that slippage is prevented and proper embroidery is obtained with the high heat.

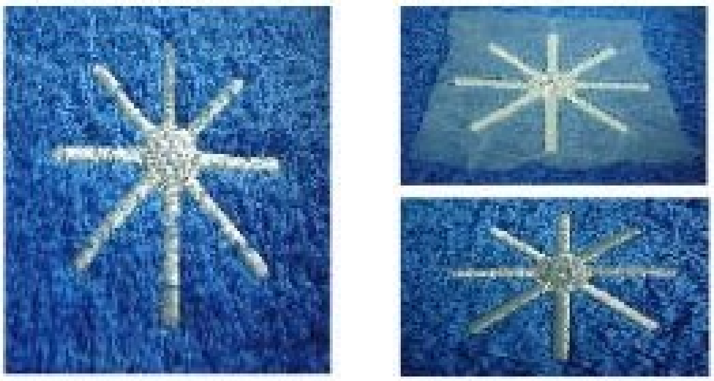
A large number of holes are created in the fabric structure during embroidery process due to the needle penetration. This causes the surface to wear out. The resistance of the product's embroidery area is related to the interlining to be used. The use of interlining is compulsory to support the shape and the strength of the garment, to reduce the tendency to crease, to increase the resistance of the embroidered region to the washing and ironing processes, and to give a certain form and hardness. The task of the interlining used in embroidery is to prepare the base for the embroidery by attaching it to the embroidery frame. The interlining allows the fabric to be supported from below during strokes while embroidering. It is stretched under the fabric in order to prevent the fabric from shrinking, stretching and to allow the embroidery to appear more smoothly. The interlining to be used is preferred according to the cleaning method and weight, taking into account the quality and frequency ofembroidery to be made and the characteristics of the fabric. In determining this preference, the knowledge and experience of the embroidery staff is very important.

In Figure 1 the interlining is used under the left embroidery, but it is not used in the right.

This example shows the importance of the usage of interlining clearly.

Figure 1. Embroidery appearance with (left) and without (right) the interlining

The interlining in embroidery can be used at the bottom as well as on top. The upper interlining is used for fabrics with high pile, velvet and terry fabrics, while the lower interlining is used for supporting the fabric. In Figure 2a, the upper interlining was not used. In the embroidery showed in Figure 2b, the upper interlining was used. The upper interlining is used to cover the surface of the fabrics and prevent the loop on the fabric surface from mixing with the embroidery pattern. In such applications, water-soluble upper interlining is preferred in order to prevent the damage to the surface pile while cleaning the interlining.



a) b)

Figure 2. Upper interlining usage in pile fabric

MATERIALS AND METHODS

Materials

In this research, nonwoven types of interlining, which are frequently preferred in the embroidery sector, have been chosen to evaluate the effect of interlining types with different properties on embroidery quality. Interlinings with cellulose-based (T1, T2, T5), PVA (T3) and PA 6 (T4) content were used in the study. The types of interlining and their weight and thickness values used in the study are given in Table 1 below.

Table 1. Weight and thickness values of interlinings used in the study

	Types of interlining	Weight (g/m²)	Thickness (mm)
T1	Single-coat torn interlining	31.76	0.16
T2	Spun bond interlining	51.50	0.41
T3	Two-coat torn interlining + one coat of sprayed interlining	29.86	0.44
T4	Water-soluble interlining	32.84	0.23
T5	Heat-melting interlining	35.08	0.04

Except from the interlining used in embroidery in the study, the parameters kept constant for the material and production are as given in Table 2.

Table 2. Constant parameters in the study

Yarn count	135/2 denier 100% PES embroidery yarn
Needle	70 Nm SUK
Pattern size	10 cm diameter circular embroidery
Number of strokes	10486
Machine	Tajima TFGN-1215 Model
Plain fabric	100% cotton, plain weave, m=120 g/m², d_{weft}=35 thread/cm, d_{warp}=45 thread/cm

The pattern studied in the application was prepared using the EOS Compucon 2.0 Embroidery pattern program (Figure 3).

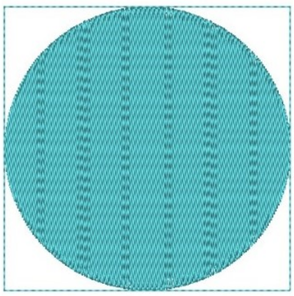


Figure 3. Pattern view

After the relevant embroidery parameters were determined, embroidery was made with five different interlining types. The weight and thickness information of the sample fabrics are as in Table 3 below. The sample N3 has the highest weight in the fabric and a single layer of tear interlining and the water-soluble interlining have the lowest weight. The thickness values of interlining types were found close to each other.

Table 3. Thickness and weight values of sample fabrics

Sample code	Interlining type	Weight (g/m^2)	Thickness (mm)
N1	Single-coat torn interlining	482.02	1.26
N2	Spun bond interlining	515.06	1.28
N3	Two-coat torn interlining + one coat of sprayed interlining	573.54	1.39
N4	Water-soluble interlining	482.30	1.26
N5	Heat-melting interlining	491.70	1.25

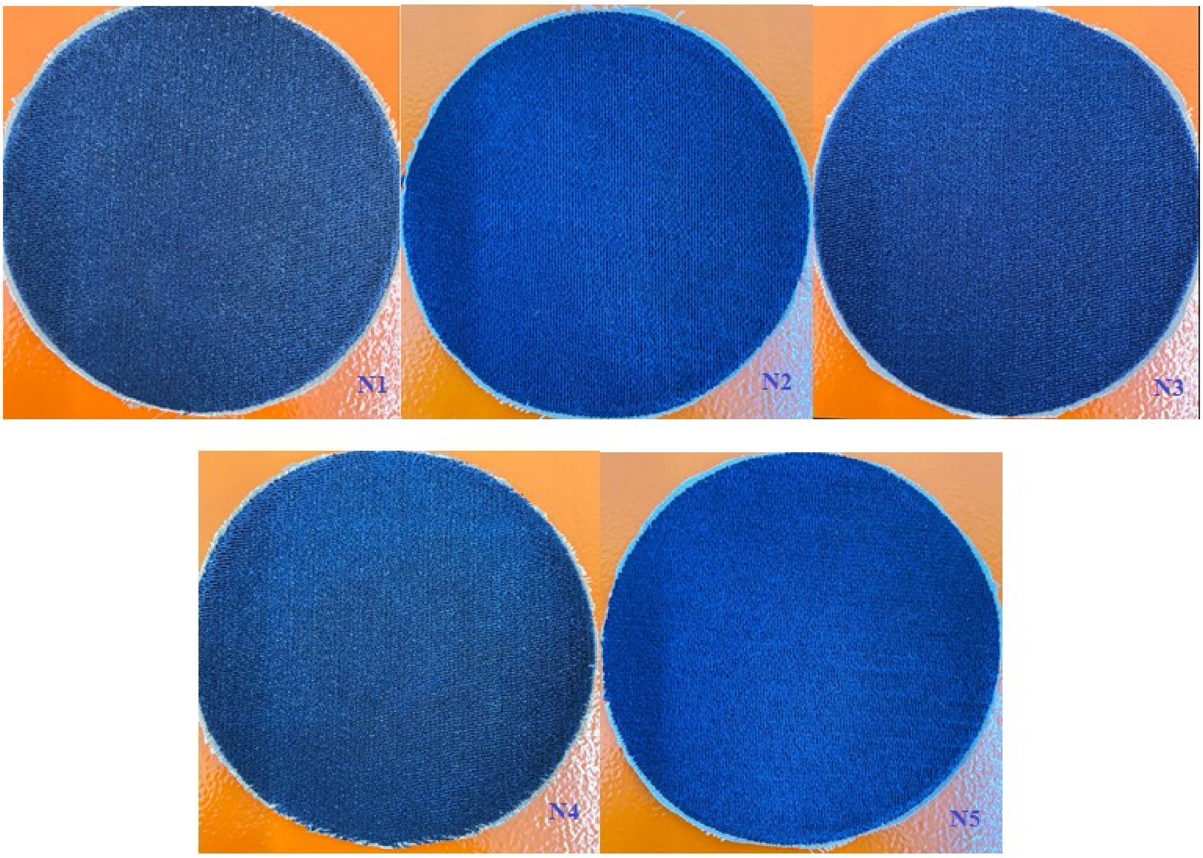


Figure 4. Front view of the embroidered surfaces

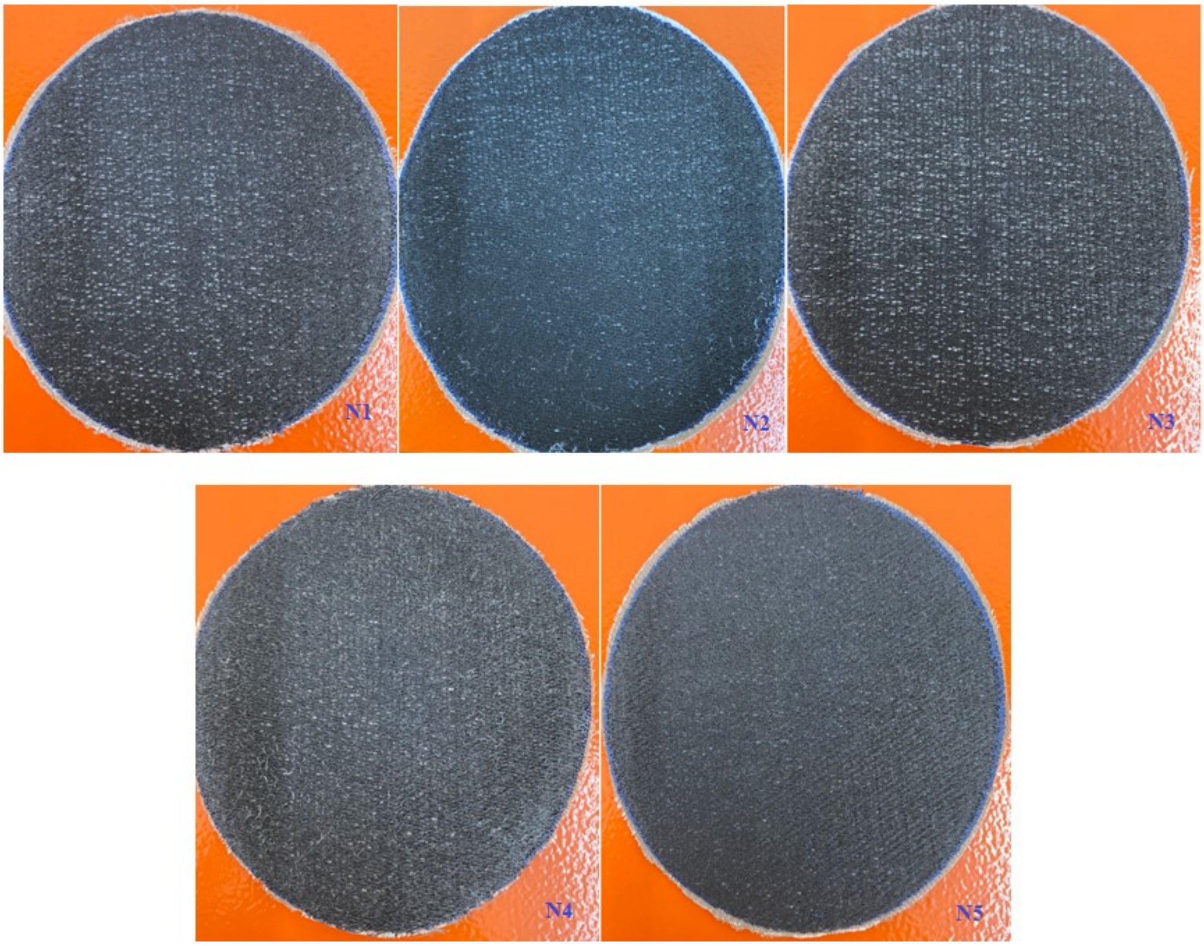


Figure 5. Back view of the embroidered surfaces

Methods

All the samples were conditioned for 24 hours in standard atmospheric conditions at 20°C ± 2°C temperature and 65% ± 4% relative humidity in a laboratory environment. The tests applied to the fabrics were carried out in Ege University Textile and Apparel Research and Application Center laboratories.

Weight per unit area

Square meter weights (g/m^2) of the used fabrics were performed with five test samples according to the ISO 3801 standard [17]. They were cut with grammage stencil having an area of 100 cm^2 and weighed in precision balance.

Thickness

Digital Thickness Gauge Modal M034A machine is used in this analysis. Thickness test was performed according to ASTM D 1777 by applying 200 g of load at 20 cm2 area of 10 test samples of each sample [18].

Circular bending rigidity

In circular bending rigidity test which gives fabric stiffness in all directions, a plunger forces a flat, folded swatch of fabric through an orifice in a platform. A plunger of 25.4 mm in diameter pushes the fabric through a 38 mm diameter orifice for a distance of 57 mm in 1.7 s [19]. The maximum force required to push the fabric through the orifice is an indication of the fabric stiffness. The circular bend procedure gives a force value in relation to fabric stiffness [20]. Tests were carried out according to the ASTM D 4032 test standard with five samples [21].

Air permeability

Measurements of air permeability of clothes were performed by Fx 3300 Air Permeability Instrument according to ASTM D 737 for air permeability test on 10 test samples of each sample, 100 Pascal pressure difference at 20 cm^2 area were applied [22].

Moisture transmission

Moisture transmission properties of the fabrics were measured with five test samples by MMT (Moisture Management Tester) instrument according to the related standard [23]. Properties measured with MMT test instrument can be listed as wetting time, absorption rate, maximum wetting diameter and spreading speed. This instrument provided objective measurement of moisture transmission of fabric. The fabric was kept at a horizontal position by top and low sensors under a certain pressure. A computer dynamically recorded resistance changes between each pair of metal rings standing next to top and low sensors. During the period of 20 s of pumping, test solution of 0.15 g was poured onto the top surface of the fabric that was transmitted in three directions within the test period of 120 s. Liquid spread from the point at the top of the fabric surface to the bottom and from the bottom of the fabric to the sides and finally evaporated.
Overall Moisture Management Capacity (OMMC) index was measured by this instrument, indicating multidirectional liquid transfer ability of the fabrics and changing between the values 0-1 [24].

Friction coefficient of the surface

Friction coefficients of the fabric surface were measured using Frictorq tester with five test samples. The upper body (contact sensor) consisted of three small special elements covered with steel needles. These elements were radially disposed at 120° and displaced at 90°. The lower body, which contains the sample, rotated around a vertical axis with a defined speed of 1.57 mm/s. The constant contact pressure was at 3.5 kPa [25]. Torque T was calculated using Equation (1) where F_a is the friction force at each pad and *r* is the distance to the centre [26].

$$T = F_a r \quad (1)$$

By definition, $F_a = \mu N$ and $N = P/3$, where P is the vertical load, the coefficient of friction is expressed using the Equation (2) below [26].

$$\mu = \frac{T}{Pxr} \quad (2)$$

All the test equipment used in the process is shown below in Table 4.

Table 4. The devices and machines used

Devices and machines	Trademark
Fabric weight measuring device	Sartorius Scales
Fabric thickness measuring device	SDL Atlas M034A
Circular Bending Rigidity	SDL Atlas 521470
Coefficient of friction measuring device	Frictroq 02
Air permeability measuring device	Textest Instruments FX330
Moisture transmission measuring device	SDL Atlas MMT

RESULTS AND DISCUSSION

The tests were performed on the samples after the embroidery process and the interlining types. In addition, the washing for the water-soluble interlining and the ironing for the heat-melting interlining was applied and the tests were repeated and results compared. The other interlining types were not cleaned as they were in the embroidery.

Air Permeability

Air permeability values of the interlining types and sample fabrics were given together in Figure 6. While the water-soluble interlining has the highest air permeability, the heat melting interlining has zero air permeability value. When the results of the sample fabrics were examined, the air permeability value of the two-coat torn interlining + one coat of sprayed interlining had the highest value. However, air permeability was low in all of embroidery areas in general.

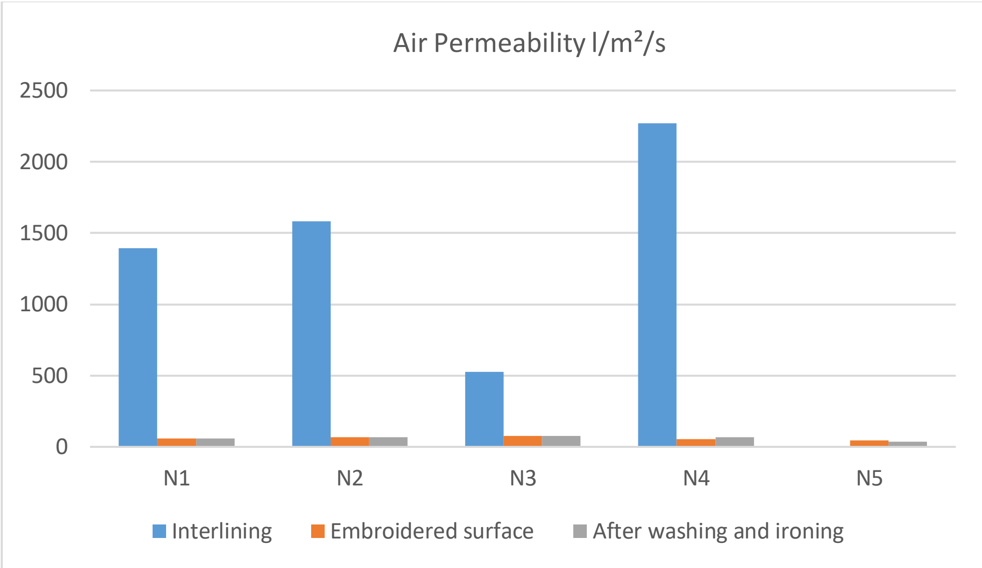


Figure 6. Air permeability values of sample fabrics

Circular Bending

Circular bending value of two-coat torn interlining + one coat of sprayed interlining was high. Circular bending value of the water-soluble interlining sample was measured low due to the soft feeling of the interlining.

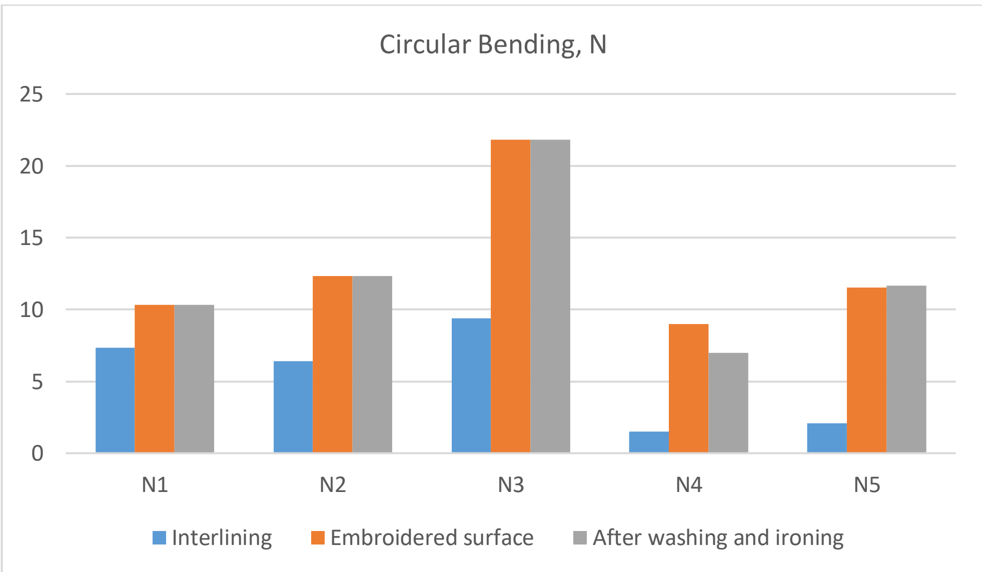


Figure 7. Circular bending values of sample fabrics

Moisture Transmission

The moisture transmission value of the water-soluble interlining was the highest. Moisture transmissions of the spun bond and heat-melting interlining types were not realized. After the embroidery process, moisture transmission was only possible with the use of single-coat torn interlining and water-soluble interlining. Due to the dense embroidered area, the cleaning of interlining was done only in water-soluble and heat-melting interlining types. Consequently, moisture transmission in these samples was increased.

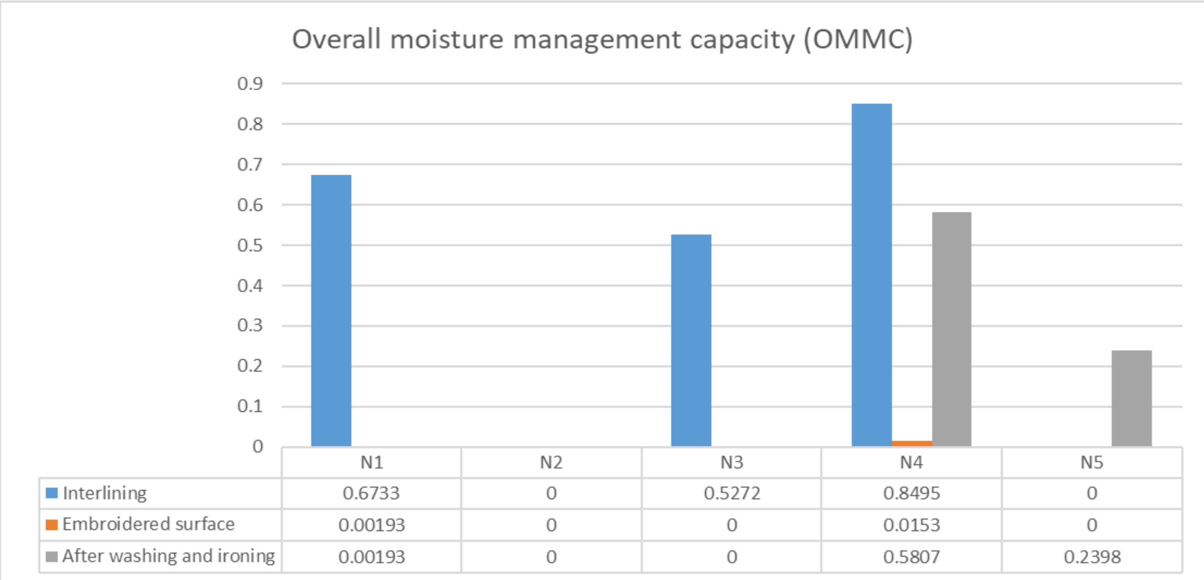


Figure 8. Overall moisture management capacity of all samples

Depending on the use of five different interlinings of the embroidered surfaces, the air permeability, circular bending and moisture transmission values before and after the washing and ironing processes were statistically analysed. Wilcoxon Sign Rank test was applied and the significance level was accepted as 0.05. According to the Wilcoxon sign rank test results, there was no significant difference between the test results before and after the washing and ironing processes of the embroidered surfaces.

Friction Coefficient

The kinetic friction coefficients of the embroidered surfaces were tested after the washing and ironing processes as they are in direct contact with the skin. The friction coefficients of sample fabrics were measured by the FricTorq device, which operates on torque principle. The measurement results are given in Figure 9 below. According to the surface, roughness and, consequently, the friction coefficient were affected due to the drape properties of the interlining types. The most intensive interlining usage was in N3 sample and its friction coefficient was high. The sample with the heat-melting interlining had the lowest friction coefficient value.

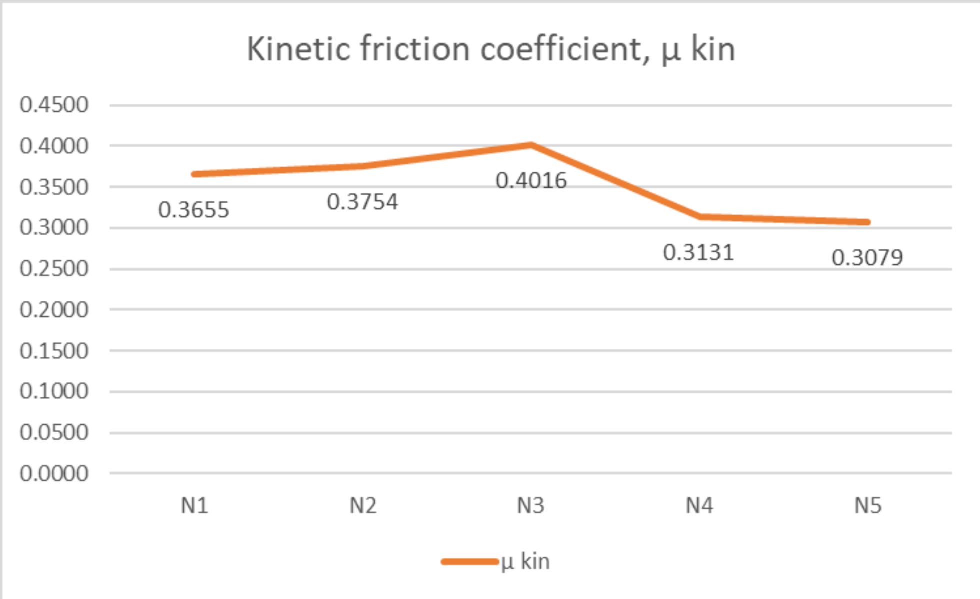


Figure 9. Kinetic friction coefficient of sample fabrics

CONCLUSION

As a result of the study, it was clear that interlinings have significant effect on clothing comfort of the embroidery area and embroidery quality. The heat-melting interlining, produced by the polyvinyl alcohol, has a plastic feel and its pores are very small. Therefore, the air permeability value is at minimum levels. However, the air permeability problem disappears when interlining in the product is removed by ironing after the production. Water-soluble interlining has the highest value in terms of air permeability due to its porous structure. The air permeability values of the embroidered surfaces obtained with five different interlinings before and after the washing-ironing were found to be quite low and close to each other.

According to the results of the circular bending test, N3 was found to be the highest depending on the hardness and weight of the surface. The test results of two-coat torn interlining + one coat of sprayed interlining had the highest weight and the embroidered areas with this interlining were found to be the highest. The interlining with the softest feel used here was the water-soluble interlining, so the circular bending value of the embroidered area using this interlining was also low. This interlining should be used for the embroidery processes of the surfaces that are expected to be soft. In tightly textured embroidery, the interlining may not melt completely after the ironing. For this reason, the interlining remains inside after the ironing and the hardness level of the surface can remain the same.

According to the moisture transmission test results, the sample with the water-soluble interlining was found as the best one with the highest value among others. The porous and soft features of this interlining allowed the possibility of moisture transmission. The usage of water-soluble interlining is suitable for clothing having direct contact with the skin and especially baby and kids' T-shirts. The embroidered surface obtained with the heat-melting interlining provides moisture transmission after the ironing. Other interlinings under embroidery that cannot be cleaned are suitable for embroideries that are used in smaller places that will not bother the skin, such as the brand logo. This study has been a guide for the criteria to be considered in interlining selection with tests.

As a result, the use of water-soluble interlining in large-area embroideries gave better results in terms of comfort properties. However, it is more appropriate to use as small embroideries as possible on surfaces in contact with the skin. The embroidery should not be placed in areas that will disturb the comfort of the person. The embroidery should be applied on the parts of the clothes that are not in direct contact with the skin, such as collars, pockets, hems or on outer garments.

Author Contributions

Conceptualization – Bahadır Ünal Z; methodology – Bahadır Ünal Z and Acar E; formal analysis – Bahadır Ünal Z and Acar E; writing- review and editing – Bahadır Ünal Z and Acar E; visualization – Acar E; supervision – Bahadır Ünal Z. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Funding

This research received no external funding.

Acknowledgements

The authors would like to appreciate to the company for material supply and the embroidery processes and Ege University Textile and Apparel Research and Application Center for their support in testing.

REFERENCES

[1] Ghazali R, Khan SM, Khalid M, Basaree RO, Anwar R. Textile designs embellishments: rethink design models for fish scales texture pattern study. The Turkish Online Journal of Educational Technology. 2015; 491-499

[2] Chen X, McCool M, Kitamoto A. Mann S. Embroidery modeling and rendering. In: Graphics Interface Conference 2012 [Internet]; 28-30 May 2012; Toronto, Ontario, Canada. ACM; p. 131-139. Available from: https://dl.acm.org/doi/pdf/10.5555/2305276.2305299

[3] Juciene M, Radaviciene S. Influence of embroidery threads on the accuracy of embroidery pattern dimensions. Fibres & Textiles in Eastern Europe. 2012; 3 (92):92-97.

[4] Daukantiene V, Mikelionyte K. Investigation of the influence of technology parameters and thread type on embroidered textile element quality. Autex Research Journal. 2020; 20(4):517-523. https://doi.org/10.2478/aut-2019-0046

[5] Anderson KM. Machine embroidery: Tools, techniques, and technologies, AATCC Review. 2005; 5(8):27-30.

[6] Karamuk E, et al. Embroidery Technology for Medical Textiles. In: Anand S, editor. Medical Textiles. Proceedings of the International Conference; 24-25 Aug 1999; Bolton, UK. Woodhead Publishing; 2001. p. 200-206.

[7] Radaviciene S, Juciene M, Juchneviciene Z, Cepukonet L, Kleveckas T, Narviliene V. The influence of the properties of embroidery threads on buckling of fabric inside of the embroidered element. Materials Science. 2012; 18(4):373-378. https://doi.org/10.5755/j01.ms.18.4.3100

[8] Zhang Y, Ng J, Tan J. Parameter analysis in fashion embroidery design. In: 86th Textile Institute World Conference; 18-21 Nov 2008; Hong Kong. Textile Institute; 2008. p. 2460-2472.

[9] Manal E, Seif A, Nasr MM. Influence of embroidery stitches on the properties of textile fabrics. Textile Asia, 2012; 43(9):27-30.

[10] Ripka G, Mychko A, Deyneka I. The analysis of machine embroidery stitches types classification. Teka Commission of Motorization and Power Industry in Agriculture. 2014; 14(2):120-126.

[11] Kuo CFJ, Juang Y. A study on the recognition and classification of embroidered textile defects in manufacturing. Textile Research Journal. 2016; 86(4):393–408. https://doi.org/10.1177/0040517515590410

[12] Mecnika V, Hoerr M, Krievins i, Jockenhoevel S, Gries T. Technical embroidery for smart textiles. Materials Science. Textile and Clothing Technology. 2014; 9:56–63. https://doi.org/10.7250/mstct.2014.009

[13] Boz S. Investigation of the Effects of Embroidery Parameters on Physical Properties and Thermal Comfort. Tekstil ve Konfeksiyon. 2022; 32(1): 86-92. https://doi.org/10.32710/tekstilvekonfeksiyon.940003

[14] Akcagun E, Dal V, Atmaca M, Yildiz Z, Kurtulus A. The effects of interlining on comfort properties of wool fabrics. In: Proceedings of the International Istanbul Textile Congress; 30 May - 1 Jun 2013; Istanbul, Turkey. p. 1-5.

[15] Sharma KR, Behera BK, Roedel H, Schenk A. Effect of sewing and fusing of interlining on drape behaviour of suiting fabrics. International Journal of Clothing Science and Technology. 2005; 17(2):75-90. https://doi.org/10.1108/09556220510581227

[16] Yildiz EZ, Özdil N. Subjective and objective evaluation of the handle properties of shirt fabric fused with different woven interlinings. Tekstil ve Konfeksiyon. 2014; 24(1):47-55.

[17] ISO 3801:1977. Textiles-Woven fabrics-Determination of mass per unit length and mass per unit area. Available from: https://www.iso.org/standard/9335.html

[18] ASTM D1777-96(2019). Standard Test Method for Thickness of Textile Materials. Available from: https://www.astm.org/d1777-96r19.html

[19] SDL Atlas Textile Testing Solutions. Digital Pneumatic Stiffness Tester. 2022. Available from: https://sdlatlas.com/products/digital-pneumatic-stiffness-tester

[20] Kayseri Go, Ozdil N, Mengüç GS. Sensorial comfort of textile materials. In: Jeon HY, editor. Woven Fabrics [Internet]. InTechOpen; 2012. Chapter 9, p. 235-266.

[21] ASTM D4032-08(2016). Standard Test Method for Stiffness of Fabric by the Circular Bend Procedure. Available from: https://www.astm.org/d4032-08r16.html

[22] ASTM D737-18. Test Method for Air Permeability of Textile Fabrics. Available from: https://www.astm.org/d0737-18.html

[23] AATCC Test Method 195-2011. Liquid Moisture Management Properties of Textile Fabrics. Available from: http://www.eytest.com/images/aatcc195-2011.pdf

[24] Hatamlou M, Ozguney AT, Ozdil N, Menguc GS. Performance of recycled PET and conventional PES fibers in case of water transport properties. Industria Textila. 2020; 71(6):538-538. https://doi.org/10.35530/IT.071.06.1691

[25] Lima M, Silva LF, Vasconcelos R, Cunha J. FRICTORQ, Design for the objective measurement of friction in 2D soft surfaces. In: Proceedings of the 13th International Congress on Project Engineering; 8-10 Jul 2009; Badajoz, Spain. p. 1728-1736.

[26] Lima M, Vasconcelos RM, Silva LF. Cunha J. Analysis of the friction coefficient in fabrics made from non-conventional blends. Tekstil ve Konfeksiyon. 2008; 19(1):15-19.