Quality assessment of fabrics obtained from waste

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ABSTRACT – REZUMAT

Quality assessment of fabrics obtained from waste

The need for ready-made clothing and home textiles produced from natural and synthetic fibres is increasing day by day in order to meet the needs of the increasing world population. Recently, the concepts of sustainability and recycling have gained importance in the textile industry. The rapid change in today's trends has developed disposable habits. Due to the rapidly changing fashion trends, the product variety has increased and mass production has been preferred. Therefore, the priority for customers to choose the products was not the material used, but whether they fit the current fashion trend. Thus, the use and production of natural fibres should be increased to reduce environmental pollution and meet production demand. Thanks to recycling, it is possible to reuse the waste textile materials that we leave to nature. Due to the increase in agricultural production costs, it has become difficult to obtain the raw materials used for textiles. When a life cycle system is created for raw materials that evaluate them until it is produced in nature and then return to nature, production with textile waste recycling can be advantageous. Using natural waste fibres instead of natural virgin fibres to produce home textile products both reduces costs and makes production easier. In this study, recycled (waste) cotton was obtained by shredding white, 100% cotton woven duvet covers and sheets purchased from a private hospital. A 50%-50% waste-natural blend was created from the cotton obtained. 54 wire reference fabrics were woven using open-end yarns numbered Ne24 and Ne12 produced from this blend. The physical characteristics of the fabric were investigated. The results obtained were analysed statistically and the effect of the blend created on the fabric quality was comprehensively examined.

Keywords: *textile waste, recycling, sustainability, life cycle*

Evaluarea calității țesăturilor obținute din deșeuri

Nevoia de produse de îmbrăcăminte și textile de casă realizate din fibre naturale și sintetice crește pe zi ce trece, pentru a satisface nevoile populației mondiale în creștere. Recent, conceptele de sustenabilitate și reciclare au câștigat importanță pentru industria textilă. Schimbarea rapidă a tendințelor de astăzi a dezvoltat obiceiuri de unică folosință. Datorită tendințelor modei în schimbare rapidă, varietatea de produse a crescut și a fost preferată producția de masă. Prin urmare, prioritatea clienților de a alege produsele nu a fost materialul folosit, ci dacă acestea se potrivesc cu tendința actuală a modei. Astfel, utilizarea și producția de fibre naturale ar trebui să crească, pentru a reduce poluarea mediului și pentru a satisface cerințele din producție. Datorită reciclării, este posibilă reutilizarea deșeurilor de materiale textile, pe care le aruncăm în natură. Datorită creșterii costurilor de producție agricolă, a devenit dificilă obținerea materiilor prime utilizate pentru producerea materialelor textile. Atunci când se creează un sistem de ciclu de viață pentru materiile prime, care le evaluează de când sunt produse în natură și până revin în natură, producția pe baza reciclării deșeurilor textile poate fi profitabilă. Folosirea deșeurilor de fibre naturale în loc de fibre naturale virgine pentru fabricarea produselor textile pentru casă reduce costurile și facilitează producția acestora. În acest studiu, bumbacul reciclat (deșeu) a fost obținut prin mărunțirea huselor de pilote și a cearșafurilor albe, țesute din 100% bumbac, achiziționate de la un spital privat. Din bumbacul obținut a fost creat un amestec 50%-50% deșeuri-fibre naturale. 54 de țesături de referință au fost obținute folosind fire de Ne24 și respectiv, Ne12 produse din acest amestec. Au fost investigate caracteristicile fizice ale țesăturii. Rezultatele obținute au fost analizate statistic, iar influența amestecului creat asupra calității țesăturii a fost examinat cuprinzător.

Cuvinte-cheie*: deșeuri textile, reciclare, sustenabilitate, ciclu de viață*

INTRODUCTION

The textile industry is among the most important consumer goods industry. Textile materials are classified according to the market in which they will be sold. The sector is divided into three main activity sub-sectors characterized by different industry dynamics and success factors. For this reason, we can talk about ready-made clothing (fashion/design), interior textiles and technical textiles [1]. The formation step of the final product, the textile material, and the processes it goes through until it becomes a product, use and recycling gain importance. If the textile raw material is a natural fibre, it is easier to be evaluated as waste. The ready-made clothing industry has given priority to synthetic fibres by simplifying production to keep up with the developing world. Since the manufacturers have adopted the disposable concept in their sales policies, and easy production system has been preferred. Due to the population growth in the global

world and fashion trends designed according to the wishes and desires of people, the natural product stock in textile products, whose consumption is increasing rapidly, has almost ended. Although the fact that the need cannot be met due to the high human population seems to be a factor, natural resources, environmental conditions and the policies followed by the countries are also effective. For this reason, the fact that natural resources will be depleted in a short time due to wrong policies should always be remembered. In this context, the importance of recovery increases even more [2, 3].

It is very difficult to produce using natural fibre in easy production methods. The quality of the material used is a determining factor in the cost. It is also known that the cost affects the sales policy negatively. The concept of health has always been prioritized in the choice of trend materials. When the concept of health comes to the fore, the tendency to natural products increases. Therefore, the cost of using natural products increases. The recycling of textile waste is not only an important tool to solve many environmental problems but also an important socio-economic and environmental sustainability tool [1]. Recycling in textiles is a method of reusing or reprocessing used clothing, fibrous materials and clothing parts by the intermediate manufacturing process [4]. Due to the low cost due to mass production and sales below the purchasing power, more purchases than needed have started. Due to mass production and falling costs, the volume of products purchased has also increased, but the quality has been compromised. Therefore, the volume of waste products has also increased. However, since these wastes generally contain low cotton, they are costly to recycle. The excess of synthetic products instead of the natural raw materials produced has led to the trend of cheap clothing. Due to the low-quality perception of the produced product, the long-term wearing and use of these products have decreased. The fashion industry, which is a global industry, has a great impact on people and the environment [5, 6].

In ecological life, there is a shortage of raw materials for the crowded world. If a sustainable product range is not implemented, there has been a tendency towards synthetic products instead of natural fibres for raw material supply in the textile sector. The fact that it is easy to provide raw material sources in rapid production has led to the preference for synthetic products over natural products. Thanks to the synthetic raw material used, the concepts of natural balance and human health have become meaningful. For example, while a carpet rug made from natural raw materials can be used for centuries, when synthetic products are used in production, it has only a few years of life. Apart from this, there is a linear relationship between the world population and the use of textile products. To meet the need for textile products, great efforts are made to recycle these products instead of destroying the waste products. Recycling has started with the recycling of wastewater and the use of this water in agricultural irrigation. In this context, treatment plants were built. Thanks to these treatment facilities, environmentally friendly businesses were established and the dyehouses used in the textile industry established their purification systems. In the textile sector, recycling systematically starts with mechanical separation and shredding. In this context, environmental wastes should be collected and processed for raw materials [3].

It is quite surprising that in the 1980s, within the framework of the concept of "redesign and reuse", the process of thinly slicing fabric pieces and processing them on hand looms and using these products in home textiles was done before the concept of recycling was known. Modern-style "reproduction" i.e., recycling, has found use in the production of blankets and home textiles in certain regions of Turkey (e.g., Uşak/Turkey) [3]. Materials obtained from recycling have been used as a "non-woven surface" in the textile industry. Felt is made from these non-woven surfaces. Other products were produced in the form of automotive textiles and cleaning cloths [3, 7]. When the raw material is decomposed in the products obtained from recycling, that is, when the content of the material from which the product is produced is known, if the material obtained is a natural fibre, it can be used for Open-end yarn production, if synthetic material is melted, it can be used in the textile industry or alternative sectors. Yarns produced in the open-end system are used as upholstery fabric knitting and knitwear [3, 7]. If the raw material is used directly in sustainable textile products without being separated as a blended fibre, it is expressed as low quality because the content of the obtained material is not known exactly and is evaluated in secondary textile products [7]. It is easier to recycle home textile products on a sectoral basis. If the raw material is a single product and the mixture is not fibre, it is easy to transform the product [3].

The surfaces woven from cotton, which is a natural fibre, with different production methods are recovered by mechanical methods. Waste materials are brought into fibre form again by passing through shredding machines and recycled cotton fibres are mixed with new cotton fibres in the proportions determined in accordance with the usage area and used in the yarn production line. It is of great importance to determine various physical, chemical and comfort properties by creating a surface with the recycled yarns obtained in this system, to present these materials to the market and to be accepted by consumers [6, 8]. As an example of the use of waste textile products, end-of-life textile products are collected and turned into cotton, and denim can be obtained from this recycled cotton [9]. Open-end spinning has an important place in these production systems. The obtained yarn properties, the material created with the help of some parametric properties of production, have new product properties. In this Open-end technology, which produces at maximum speed in the production settings and uses high technology, certain

settings in the machine must be meticulously selected in order to ensure high-performance yarn production with high-quality properties [10]. Machine settings have a significant effect on the quality of the yarn and the production quality. Today, the open-end rotor spinning system has become able to compete with the ring spinning system. The fact that open-end spinning machines are suitable for automation has developed together with technology, enabling it to surpass many other spinning systems and have a share of 30% worldwide [11].

In sustainable product designs, it is not enough to melt the product, cut it into strips, shred and produce it as Open-End yarn. Since recycling is long in terms of process and low in cost, other production methods are also included in the system. In the compact yarn production system, yarns that can be used in different fields are produced by using the shredding system to recycle the products produced from a single type of raw material [3]. Recycling is not just about home textiles. Clothes are made from textile materials produced as weaving and knitting. Before production, our people consciously collect the right recycling in the right place, thus expanding the usage area of the product, which is formed uniformly. Clothing and some home textile products, which are among the economic life cycle textile products, have very little life cycles. It is also possible to recycle textile products used in daily life with zero waste projects and contribute to the economy, raise awareness of customers and prevent environmental pollution [12–16].

MATERIAL AND METHOD

In this study, recycled (waste) cotton was obtained by shredding white, 100% cotton woven duvet covers and sheets purchased from a private hospital. A 50%-50% waste-natural blend was created from the cotton obtained. For Ne12 used as warp yarn in the compact yarn production line produced from this blend; 1500 rpm, exit roller speed of 24.19 m/min., used traveller model C1EL udr 63 and ring diameter of 40 mm (Titan). For Ne24, the weft yarn produced from the determined blend; 1700 rpm, exit roller speed 22.66 m/min., used traveller model C1EL udr 45 and ring diameter of 40 mm (Titan). The fabric was woven from this blend using compact yarns of Ne24 and Ne12. 177 grams/linear meter fabric is woven using Ne24 yarn for weft and Ne12 yarn for warp using reference (54 wire) plain weave. 54 wire reference fabric was woven with a weft density of 32 wire/cm and a warp density of 22 wire/cm. The properties of the fabric obtained are shown in table 1.

RESULTS AND DISCUSSION

10 samples were randomly selected from the edge and middle regions of the fabrics produced. The samples taken were examined for physical properties such as tensile strength, tear strength, bending strength, and air permeability according to TSE standards. The physical properties of the fabric obtained from recycling in the study are given in table 2.

Table 1

EXAMINED WOVEN FABRIC STRUCTURES AND PROPERTIES

Sample	Specifications
Fibre composition	Recycled-Natural 50%-50%
Weft	Ne 24 Compact Ring
Warp	Ne 12 Compact Ring
Yarn layers	Single
Warp density	22
Weft density	32
Weft yarn twist number (t/m)	552
Weft yarn twist factor (αe)	3.5
Warp yarn twist number (t/m)	795
Warp yarn twist factor (αe)	4.5
Weight	178
Fabric width (cm)	165

The determination of whether recycling is logical to re-join life and the contribution of the place where it is located will be positive. In the textile sector, renewable products will gain an important place in the field of clothing and home textiles.

Tensile strength, tear strength, bending strength and air permeability of the fabric properties are shown in figures 1–4, respectively.

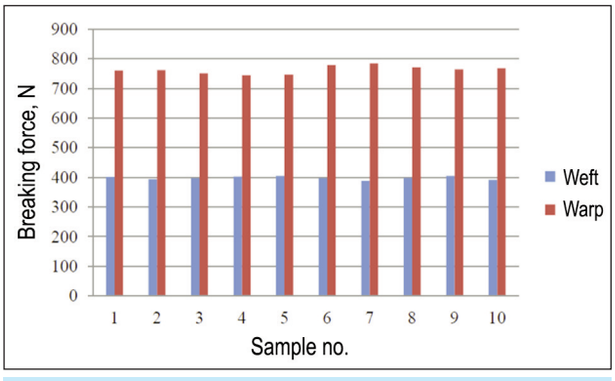

Fig. 1. Tensile strength plot

Figure 1 shows the tensile strength of the fabric produced for experimental work. When the data in table 2 are examined, the average tensile strength in the weft direction used in production was found to be 397.87 N. The warp tensile strength average of the recycled fabric was found to be 763.33 N. The standard deviation of weft grabbing strength was 5.37 and the warp breaking strength standard deviation of the sample obtained was determined as 12.29. In the light of the data obtained, there was no visible loss of value in tensile strength values. The average weft rupture elongation and standard deviation of the produced sample were determined as 9.26% and 0.28.

Table 1

REFERENCE FABRIC PHYSICAL PROPERTIES												
Fabric	Tensile strength				Tear strength (N)		Flexural strength (mg·cm)	Air permeability (mm/s)	Abrasion resistance (Tour)	Pilling (pilling/field)	Weight (g/m^2)	Thickness (mm)
	Breaking force (N)		Elongation at break (%)									
	Weft	Warp	Weft	Warp	Weft	Warp						
1	402.06	760.24	9.05	11.30	33.22	38.18	10.63	321.00	15230	138	177.80	0.41712
2	393.50	762.11	9.14	12.50	34.49	37.90	11.286	325.00	15230	132	178.00	0.38192
3	396.82	751.69	8.97	12.31	35.40	38.55	11.55	325.00	15230	141	178.20	0.38016
4	402.72	744.84	9.26	12.78	36.04	41.95	10.592	332.00	15230	140	178.60	0.42416
5	405.21	747.16	9.00	12.89	35.96	38.18	12.24	329.00	15230	147	177.95	0.41536
6	396.33	778.31	9.08	13.31	36.86	43.42	11.25	321.80	15230	136	177.95	0.39952
7	388.52	784.36	9.66	12.59	36.58	41.86	13.328	321.50	15230	139	177.88	0.46112
8	397.49	771.81	9.56	13.52	36.67	42.78	11.253	331.00	15230	140	178.41	0.43648
9	404.63	765.04	9.75	13.42	39.31	43.52	12.39	325.00	15230	142	178.20	0.43472
10	391.68	767.71	9.10	13.37	38.68	42.78	13.015	314.00	15230	144	178.20	0.38192
Mean	397.89	763.33	9.26	12.80	36.32	40.91	11.75	324.53	15230	141	178.12	0.41
Standard deviation	5.37	12.29	0.28	0.64	1.70	2.27	0.90	5.08	-	15.4	0.24	0.03

The average warp breaking elongation and standard deviation of the sample produced were determined as 12.80% and 0.64.

Figure 2 shows the tear strength graph of the samples produced. When the tear strength values are examined in table 2, the weft tear strength average was determined as 36.32 N and the standard deviation was 1.70. The warp tear strength was found to be 40.91 N and its standard deviation of 2.27. When the tear strength values of the fabric were examined, it was observed that there was no noticeable decrease.

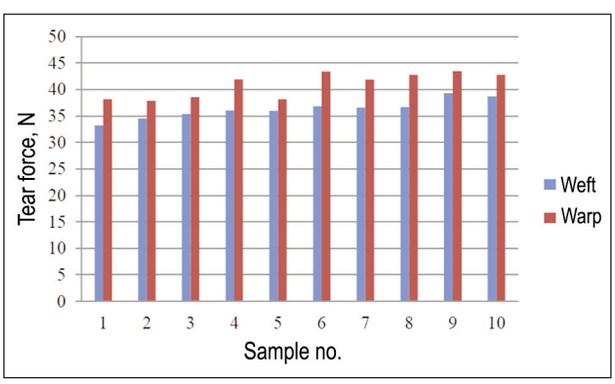

Fig. 2. Tear strength plot

Figure 3 shows the bending strength graph of the fabric produced. When the bending strength of the produced sample is examined in table 2, it has been determined as 11.77 mg·cm and its standard deviation as 0.90.

The air permeability graph of the sample fabric produced is shown in figure 4. When examined in table 2, the average air permeability value was found to be 324.53 mm/s and its standard deviation as 5.08. The

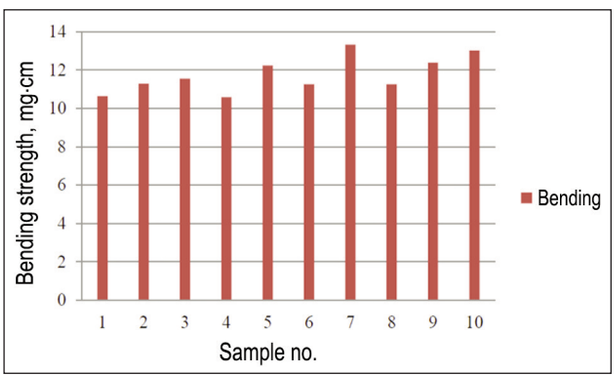

Fig. 3. Bending strength plot

production method, kniwasing type and yarn twist value of the fabric produced can significantly affect this air permeability.

The pilling graphic of the fabric produced is shown in figure 5. When examined in table 2, the pilling value abrasion resistance was determined as an average of 140 in 15230 turns and its standard deviation as

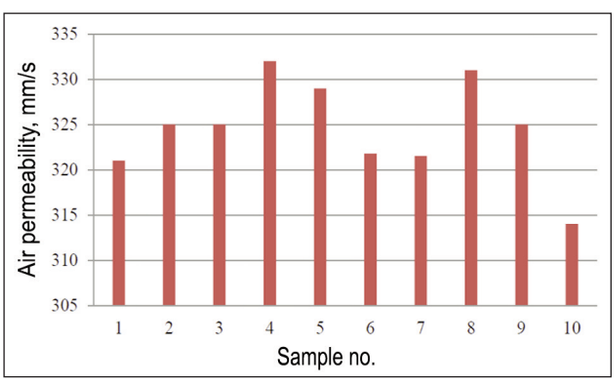

Fig. 4. Air permeability chart

15.40. This stage has been observed to have a good performance considering that the pilling value is a product obtained from recycling. When the pilling value is given for the twist values given to the yarn in the yarn formation and the abrasion resistance, it can be observed that the pilling value varies. Since the sample was prepared in an ongoing production facility, the settings of 552 t/m for weft and 795 t/m for warp in the system were taken. Pilling value, during

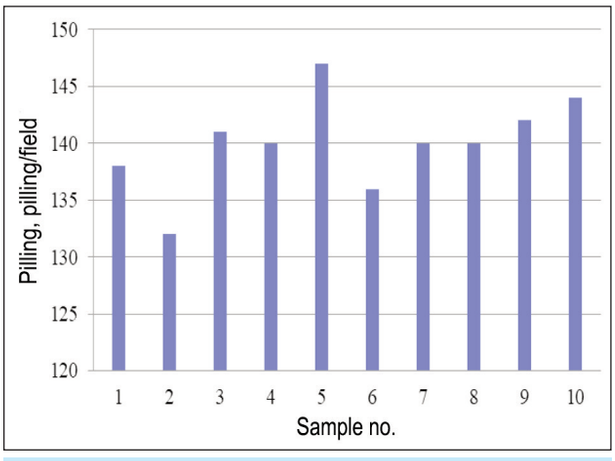

Fig. 5. Pilling chart

yarn formation, yarn twist, yarn count and yarn hairiness can affect values [14].

The physical properties of the yarn used in production affect many physical properties of the fabric formed. When the fabric production parameters are progressed step by step with the in-house machine settings starting from the raw material, the physical factors of the fabric can be influenced.

CONCLUSIONS

When the results were evaluated, it was observed that the quality parameters of the fabric prepared with the blend of cotton obtained from recycling were lower than expected. In another fabric obtained from average good cotton, tear strength and tensile strength are higher. The quality of cotton obtained from recycling has an effect on the quality of previous processes. The breaking strength was 14% lower than expected in the weft direction and 11% lower in the warp direction. Tear strength was observed at 13% in the weft direction and 10% in the warp direction. On the other hand, the other two properties were observed as low between 6% and 8%. When the physical properties and quality parameters of the produced sample are examined, it may be possible to produce yarn with the desired quality if the mixture is adjusted in appropriate proportions for recycling. If the texture type and knitting type are selected correctly in the material (bedlinens, towels, mats, rugs, etc.) obtained according to the production method of the yarn (open-end, compact, ring etc.), the quality level is similar to that of the material produced from virgin raw materials can be achieved. Physical quality parameters deteriorate because textile products are exposed to various chemical processes (for example, washing with detergent) and mechanical stresses until they reach the end of their life and become waste. Therefore, a low-quality product is obtained by using only these waste materials. It is possible to obtain high-quality yarn when natural fibres are mixed with fibres obtained from waste textiles in certain proportions (for example, 50–50%). It is foreseen that these yarns can be used especially in home textile products. It would be more appropriate to use it as a natural product in order to maintain the quality performance in woven or knitted raw (not finished) fabric.

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