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EFFECT OF DIFFERENT FINISHING PROCESSES ON ABRASION RESISTANCE OF UPHOLSTERY FABRICS PRODUCED FROM POLYESTER AND ACRYLIC CHENILLE YARNS

POLYESTER VE AKRİLİK ŞENİL İPLİKLERDEN ÜRETİLEN DÖŞEMELİK KUMAŞLARIN AŞINMA DİRENCİNE FARKLI TERBİYE İŞLEMLERİNİN ETKİSİ

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ABSTRACT

Abrasion resistance is one of the primary performance features of chenille fabrics, which have been widely preferred in upholstery production for many years. Therefore, enhancing abrasion resistance is a critical consideration for fabrics containing chenille yarn, as it significantly impacts their performance in various applications. One effective method of improving the abrasion resistance of chenille fabrics is through the finishing processes applied to upholstery fabrics, which play a crucial role in enhancing their durability and longevity. To achieve this, in our study, fabrics were produced using chenille yarn made from two different raw materials, and four distinct finishing processes were applied to these fabrics to assess their impact on performance. Then, the abrasion resistance of the fabrics was measured according to international standards. The results of the abrasion resistance test, including the pile loss, were comprehensively evaluated through both graphical and statistical analyses. Based on these evaluations, the finishing processes that proved to be most effective in enhancing abrasion resistance were identified, thoroughly examined, and discussed in detail.

Keywords: Upholstery fabric, chenille yarn, abrasion resistance, finishing processes

ÖZET

Aşınma direnci, uzun yıllardır döşemelik üretiminde yaygın olarak tercih edilen şenil kumaşların temel performans özelliklerinden biridir. Bu nedenle, şenil iplik içeren kumaşlarda aşınma direncinin artırılması, farklı kullanım alanlarındaki performanslarını doğrudan etkileyen kritik bir husustur. Şenil kumaşların aşınma direncini iyileştirmenin etkili yöntemlerinden biri, döşemelik kumaşlara uygulanan bitim işlemleridir. Bu işlemler, kumaşların dayanıklılığını ve kullanım ömrünü artırmada önemli rol oynamaktadır. Bu doğrultuda, çalışmamızda iki farklı hammaddeden üretilmiş şenil iplik kullanılarak kumaşlar dokunmuş ve bu kumaşlara dört farklı bitim işlemi uygulanarak performans üzerindeki etkileri incelenmiştir. Daha sonra, kumaşların aşınma dirençleri uluslararası standartlara göre ölçülmüştür. Aşınma direnci test sonuçları, hav kaybı da dâhil olmak üzere hem grafiksel hem de istatistiksel yöntemlerle kapsamlı biçimde değerlendirilmiştir. Bu değerlendirmeler sonucunda, aşınma direncini artırmada en etkili olan bitim işlemleri belirlenmiş, ayrıntılı olarak incelenmiş ve tartışılmıştır.

Anahtar Kelimeler: Döşemelik kumaş, şenil iplik, aşınma dayanımı, bitim işlemleri

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INTRODUCTION

Chenille yarn generally composed of two twisted core yarns and short lengths of pile yarn is widely recognized for its distinct, velvet-like surface, making it a popular choice in the production of various textiles, especially upholstery fabrics. Although this yarn structure is aesthetically pleasing, its abrasion resistance is not very high due to its nature. The pile yarns, which project out from the core, can experience damage during use or processing, leading to the shedding of fibers and a bare appearance, further compromising the durability of chenille fabrics. As such, the abrasion resistance of chenille yarns has been a focal point in textile research, with studies highlighting the influence of fiber properties, yarn twist, yarn count, and fabric finishing processes on the performance of the yarn (Ceven et al., 2007)

The demand for chenille yarns is particularly high in upholstery, where the fabric must not only offer visual appeal but also meet durability standards. Upholstery fabrics made from chenille are expected to have high abrasion resistance and durability under various conditions. The finishing processes applied to chenille fabrics play a crucial role in enhancing these properties. However, due to the yarn structure, issues like pile loss is common challenges that affect the performance of chenille upholstery fabrics. Researchers have explored the effects of yarn structure, material composition, and finishing process on abrasion resistance, finding that these factors significantly influence the pile loss and overall durability of the yarns (Ozdemir & Ceven, 2005).

In response to the growing demand for high-performance upholstery fabrics, manufacturers have increasingly focused on improving the abrasion resistance of chenille yarns by using advanced processing techniques and innovative materials. (Sener et al., 2022). The incorporation of finishes, such as softening treatments, water/oil repellent finishes, and calendering processes, further enhances the fabric's performance, ensuring it meets both aesthetic and functional requirements (Ilhan, 2017). As the textile industry continues to develop, particularly with the growing importance of home textile applications, the development of chenille yarns with improved abrasion resistance remains a key area of focus. This study aims to explore various methods for enhancing the durability of chenille fabrics, examining the role of finishing processes in improving their abrasion resistance.

In his study, Ilhan I. investigated how factors like twist level, binder yarn, and yarn count affect the abrasion resistance of chenille fabrics. Through both theoretical modelling and statistical analysis, he found that binder yarn count and twist level significantly influence the breaking force of chenille yarns. Additionally, chenille yarn count was identified as a key factor for breaking elongation (Ilhan, 2017). Unal B. et al. examined the impact of water-repellency finishing on the performance of chenille fabrics, particularly in relation to abrasion resistance. Different chenille yarns, made from various raw materials such as polyester, acrylic, and viscose, were used to weave upholstery fabrics. Water-repellency finishing was applied using fluorocarbon-based chemicals. The study found that the water-repellent finish improved the abrasion resistance of the fabrics, as finished samples showed less wear compared to untreated ones. However, after abrasion, the water-repellency properties of the fabrics were negatively affected (Unal et al., 2019). Özdemir et al. conducted a study on the abrasion resistance of chenille yarns, produced with various material types. The yarns were produced using different pile length, twists and their performance was measured using abrasion resistance testing devices. The study found that increasing the twist, pile length, can increase fabric performance (Ozdemir & Ceven, 2005). Babaarslan & Ilhan (2005) investigated the effect of pile length on the abrasion resistance of chenille fabrics. Chenille yarn samples with varying pile lengths were woven into upholstery fabric and subjected to Martindale abrasion testing. The results revealed that pile length significantly influences the mass loss of chenille yarns. As pile length increased, the rate of mass loss also increased. The smallest mass loss occurred with the shortest pile length, and it was observed that the removed fibers were not only pulled out but also broken during abrasion Utku S. et al. explored the impact of twist levels, pile lengths, and weaving constructions on the abrasion resistance of upholstery fabrics. Different acrylic chenille yarns were produced with varying twist levels and pile lengths, and these yarns were then used in different weaving constructions as weft yarns. The samples were tested for abrasion resistance using the abrasion test machine The results showed that twist levels, pile lengths, and weaving constructions significantly influence the abrasion resistance of upholstery fabrics (Utku et al., 2003)

Sener A. et al. examined factors affecting the abrasion resistance of chenille yarns in upholstery fabrics to improve their quality, durability, and performance. The study focused on viscose and polyester yarns with different production parameters, such as yarn state (fixed/unfixed) and twist values. The yarns were woven into fabrics and tested for abrasion resistance using the Martindale Test Machine, which measures friction and impact. The study aimed to advance chenille yarn production in this field (Sener et al., 2022).

Ceven et al. studied the abrasion resistance of chenille yarns made from wool and wool-polyester blends using sirospun and two-folded ring yarns. They tested the abrasion resistance the chenille fabrics using a Martindale Abrasion Tester and analysed abrasion behavior with image analysis. The study found that wool blends and sirospun yarns improved abrasion resistance, with strong correlations between mass loss and abrasion coefficients (Ceven & Ozdemir, 2006). Tekoglu et al., examined the effects of chenille yarn and four different raw materials (acrylic, cotton, polyester, and viscose) on the abrasion and tensile properties of woven upholstery fabrics. The study found that yarn type and material significantly impacted these properties. Cotton and polyester chenille yarns showed better abrasion resistance, with polyester chenille fabrics exhibiting the highest tensile strength. Viscose chenille fabrics were more susceptible to abrasion. Yassin M. (2023), investigated the effect of weaving structure on the efficiency properties of upholstery fabrics. Four different weaving structures were produced using chenille yarns. The study tested fabric friction, pilling, thickness, weight, and tensile properties. The results showed that weaving structure significantly influences the efficiency properties of upholstery fabrics. Shanbeh M. et al. (2014) studied the effect of abrasion on color change and reflectance in woven fabrics with acrylic chenille weft and cotton warp yarns. The results showed that higher abrasion levels decreased reflectance and increased color change, with fabrics having higher weft density being more affected. Weft density had the most impact on reflectance, while abrasion cycles were key for color change. Regression models showed strong correlations for both properties.

The originality of this study lies in its novel approach to improving the abrasion resistance of upholstery fabrics by applying four specific processes to the fabric. While previous studies have explored the impact of factors such as yarn properties, material types, and weaving structure on abrasion resistance, the effect of applied various processes on this characteristic has not been extensively studied. In this context, this work investigates the influence of four widely used processes; thermofixing, calendering, softening, and fluorocarbon finishing treatments on the abrasion resistance of upholstery fabrics. These processes are commonly employed in the upholstery industry to enhance the aesthetic and functional properties of fabrics. However, their combined effects on fabric abrasion resistance have not been previously explored in such a systematic manner. This study not only applies these processes individually but also compares their effectiveness in improving the abrasion resistance of upholstery fabrics. The findings offer new insights into which process has the most significant impact on improving abrasion resistance. As such, this work fills a gap in the existing literature and makes a valuable contribution both theoretically and practically, especially for the upholstery industry.

MATERIALS AND METHODS

In this study, polyester and acrylic chenille yarns were used as weft threads to produce two types of fabric with a plain weave structure on polyester warp. In all samples, 100% polyester filament yarns were used as warp yarns with 169 dtex and 350 TPM twist. The warp beam preparation process was carried out on a "Devsan" brand warping machine at a speed of 300 m/min, resulting in a warp beam consisting of 9600 ends. After weaving, the fabrics underwent four finishing treatments thermofixing, softening, calendering, and fluorocarbon finishing to enhance their surface characteristics and overall quality. The abrasion resistance was tested at specified rubs to evaluate the impact of yarn type and finishing treatments on fabric durability. The detailed properties of the yarns used in the warp and the weft direction, including their fiber composition and twist, are provided in Table 1.

Table 1. Technical properties of the warp and weft yarns used in fabric production

Yarn position	**Materials**	**Yarn Count**		**Twist**		**Breaking Strength**		**Breaking Elongation**	
		dtex	**%CV**	**TPM**	**%CV**	**cN/dtex**	**%CV**	**%**	**%CV**
Warp	Polyester Yarn	169	%0.59	350	%1.42	4.1	%0.6	24.7	%1.01
Weft	Polyester chenille yarn	2740	%1.67	830	%8.10	0.46	%5.45	28.5	%7.64
Weft	Acrylic chenille yarn	2760	%1.91	875	%0.98	0.36	%10.3	15.7	%21.72

A PREISA brand precision scales were used to accurately measure the yarn numbers, ensuring determination of the yarn weight and count. Additionally, the breaking strength and breaking elongation of the yarns were measured using the UCK strength testing device, providing reliable data on the mechanical performance of the yarns under stress. The yarn twist was measured using the UNIVERSAL twist tester, offering important insights into the yarns' structural integrity and processing characteristics. Using the yarns specified in Table 1, two distinct types of fabric were produced on a DORNIER brand weaving loom, operating at a speed of 400 picks per minute (PPM), while keeping the warp constant throughout the process. For the weft, polyester and acrylic chenille yarns were employed to assess their impact on fabric characteristics. Given that four different finishing processes were applied, the fabrics were woven in four separate passes to ensure thorough treatment and consistent results across all finished fabric samples. The properties of the raw woven fabric samples are presented in Table 2.

Table 2. Technical properties of the raw fabric samples

Raw Fabric Code	Weft yarn type	Warp yarn type	Warp density (Threads/cm)	Weft density (Threads/cm)	Weave type
F1	Polyester chenille yarn	Polyester Yarn	66	7	Plain
F2	Acrylic chenille yarn	Polyester Yarn	66	7	Plain

The fabrics, designated as F1 and F2, underwent a detailed and systematic series of finishing treatments aimed at optimizing various fabric characteristics. These treatments included thermofixing, which was employed to enhance the dimensional stability and structure of the fabrics, softener finishing to significantly improve the tactile softness and overall comfort, fluorocarbon treatment to provide superior water and stain resistance, and calendering processes to impart a smooth, glossy, and polished surface finish. Each of these processes was applied sequentially to thoroughly assess their cumulative impact on the fabric's mechanical and functional properties. The primary aim of this research is to thoroughly examine how these processes, which are frequently applied in upholstery, influence the abrasion resistance of fabrics and to comprehensively assess their overall impact on the fabric's long-term durability and performance. By exploring these effects, the study aims to provide valuable insights into how the joint application of these processes can enhance fabric performance, particularly in terms of longevity and wear resistance in real-world applications.

In this study, four distinct finishing processes were systematically applied to fabrics labeled as F1 and F2. To create unique identification codes for the finished fabrics, the first letter of each corresponding treatment was appended to the base fabric code. Specifically, the letter 'T' denoted Thermofixing, 'S' represented Softener treatment, 'F' indicated Fluorocarbon treatment, and 'C' stood for the Calendering process. The detailed properties and codes of the finished fabrics, resulting from the application of these treatments, are presented in Table 3 for further analysis and comparison.

Table 3. Properties of the finished fabric samples

Finished Fabric Code	Raw Fabric Code	Finishing Process	Warp density (Threads/cm)	Weft density (Threads/cm)	Weft crimp value (%)	Fabric Weight (g/m2)
F1-T	F1	Thermofixing	69	7.2	1.8	309
F1-S	F1	Softening	69	7.2	1.0	342
F1-F	F1	Fluorocarbon	69	7.2	1.3	316
F1-C	F1	Calendering	69	7.2	1.3	365
F2-T	F2	Thermofixing	70	7.3	1.3	320
F2-S	F2	Softening	70	7.3	1.3	338
F2-F	F2	Fluorocarbon	70	7.3	1.4	330
F2-C	F2	Calendering	70	7.3	1.4	368

The thermofixing process was conducted using an EFFE brand stenter machine equipped with eight drying units, with the temperature of each unit set to 130°C. In the softening treatment, prior to entering the stenter machine, 30 g/l softener was applied via the impregnation method. The fabric was then subjected to a drying process at 150°C. For the fluorocarbon treatment, 20 g/l chemical solution was applied using the impregnation method, followed by drying at 150°C. Both the softening and fluorocarbon chemicals were sourced from EKSEN Chemical Company. In the calendering process, a TURAL brand machine was employed to perform felted calendering at 170°C. All processes were conducted individually, with the fabric usable width consistently adjusted to 140 cm. It is important to note that the process parameters remained identical for both polyester and acrylic chenille fabrics.

The abrasion resistance of the upholstery fabrics, produced through the application of four distinct finishing processes, was evaluated in accordance with the 'ISO 12947-3 / determination of the abrasion resistance of fabrics by the martindale method - Part 3: determination of mass loss' standard.

In this method, a circular specimen is placed in a specimen holder and subjected to a defined load while being rubbed against a standard abrasive fabric. The movement follows a translational path that traces a Lissajous figure and the specimen holder can rotate freely around its axis perpendicular to the specimen plane according to ISO 12947 standard (Lissajous motion). Each test is performed using 3 specimens per fabric type, and the mean values were used for evaluation. To prevent fiber loss effect during specimen handling, ISO 12947-3 was strictly followed. Each fabric was tested on separate Martindale specimen heads to prevent fiber transfer, and three tests per fabric were averaged to ensure reliable and repeatable results.

The abrasion resistance is assessed by measuring the mass loss of the specimen after testing. Specimens are mounted with foam backing, except for those with a mass per unit area greater than 500 g/m², which are mounted without foam. For pile and cord fabrics tested without foam, a specified preparatory treatment is applied. The abrasion load, consisting of the specimen holder assembly and the appropriate loading piece, has a total effective mass of (795 ± 7) g, corresponding to a nominal pressure of 12 kPa, which is used for workwear, upholstery, bed linen, and technical fabrics.

In the study, the fabric tests were conducted using an abrasion and pilling test machine from the JAMES HEAL brand, which is specifically designed for accurate and reliable performance evaluations. This machine was utilized to assess the fabrics' resistance to abrasion performance under controlled conditions. A detailed image of the test machine can be seen in Figure 1, providing further insight into the equipment used for the testing process.

Figure 1. Martindale Abrasion and Pilling Test Device

RESULTS AND DISCUSSION

The produced samples were evaluated for abrasion resistance following the ISO 12947-3 standard, with testing conducted across a range of specified rubs, from 1,000 to 16,000, to assess the durability and wear performance under controlled, standardized conditions. The pile loss data for all samples, corresponding to the specified number of rubs, are systematically are illustrated in Figure 2 and Figure 3, providing a clear comparison of the wear behavior of the different fabric treatments and compositions.

Upon examining Figures 2 and 3, it becomes evident that the felted calendering process significantly outperforms other treatments in enhancing the abrasion resistance of upholstery fabrics, particularly those composed of both polyester and acrylic chenille yarns. Upon reviewing the other processes, it is clear that the thermofixing process proves to be more effective in enhancing abrasion resistance than the fluorocarbon process. Furthermore, it is apparent that the softening treatment yields even more significant improvements in abrasion resistance, outperforming both the thermofixing and fluorocarbon processes. When evaluating all processes and raw materials across tests ranging from 1,000 to 16,000 rub. Among the fabrics treated with softening, the results are more favorable for polyester fabrics compared to acrylic fabrics. As demonstrated by the findings, the softening treatment is particularly effective in enhancing the abrasion resistance of polyester fabrics. However, it appears to be less impactful on acrylic fabrics, indicating that while the softening process is a preferred method for improving the durability of polyester, its effectiveness for acrylic fabrics is limited. Along with these evaluations, the performance of the fabrics based on their raw materials is clearly presented in Figure 2 and Figure 3, offering a comparative overview of how different fabric compositions and treatments affect abrasion resistance and durability.

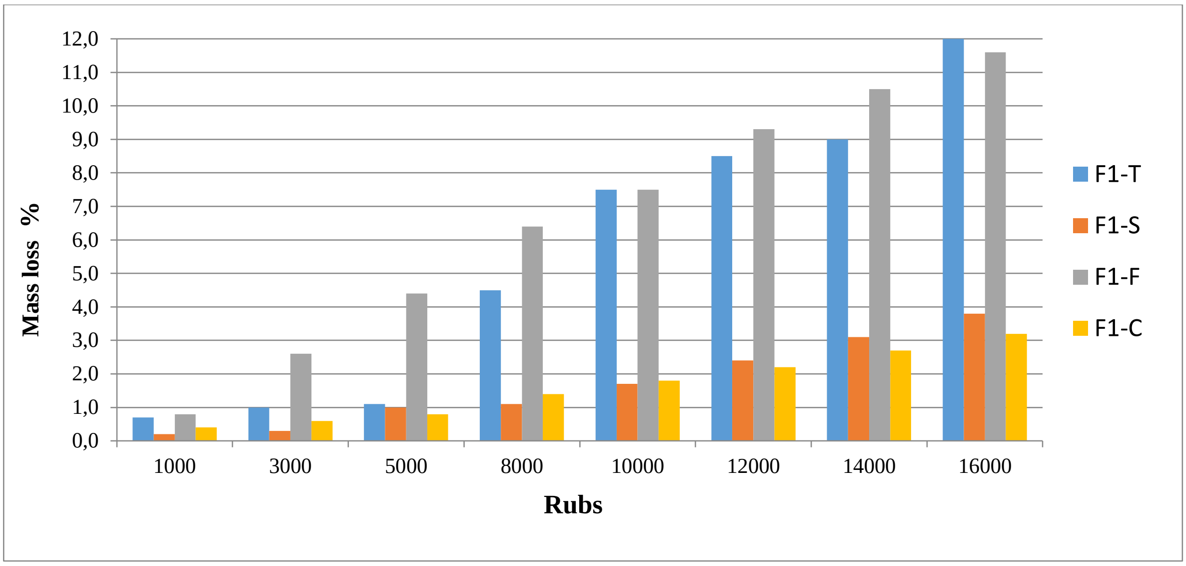

Figure 2. The pile loss graph of polyester chenille yarn fabrics

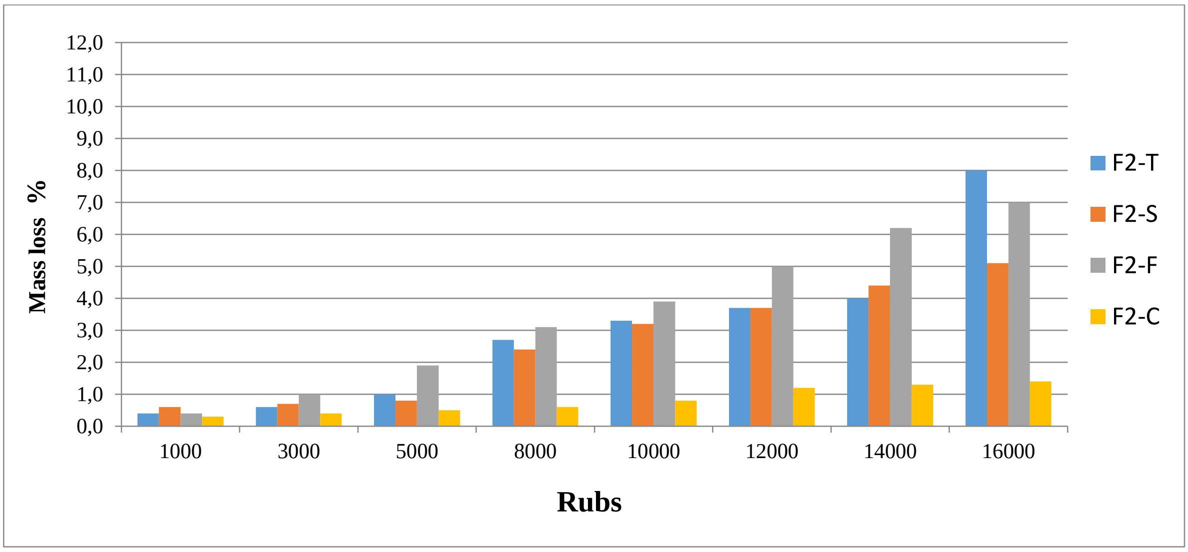

Figure 3. The pile loss graph of acrylic chenille yarn fabrics

Upon examining Figure 2, it becomes evident that in polyester chenille fabrics, the thermofixing, softening, and felted calender processes exhibit a mass loss of less than 1.5% within the initial 5000 rubs, indicating strong resistance to abrasion in the early stages of use. Among these processes, the softening and felted calender treatments demonstrate a mass loss of less than 4% after 16,000 rubs, a result that can be considered highly successful in terms of durability and long-term performance. These treatments not only maintain the fabric's structural integrity but also offer enhanced resilience to wear compared to untreated fabrics. In contrast, the fluorocarbon treatment displays comparatively lower efficacy in enhancing abrasion resistance when juxtaposed with the other methods. This suggests that while the fluorocarbon process may provide some degree of protection, its performance in increasing the fabric's resistance to mechanical abrasion is less substantial, thereby limiting its overall effectiveness in this context.

When analysing Figure 3, it is apparent that in acrylic chenille fabrics, the mass loss across all processes remains below 2% within the initial 5000 rubs, indicating relatively strong resistance to abrasion in the early stages of use. Furthermore, after 16,000 rubs, the mass loss performance of felted calender processes, which remains below 5%, is particularly noteworthy, demonstrating their ability to maintain fabric integrity under extended wear conditions. This outcome underscores the effectiveness of these treatments in prolonging the fabric's durability. Similar to the results in polyester chenille fabrics, the fluorocarbon process is the least effective in enhancing abrasion resistance in acrylic chenille fabrics, showing inferior performance compared to the other processes.

Overall, when the test results are examined, it is evident that the process with the most positive effect on both polyester and acrylic upholstery fabrics is the felted calendering process. This method enhances the abrasion resistance of the fabrics by compressing the fabric surface, strengthening the bond between fibers, and reducing surface roughness, which collectively improve the fabric's durability and overall performance. Following felted calendering, the softening process for polyester chenille fabrics emerges as the second most effective treatment for enhancing abrasion resistance. The softening process contributes to this improvement by applying a protective, elastic layer to the fabric, which not only reduces friction but also minimizes fiber wear, thereby preserving the fabric's integrity over time. This protective process also helps to maintain the aesthetic qualities of the fabric, such as its texture and appearance, making it an excellent choice for improving the longevity of upholstery material. In contrast to this, it is observed that the softening process does not achieve the desired effect on acrylic chenille fabrics.

Statistical analysis

Statistical analysis using the t-test was conducted on the test results which are in Table 4. For this analysis, performance values were measured for finished fabrics subjected to 1000 to 16,000 rubs. All parameters were evaluated statistically, and the relationships between the finishing process and raw material were analyzed through the t-test. Statistically significant relationships were identified between the finishing process and raw material ($p<0.05$). The performance values exhibited significant changes after abrasion ($p<0.05$), indicating a clear impact of the finishing process on fabric durability. Statistical analyses are shown in Table 4 and Table 5. In Tables 4 and 5, the processes applied to polyester and acrylic chenille fabrics are statistically evaluated based on the outcomes of the thermofixing process. The primary rationale for selecting the thermofixing process in this context is its essential role as a foundational process for all upholstery fabrics. This process facilitates width adjustment of the fabrics, thereby ensuring their stability.

Table 4. Statistical analysis according to the t-test for polyester chenille fabrics

Comparative Properties	**Sig. Value**	**Signification Status**
Thermofixing - Softening	0.03	Significant
Thermofixing - Fluorocarbon	0.59	Not significant
Thermofixing - Calendering	0.02	Significant

Table 5. Statistical analysis according to the t-test for acrylic chenille fabrics

Comparative Properties	Sig. Value	Signification Status
Thermofixing - Softening	0.75	Not significant
Thermofixing - Fluorocarbon	0.63	Not significant
Thermofixing - Calendering	0.03	Significant

Upon examining Tables 4 and 5, it is evident that the results of applying the felted calendering process are statistically significant for both polyester and acrylic chenille fabrics when compared to the thermofixing process. In contrast, the application of the softening process yields statistically significant results only for polyester chenille fabrics. It was observed that the abrasion results of fabrics treated with the fluorocarbon process are not statistically significant when compared to those treated with the thermofixing process. Additionally, when comparing polyester and acrylic fabrics across all process values, some little differences in the results are observed. However, according to the statistical analyses, since the p-values exceed 0.05, it can be concluded that these differences are not statistically significant. This is illustrated in Table 6.

Table 6. Statistical analysis according to the t-test for both polyester and acrylic chenille fabrics

Process	Sig. Value	Signification Status
Thermofixing	0.16	Not significant
Softening	0.26	Not significant
Fluorocarbon	0.07	Not significant
Calendering	0.06	Not significant

To complement the statistical evaluations, visual observations of surface wear were also carried out, providing an additional layer of insight into the fabrics’ performance under repeated abrasion rubs. Representative images of the polyester (PES) and acrylic (PAN) chenille fabrics, took both before the test and after all abrasion cycles, are presented in Figure 4 and Figure 5. These images allow for a direct visual comparison of the effects of the finishing processes on surface integrity. By correlating these visual observations with the quantitative results, it becomes evident how each finishing treatment influences wear resistance, as well as how the two different fiber types respond uniquely to repeated mechanical stress.

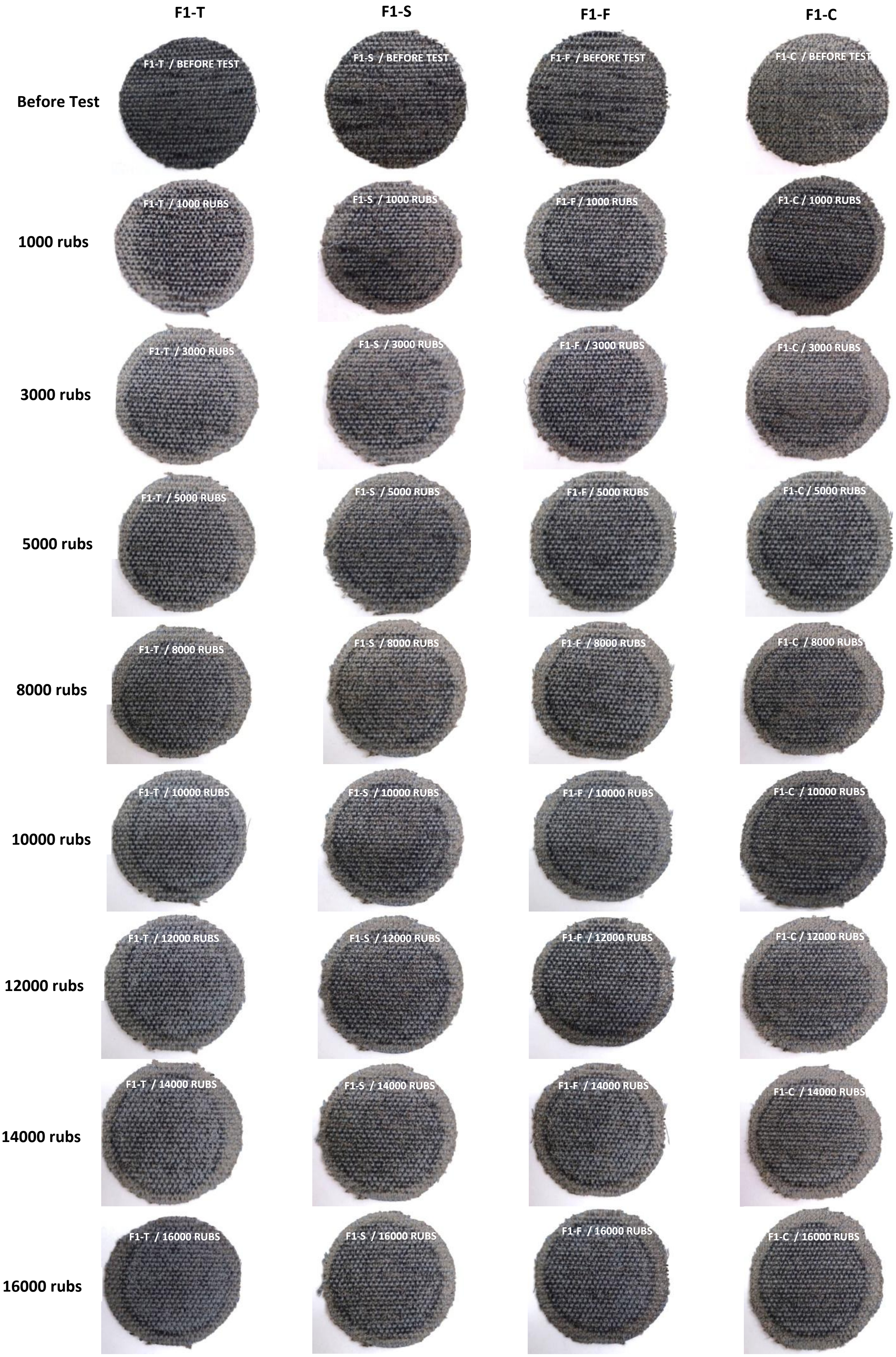

Figure 4. Comparative surface wear of polyester (PES) chenille fabrics under increasing abrasion cycles

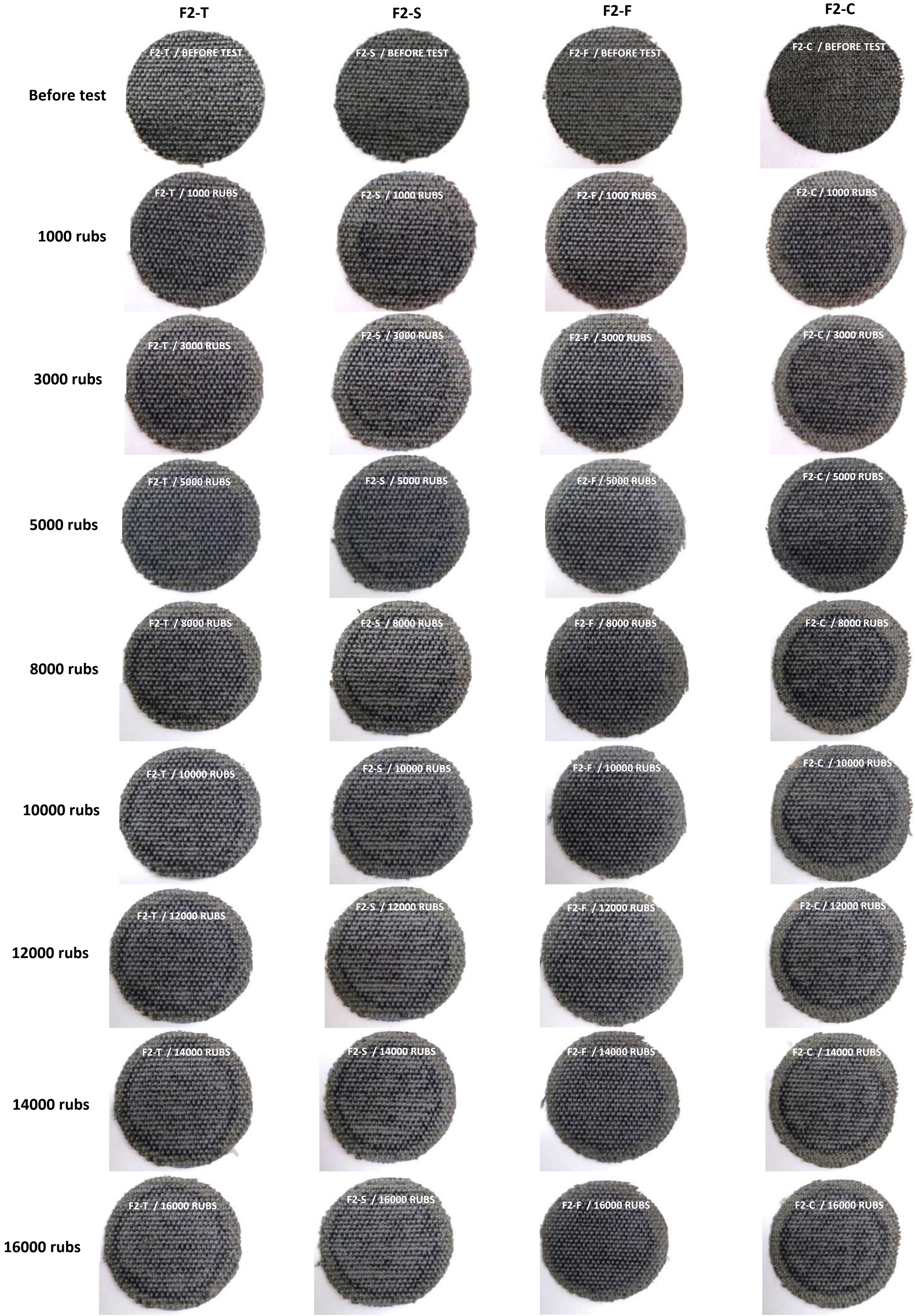

Figure 5. Comparative surface wear of acrylic (PAN) chenille fabrics under increasing abrasion cycles

Evaluation of SEM Images

The scanning electron microscopy (SEM) images of polyester and acrylic fabric chenille samples, subjected to textile finishing processes including thermofixing, softening treatment, fluorocarbon application, and calendaring, are presented in detail in Figure 6 and Figure 7. These high-resolution micrographs reveal surface morphology, emphasize structural modifications induced by each process, and confirm the presence, distribution, and adhesion of chemical finishes, illustrating the effectiveness and depth of interaction between the chemicals and textile substrates.

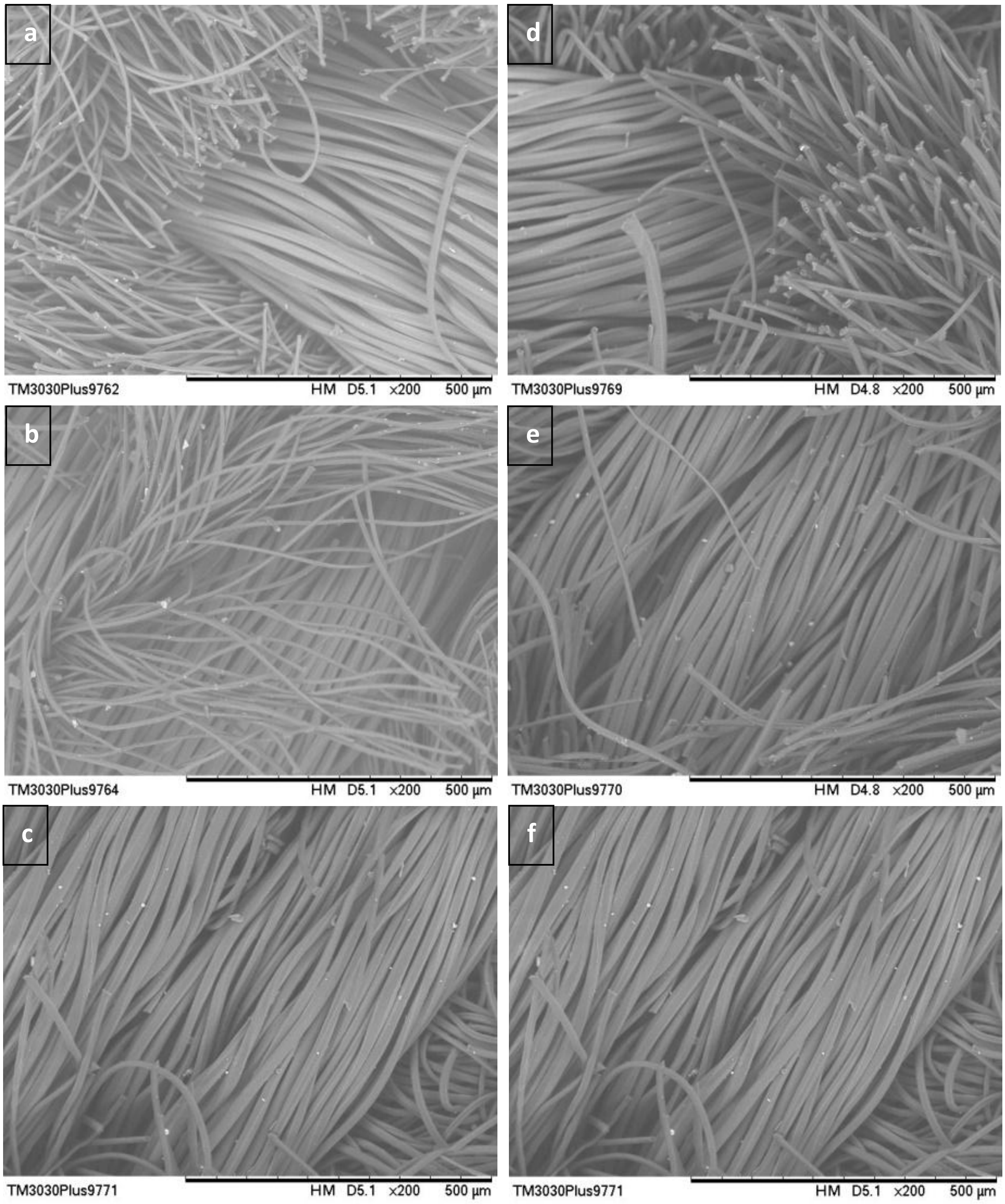

Figure 6. SEM images (200× magnification) of polyester and acrylic chenille fabric samples after finishing treatments: thermofixing (a, d), softening (b, e), and fluorocarbon applications (c, f) respectively

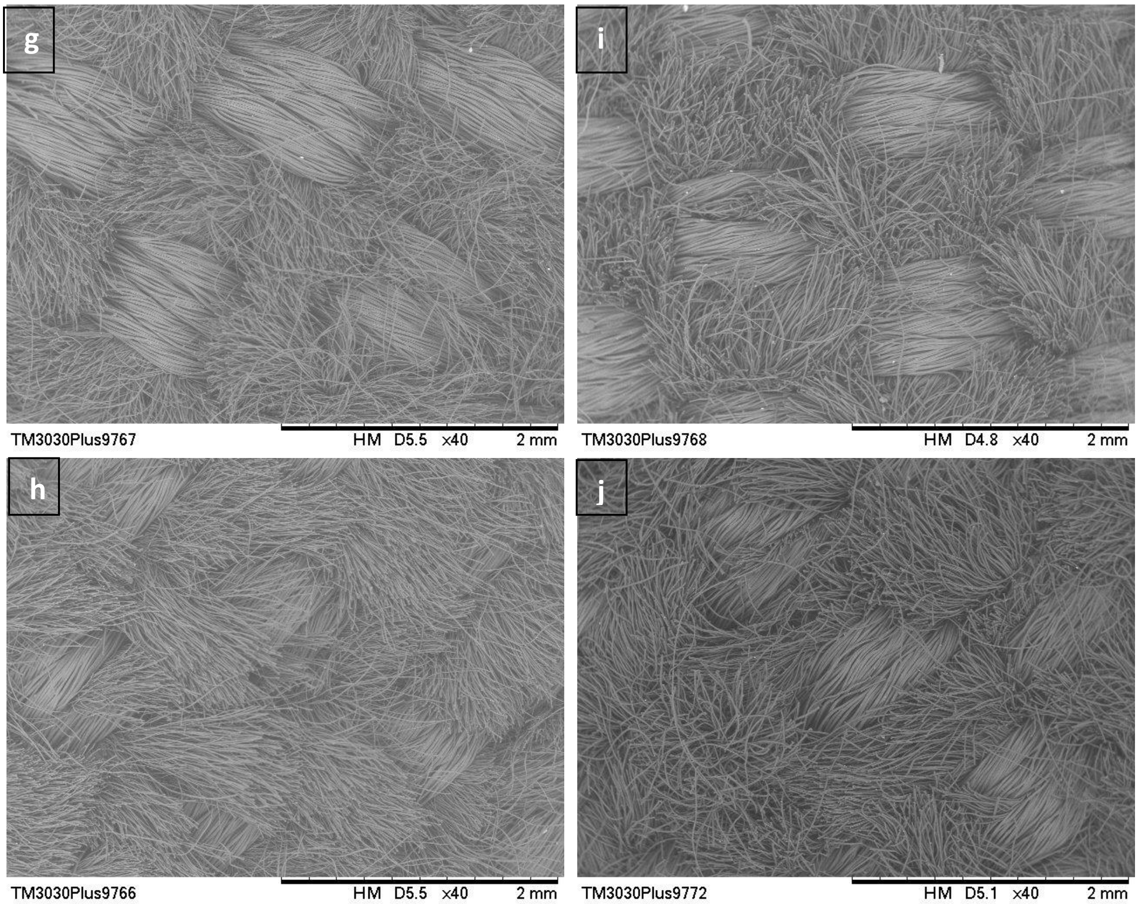

Figure 7. SEM images (40× magnification) of polyester and acrylic chenille fabric samples after thermofixing (g, i) and calendaring (h, j) treatments respectively

To further elucidate the surface morphology and the effects of the applied finishing treatments, SEM imaging was conducted at two different magnifications (200× and 40×). The resulting micrographs, presented in Figures 6 and 7, offer visual insights into the structural modifications and chemical deposition associated with the finishing processes applied to both polyester and acrylic chenille fabrics.

As illustrated in Figure 6, the SEM images captured at 200× magnification reveal distinguishable surface characteristics following the application of the softener and fluorocarbon finishes. Compared to the thermofixing samples, both polyester and acrylic based fabrics exhibit visible surface coatings that suggest the presence and uniform distribution of the chemical agents. These coatings appear as particulate layers adhering to the fiber surfaces, particularly along the yarn boundaries, indicating successful impregnation and retention of the applied finishes.

In Figure 7, the SEM micrographs at a lower magnification (40×) emphasize the mechanical influence of the calendaring process. In comparison to the thermofixing samples, fabrics subjected to calendaring display a noticeably more compact and flattened surface texture. This compression effect is consistent with the expected outcome of calendaring, where fabric passes between heated rollers, resulting in reduced surface roughness and a smoother, glossier appearance. The observed flattening aligns with the increase in fabric weight and confirms the structural densification imparted by this mechanical finishing stage. These SEM observations provide complementary evidence supporting the effectiveness and functional contributions of each finishing treatment, particularly in terms of surface modification, chemical adherence, and morphological changes that potentially influence the abrasion resistance and overall performance of the upholstery fabrics.

CONCLUSION

In this study, woven fabrics were produced using polyester and acrylic chenille yarns in the weft and polyester yarns in the warp, resulting in plain woven upholstery fabrics. Four commonly used processes in upholstery were applied to the fabric samples, and the effects of variations in raw materials and processes on the abrasion resistance of the fabrics were investigated. The test results were analysed both graphically and statistically, and the key findings can be summarized as follows:

• The best abrasion performance in this study was exhibited by acrylic chenille fabrics treated with the felted calendering process, which demonstrated superior durability under abrasion compared to all other treatments. In contrast, the poorest abrasion performance was observed in polyester chenille fabrics treated with the fluorocarbon process, which showed significantly lower resistance to abrasion than other processes applied in the study.

• The felted calendering process notably improved the abrasion resistance of both polyester and acrylic chenille fabrics, with a substantial increase in durability observed for both materials. This process outperformed all other treatments, highlighting its potential as an effective method for enhancing the abrasion resistance of upholstery fabrics. The increase in performance was particularly noticeable when compared to other processes, underscoring the importance of selecting appropriate finishing techniques for improving fabric longevity.

• The fluorocarbon process, although commonly used in textile treatments, proved to be the least effective in improving the abrasion resistance of both polyester and acrylic chenille fabrics in this study. Fabrics treated with the fluorocarbon process showed considerably poorer abrasion resistance than those treated with other processes. This indicates that while the fluorocarbon treatment with 20 g/l impregnation ratio may offer other benefits, such as water or stain resistance, it does not contribute significantly to enhancing the abrasion performance of the fabrics tested.

• When comparing polyester and acrylic raw materials across all process values, some minor differences in the results were observed. Despite these small variations, statistical analysis revealed that these differences were not statistically significant, as the p-values exceeded the 0.05 threshold. This suggests that, at least in the context of the treatments applied in this study, the type of raw material (polyester vs. acrylic) does not play a statistically significant role in determining the abrasion resistance when subjected to the processes examined.

• The abrasion resistance values of polyester and acrylic chenille fabrics treated with the felted calendering process, as well as polyester fabrics treated with the softening process was found to be statistically significant when compared to the thermofixing process. This was confirmed through t-test analysis, which indicated that these treatments provided a notable improvement in abrasion resistance over the thermofixing process. The findings emphasize the importance of process selection in achieving desired fabric durability, particularly for upholstery applications where long-lasting performance is crucial.

Artificial Intelligence Contribution Statement

This manuscript was written, analysed, and prepared entirely by the authors. Artificial intelligence tools were not employed for content generation, data analysis, or figure preparation. They were used solely for minor language and grammar checking.

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