Performance analysis of sustainable fabrics inspired by Ottoman caftan motifs

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ABSTRACT – REZUMAT

Performance analysis of sustainable fabrics inspired by Ottoman caftan motifs

In this study, sustainable fabrics were developed by taking inspiration from tulips, pomegranate and carnation motifs in the caftan patterns used in the 16th – 17th century Ottoman Empire. In fabric production, sustainable raw materials such as PET and rPET were used for warp yarns. In contrast, polyviscose, Tencel, RO (recycled olefin), organic cotton, and bamboo were used for weft yarns. Yarn counts, yarn strength, elongation and twist properties were analysed. After fabric production, seam opening test, breaking strength, breaking elongation, abrasion, light fastness, abrasion resistance and air permeability tests were performed. The structural characterisation, comfort and durability properties of the fabrics were evaluated. The breaking strength, breaking elongation, and seam opening strength results of the RO-containing K2 are better than those of the natural raw material-containing K1, K3, K4, and K5 fabrics. In tests on fabrics containing natural fibres, it was observed that the K5-coded organic cotton fabric was advantageous in terms of breaking strength, breaking elongation, abrasion resistance, and air permeability. The study revealed that K5 organic cotton fabrics exhibited superior tensile strength, elongation, abrasion resistance, and air permeability, whereas K2 fabrics containing RO showed better seam strength but lower abrasion resistance. All fabrics were transformed into clothing, and modern caftan designs were made. It was concluded that many products could be developed from the patterns of caftan fabrics by considering their usage performance with sustainable materials, and that their applicability in modern textile design and production in different areas would become widespread.

Keywords: *sustainability, pattern design, environmentally friendly, woven fabrics, caftan patterns*

Analiza performanțelor țesăturilor durabile inspirate de motivele caftanelor otomane

În cadrul acestui studiu, au fost create țesături durabile inspirate din motivele cu lalele, rodii și garoafe ale caftanelor utilizate în Imperiul Otoman în secolele al XVI-lea și al XVII-lea. În procesul de producție a țesăturilor, s-au utilizat materii prime durabile precum PET și rPET pentru firele de urzeală, iar pentru firele de bătătură s-au folosit poliviscoză, Tencel, RO (fibră poliolefinică reciclată), bumbac organic și bambus. Au fost analizate finețea, rezistența, alungirea și proprietățile de torsiune ale firelor. După producerea țesăturilor, au fost efectuate teste de rezistență a îmbinării, rezistență la rupere, alungire la rupere, rezistență la abraziune și la lumină, precum și teste de permeabilitate la aer. Au fost evaluate caracteristicile structurale, de confort și de durabilitate ale țesăturilor. Rezultatele privind rezistența la rupere, alungirea la rupere și rezistența îmbinării obținute pentru țesătura K2 cu conținut de RO sunt superioare celor obținute pentru țesăturile K1, K3, K4 și K5, care conțin materii prime naturale. În cadrul testelor efectuate pe țesături care conțin fibre naturale, s-a observat că țesătura din bumbac organic cu codul K5 prezintă avantaje în ceea ce privește rezistența la rupere, alungirea la rupere, rezistența la abraziune și permeabilitatea la aer. Studiul a relevat că țesăturile din bumbac organic K5 prezentau caracteristici superioare de rezistență la tracțiune, alungire, rezistență la abraziune și permeabilitate la aer, în timp ce țesăturile K2 care conțin RO prezentau o rezistență mai bună a îmbinării, dar o rezistență la abraziune mai scăzută. Toate țesăturile au fost transformate în articole vestimentare și s-au creat modele moderne de caftan. S-a ajuns la concluzia că, luând în considerare performanțele de utilizare ale acestora și folosind materiale durabile, se pot dezvolta numeroase produse pornind de la modelele țesăturilor de caftan, iar aplicabilitatea acestora în proiectarea și producția modernă de textile în diverse domenii se va extinde pe scară largă.

Cuvinte-cheie: *durabilitate, proiectare de modele, ecologic, țesături, modele de caftan*

INTRODUCTION

In recent years, the rapidly increasing production and consumption volume in the textile sector, especially under the influence of the “fast fashion” approach, has led to significant problems in terms of environmental sustainability; this has made the textile industry one of the sectors that pollutes the environment the most. Today, environmentally friendly fashion supported by low-carbon production and green growth policies directs individuals to be more conscious and proactive about the protection of natural resources and sustainability [1]. In the sustainable product design process, factors such as raw material supply, production methods, purpose of use, waste management and working conditions should be structured in the light of ecological principles. In this context, environmentally friendly material selection, application of clean production techniques, extension of the product life cycle and ensuring energy efficiency are among the fundamental strategies of sustainable design.

In material selection, natural fibres such as cotton, linen, hemp, mulberry and ramie offer more sustainable options compared to synthetic fibres due to their technical performance, biocompatibility and low environmental impact [2].

During the Ottoman period, motifs such as tulips, carnations, hyacinths, plane leaves, spring branches, pomegranate leaves, and dagger leaves among curved branches were frequently used in caftan fabrics [3]. Many floral motifs have been adapted and modernised in academic studies. Cihan developed new design suggestions in his thesis study based on tulip, haliç and Chintamani motifs [4]. Similarly, Tekkılıç and his friends created home textile designs using rumi, tulip and spring branch motifs [5]. Tulip and carnation motifs, which are frequently found in plant ornaments and are designed with inspiration from nature, and pomegranate, also known as the fruit of heaven, symbolising fertility and continuity of life, are motifs that are the common denominator of the past and the present. The tulip motif developed as part of a rich visual culture intertwined with the use of floral motifs and aesthetic and symbolic meanings in Ottoman art [6]. The pomegranate motif, on the other hand, is a plant that can remain green throughout the year and has been associated with themes such as immortality, eternal life and fertility [7]. The carnation motif also stands out as a frequently preferred floral pattern in Ottoman art. Indeed, there are studies in the literature on the adaptation of motifs from the Ottoman period to modern design applications. Bağcı and Kiper developed a home textile collection with the theme of "Dynasty" inspired by the pattern and colour harmony in Ottoman caftans and introduced hatayi and leaf motifs to use with the digital printing technique [8]. Gümüşer showed that traditional motifs can be transferred to different textile areas from upholstery fabrics to wall coverings through nine original patterns inspired by 16th-century Ottoman palace fabrics [9]. Although previous studies have investigated the adaptation of Ottoman motifs to modern textiles, few have systematically examined their integration with sustainable fibres, which constitutes the research gap this study addresses.

The study aimed to modernise the motifs used in caftan patterns from the 16th and 17th centuries during the Ottoman period, produce fabrics with sustainable raw materials, and predict the commercial use potential of the fabrics by transforming them into clothing forms. Tulip was chosen for its strong symbolic role in Ottoman art and sustainability symbolism; pomegranate for its association with fertility, continuity, and cyclical life; and carnation for its aesthetic richness and prevalence in caftan ornamentation. In addition to motif adaptation, the sustainability aspect is strengthened by focusing on water consumption, carbon footprint, and potential life cycle assessment (LCA) implications of fibre selection. The fabrics produced were made using sustainable linen, bamboo, RO, Tencel, and organic cotton. All fabrics were woven on jacquard weaving machines. To evaluate the physical and mechanical properties of yarns and fabrics, yarn breaking strength, breaking elongation, twist, fabric breaking strength, breaking elongation, abrasion resistance, seam opening, washing and rubbing fastness, and air permeability tests were performed.

EXPERIMENTAL

Materials

As recycled fibres, polypropylene-based recycled olefin and yarns made of recycled polyester fibre were used in fabric production (table 1). RO yarn is known as the first recycled olefin yarn developed by KETS (local fabric manufacturer) and produced entirely from post-consumer textile waste. RO stands out as an environmentally friendly option since its production process is carried out without the use of water. While traditional textile production processes, particularly in dyeing, finishing, and wet processing stages, consume large amounts of water, the production of RO yarn eliminates water use during the yarn manufacturing stage. RO yarns have approximately 40% lower carbon footprint compared to raw

Table 1

YARN PROPERTIES USED IN FABRICS

Raw materials in used yarns	Weft yarn (denier)	Warp thread denier/filament	Yarn elongation (%)	Yarn tensile strength (cN/tex)	Twist count (t/m)	Yarn twist direction
r-PET	450/145	1062	25.9	27.3	-	s
PET	-	150/50	-	-	-	s
RO	1200	-	17.9	18.0	400	s
Polyviscose	30	-	16.1	12.8	261	s
Tencel	298	-	8	25.9	214	s
Bamboo	298	-	14	14.8	202	s
Organic cotton	298	-	5	17.3	240	s
Linen	30	-	4.2	22.0	-	s

Table 2

FABRIC COMPOSITION AND YARN CONTENTS					
Fabric codes	**Fabric composition**	**Weft yarn (1st weft)**	**Weft yarn (2nd weft)**	**Weft yarn (3rd weft)**	**Warp yarn**
K1	%21 CV %9 LN %41 RO %29 r-PET	Polyviscose	Linen	RO	r-PET
K2	%44 RO %17 r-PET %39 PET	RO	r-PET		PET
K3	%44 Tencel %17 r-PET; %39 PET	Tencel	r-PET		PET
K4	%44 Bamboo %17 r-PET %39 PET	Bamboo	r-PET		PET
K5	%44 OC %17 r-PET %39 PET	Organic cotton	r-PET		PET

polypropylene yarn and approximately 50% lower carbon footprint compared to raw Polyester yarn [10].

Methods

Creation of caftan motifs

In the study, new pattern designs were first developed inspired by tulip, pomegranate and carnation motifs found in the caftan patterns. All pattern designs were created in the Adobe Illustrator 2021 program (figure 1).

a *b* *c*

Fig. 1. Pattern designs: *a* – Tulip; *b* – Pomegranate; *c* – Carnation

Fabric production

All fabric productions used in the study were made on the Dorier Brand 2008 model jacquard weaving machine. Fabric production was carried out by determining structural parameter values. In fabric production, the average fabric weight of all fabrics in the structural parameters is 294–344 g/m^2, and the fabric width is 140–150 cm. Fabric compositions are given in table 2.

Material tests

Within the scope of the study, breaking strength, breaking elongation (TS 245 EN ISO 2062), and twist tests (TS EN ISO 2061) were applied to yarns, and seam opening (EN ISO 13936-2), breaking strength, breaking elongation (EN ISO 13934-1), rubbing fastness (ISO 105 B06:2020 Cycle(1/3), light fastness (EN ISO 105-B02), abrasion resistance (ISO 12945-4) and air permeability (EN ISO 9237) tests were applied to fabrics. All tests were conducted with at least five replicates (n = 5), and average values with standard deviations were reported.

RESULTS AND DISCUSSION

Yarn count

Yarn counts are given in table 3. Since the 5 fabrics produced in this study had different weft densities, the direct comparison of mechanical properties was interpreted with caution.

Table 3

YARN COUNTS USED IN FABRICS				
Fabric codes	**Weft yarn (1st weft) (denier)**	**Weft yarn (2nd weft) (denier/ filament)**	**Weft yarn (3rd weft) (denier)**	**Warp thread (denier/ filament)**
K1	30	30	1200	1062
K2	1200	450/145		150/50
K3	298	450/145		150/50
K4	298	450/145		150/50
K5	298	450/145		150/50

Yarn tensile strength, elongation at break and twist

Viscose, found in K1 fabric, is a cellulose-based regenerated fibre and offers a natural softness and shine; however, its strength, especially in the wet state, is limited. Polyester, on the other hand, is known for its high strength and durability properties as a synthetic fibre. Although the low strength of viscose in polyviscose fabrics is increased somewhat with the contribution of polyester, it is known that the breaking strength of polyviscose fabric is generally lower than fabrics produced from other natural and regenerated fibres such as organic cotton, Tencel, and bamboo [11]. The weft yarn belonging to the K4 coded fabric containing Tencel has the highest breaking strength among natural raw material-based fabrics. Tencel, also known as Lyocell, found in the fabric coded K4, is a regenerated cellulose fibre with high crystallisation and orientation. Thanks to these features, the breaking strength and elongation values of Tencel fibres are higher than those of cotton and viscose fibres. The higher tensile strength of Tencel yarns compared to viscose and bamboo can be attributed to their higher crystallinity and orientation, which is consistent with the findings of Bilir and Şardağ [12].

In the warp yarns, yarns containing r-PET and PET raw materials were used. PET is a polymer with high crystallinity. This crystalline structure is supported by strong van der Waals and hydrogen bonds between molecules, which increase the mechanical strength of the material [13]. Despite the recycling process, r-PET largely preserves the crystalline structure of the original PET, which ensures that the breaking strength of r-PET yarns is high. The high strength of the warp yarns creates a factor that increases fabric strength.

For the breaking elongation values, the highest breaking elongation is seen in the RO yarns in the K2 coded fabrics, while the lowest breaking elongation is seen in the organic cotton in the K5 coded fabric. It has the highest breaking elongation value after the polyviscose RO in the K1. Thirdly, the highest value was observed in the 1st weft yarn in the K4 coded fabric, which contained bamboo yarn. In the K2, K3, and K4 coded fabrics, PET was used in the warp direction, and in the K1 coded fabric, r-PET was used. r-PET provides elasticity with the highest elongation rate (25.9%) as the warp yarn in all fabrics (table 4).

When the twist tests of the 1st weft yarns of the fabrics are performed, all yarns are S twisted. The highest twist value belongs to the K2 coded fabrics and is the RO yarns. The lower twist value (240–261 T/m) is the K1, K3, and K4 coded fabrics (table 4).

Structural parameters of fabrics

The structural values of the fabrics are given in table 5. The designs were produced by using the Dornier Brand 2008 model jacquard weaving machine and the EAT program at Kadifeteks Industry.

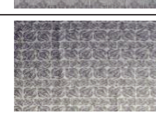
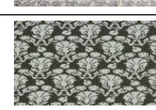
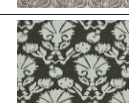
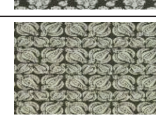
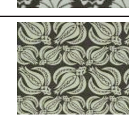
Table 4

YARN STRENGTH (CN/TEX) AND YARN ELONGATION (%) VALUES USED IN FABRICS

Fabric codes	Yarn strength (1st weft) (cN/tex)	Yarn elongation (1st weft) (%)	Yarn strength (2nd weft) (cN/tex)	Yarn elongation (2nd weft) (%)	Yarn strength (3rd weft) (cN/tex)	Yarn elongation (3rd weft) (%)	Twist (T/m)
K1	12.8	16.1	22.0	4.2	18.0	17.9	261
K2	18.04	17.9	27.3	25.9	-	-	400
K3	25.9	8	27.26	25.9	-	-	214
K4	14.8	14	27.26	25.9	-	-	202
K5	17.3	5	27.26	25.9	-	-	240

Table 5

STRUCTURAL PARAMETERS OF FABRICS

Fabric code	Weft density (weft/may)	Fabric width (cm)	Warp frequency (wire/cm)	Fabric weight (g/m²)	Fabric view	Pattern view
K1	9	141	68	342		
K2	18	143	67	295		
K3	32	148	65	312		
K4	42	148	65	310		
K5	52	148	65	301		

Fabric seam opening and abrasion test on fabrics

The seam opening test evaluates the resistance of fabrics to seam slippage under stress. Higher opening values indicate lower resistance, meaning that the fabric is more prone to seam failure during garment use, which negatively impacts durability. In this study, since all warp yarns are used as PET and r-PET, the seam opening values in the warp direction are approximately in the range. When the table is examined, the lowest performance for the opening balance in the warp and weft directions is seen in the K1 fabrics. The polyviscose and linen fabrics in the K1 have the lowest values, especially in the weft seam opening. The reason why the seam opening strength of the polyviscose and linen fabrics in the K1 is lower than that of fibres such as bamboo of the K4 coded fabric, organic cotton of the K5 coded fabric, Tencel of the K3 coded fabric and polyolefin of the K2 fabrics is the low flexibility and strength properties of these fibres. This situation leads to easier opening in the seam areas. On the other hand, bamboo, organic cotton, Tencel and polyolefin fibres increase the seam opening strength thanks to their high flexibility and strength properties [11, 14, 15]. Kutgi and Zervent Ünal observed in their studies that viscose fibre has lower seam opening strength than bamboo [16]. Similarly, K1 fabrics gave lower seam opening values than K4 fabrics. While Tencel and bamboo blends showed higher weft direction opening, organic cotton showed a lower weft direction opening value (figure 2).

Abrasion is basically the mechanical deterioration of fabric components by rubbing against another surface. In the abrasion cycle results applied to the fabrics, the most notable measurement (figure 3) is the low abrasion cycle values of the K2 RO-containing fabrics. The RO in these groups is produced from polymers such as polypropylene and polyethylene. These fibres are known for their low density and low melting point. Low density can cause the fibres to be less compact and less durable. In addition, the low melting point increases the possibility of damage to the fibres during thermal processes, which negatively affects the abrasion resistance [17–21]. These results agree with Arora (2020), who reported that lower-density polymers exhibit reduced durability under repeated friction [22].

Fabric tensile strength and elongation at break test

It is seen in the graph that the warp breaking strength values in the warp direction are very close to each other in the fabrics with codes K4 and K5. It was determined that the warp breaking strength values in the fabrics with codes K1 and K2 are low, and the strength is high in the fabric with code K5. The first weft yarn is used as the organic cotton, and the second is for the fabric’s breaking strength. It is seen in the graph that the fabric with the lowest breaking strength is among the fabrics with codes K1 and K3 (figure 4).

In the measurements of the breaking strength and breaking elongation (figure 5) of the fabric containing organic cotton in the K5, a good breaking strength. The crystalline structure of the organic cotton fibres in the K5 increased the durability of the fibres and provided an increasing effect on the breaking strength [21]. Thus, it shows higher strength than fabrics belonging to other groups containing Tencel, bamboo and polyviscose. When the breaking elongation values are examined, the fabrics containing Tencel in the K3 gave the lowest results. This situation is associated with the fact that Tencel fibres contain a high percentage of crystalline regions, which increases the strength of the fibres while reducing their flexibility. In addition, the low microfibril angle of Tencel fibres has a limiting effect on the elongation capacity of the fibres [17–20]. All fabric breaking elongation values of the fabrics were measured. Since PET and r-PET are used in the warp

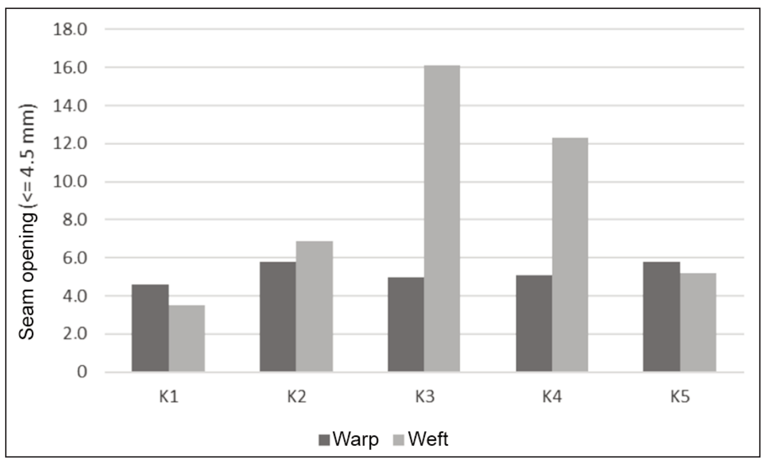


Fig. 2. Fabric seam opening results

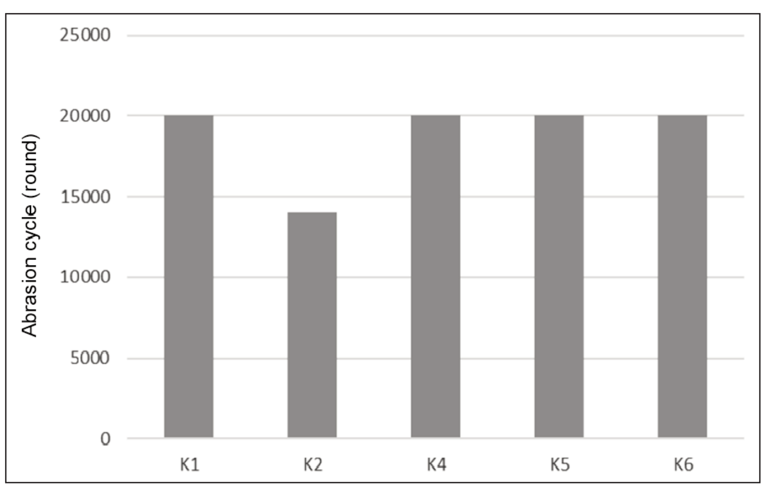


Fig. 3. Abrasion cycle test results of fabrics

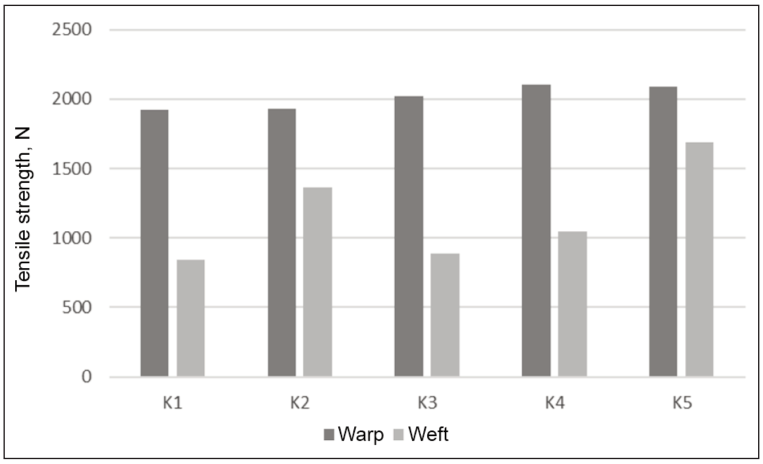


Fig. 4. Fabric tensile strengths results

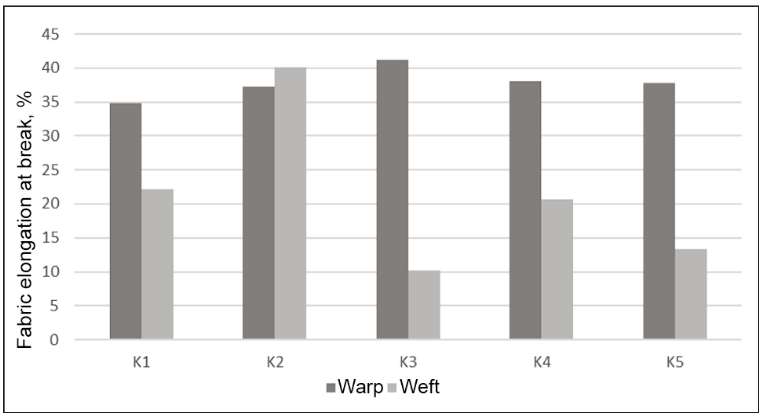


Fig. 5. Elongation at break test results

yarns, the elongation values in the warp direction are more consistent and vary in a narrow range (34.8–41.25%). It was determined that the fabric with the lowest weft breaking elongation was the K3-coded fabric with Tencel in it.

Rubbing and light fastness test of fabrics

Dry rubbing and wet rubbing fastness were evaluated between 4–4/5 for all fabrics. For light fastness, all fabrics have a 4/5 rating. In general, it is seen that all fabrics show high performance in terms of rubbing and light fastness values. When the rubbing and light fastness results of the fabrics were evaluated, it was seen that the fabrics had good light resistance and showed colour fastness against long-term light exposure. In terms of fastness performance, all fabrics were found to be suitable for commercial use and at a reliable level.

Measurement of the air permeability of fabrics

The desired air permeability level in fabric design is optimised according to the application area. Fabrics with high air permeability can provide a comfort-enhancing effect by allowing moisture and heat transfer. Air permeability values in K1 and K2 fabrics are relatively lower than those of other fabrics. (20.1–11.25; 20,42–11,75 Pa-L/min). Air permeability measurements were made at the highest level for K3 coded fabrics (23–11.0 Pa-L/min). Tencel, bamboo and organic cotton fabrics in K4 and K5 exhibit medium-level air permeability values (22–10.75 Pa-L/min; 21–10,5 Pa-L/min). Air permeability values were significantly higher in fabrics containing natural fibres (K3, K4, K5) compared to those with polyviscose/ linen or recycled olefin, which correlates with the porous microstructure of natural fibres. This is consistent with Adamu and Gao (2022), who observed that fabrics with thicker yarns and lower density exhibited increased permeability [19].

Transforming fabrics into clothing form and creating styles

First, sketch drawings of the designs were made. Modelling was done with sketch drawings, and style studies were detailed, and the form, aesthetic lines and details of the design were visually concretised (figure 6).
Various stages of the design process, such as style details, layered arrangements and colour studies,

Fig. 6. Design I and Design II sketch, Design I and II Modelling

Fig. 7. Front and right view of blouse and pants models

were modelled using the Iartbook program and the design development process was completed. In the Design I model, the fabrics with pattern motifs were combined with the patchwork technique and turned into a sleeveless top, and in the Design II model, into a long vest product (figure 7). The fabrics obtained were made into three different forms of clothing: a sleeveless blouse, trousers and three skirts. The conversion of fabrics into garments demonstrated that performance characteristics influenced design choices; for example, the high breathability of K5 fabrics made them suitable for summer tops and skirts.

In addition to the mechanical and comfort-related evaluations, the sustainability dimension of the fabrics requires a more detailed discussion. Life Cycle Assessment (LCA) studies have shown that conventional textile fibres such as virgin polyester and polypropylene are associated with high carbon emissions and significant water use, particularly during dyeing and finishing processes [2]. r-PET bottles supply both emissions and fossil fuel consumption reductions ranging from 12% to 82%, respectively, on a cradle-to-grave basis compared to fossil fuel-derived PET bottles, assuming PET bottles are landfilled [23]. Similarly, the production of RO yarn, which is based on post-consumer textile waste, eliminates water usage at the yarn manufacturing stage and demonstrates a lower carbon footprint compared to conventional polyolefin fibres.

Among the natural fibres tested, organic cotton and bamboo provide distinct ecological advantages. Organic cotton cultivation avoids synthetic pesticides and fertilisers, thereby reducing eutrophication potential and soil degradation [24]. Bamboo, on the other hand, is known for its rapid renewability and lower irrigation needs compared to conventional cotton, offering additional environmental benefits. Tencel (Lyocell) fibres are also noteworthy due to their closed-loop production process, in which more than 99% of the solvent is recovered and reused, making it one of the most environmentally friendly regenerated cellulose fibres [21].

Considering these factors, the integration of Ottoman caftan motifs with sustainable fibre compositions not only preserves cultural heritage but also aligns with the global agenda of reducing carbon emissions, water footprint, and energy consumption in the textile sector. The superior seam strength of RO-based fabrics and the enhanced breathability of organic cotton and bamboo blends indicate that these materials could be applied in apparel manufacturing where durability and comfort are prioritised. Moreover, the use of jacquard weaving with sustainable fibres demonstrates compatibility with current industrial looms, supporting scalable production without process modification. Therefore, beyond aesthetic and mechanical performance, the fabrics developed in this study have the potential to contribute to a circular textile economy by lowering the environmental load associated with raw material selection and production processes.

CONCLUSION AND RECOMMENDATIONS

This study highlights the dual contribution of reviving Ottoman caftan motifs and employing sustainable fibres to create fabrics with favourable performance and comfort properties. In this study, pomegranate, tulip and carnation motifs from the caftan patterns of the Ottoman Empire from the 16th and 17th centuries were used in the patterning of fabrics to keep traditional values alive. Fabric compositions were created with natural and recycled fibres such as polyviscose, linen, RO, Tencel, r-PET, bamboo and organic cotton. A total of 5 different fabric compositions were used. The physical test, comfort and fastness properties were determined for each fabric and the yarns contained in the fabrics were measured. In the measurements made for the yarns, yarn count, breaking strength, breaking elongation and twist measurements were made. In the measurements made for the fabrics, breaking strength, breaking elongation, seam opening, abrasion cycle, rubbing and washing fastness and air permeability tests were applied. PET or r-PET were used in the warp yarns in all fabrics. Natural or recycled yarns were used in the weft yarns. Therefore, the observed performance changes are due to the weft yarns.

K1 polyviscose linen containing fabrics showed the lowest values in seam opening, breaking strength and elongation at break tests. This situation is related to the fact that viscose fibres have low strength due to their low crystalline regions, despite having a cellulosic structure, and that linen fibres have a hard and brittle structure despite having a high crystalline structure. Apart from K1, K3 Tencel containing fabrics showed low value results. It is thought that this situation is because Tencel fibres contain high crystalline regions and thus increase the strength of the fibres while decreasing their flexibility. Among the tested fabrics, K5 organic cotton was the most advantageous in terms of mechanical strength, abrasion resistance, and air permeability, while K2 recycled olefin fabrics performed better in seam strength. All fabric structures were found to be suitable for commercial use and reliable in terms of friction and light fastness performance. When evaluated in terms of air permeability, it was observed that fabrics containing natural raw materials coded with K3, K4 and K5 had higher air permeability. The porous structure of natural fibres exhibited a good performance in terms of air permeability.

Within the scope of the study, as a result of the tests applied to the fabrics produced from the sustainable textile fibres used, textile garments with high physical and comfort properties were produced. All fabrics produced were created with modern kaftan designs and transformed into clothing forms. Fabrics have versatile usage potential both commercially and in terms of design. As in many studies [25, 26], combining traditional design approaches with material functionality features will contribute to design efficiency. From a circular textile economy perspective, this study contributes to closing material and cultural loops by combining recycled synthetics and renewable natural fibres with the reinterpretation of Ottoman caftan motifs. The use of r-PET and recycled olefin reduces dependence on virgin polymers and diverts post-consumer waste from landfills, while organic cotton, bamboo, and Tencel represent renewable and biodegradable resources. From a life cycle perspective, the combination of recycled and renewable fibres used in this study contributes to measurable reductions in environmental burdens. Literature-based [27, 28] LCA data show that r-PET and RO lower greenhouse gas emissions and water use by up to 60% and 100%, respectively, compared to virgin synthetics, while Tencel and bamboo minimise chemical and irrigation demands. Thus, the integration of Ottoman motif-inspired design with eco-efficient fibre systems supports both cultural continuity and life-cycle-based sustainability. Future studies should extend this work by integrating other traditional motifs, applying digital printing techniques, and conducting full LCA analyses to evaluate environmental impacts.

REFERENCES

[1] Park, Y.M., Park, K.S., *Fashion textile planning by eco-friendly fabrics with traditional patterns*, In: Korean Journal of Human Ecology, 2009, 18, 5, 1103–1113

[2] Islam, M.T., Jahan, R., Jahan, M., Howlader, M.S., Islam, R., Islam, M.M., Hossen, M.S. Kumar, A., Robin, A.H., *Sustainable textile industry: An overview*, In: Non-Metallic Material Science, 2022, 4, 2, 15–32

[3] Öztürk, H., Yazar, T., *Ottoman Padishah Knobs and Codes as a Symbolic Value for Weaving and Motific Properties*, In: Researcher, 2017, 5, 3, 148–168

[4] Cihan, N., *New Desıgn Offers on Ceramıc Surfaces (Inspıred By Tulıp, Golden Horn Work and Chıntomanı) Patterns on Ottoman Kaftans in the 17th Century,* Master's thesis, Erciyes University, Türkiye, 2012

[5] Tekkılıç, E.İ., Soysaldı, A., Kılıç, Ö., *Areas of Traditional Turkish Motifs in Home Textile Design*, In: Akademik Sanat, Journal of Art, Design and Science, 2016, 1, 1, 12–19

[6] Obidovna, M.Z., *History of Textiles During the Ottoman Empire Fabric Analysis*, In: Ijodkor O'qıtuvchı, 2024, 4, 40, 51–56

[7] Darvishi, N., Narimani, S., *The Symbolic Role of Tulip and Pomegranate Flowers in the Tiling Art of Iran and Ottoman Turkey,* In: Journal of Art and Civilization of the Orient, 2022, 10, 23–28

[8] Bağcı, V., Kiper, E., *Home Textile Designs Inspired by 16th and 17th Century Ottoman Kaftans with Leaf and Hatayi Motifs and Sample Application*, In: Afyon Kocatepe University Journal of Social Sciences, 2023, 25, 4, 1479–1508

[9] Gümüşer, T., *Motifs in contemporary Turkish textile designs influenced by Ottoman court fabrics in 16th century*, Master's thesis, İzmir Ekonomi University, Türkiye, 2011

[10] Kets, *Rolefin Recycle Yarn*, 2024, Available at: https://kets.com.tr/rolefinrecycledyarn/ [Accessed on 22 October 2024]

[11] Elibüyük, U., Bulut, M.O., Üçgül, İ., *Comparison of Some Physical and Dyeing Properties of Bamboo-Cotton and 100% Cotton Fabrics*, In: Journal of Technical Sciences, 2018, 8, 2, 11–16

[12] Bilir, T.B., Şardağ, S., *The Investigation of Performance Properties of Tencel Cotton Blended Yarn,* In: Uludag University Journal of the Faculty of Engineering, 2017, 22, 1, 13–27

[13] Doğmuş Yılmaz, N., *Investigation of mechanical properties of polyethylene terephthalate (PET) yarns having ultraviolet resistant properties after outdoor weathering tests*, Master's thesis, Bursa Uludağ University, Türkiye, 2020

[14] Sundaresan, S., Ramesh, M., Sabitha, V., Ramesh, M., Ramesh, V., *A detailed analysis on physical and comfort properties of bed linen woven fabrics,* In: International Journal of Advanced Research and Innovative Ideas in Education, 2016, 2, 2, 1649–1658

[15] Okur, N., *Comparative analysis of bamboo fiber and yarn properties with performance properties of other fibers and yarns*, Master's thesis, Istanbul Technical University, Türkiye, 2006

[16] Kutgi, M., Zervent Ünal, B., *Comparison of Cotton-Viscose and Cotton-Bamboo Blended Fabrics According to Selected Parameters*, le Congress*,* 26-27 September 2019*,* Adana*,* Türkiye

[17] Kumpikaitė, E., Tautkutė-Stankuvienė, I., Redeckienė, D., *Interrelation between tensile properties of yarns and woven fabrics with these yarns*, In: AUTEX Research Journal, 2019, 19, 4, 235–241

[18] Li, X., Yang, K., Yuan, Z., Liu, S., Du, J., Li, C., Meng, S., *Recent advances on the abrasion resistance enhancements and applications of superhydrophobic materials,* In: The Chemical Record, 2023, 23, 4, e202200298.

[19] Adamu, B.F., Gao, J., *Comfort related woven fabric transmission properties made of cotton and nylon*, In: Fashion and Textiles, 2022, 9, 1, 8

[20] Medar, R., Mahale, G., *Quality characteristics of cotton, polyester, bamboo and Tencel yarns*, In: Indian Journal of Pure & Applied Biosciences, 2020, 8, 1, 127–134

[21] Baig, S., Hussain, T., *Comparison of mechanical and thermal comfort properties of Tencel blended with regenerated fibers and cotton woven fabrics*, In: AUTEX Research Journal, 2019, 19, 1, 23–30

[22] Arora, A., *Effect of abrasion resistance on the woven fabric and its weaves*, In: International Journal of Sciences: Basic and Applied Research (IJSBAR), 2020, 50, 2, 9–19

[23] Benavides, P.T., Dunn, J.B., Han, J., Biddy, M., Markham, J., *Exploring comparative energy and environmental benefits of virgin, recycled, and bio-derived PET bottles,* In: ACS Sustainable Chemistry & Engineering, 2018, 6, 8, 9725–9733

[24] Textile Exchange, 2025, Available at: www.textileexchange.org [Accessed on 22 August 2025]

[25] Chen, H., Shen, L., Zhang, X., Ren, X., Wang, M., Min, X., Li, X., *Digital design of regional characteristic apparel pattern driven by GAN*, In: Industria Textila, 2022, 73, 3, 233–240, http://doi.org/10.35530/IT.073.03.202117

[26] Carp, M., Popp, A., *The influence of traditional art in the current fashion design*, In: Industria Textila, 2013, 4, 217–221

[27] Shen, L., Worrell, E., Patel, M.K., *Open-loop recycling: A LCA case study of PET bottle-to-fibre recycling*, In: Resources, Conservation and Recycling, 2010, 55, 1, 34–52

[28] La Rosa, A.D., Grammatikos, S.A., *Comparative life cycle assessment of cotton and other natural fibers for textile applications*, In: Fibers, 2019, 7*,* 12, 101

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