Improving the properties of woollen yarns and fabrics using spandex

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Abstract:
The consideration of blending wool with various industrial raw materials was deemed essential in order to attain novel qualities that align with the intended application and consumer preferences, while also ensuring economic viability. The objective of our work is to create yarns that incorporate synthetic fibers in order to attain a favorable economic outcome. Furthermore, enhancing the quality of mixed woolen yarns has a direct impact on their functional performance. Our research involves the combination of wool, polyacrylic, and Lycra in specific proportions. Specifically, we blend 25% wool material with 75% polyacrylic material, and then add an additional 5% Lycra to this blend. This process allows us to create three distinct variations. The experimental findings demonstrated a significant augmentation in the tensile strength, as well as an increase in the percentage of regularity. There was an improvement in the association between the count and the elongation percentage. Furthermore, we weaved 6 plain fabrics 3 of them were weaved from the blend of 75% wool 25% acrylic the other 3 were weaved from the second blend of 75% wool 25% acrylic 5% lycra. We examined those 6 fabrics for weight, tensile strength, elongation, friction, wrinkle resistance and absorption. The specimen from the blend of 75% wool 25% acrylic 5% lycra with the count of 20/1 had shown the highest results for all examination.

Keywords:
core spun; lycra; polyacrylic; wool; fabrics

الملخص:
Research Problem: غالبًا ما تُعتبر الخيوط المكون الأساسي للخيوط بمختلف أنواعها. وبينما تُشكل الألياف الطبيعية الأساس، يُعتبر ظهور الألياف الصناعية عاملًا محوريًا أثّر بشكل كبير على تطور صناعة النسيج. يتكون كلا النوعين من الألياف من جزيئات كبيرة أو بوليمرات خطية، تتكون من تكرارات متعددة من مونومرات بسيطة. غالبًا ما تُعتبر المواد الخام الحيوانية الطبيعية باهظة الثمن ويصعب الحصول عليها، مما يؤدي إلى نفقات مالية باهظة. لذلك، كان من الضروري النظر في حلول محتملة تُعالج هذه العقبات بفعالية. واعتُبر مزج الصوف مع مختلف المواد الخام الصناعية أمرًا أساسيًا لتحقيق خصائص جديدة تتوافق مع الاستخدام المقصود وتفضيلات المستهلك، مع ضمان الجدوى الاقتصادية في الوقت نفسه. يهدف عملنا إلى إنتاج خيوط تحتوي على ألياف صناعية لتحقيق نتيجة اقتصادية مواتية. علاوة على ذلك، فإن تحسين جودة خيوط الصوف المختلطة له تأثير مباشر على أدائها الوظيفي. يتضمن بحثنا مزيجًا من الصوف والبولي أكريليك والليكرا بنسب

محددة. على وجه التحديد، قمنا بمزج 25% من مادة الصوف مع 75% من مادة البولي أكريليك، ثم أضفنا 5% إضافية من الليكرا إلى هذا المزيج. تتيح لنا هذه العملية إنشاء ثلاثة اختلافات مميزة. أظهرت النتائج التجريبية زيادة كبيرة في قوة الشد، بالإضافة إلى زيادة في نسبة الانتظام. كان هناك تحسن في العلاقة بين العدد ونسبة الاستطالة. علاوة على ذلك، نسجنا 6 أقمشة سادة، 3 منها منسوجة من مزيج 75% صوف و25% أكريليك، والـ 3 الأخرى منسوجة من المزيج الثاني من 75% صوف و25% أكريليك و5% ليكرا. فحصنا هذه الأقمشة الستة من حيث الوزن وقوة الشد والاستطالة والاحتكاك ومقاومة التجعد والامتصاص. أظهرت العينة من مزيج 75% صوف و25% أكريليك و5% ليكرا نمرة1/20 أعلى النتائج لجميع الفحوصات.

Natural animal raw materials are expensive and not readily available because they are taken from sheep, which require significant amounts of care, maintenance, and feeding. Therefore, attention must be paid to this raw material, which is used in many diverse types of textiles and clothing, including men's suits, women's suits, sweaters, and socks, each of which requires specific properties and specifications.
Therefore, it was necessary to consider solutions to overcome these challenges. This required blending wool with some synthetic materials to achieve new properties that suit the nature of use and consumer tastes, while achieving economic returns.

Research Objectives:

1. To identify the best blends to achieve the best functional properties of the produced yarns.
2. To utilize the process of blending natural fibers with various fibers to improve the properties of the yarns and fabrics produced.
3. To produce yarns blended with certain synthetic fibers to achieve economic returns.
4. To improve the quality of blended wool yarns, which affects their functional performance.
5. To study the effect of mixing variables on blended yarns.

Research Importance:

1. To reveal the role of the raw material and its impact on the properties of the produced yarns and the final product.
2. To determine the extent to which the blending of raw materials affects the properties of the final product.
3. To achieve economic returns resulting from mixing different raw materials and producing yarns with effects.
4. To produce new types of yarns with superior properties that suit the nature of their use.

Research Assumptions:

1- Different types of raw materials affect the properties of the yarns and the final product.
2- Different blending ratios play a significant role in influencing the properties of the final product.
3- Mix wool with polyacrylic and lycra at a ratio of 25% wool and 75% polyacrylic, with the addition of 5% lycra, to produce three different patterns.

Introduction:

The core spinning technique involves the twisting of fibers around a pre-existing yarn, whether it be a continuous yarn or individual strands of yarn. The thread is composed of small filaments that are spun together. This results in a compound structure with a core and a sheath. The core is located in the center of the thread, while the sheath surrounds the core. This arrangement is depicted in Figure 1 [1, 2].

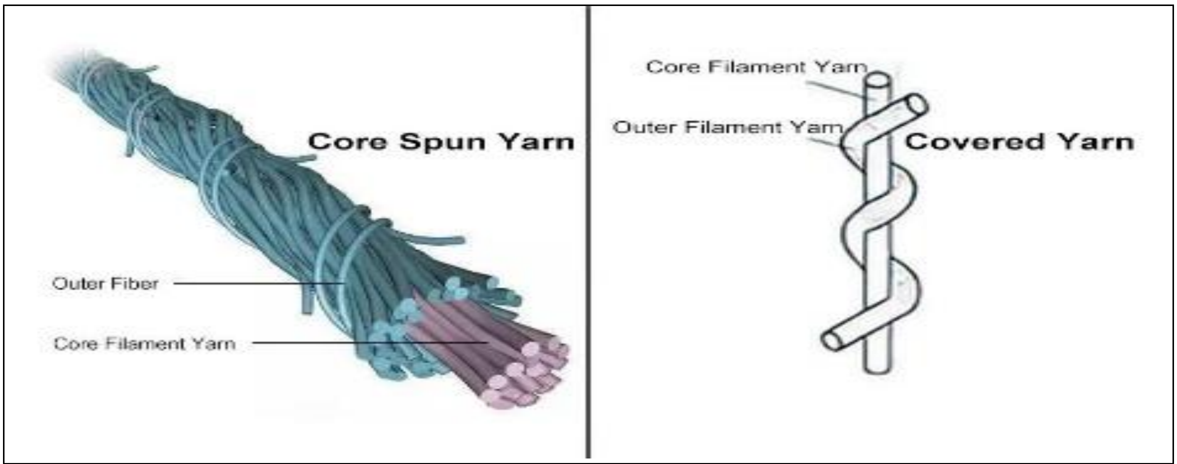


Fig.1 Formation of core spun yarn

According to Miller, core spun yarns can be characterized as threads composed of multiple components, with one component permanently positioned along the central axis and the remaining components serving as a covering layer. The term "supported yarn" is occasionally used to refer to a thread that has a core, which enhances its strength. However, it is important to note that this designation does not universally apply [3]. It has been established that the combination of two or more fiber types in a blend leads to a substantial enhancement in the qualities of the resulting mix. The surface of core spun yarns has reduced elastic characteristics, while the core demonstrates enhanced elasticity, resulting in increased strength, improved elasticity, and exceptional recovery. The core spun yarns exhibit a simplistic design, utilizing uncomplicated materials. The fabric exhibits diversity in both its core and cover, and its applications span a wide range. One such use is the enhancement of functional attributes in fabrics, including but not limited to strength, durability, elasticity, and comfort, through the implementation of axle thread [3]. Core spun yarns are manufactured through various spinning systems, with each system possessing distinct attributes. The process of ring spinning is characterized by its simplicity and cost-effectiveness, while the placement of the core in the central position presents a challenging task. The most significant issue that may arise during the production process is the occurrence of thread peeling, which can subsequently manifest in subsequent operations and lead to damage to the core yarn as in Figure 2 [4] .

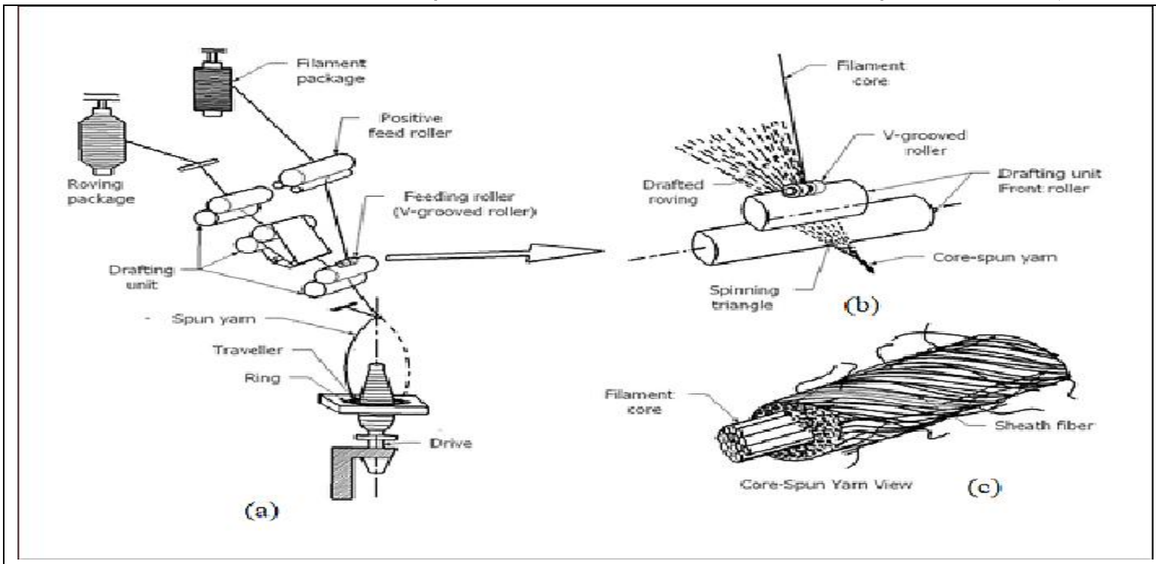


Fig. 2 Methods of producing core spun yarns

There are several advantages associated with the utilization of core spun yarns.

1- The incorporation of multiple components in the thread enables the production of a diverse range of products across various industries. These products can be composed of high-performance fibers in both the core and cover, or a combination of traditional fibers in the core (such as metal wire or optical fibers) and traditional fibers in the cover [3].

2- The issue pertaining to the exorbitant expenses associated with the importation of lengthy cotton filaments has been successfully resolved. Consequently, other materials such as single-filament nylon threads and Indian cotton of varying lengths, including long and medium, have been employed as substitutes.

3- Glass fibers, when utilized in isolation, have the propensity to fracture throughout operational processes, hence inducing skin irritation and allergic reactions in individuals who come into contact with them. Due to this rationale, the utilization of core spun yarns in lieu of continuous threads proves to be more convenient in weaving and knitting procedures [5].

4- The core and jacket of a material have been utilized effectively in several new technical applications. These applications include heat protection, fire resistance, cut resistance, personal protective equipment, technological sewing threads, lightweight components, and lightweight packaging components [5].

5- There are several advantages associated with the utilization of synthetic fibers and polymers, such as continuous core fibers, in the production process. These materials offer improved qualities in terms of coating, ease of maintenance, and comfort. Additionally, they contribute to a more efficient and expedited production rate, resulting in enhanced economic feasibility [6].

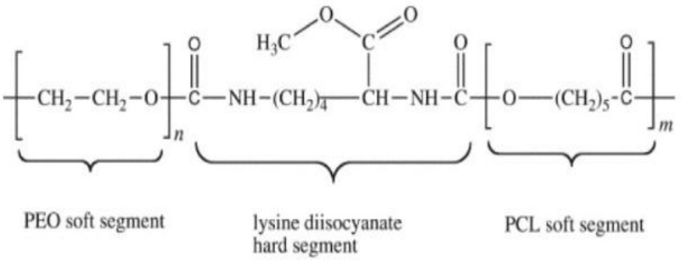
6- Fabrics composed of cotton core yarns do not necessitate specialized treatments in contrast to those fabricated from polyester yarns.

7- Woolen fabrics composed of coaxial yarns exhibit reduced thickness and weight compared to conventional fabrics. Furthermore, worsted core spun yarns surpass the constraints of traditional yarns by modifying their composition to achieve lighter and thinner fabrics, employing continuous threads and twisted wool [7, 8].

Wool is classified as a naturally occurring textile fiber. Wool is widely regarded as the predominant animal fiber in terms of usage. The fiber is derived from the fine, fibrous outer layer of sheep and occasionally goats. Woolen clothes also have exceptional form retention as a result of the inherent crimp structure present in the wool fibers. When two fibers make contact, the scales on their surfaces have a tendency to adhere and adhere to one another [9]. The phenomenon of physical adhesion facilitates the effortless spinning of wool fibers into thread, enabling the production of stronger yarn without the need for excessive twisting. In addition, wool has historically been employed as a covering material for cloth diapers. The outer surface of wool fibers exhibits hydrophobic properties, causing them to reject water, while the inside structure of these fibers is hygroscopic, meaning it has a tendency to collect water. This unique combination allows wool clothes to effectively shield wet diapers without facilitating the transfer of moisture, so ensuring that outer clothing remains dry [10]. Wool is widely regarded as the second most significant textile material, following cotton, owing to its exceptional capacity to regulate body count. As the predominant animal fiber in the textile industry, wool has garnered a reputation as a luxurious commodity due to its elevated cost and the associated expenses involved in its maintenance. The quantity of skeins per pound, assuming that each skein measures 560 yards in length. Consequently, there exists a positive correlation between the grade of wool and its thickness, wherein a higher grade (shown by a greater number of skeins per pound) corresponds to a finer texture. The measurement of filament length plays a significant role in defining the wool manufacturing process and the resulting yarn count. This is because both length and fineness are crucial components in determining the yarn count [11]. Numerous developing nations have established manufacturing facilities for the production of Polyacrylic fibers, mostly driven by the manifold attributes associated with these fibers, alongside the straightforward accessibility of their constituent raw materials [12]. The research in this sector was initiated by Du Pont in 1940, leading to the subsequent achievement of production. In 1942, fibers possessing exceptional requirements were employed for military applications. Subsequently, through ongoing enhancements, these fibers were produced on a significant industrial level and introduced into the commercial market as "Orlon" fibers [13]. This particular fiber is under the category of synthetic chemical fibers and is commonly referred to as polyvinyl nitrile or polyacrylic nitrile. Acrylic fibers are well recognized as the most prevalent type of synthetic fibers. This particular fiber is characterized by its unique features, which encompass both thermal insulation and a gentle tactile sensation. Furthermore, it exhibits resistance to detrimental chemical, biological, and climatic factors. The molecular structure of polyacrylic fibers is established through the polymerization mechanism of the acrylic monomer, which accounts for 85% of the material's overall weight [14].
Lycra, also referred to as Spandex, is famous for its exceptional elastic properties [15]. Polyurethane, a lengthy polymer, is synthetical via the chemical reaction between polyester and dicyanide, resulting in the formation of these materials[16]. Spandex fibers exhibit superior resistance to count and oil in comparison to rubber, as illustrated in Figure 3 [17]. The production of stretchable yarns frequently involves the utilization of the core spinning method. This approach allows for the incorporation of stretchable fibers or filaments, such as spandex or lycra, as the core material. Various technologies, including ring spinning, abrasion spinning, rotor spinning, and air jet/vortex spinning, can be employed to manufacture these stretchable yarns [18]. Every spinning technique possesses distinct characteristics. Among the several

procedures discussed, ring spinning stands out due to its simplicity, cost-effectiveness, high strength, exceptional resistance to abrasion, and flexibility in meeting stretch needs. Additionally, it possesses the capability to produce a diverse variety of yarn counts [19].

raw fiber form



Chemical composition of spandex fibers

Fig. 3 Chemical series of Lycra molecules [20]

The purpose of incorporating synthetic fibers with natural fibers simultaneously fulfills two objectives: the economic dimension and the technological dimension. As for the economic aspect: it implies cutting the price of creating garments from natural materials. Regarding the technological dimension, it entails the advancement of diverse fabric varieties that possess characteristics conducive to optimal utilization [21]. The blending process within the textile industry involves the amalgamation of fibers possessing distinct qualities, resulting in the creation of yarns utilized for the production of a uniform mixture of diverse fibers [22]. Hence, the process of blending is a meticulous undertaking that necessitates extensive expertise and proficiency in order to create a mix that is well-suited for its intended application, taking into account factors like as the quality of the raw materials, color, and price.

Synthetic fibers have been introduced into the textile industry, either as standalone materials or in combination with natural fibers, in order to address the limitations of the latter and cater to the increasing demand of a growing population, all while maintaining affordability [23]. The significance of incorporating synthetic fibers into the wool industry is evident, particularly in Egypt where this sector heavily relies on imported raw materials, both synthetic and natural. Given the imperative to minimize the expenses associated with wool imports, it becomes essential for this industry to enhance the practice of blending synthetic fibers with wool, which is characterized by its high price. Fabrics and garments created from mixes of polyester fibers and polyacrylic fibers see a reduction in cost and price, since they are priced at more than twice the cost of polyester fibers and more than three times the cost of polyacrylic fibers [24]. Blended textiles offer advantages beyond cost reduction, as they frequently exhibit superior qualities compared to pure wool fabrics. The incorporation of synthetic fibers into wool blends provides a dual benefit: the production of fabrics at affordable rates and the enhancement of woolen fabric quality [25].

There is a common belief among individuals that the incorporation of synthetic fibers in the blending process of wool leads to a decline in the overall quality of the resultant fabrics, mostly due to the synthetic nature of these fibers. The assertion made is unsubstantiated as it contradicts scientific evidence derived from experiments and analyses conducted on blends. These studies have consistently demonstrated that the inclusion of synthetic fibers in conjunction with wool and other natural fibers effectively enhances the properties of the resultant fabrics, thereby

compensating for any inherent deficiencies in the natural fibers' properties [26]. In addition to decreasing its expenditure. Companies engaged in the production of blended fabrics undertake requisite advertising efforts to elucidate the benefits associated with the amalgamation of synthetic fibers. These advantages are effectively communicated by inscribing them directly onto the garments [27]. For instance, on socks composed of a blend of wool and nylon, the manufacturer includes descriptors such as "wool for enhanced thermal insulation" and "nylon for increased longevity," elucidating the benefits that the consumer derives from the incorporation of these materials. The mixture contains synthetic bristles. Hence, the incorporation of synthetic fibers with natural fibers serves not only an economic purpose but also holds significant technological importance in the development of diverse fabric varieties that possess efficient qualities tailored to certain functional requirements. As a result of accumulated experiences, consumers have developed a propensity to purchase textiles composed of blended materials. Industrial brushes are chosen for their excellent efficiency and cost-effectiveness [28].
Weaving is simply weaving two sets of yarn at right angles to one another, either on a basic hand loom or a power loom. Warp yarns are the yarns that weave the fabric lengthwise, and weft yarns, commonly referred to as filler, are the yarns that weave from side to side. In generally, warp yarns are stronger than weft yarns because the various loom motions used throughout the weaving cycle put a lot of stress and strain on the warp yarns during the weaving process. The weave is the way that the warp and weft threads entwine with one another. Three main processes need to finish one loom cycle or one full loom rotation in order to interlace the warp yarn with the weft yarn. Shedding, picking, and beat-up are the three main processes. Weaving cannot occur without any of these mechanisms [29]. Min Dang and his colleagues utilised spandex as the core and sixty-six samples of wool fibre for the wrapping material. They discovered that, in comparison to regular yarn, elastic core-spun yarn offers superior qualities. According to their research, as twist factor and spandex drawing ratio increase, tenacity and breaking elongation initially rise and subsequently fall [30].
From the literature there is no researches about using lycra as core blended with wool and polyacrylic, so the objective of our work is to develop yarns that incorporate synthetic fibers in order to attain a favorable economic outcome. Furthermore, enhancing the quality of mixed woolen yarns has a direct impact on their functional performance. Our research involves the combination of wool, polyacrylic, and Lycra in specific proportions. Specifically, we blend 25% wool material with 75% polyacrylic material, and incorporate an additional 5% of Lycra. This is in comparison to the blending of wool and polyacrylic at the same 25% wool and 75% polyacrylic ratio. Through this process, we are able to produce three different counts. We weaved plain fabric using 3 different thread counts from every previous blend and tested them. The count 20/1 had recorded the highest results from the first blend in weight per meter square, elongation, tensile strength, resistance to abrasion and time of absorption. Also, the same count recorded the highest results from the second blend.

Experimental:

Materials and Methods

The materials specification used in blending are shown in Table (1,2).

Table 1 The specification of the used Worsted wool

Specification	Value	Origin
Filament length	88 mm	England
Micronair	32.5	
Plant impurities	2.5 %	
percentage of yellowness in color	4 %	
Moisture in the material	17 %	
Fat percentage	0.1 %	

Table 2 The specification of the used polyacrylic

Filament length	Filament fineness/ microns	Origin
88 mm	3 microns	Turkey

Blending:

<u>Counts produced from blending wool fibers/ polyacrylic fibers with and without adding 5% lycra</u>

The blends of the producing counts (20/1), (30/1), and (40/1) in a ratio of 3:1 as well as the producing count shows the ratio of blending wool and polyacrylic with and without adding 5% lycra in Table (3).

Table 3 The percentage of blending wool with acrylic for the counts (20/1), (30/1), and (40/1)

Material	Filament fineness/microns	Filament length	Blend ratio	Count	Origin
Wool	23.5	80 mm	25 %	(20/1), (30/1), (40/1)	England
Acrylic	3	88 mm	75 %		Turkey
By adding 5% of Lycra					

Stages of blending preparation:

The operations were carried out at the Stia Premium Wool Company in Alexandria

blending stage

The blending process took place in the drawing stage, which consists of two stages of drawing, a first drawing and a second withdrawal.

Machine name: Schlumberger Model: GN6 Date of manufacture: 1989

A- The combing stage (combing machine)

Machine name: Schlumberger Model: PB2 Date of manufacture: 1989 Date of installation: 1989

B- Final withdrawal stage (withdrawal machine)

This stage consists of four drawing stages, the goal of which is to reduce the weight of the tape resulting from the previous stage until it reaches the required twisted count.

Machine Name: Schlumberger Model: GN6 Date of manufacture: 1989

C- The twisting stage (twisting machine)

Machine Name: Schlumberger Model: FMv36 Date of Manufacture:1998 Date of Installation:1998

D- Spinning stage (spinning machine)

The spinning stage was carried out at Woolltex Wool Spinning Company, Imbaba, Giza

Machine name (type): Zinser Model: 319 Date of manufacture: 1983 Date of operation: 198

Textile preparations:

textile preparations were carried out at Woolltex company as follows:

A- warping stage (warping machine)

Machine name: Blinger Country of origin: western Germany Date of manufacture: 1984

Bobbin holder capacity: 320 bobbins Number of threads per skein: 220 strands

Number of strands: 14 strands + 16 strands

B- drawing and drafting in shafts

Number of shafts: 4 (four shafts plus two locking shafts on both sides)

Type of drawing in: On the row Drawing in Layout: 2 threads in the door

C- Weaving (Weaving machine)

Machine name: Modified Dornier Installation date: 1984 Number of shafts: 4 Machine speed: 400 weft/min

D- Executive specification:

Warp specification

1) Warp yarn number: 48/2 polyester mixture with a percentage of 65% polyester: 35% polyacrylic
2) Number of threads per centimeter: 19
3) Number of edge threads: 48
4) Number of shafts used: 4
5) Comb used: 9.5
6) Layout: 2 threads/door
7) Width at comb: 160 cm
8) Number of warp threads: 48 edge + 3059 woven yarn +5 Completion yarn + 48 edge= 3160 threads

weft specification

1) Weft thread number: 1/20, 1/30, 1/40, English numbering. (produced in the research from blending)
2) Number of wefts per centimeter: 16 wefts/cm.
3) The textile composition is plain 1/1

Characterization of yarns and fabric

Tensile strength

The measurement of tensile stress-strain characteristics is the most prevalent mechanical measurement conducted on fabrics. It is employed to ascertain the response of a specimen when subjected to a uniaxial tensile force. The breaking load and elongation can be derived from this. The tensile strength test operates on a straightforward principle: a specimen is securely held at two or more points and subjected to extension until it fractures. The measured tensile characteristics are typically regarded as subjective rather than definitive. The outcome is contingent upon the shape of the specimen, the type and organization of the fibers, and the structure of the fabric [31-35].

Elongation

Elongation at load refers to the extent to which a fabric lengthens from its initial length when subjected to a specific load. This term is frequently employed to specify the degree of elasticity in the fabric. Woven fabrics exhibit significantly less elasticity compared to knitted fabrics. Elongation force refers to the amount of force needed to stretch a fabric to a specific distance. The parameter referred to as power or tension of the fabric at elongation plays a crucial role in determining the comfort aspects of garment design [36-39].

Regularity

The measurement of wrinkle or crease recovery is prioritized over the measurement of wrinkle resistance. Multiple testing techniques exist for quantifying the wrinkle and crease recovery of fabrics. These can be categorized into two main groups: one involves the insertion of a single sharp crease, resulting in a fixed deformation, while the other involves the insertion of a family of mostly random creases or wrinkles, resulting in random distortion of the fabric. Both fabric deformation and recovery conditions are crucial and require precise control and consistency in both circumstances. The ambient conditions, especially the relative humidity, and the moisture content of the fiber are also crucial factors to consider throughout both the creasing and recuperation processes. Wear trials are a subjective method used to evaluate the performance of wrinkles. It is crucial to note that the outcomes produced by various testing techniques typically exhibit low correlation. The fabric specimen, whether wet or dry, is subjected to creasing and compression using a Shirley crease recovery tester. This is done under specific load and atmospheric conditions for a predetermined duration, such as 5 minutes. Subsequently, the load is removed and the specimen is allowed to recover, once again under specified conditions and durations, such as 5 minutes. The angle of recovery, known as the crease recovery angle, is then measured. Test methods include AATCC 66, BS EN 22,313 and ISP 2313 Test methods include AATCC 66, BS EN 22,313 and ISP 2313..[40].

Weight/m^2

The weight of fabric can be calculated by measuring either the mass per unit area or the mass per unit length. To ensure uniformity in specimen size, a cutting device or template is used to obtain specimens with predetermined dimensions. Greater specimen size yields higher measurement accuracy, and most test standards mandate measuring an area of 10,000 mm2 or greater. The precision of cutting the specimen should be within a 1% margin of error in terms of the area. Each fabric sample should be represented by five examples. When selecting specimens, it is important to refrain from sampling the fabric selvedge or areas around the ends of a fabric piece. Testing should be performed in a controlled environment using pre-conditioned samples, and precautions should be made to prevent the loss of fibers/threads during the weighing process. Results are often expressed in grams per square meter (g/m^2) [41].

Abrasion resistance

Abrasion is the process of gradual erosion or wearing down of a fabric due to friction with another surface. Nevertheless, the capacity to withstand abrasion is just one of several aspects that influence the overall wear performance and durability. Abrasion can manifest in several forms, such as the rubbing of fabric against fabric while sitting, the abrasion of fabric on the ground during crawling, and the rubbing of sand into upholstery fabric. It is challenging to establish a direct relationship between the conditions of textile abrasion during wear or use and laboratory tests. The abrasion resistance of a fabric is influenced by various factors, including the type of fiber, the inherent mechanical properties of the fibers, the dimensions of the fibers, the structure of the yarns, the construction and thickness of the fabrics, and the type and quantity of finishing material applied to the fibers, yarns, or fabrics [42].

Water Absorption resistance
ISO 18696:2006 is relevant to all textile fabrics, regardless of whether they have been treated with a water-resistant or water-repellent coating. The tumble-jar absorption test is used to quantify the resistance of fabrics to being wetted by water. This method is especially appropriate for evaluating the effectiveness of water-repellent treatments on fabrics. It exposes the treated materials to dynamic conditions that closely resemble those experienced during real-world use [43].

RESULTS AND DISCUSSION
1. **The thread examinations**

The results obtained from the blend of wool/polyacrylic with and without lycra shown in Table (4).

Table 4 shows the average test results of the tensile strength, elongation and regularity of the produced yarns

Thread count	Tensile strength without lycra MPa	Tensile strength with lycra MPa	Elongation % without lycra	Elongation % with lycra	Regularity % without lycra	Regularity % with lycra
20	375	417.5	6.4	8.1	12.73	14.1
30	260	335	8.3	9.8	13.47	14.5
40	186	265	10	11.5	14.55	15.2

a) The tensile strength
The correlation coefficient and regression line equation were obtained from Table 4. Regarding the correlation between the thread count and the tensile strength in MPa, as depicted in Figure 4. The analysis determined a correlation coefficient within the presence of 5% Lycra of R = 0.99 and R=0.98 without lycra between the count and the tensile strength. This strong positive correlation indicates that as the thickness of the thread increases, the tensile strength also increases, and vice versa. The reason for the observed increase in tensile strength can be attributed to the thicker thread, which results in a higher filament count within the cross-sectional area. Consequently, the thread diameter is enlarged, promoting cohesion among the filaments. This enhanced inter-filament bonding contributes to the overall rise in tensile strength. This phenomenon occurs due to the positive correlation between hair thickness and the quantity of hairs present in the cross-sectional area, resulting in an increase in diameter. The presence of the thread fosters cohesiveness among the individual hairs, resulting in a notable enhancement of the overall tensile strength. The equation for the regression line with 5% of

lycra was generated as follows: y = -76.25x + 491.67 and without lycra was y = -94.5x + 462.67.k2

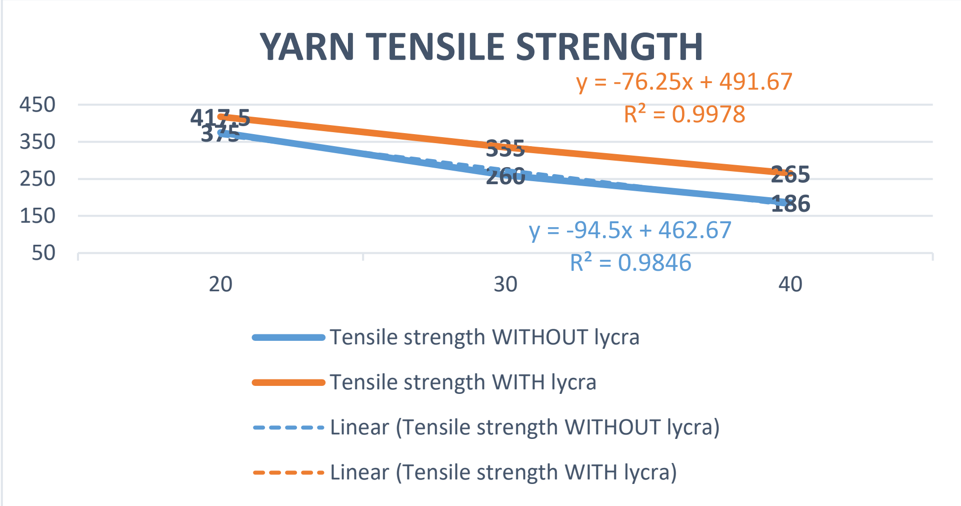


Fig. 4 modification yarn tensile strength with and without lycra

b) The Elongation %

Regarding the correlation between thread count and elongation percentage, Referring to Table 4. In Figure 5, the analysis revealed a correlation coefficient within the presence of 5% Lycra between the thread count and the elongation percentage, denoted as R^2=1 and without lycra R^2=0.99. The relationship between the thread and the elongation percentage shown a significant positive connection. This indicates that as the thickness of the thread increased, the rate of elongation decreased, and conversely, as the thickness of the thread decreased, the rate of elongation increased. This phenomenon can be attributed to the fact that a thin thread possesses a greater number of twists, and as the number of twists increases, the length of the thread decreases. The drop experiences an increase, and during the execution of an elongation test, the thread exhibits elasticity, resulting in a rise in the percentage of elongation. The equation for the regression line with lycra was determined to be y = 1.7x + 6.4 and without lycra y = 1.8x + 4.6333.

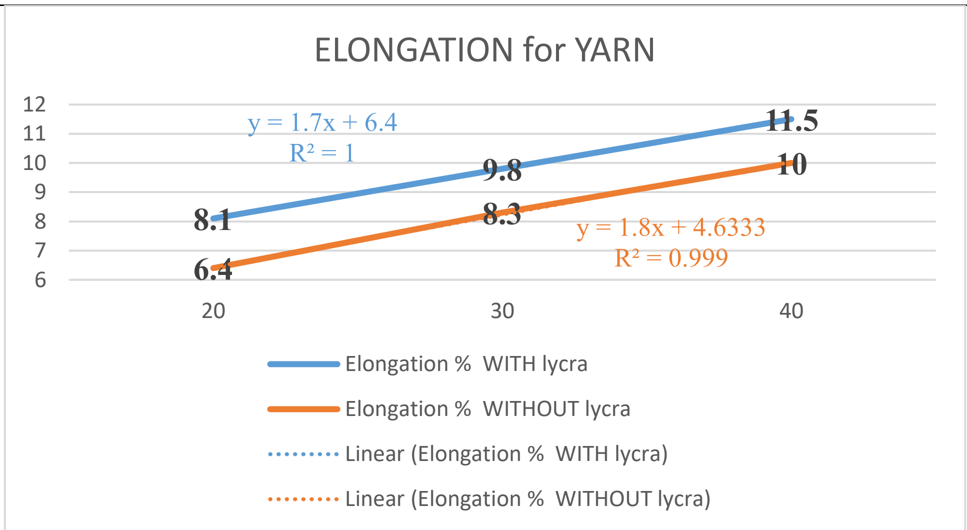


Fig. 5 modification yarn elongation % with and without lycra

c) The regularity %

Concerning the association between thread count and the percentage of regularity, According to Table 4. In Figure 6 a correlation coefficient with lycra of R= 0.97 and without lycra R= 0.98 was observed between the count and the percentage of regularity. The correlation between the count and the percentage of regularity was found to be strong and positive. This indicates that an increase in the count, particularly in thick and thin places, is associated with a decrease in the percentage of regularity, and vice versa. This is due to the quantity of slender components. The thread exhibits a reduced number of regions with varying thickness, and as the count of such regions decreases, the thread's regularity and the regularity of the resulting drop increase. In other words, a higher thread count, characterized by a consistent diameter throughout without variations in thickness, results in enhanced regularity. When subjecting the thread to a % regularity test, discrepancies in thread diameter are observed, which subsequently enables the determination of the regularity rate with lycra, expressed as y = 0.55x + 13.5 and without lycra as y = 0.91x + 11.763.

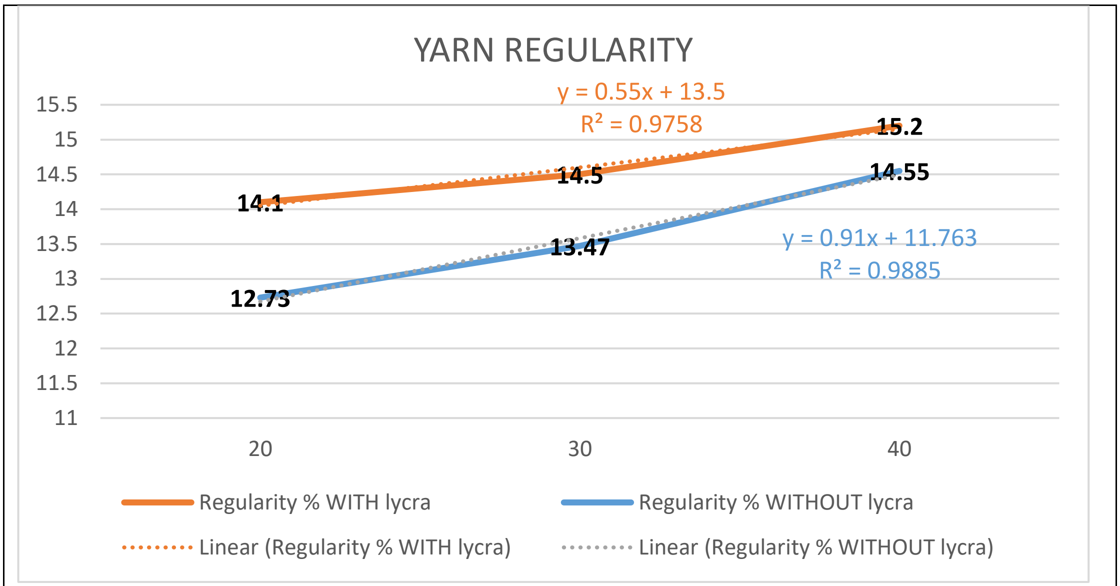


Fig. 6 modification yarn regularity with lycra

2.**The textile examinations**

- **First: Results of fabrics produced from the two blends**

Table 5 shows the average test results of the fabrics produced

thread count	tensile strength Mpa		Elongation %		Wrinkle Resistance		Weight/m²		Abrasion resistance		Water Absorption resistance	
	without lycra	with lycra	without lycra	with lycra	without lycra	with lycra	without lycra	with lycra	without lycra	with lycra	without lycra	with lycra
20	54	64.8	13.1	15	122.33	121	147.6	213.5	172	198	51	47
30	45	56.3	17.6	19	106.33	115	140.2	201	160.5	172	45.5	41

40	36	47.5	22.1	23	100.33	109	132.8	188.5	149	146	40	35

a) The relationship between count and weight per square meter:

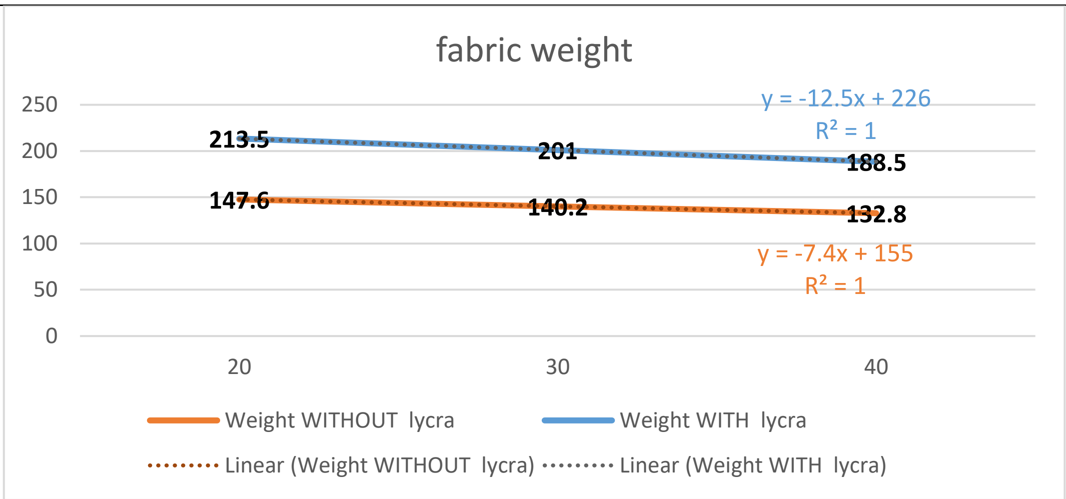


Fig.7 The relationship between thread count and amount of weight per square meter for the two blends

From Table 5, the correlation coefficient was extracted, then the equation of the regression line for the relationship between the count and the weight of a meter square. It was found that the correlation coefficient between the count and the weight of a meter square is R^2 =1 Figure 7. This correlation is negative (inverse correlation), meaning that the thicker the number of hairs in the cross-section, the greater the weight of the meter, and vice versa, the thinner the number of hairs, the less the number of all hairs in the cross-section and the less the weight of the meter, especially since polyacrylic is very light in weight by comparison with the weight of the wool, the equation of the regression line was derived and it was y = -12.5x + 226X with lycra and y = -7.4x + 155 without lycra. Therefor we can conclude that adding lycra had made an enhancement in the weight to the blend.

b) The relationship between count and tensile strength:

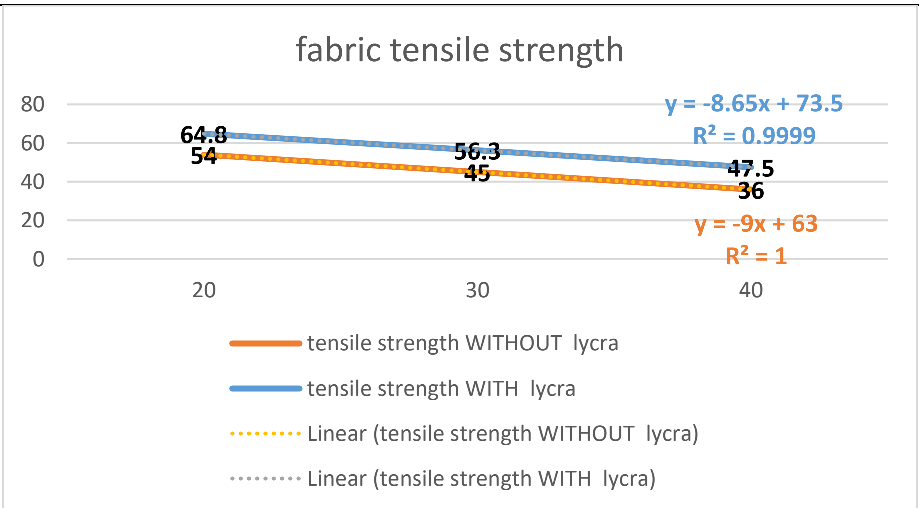


Fig. 8 The relationship between thread count and tensile strength for the two blends

The regression line for the relationship between fabric tensile strength and thread count, as in Figure 8. It was found that the correlation coefficient with lycra was R = 0.99 and without lycra was R^2=1 Table 5.This correlation is negative (inverse correlation), meaning that the thicker the thread(20), the greater the strength of the fabric tension, because it contains a greater number of hairs in the cross-section of the thread, which leads to an increase in the abrasion between the hairs and each other, and vice versa, the thinner the fabric, the less strength it has. Tension, because the thin fabric has a smaller diameter and contains a smaller number of hairs. The equation with lycra of the regression line was concluded y= -8.65+73.5 and without is y= -9x + 63. In conclusion the tensile strength with lycra had improved than without lycra.

c) The relationship between count and elongation:

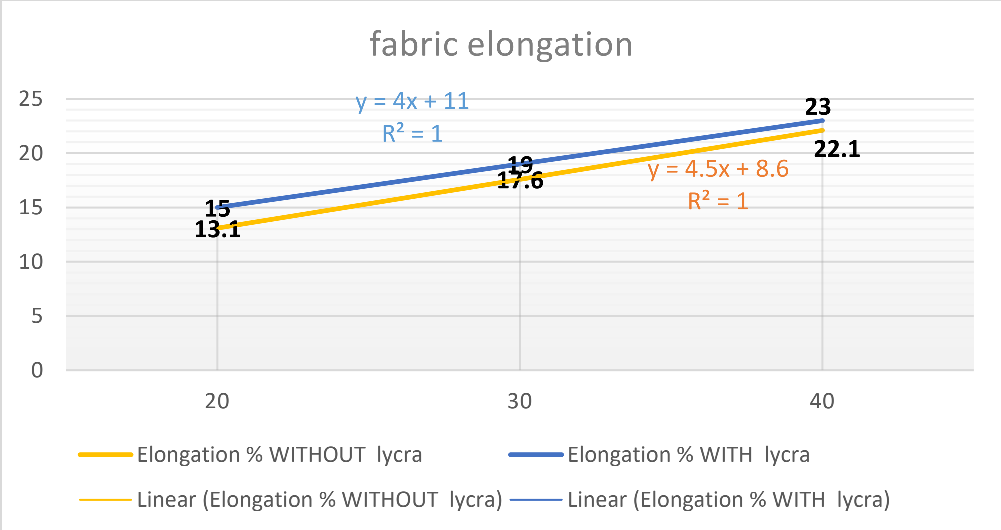


Fig. 9 The relationship between thread count and elongation % for the two blends

The correlation coefficient was extracted, then the equation of the regression line for the relationship between count and elongation percentage % Table 5, meaning that if one of the two properties is known, it is possible to obtain from this relationship the second property without conducting experiments, as in the Figure 9. R^2 =1 with and without lycra. This correlation is (positive) meaning that the thinner the thread, the greater the elongation rate. This is because the thinner thread contains a greater number of twines, and the more twists the length of the thread decreases and the thickness of the thread increases. When a tension and elongation test is performed, the length of the thread becomes unique and the thickness decreases, so the elongation percentage increases, and vice versa, the higher the thickness. Thick, the elongation rate decreases because the thread contains fewer twists. The equation of the regression line with lycra was derived and it was y = 4x + 11 and without lycra was y = 4.5x + 8.6. in addition, adding lycra has increased the elongation.

d) The relationship between the count and wrinkle resistance:

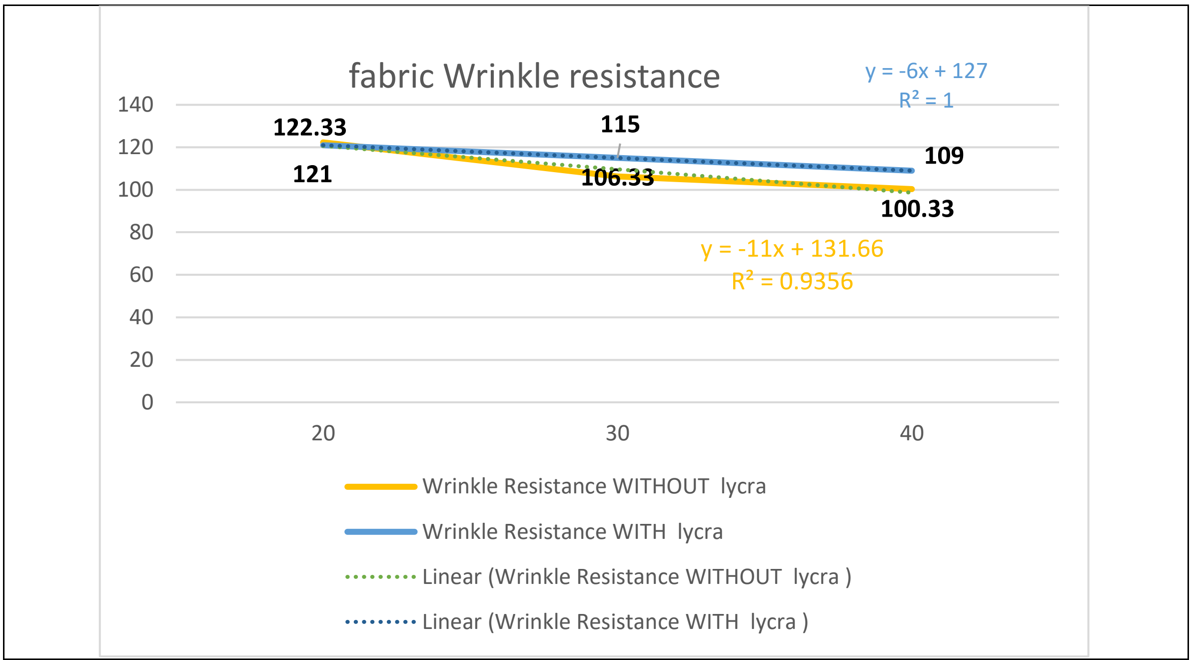


Fig. 10 The relationship between thread count and wrinkle resistance for the two blends

The correlation coefficient was extracted, then the equation of the regression line for the relationship between count and the resistance of fabrics to wrinkles, meaning that if one of the two properties is known, as in Figure 10. It was found that the correlation coefficient between the two and the resistance of fabrics for wrinkle with lycra was, $R^2 = 1$ and without lycra was $R^2 = 0.9356$. This correlation is negative (inverse), meaning that the thicker the fabric, the more resistant the fabric is to wrinkles. This is because the thick fabric has a large diameter and contains many hairs in the cross section, which resists wrinkles, unlike the thin fabric, which has a small diameter and the number of hairs in the cross section is less, and therefore it is not resistant to wrinkles. This relationship between wrinkles and the resistance of fabrics to wrinkles is strong, and the equation of the regression line with lycra was concluded and it was $y = -6x + 127$ and without lycra was $y = -6x + 127$.there for adding lycra has shown enhancement Table 5.

e) The relationship between count and abrasion resistance until breakage:

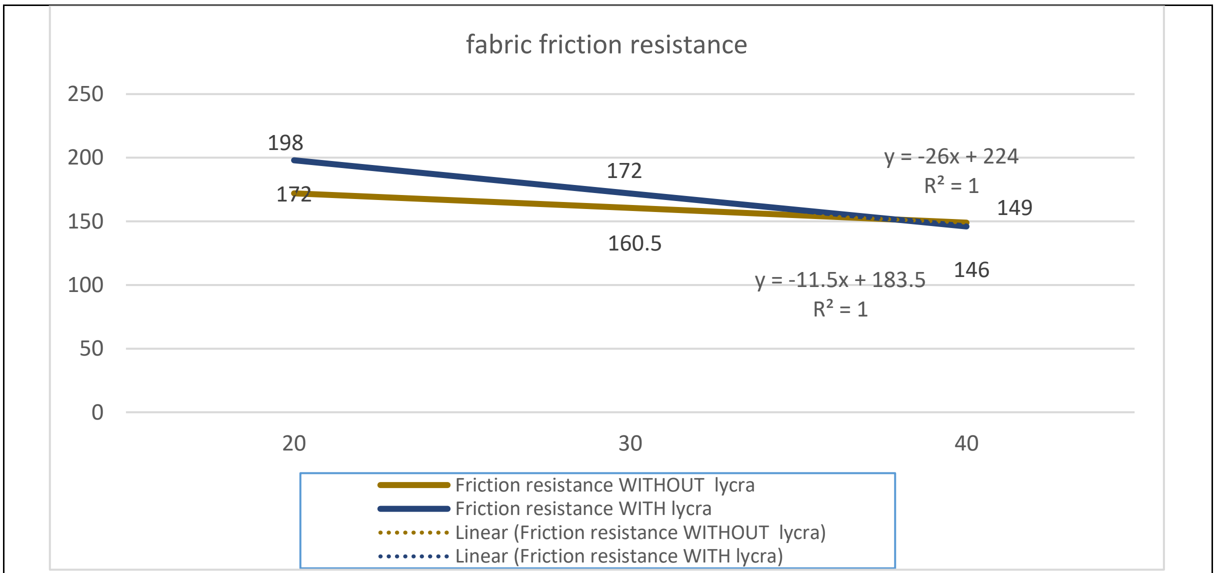


Fig. 11 The relationship between thread count and abrasion resistance for the two blends

From Table 5, the correlation coefficient was extracted, then the equation of the regression line for the relationship between the number and the resistance of fabrics to friction, as in Fig. 11. It was found that the correlation coefficient between the number and the resistance of fabrics to abrasion with and without lycra is $R^2 = 1$. This correlation is negative (inverse), meaning that the thicker the fabric, the greater the resistance of the fabric to friction. This is because the thick fabric has a large diameter because it contains a large number of hairs in the cross-section, which leads to increased resistance to friction, unlike the thin fabric, which has a smaller diameter and contains a smaller number of hairs in the cross section. The cross-section, and thus its resistance to abrasion decreases. The equation of the regression line with lycra was concluded y = -26x + 224 and without was y = -11.5x + 183.5. as a conclusion adding lycra shown enhancement in abrasion resistance.

f) The relationship between count and absorption time

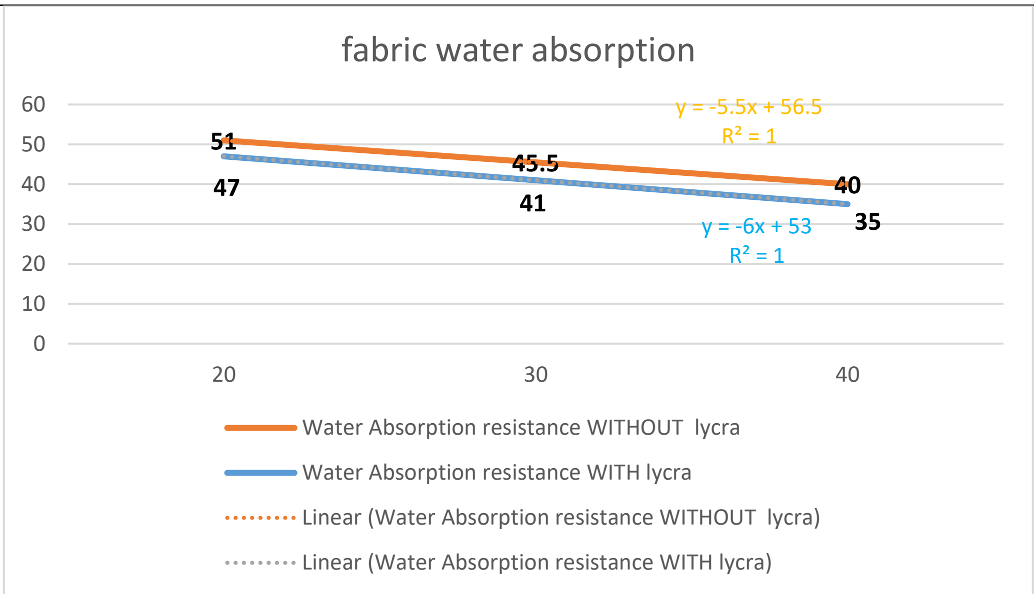


Fig. 12 The relationship between thread count and absorption time for the blend: 25% wool: 75% polyacrylic

The correlation coefficient was extracted, then the regression line equation for the relationship between the count and the water absorption time of fabrics Table 5, meaning that if one of the two properties is known, it is possible to obtain from this relationship the second property without conducting experiments, as in Fig. 12. It was found that the correlation coefficient between the count and absorption time with and without lycra was $R^2 = 1$. This correlation is positive (direct), meaning that the thicker the fiber, the shorter the absorption time. This is because the thick fiber has lower strands and the interstitial distance between the capillaries is large, which allows water to penetrate into the capillaries, thus reducing the absorption time. Conversely, the thinner the strand, the greater the number of strands, and thus the compression of the capillaries increases, so the distance decreases. The interface between the capillaries and each other increases the absorption time. This connection between the number and absorption time is strong, and the equation of the regression line with lycra was derived y = -5.5x + 56.5 and without lycra was y = -6x + 53. Adding lycra shown improvement in the absorption property.

conclusion

The objective of this study is to produce core spun yarns including lycra fibers enveloped by a blend of wool and polyacrylic fibers. A blend of wool, polyacrylic, and Lycra was created by combining 25% wool with 75% polyacrylic, along with an additional 5% Lycra. This was compared to a blend of wool and polyacrylic at the same 25% wool and 75% polyacrylic ratio, resulting in the production of three distinct counts. The inclusion of lycra fabric demonstrated enhancements in the tensile strength, regularity percentage, and elongation percentage. Also, we had produced 6 plain fabric from the 3 counts produced from every blend. The fabric examinations show that the count 20/1 was the best in tensile strength but when we added to the blend lycra it shows a higher result. The elongation % test demonstrated that count 20/1 was the higher result specially with 5% of lycra to the blend. The weight per meter square was also higher when we blended lycra to the count 20/1. Wrinkle resistance test also was higher with the count 20/1 after 5% lycra. Abrasion resistance increased until 198 after adding lycra to the count 20/1. Unless the blend with lycra to the count 20/1 decreased the absorption resistance.

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no competing of interest.

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Author Contributions

Conceptualization - Abualmagd; methodology - Abualmagd; investigation - Abualmagd; resource - Nashwa; original draft preparation - Nashwa; writing-review and editing - Nashwa; visualization - Nashwa; supervision – Hamed; experiment- Hamed; writing and editing. All authors have read and agreed to the published version of the manuscript.

Hazards

No hazards are involved.

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