STUDY REGARDING THE USE OF NEW SUSTAINABLE TEXTILE MATERIALS

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Abstract: This paper presents a new eco-efficient way about using textile materials in order to minimize potential environmental impacts and human health. It also shows the advantages and the limitation of these materials. Because conventional textile production is one of the most polluting industries on the planet, we propose a parallel with viable solutions in achieving textile products from raw materials with high ecological alternative Finding the right ways to reduce the environmental pollution caused by textile production starts with finding new ways to produce fabrics that don't require toxic materials and large amounts of water, and which minimize harm to local environment. Sustainable textile solutions is dedicated to assist brands, retailers and industry partners to implement sustainable textile production that is meeting both, quality and eco-requirements, and makes the use of resources more efficient. The study conducted in this paper is directed towards organic yarns used to produce knitted fabrics for clothing, as an alternative to the classic cotton yarns. Raw materials like different type of cotton, organic cotton, bamboo, soybean, kapok, etc. will be analyzed. The life cycle of textiles and consumer safety are goals to be achieved by the use of improved and new types of natural raw materials.

Keywords: Sustainable textiles, raw material, organic yarns, eco-efficiency.

1. INTRODUCTION

What means a sustainable textile? Broadly speaking, the answer lies in four main factors: raw material extraction, textile production, added chemistry and end-of-life.

Raw material extraction for example, addresses the land / animals and water used to grow/ harvest natural fibers like cotton and wool, vs the impact of extracting fossil fuels for synthetic fibers such as polyester or nylon. Production considerations must include the water and the energy used for manufacturing, the impact of production waste and a company's social responsibility towards its workers and the communities that surround its production facilities [1].

Added chemistries, including dyes, finishes and coatings, may have an impact on the health of textile workers as well as on the health of the consumers of the final product. Finally, the end-of-life scenario, including textile biodegradability and the recycling infrastructure required to turn it into new raw material, strongly affect its sustainability.

What constitutes a high performance fabric?

Ultimately it comes down to longevity. As such, the first consideration is durability, or the degree to which a fabric resists deterioration. Tied in with this is the question of maintenance, or the ease with which a consumer can clean stains from carpet and upholstery or launder drapery and clothing. In this context, longevity is an aspect of its sustainability. After all, garments that must be discarded after a short time are hardly sustainable. For that matter, neither are carpets or furniture textiles that need to be regularly replaced [1].

Sustainability and performance: can you have it all?

With the health implications becoming ever more evident, it's worth asking what kind of performance is necessary for fabrics, and what level of risk is acceptable for the continued use of harmful additives. Fortunately, performance can be found in safer alternatives that are now entering the market, and in natural fibers that have perhaps been overlooked for their performance attributes. One promising route is biomimicry, the application of nature's designs to man-made products. Research in this area has already led to the development of textiles that mimic the stain resistant properties found in lotus leaves. Other natural treatments have focused on mimicking the antimicrobial properties of crab and lobster shells. Textile applications of these technologies are already gaining strength [1]. Another route is to use existing fibers that have both performance and sustainable attributes. One example is solution-dyed nylon, which is widely used in carpet, upholstery and apparel. Solution dying, a process of locking the color into the fiber itself, produces a high-performing fabric. In garment applications, it produces clothing that does not fade after repeated laundering. Solution-dyed nylon furnishings, including carpet and upholstery, can withstand strong cleaning regimes without fading or deteriorating [2].

2. RAW MATERIAL

As the name implies, organic cotton is grown without chemical pesticides and fertilizers. Textiles made of organic cotton require less water to manufacture than conventional cotton textiles and are often more comfortable.

Fig. 1. Cotton plant.

Fig. 2. Ecolabel.

Fig.e 3. Bamboo plant.

For the consumer, the advantages are obvious, says Schwab. “It is softer [and] it feels better on the skin. The skin is your largest organ, so you are not absorbing the chemicals.”

Organic cotton requires specialized equipment that allows the cotton to be harvested easily without conventional methods. Some fair trade cooperatives don’t advertise organic cotton, but still strive for a sustainable, humanely produced product. Still, the use of third-party certification, such as used by Mata Traders, that supports worker cooperatives and non-toxic dyes have their own sustainability value [4, 13].

Bamboo is used quite differently today than in early Chinese culture, when it was used as a source for shoes and corsets. Today, weavers blend it with other fabrics through complex processes that soften the fabric [5].

There are two ways that bamboo can be used to produce fabric. The first involves pulverizing the woody fiber until it can be combed and spun into a yarn. It is a labor-intensive process that makes the end linen product more expensive. The second way involves solvents that break down the fibers and create a viscose bamboo solution that is eventually hardened and spun into fibers. Techniques can vary, and not all manufacturers use sustainable methods to break down the fibers [3, 5]. So why bamboo is considered a sustainable source for textiles? In a word: adaptability. It is an extremely fast growing plant that doesn’t need to be replanted each year, doesn’t require massive amounts of pesticides and is a great air cleaner for global warming concerns. As Schwab points out, the advent of cultivated bamboo plantations that negate the demand for clear-cut forest harvesting has made bamboo a worthwhile choice for some textiles [4].

Soy textile: ¤ Provides air circulation (better than cotton), ¤ Protection against ultraviolet radiation and electromagnetic, ¤ Soybean fiber knitted fabric remove moisture, which allows us to improve perspiration: moisture is absorbed instantly and then just as quickly evaporate, ¤ Have antibacterial properties, ¤ Easy maintenance: washing without detergents and even do not require warm water, dries quickly. In general, soy fabrics are excellent for making sports clothes or underwear, but also for bath products, especially towels and robes.

3. DESIGN OF EXPERIMENT

For test we chose both classic knitting yarn for stockings - 100% cotton and blended yarns obtained artificially by regenerating cellulose – table 1. Apparatus are presented in figure 4.

Table 1. **Type of yarns**

CODE	Raw material	Fineness		Spinning Technology
		Ne	Nm	
BU	Cotton 100%	20 / 1	34 / 1	carded
BO	Organic cotton 100%	20 / 1	34 / 1	combed
BS	Cotton + soy	20 / 1	34 / 1	combed
BV	Bamboo viscose	20 / 1	34 / 1	carded

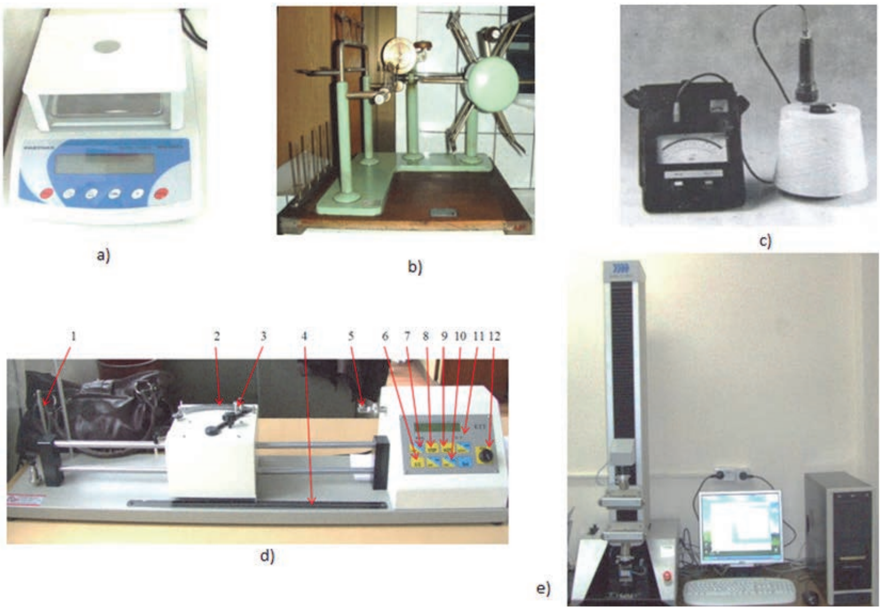

Fig. 4. Apparatus for testing:
a – Electronic balance; *b* – Yarn winding frame; *c* – MESDAN Humy Tester 185 A; *d* – Electronic torsiometer Mesdan ETT; *e* – Titan - Universal Strength Tester by James H. Heal & Co. Ltd. [6].

The following standards were used for accuracy of results:

- SR 7271:2008 – Textile. Determination of linear density for textile yarns.
- SR EN ISO 2061:2011 – Textiles – Determination of twist in yarns – Direct counting method.
- SR EN ISO 2062:2010 – Textiles – Yarns from packages – Determination of single-end breaking force and elongation at break using constant rate of extension (CRE) tester.

Five parameters of the yarns were analyzed:

1. Yarn fineness is defined as the degree of yarn thinness, unconcerned the nature and the spinning process used. Yarn fineness or linear density can be defined in the directly or indirectly system, in both cases expressing the ratio of unit mass and unit length [6], [7]. We measured and calculate this indices of finesse and the values have been summarized in the table 2.

2. The twist of yarn is very important not only because it affects the characteristics of the yarn and thus their quality, but also has an effect on production, the speed spinning and the number of yarn breakages. By using an optimal twist are obtained yarns which gives the product a better touch, better elasticity and comfort, as well as a higher productivity [8], [9].

In order to determinate the optimal twist of the yarn for knitting must take into account the undesirable effects of both: overtwisted and weak twisted yarns. Overtwisted yarns become too rigid and has tendency to form tendrils (loop). Weak twisted yarns means low tensile strength and friction, also low gloss. Knitted fabrics made from such yarns have uneven stitches and shows a tendency to pilling and felting during wear, especially after washing [10].

3. The moisture content is the amount of water absorbed by the yarns from the environment, being an indication of their hygroscopicity. The moisture content depends on the raw material, and is related to the chemical structure of the fiber. From this point of view there are two types of threads: hydrophilic and hydrophobic [10].

4. Tensile strength and elongation at break. The breaking force is one of the basic characteristics of the yarn because it influences the behavior of the yarns in the knitting process parameters, adjustment the values of machinery and their productivity [9], [11]. Also, the tensile strength is a qualitative feature, because its value have influence on the quality of the product. [9], [11], [12].

4. RESULTS AND DISCUSSIONS

Comfort properties of knitted fabrics are influenced by the properties of fibers, yarns and structure of knits. The type of fiber, spinning technology, the number of yarns, the degree of torsion of the yarns, the thickness of the fabric, its finish are some of the factors which play a decisive role in the determination of physico-mechanical and comfort properties of textile materials.

The fact that we choose to produce or to buy products from raw materials environmentally friendly, means that not only we protect our environment and our family's health, but we also bring our contribution and the health of the world and of humanity.

It is, if you prefer, a sign of solidarity for everything around us!

Table 2. **Values of fineness and yarn twist [6]**

CODE	Raw material	Fineness			Twist [twists/m]	Twist direction
		Ttex	Nm	Ne		
BU	Cotton 100%	30	34 / 1	20 / 1	332	Z
BO	Organic cotton 100%	30	34 / 1	20 / 1	305	Z
BS	Cotton + soy	30	34 / 1	20 / 1	352	Z
BV	Bamboo viscose	30	34 / 1	20 / 1	301	Z

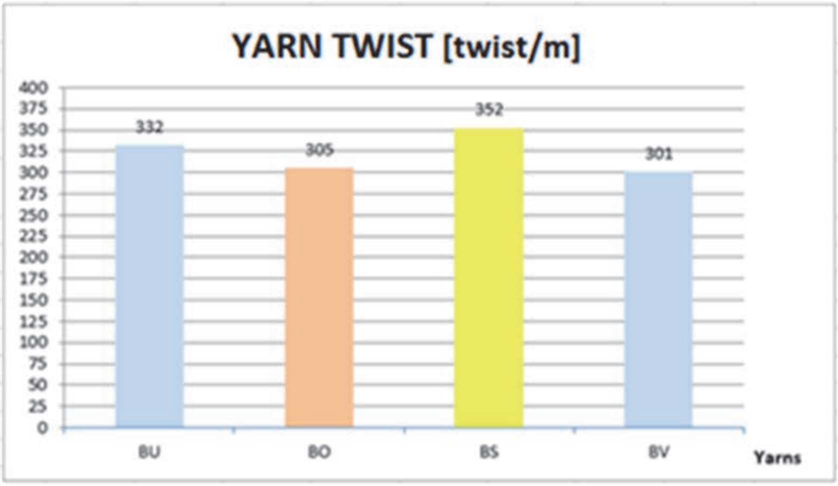

Figure 5. Histogram of twist values [6]

In figure 6 was represented the values of humidity depending on the raw material of yarn.

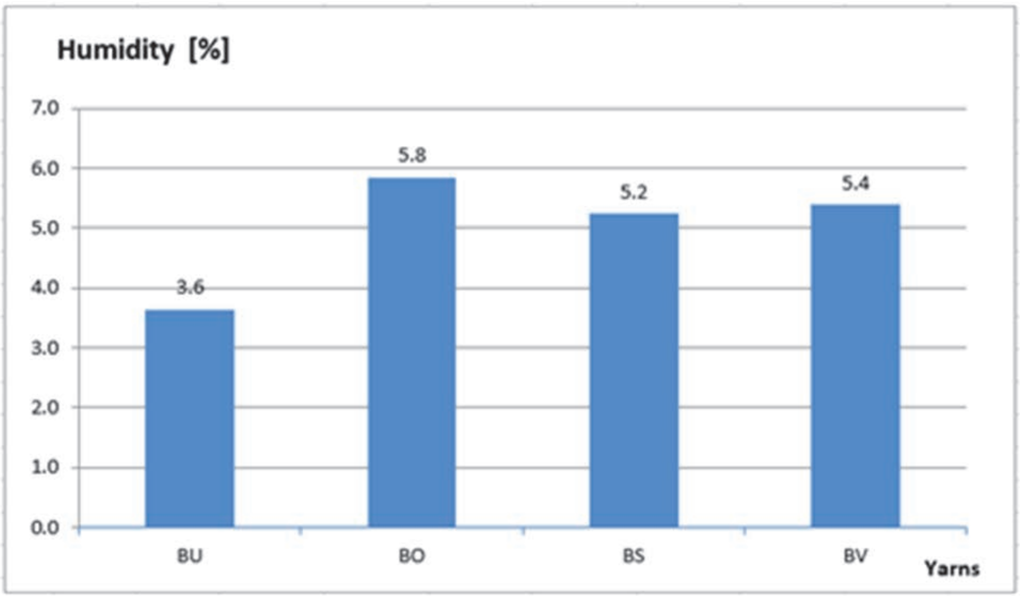

Fig. 6. The values of humidity depending on the raw material of yarn.

Table 3. **Results for dry test and wet test - Tensile strength and elongation at break**

Cod	Raw material	DRY test				WET Test			
		Force [cN]	C.V. [%]	Elongation [%]	C.V. [%]	Force [cN]	C.V. [%]	Elongation [%]	C.V. [%]
BU	**Cotton 100%**	393	7.05	6.38	11.29	448	14.41	10.14	11.73
BO	**Organic cotton**	350	9.64	5.24	13.34	574	5.33	11.99	5.83
BS	**Cotton + soy**	467	9.34	9.92	15.20	519	5.94	16.53	4.58
BV	**Bamboo viscose**	588	8.44	16.86	5.14	310	6.52	20.26	5.10

For each test, the strength test machine Titan2 provide automatically, through his software, the graphs breaking-elongation, presented in the figures 7-14 [6].

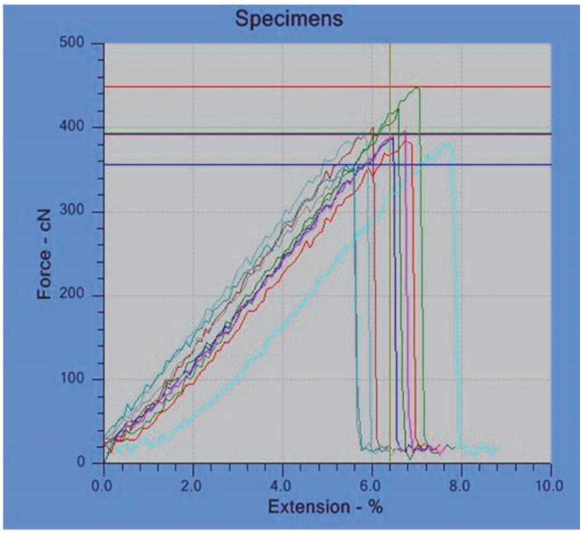

Fig. 7. Graph test - dry estate - variant BU.

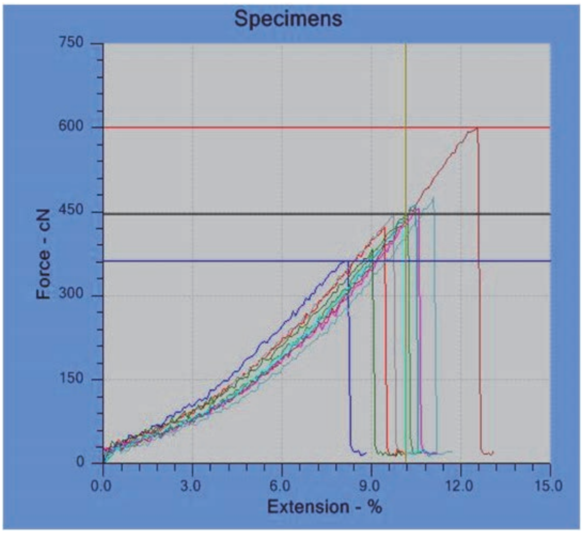

Fig. 8. Graph test - wet estate - variant BU.

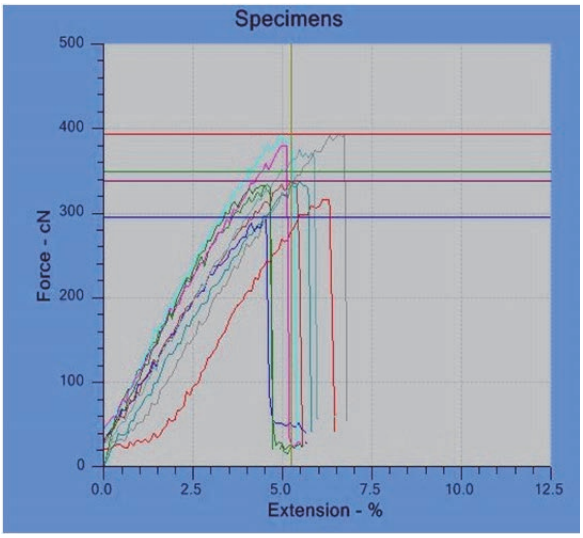

Fig. 9. Graph test - dry estate - variant BO.

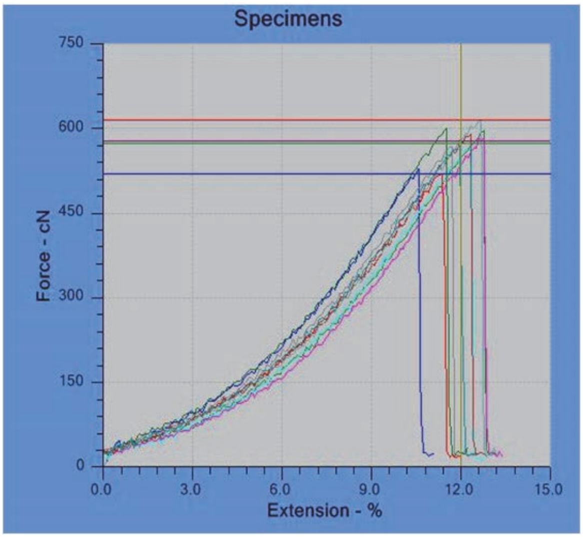

Fig. 10. Graph test - wet estate - variant BO.

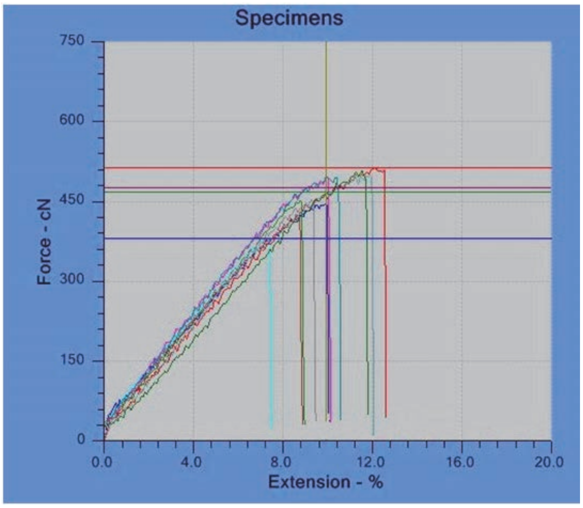

Fig. 11. Graph test - dry estate - variant BS.

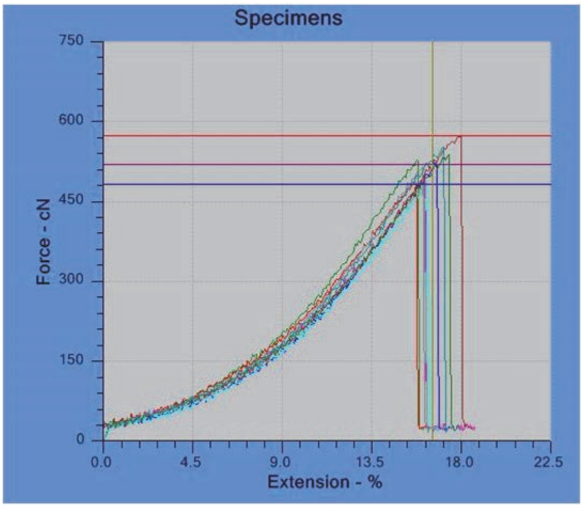

Fig. 12. Graph test - wet estate - variant BS.

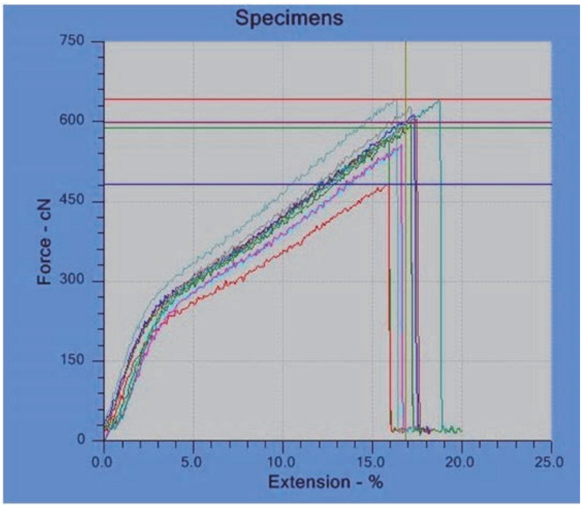

Fig. 13. Graph test - dry estate - variant BV.

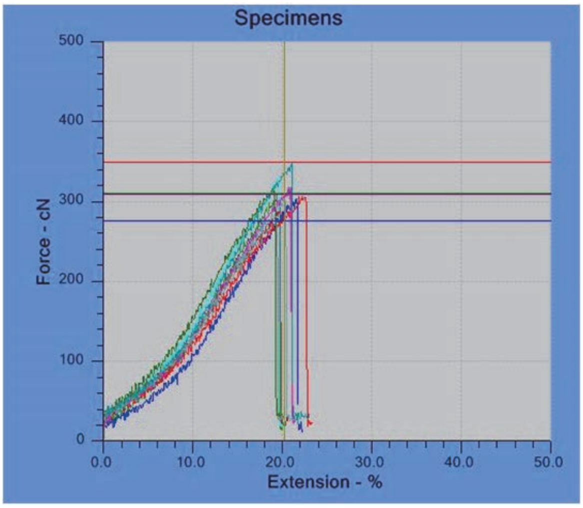

Fig. 14. Graph test - wet estate - variant BV.

- The breaking force is less on wet test than dry for yarn BV and vice versa for others yarns.
- We observe a better uniformity of the breaking force in case of BV yarn - figure 13.
- We observe a better uniformity of the elongation at break in case of BS and BV yarns - figures 12, 14.
- Elongation at break in wet test increase almost 40% for all samples - table 4.

Table 4. **The influence of moisture on the breaking force and elongation at break [6]**

CODE	**Raw material**	**Breaking force – dry test**	**Breaking force – wet test**	**In wet test increase or decrease with …%**	**Elongation – dry test**	**Elongation – wet test**	**In wet test increase or decrease with …%**
		[cN]	**[cN]**	**[%]**	**[%]**	**[%]**	**[%]**
BU	**Cotton 100%**	393	448	↗ **14**	6.38	10.14	↗ **59**
BO	**Organic cotton 100%**	350	574	↗ **64**	5.24	11.99	↗ **129**
BS	**Cotton+soy**	467	519	↗ **11**	9.92	16.53	↗ **67**
BV	**Bambooviscose**	588	310	↘ **90**	16.86	20.26	↗ **20**

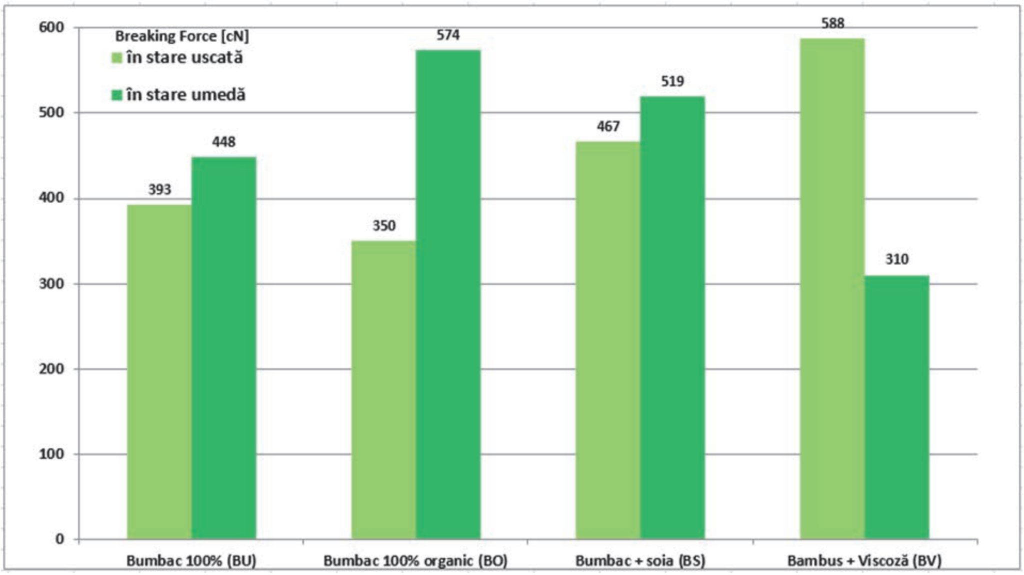

Fig. 15. The influence of moisture and raw material on the breaking force.

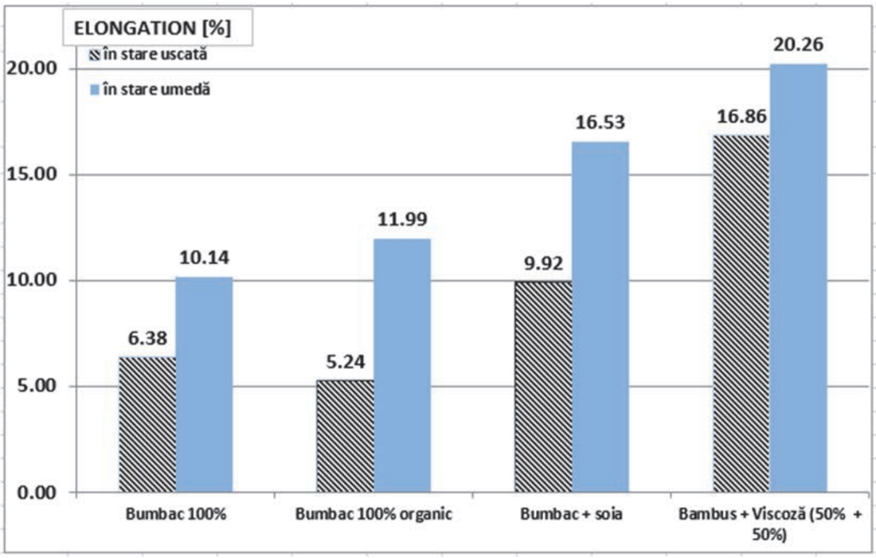

Fig. 16. The influence of moisture and raw material on the elongation at break.

5. FINAL CONCLUSIONS

5.1. Related to fineness

● The fineness for 4 variants of yarns has been tested. The result was that they fit within the specification of the customer.

● Yarns with a finesse of 34/1 Nm have been selected which are most commonly used for knitting classic stockings for women, children, men.

5.2. Related to yarn twist

● The highest value of the twist has been registered in the case of BS sample - figure 5.

● For the same raw material and finesse - 100% cotton (BU) and organic cotton 100% (BO), the twist is increased by 9% in the case of variance BU - figure 5.

● We have the same values in the case of samples BO and BV - table 2, figure 5.

5.3. Related to humidity

● Relative humidity of the cotton yarns is by 50% lower than standard value of humidity. This is due to the fact that tests have been carried out at a temperature of 25°C. Was registered the same percentage in the case of BS sample.

● Samples BO and BV have a lower humidity than standard value of humidity.

● It is necessary to maintain a standard atmosphere for bobbins with yarns before being brought into the knitting sector.

5.4. Related to tensile strength and elongation at break - dry test

● By analyzing the values obtained in the case of BU yarn (classic cotton) and BS (cotton + soy) we notice that the percentage of soy in the structure of yarn (BS) leads to an increase in the traction force with 15.8 %. This is a result the fact that the yarn BS presents a torsion greater than the yarn BU - table 3, figures 7, 11.

● For the same raw material and finesse - classic cotton (BU) and organic cotton 100% (BO), breaking force is greater in the case of variant BU with 9 %. A twist is greater in the case of BU yarn, leads to better tensile strength of their - table 3, figures 7.9.

● The biggest elongation at break is present to the bamboo viscose yarn (BV) - 16, 86 %, and the smallest value is the one of the organic cotton yarn (BO) - 5.24 % - table 3, figures 9, 13.

● For the same raw material and finesse - classic cotton (BU) and organic cotton 100% (BO), the breaking elongation is greater in the case of variance BU with 22 % - table 3, figures 7.9.

● By analyzing the values obtained in the case of BU yarn (classic cotton) and BS yarn (cotton + soy) we notice that the percentage of soybeans in the structure of the yarn (BS) leads to an increase in the breaking elongation by 55% - table 3, figures 7, 11.

5.4. Related to tensile strength and elongation at break - wet test

● The breaking force in wet state testing increases with a certain percentage - table 4 - in the case of yarns made from natural fibers (BU, BO, BS) and decreases by 90% in the case of sample BV - yarn obtained artificially.

● Following the analyses of the values obtained in the case BU (classic cotton) and BS (cotton + soy) we notice that the percentage of soy in the structure of yarn (BS) leads to an increase in the breaking force in wet state (condition) with 63% - table 4, figures 8, 12 .

● For the same raw material and finesse - 100% cotton (BU) and organic cotton 100% (BO), the breaking force in wet state is greater in the case of variant BO with 18% - table 4, figures 8, 10 .

● The breaking elongation of the yarns in wet state increases with a certain percentage compared with values in the dry state - table 4 - in the case of all yarns analyzed.

● The breaking elongation in wet state has the maximum value for variant BS, and the minimum value for variant BU – table 4.

FUTURE RESEARCH

Our research permit the achievement of new topic research, in the case of functionalization treatments for textile products, especially knits. Below have been listed some of these lines of approach in the future, to produce a final product value-added, to make it more competitive on the market.

- Research for antimicrobial treatments on knits.
- The study of the thermal comfort properties of the knits.
- Research on using "eco-friendly" dyes for materials obtained from analyzed yarns.

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STUDIU COMPARATIV PRIVIND METODOLOGII ANTIBACTERIENE SUSTENABILE CU POTENȚIAL APLICATIV ÎN DOMENIUL TEXTILELOR

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Rezumat: Lucrarea se dorește a fi o sinteză privind cele mai noi metodologii de aplicare a agenților antibacterieni pe suporturi textile naturale și chimice, dar și o antiteză centrându-se pe compararea cu agenții antibacterieni consacrați începând cu compușii organici sintetici, precum

triclosan, chitosan, săruri cuaternare de amoniu, polibiguanide, N-alamine, pâna la metale - ionii de argint. Sunt abordate metode diferite de aplicare a unor posibili agenți antimicrobieni, de investigare a materialelor tratate, dar și beneficiile aplicării acestor tratamente**.** Ca structuri antimcrobiene, sinteza are in atenție antibioticele și peptidele antimicrobiene, pe de o parte, dar și extactele de coloranți naturali, pe de altă parte. Metode de imobilizare a unor cunoscute peptabiotice din clasa peptidelor au fost recent investigate și au ca scop ancorarea lor stabilă, prin legături covalente de suporturile celulozice sau celulozice modificate. În ultimul timp textilele bio-funcționale cu activitate antimicrobiană au cunoscut o dezvoltare fără precedent. Tehnologiile de aplicarea a agenților antimicrobieni prin intermediul ciclodextrinelor grefate pe suporturile textile sunt actuale și cuprind compuși gazdă, precum: acid ferulic, cafeic, etil ferulate, alantoina, etc. Ulterior se pot obține și efecte antialergice ce completează protecția antibacteriană prin utilizarea unor compuși naturali gen propolis cu Viola tricoloris Herba, mentol,etc.Studiul evidențiază ideea că, agenții antimicrobieni reprezintă o alternativă la folosirea antibioticelor standard și demonstrează potențialul lor de aplicabilitate în domeniul textilelor medicale, fiindu-le pe deplin recunoscute atributul de agenți bioactivi/biodisponibili sustenabili. Se impune deci ca cele mai bune tehnologii antimicrobiene aplicate în vederea obținerii textilelor medicale să minimizeze potențialele riscuri, în aceeași măsură în care le conferă o funcționalitate durabilă.