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Comparative Study between the Characteristics of the Egyptian and the Sudanese Cotton Knitted Fabrics

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Abstract

Due to the spread of the Egyptian cotton substitutes (the Greek and the Sudanese); this study aims at evaluating the characteristics of the single jersey knitted fabrics produced from these cotton types. Moreover, to evaluate the extent of the change in these characteristics as the fabric cost decreases. Single Jersey knitted fabrics were produced with the same stitch length, but from different cotton yarns; Egyptian (Giza 86), Sudanese (Acala), and Egyptian/Sudanese blend 50:50, and by using three levels of yarn twist factor. Several fabrics characteristics were tested such as color characteristics and color fastness to washing, perspiration, and abrasion. The moisture management properties were measured and the results showed that the Egyptian cotton fabrics exhibited a significant improvement in terms of the overall moisture management, the weight of square meter, a slight improvement in the shrinkage and some color properties. However, the results showed the insignificant effect of cotton type or yarn twist factor used on the color fastness properties.

Keywords: Single Jersey knitted fabrics; Yarn twist factor; Dyeing; bleaching; Color fastness; Moisture management

Introduction

Egyptian cotton is known for its high quality, and thus the fabrics knitted from it have distinct properties. Due to its scarce production recently, the growing demand, as well as its rising price, textile manufacturers are seeking to use alternative cotton fibers such as the Sudanese, the Greek, and other cottons to spin coarse and medium yarn counts. This may influence the quality of the produced fabric [1,2]. Many researchers studied the characteristics of the single Jersey fabrics knitted from cotton blends with other types of fibers such as Modal, Viscose, and Bamboo. The results pointed out that the Bamboo/Cotton fabric is brightest, deepest dyed, and more abrasion resistant. The rubbing, wash, and perspiration fastness properties of the Bamboo/Cotton blend are slightly worse than those of the other fabric types. Nevertheless, it recorded the highest light fastness results [3].

The moisture management is an important property of the knitted fabrics. It was studied for double face sportswear fabrics knitted from cotton blends with other types of fibers such as Polyester, and Polypropylene [4,5]. This necessitates obtaining a special knitting structure contains a variety of yarn combinations in the face and in the backsides. Based on the different combinations among yarns; Cotton/Cotton, Cotton/Polypropylene,

Polypropylene/Cotton, and Polypropylene/Polypropylene, the results revealed that, the Polypropylene (as inner)/Cotton (as outer) fabric has a superior moisture management property, as well as provides the best comfort which is preferred for summer, active and sportswear [6,7]. Yet, there is less information about the blends of different kinds of cottons. Therefore, this study aims at conducting a comparative study between the new characteristics of the single Jersey fabrics knitted from the Egyptian and the Sudanese cotton, taking into consideration the influence of yarn twist factor and finishing process.

Materials and Methods

Three different types of cotton fibers were used; Egyptian, Sudanese, and their blend 50:50 (blended at the drawing stage). 30/1 Ne carded/waxed yarn was spun by using three levels of twist factor (αe); 3.4, 3.8, and 4.2. Single Jersey knitted fabrics were produced using ALBI circular single Jersey knitting machine with loop length 2.9 mm, gauge 28, diameter 17 inch, and number of feeders 34. All fabrics were divided into two groups; one was bleached by Hydrogen Peroxide (H_2O_2 50%) and the other was dyed with Reactive Dye (S2G). The 140/3 Luft Rotoplus, this jet dyeing machine was used. All fabric samples were washed in a home laundry machine for three consecutive washing cycles. The washing process was carried out on (A) program designated for cotton fabrics at 60°C [8]. Then the fabric shrinkage was tested. The fabric bursting strength was tested by using Tinius Olsen material testing machine 500 according to ASTM D3787-2001 by applying 50 kgf load, 95 mm extension range, head speed of 305 mm/min, 90 mm endpoint and 0.1 kgf preload. The fabric spirality was measured using AATCC pillowcase method 179-2001, where two knitted samples were sewed from three sides while the fourth side is kept free. After repeated washing, the inclination angle of the sewing line was measured. 40 × 40 cm fabric samples were weighted five times using a digital balance of two decimal digits accuracy [9]. All color fastness properties to washing, perspiration, abrasion, and light were measured according to the Egyptian standards ES4825-1, ES362, ES5949, and ES 240/2005 respectively. The Moisture Management Tester (MMT) is used to measure the liquid moisture transport capabilities of the fabric. The MMT tester is an efficient instrument mainly senses and records the behaviours of the liquid moisture transport in multiple directions. It works on the principle that when the moisture is transported through a fabric, a change occurs in the fabric contact electrical resistance. This change depends mostly on two factors; the water content in the fabric and the nature of the liquid. The liquid components are constant; therefore, the measured electrical resistance is associated with the water content in the fabric [10-13]. For simulating the sweating action,

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a solution was prepared which contains 1 litre of distilled water in addition to 9 g of sodium chloride to achieve a 16±0.2 ms solution conductivity. The fabric surface is considered as the inner surface that is in contact with the human skin. To determine the statistical significance of cotton type, twist factor, and finishing process on all knitted fabric tested properties, analysis of variance (ANOVA) tests were applied using SPSS software [14].

Results and Discussions

P-Values of the results obtained were examined, if greater than 0.05 ($p>0.05$), the Parameter is insignificant and should be ignored. Table 1 shows the results of the statistical significance at 95% confidence level.

Fabrics and their blend at different levels of yarn twist factor. It is clear from the figure that by increasing the twist factor from 3.4 to 4.2, the fabric bursting strength increases by up to 17% due to the increased yarn strength. The bursting strength of the Egyptian cotton fabrics surpasses the corresponding Sudanese by up to 57% due to the difference in the characteristics of both cotton fibers. Moreover, as expected, the bursting strength of the fabrics produced from the cotton blend 50/50 improves only by half of the former ratio. It is obvious from the Figure 1 and the statistical analysis (Table 1) that the finishing process, either dyeing or bleaching, has an insignificant effect on the bursting strength of the knitted fabric.

Figure 2 shows the weight of both bleached and dyed fabrics knitted from different kinds of cotton; the Egyptian (Giza 86), the Sudanese, and their blend 50/50 at different levels of yarn twist factor. It is clear from the figure that the weight of the square meter increases by up to 10% with an increase of the twist factor from 3.4 to 4.2. This is due to the increase of the stitches density per square cm as yarn twist factor increases. It is also noted that the weight of fabric knitted from the Egyptian cotton is higher than the corresponding Sudanese cotton by up to 7%. As far as the influence of the finishing process is concerned, results show that it has a significant effect where the weight per square meter of the dyed fabrics is lower than the bleached fabric by a ratio up to 6%. This may be ascribed to the removal of more impurities as the cotton fabric is treated longer time in the hot water.

Figure 3 shows the spirality of both bleached and dyed fabrics knitted from different kinds of cotton. Obviously, by increasing the twist factor, the fabric spirality increases because of the existence of

Property	Cotton type	Finishing	Twist factor
Bursting force	0	0.831	0
Shrinkage	0.134	0.001	0.007
Weight	0	0	0
Spirality	0	0	0
Color properties	0.566	0	0.043
Moisture management	0	0.274	0.016

Table 1: Statistical significance (p-value) of the cotton type, finishing process, and yarn twist factor on fabric properties.

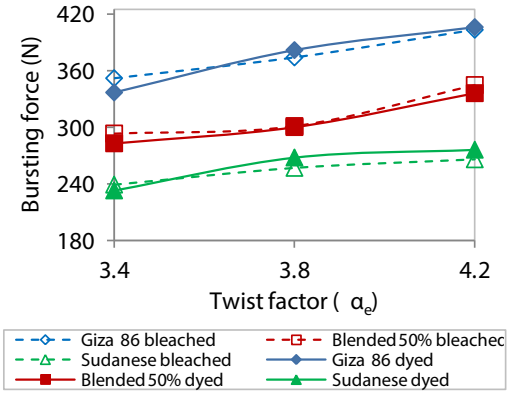

Figure 1: The bursting force of the Egyptian and the Sudanese cotton fabrics at different levels of yarn twist factor.

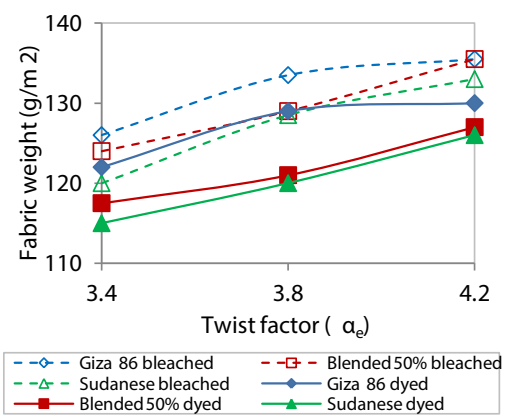

Figure 2: The weight of the Egyptian and the Sudanese cotton fabrics at different levels of yarn twist factor.

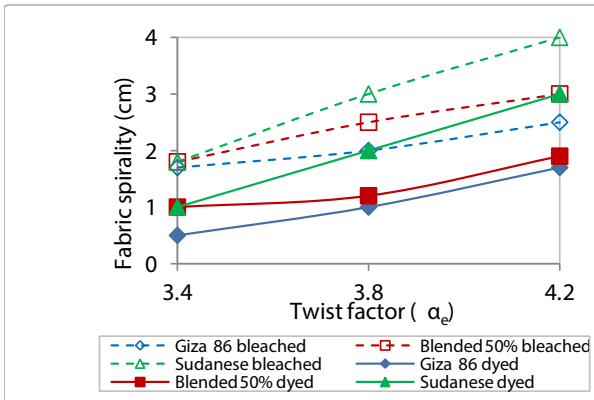

Figure 3: Spirality of the Egyptian and the Sudanese cotton fabrics at different levels of yarn twist factor.

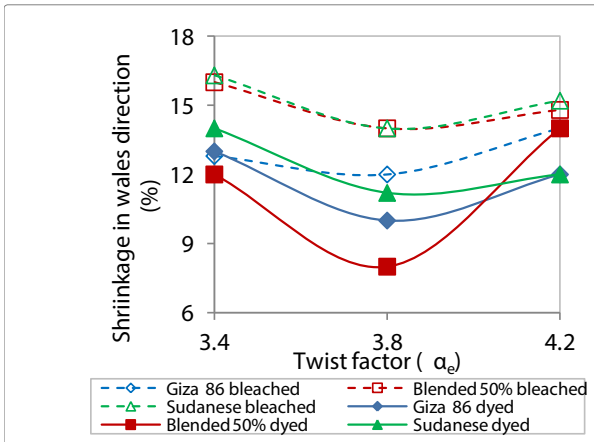

Figure 4: The fabric shrinkage in the wales direction of the Egyptian and the Sudanese cotton fabrics.

the twist liveliness in the yarn. As shown, when twist factor increases from 3.4 to 4.2, the spirality increases by up to 200%, either in fabrics knitted from the Sudanese or the Egyptian cotton. But the spirality of the Egyptian cotton fabrics is less than the Sudanese by up to 50%. And this is because the twist liveliness of the yarns spun from the Sudanese cotton is higher than that from the Egyptian cotton at the same level of twist factor. It is also remarked that the fabric dyeing process decreases the spirality by up to 40%. Perhaps because the increase in the hot treatment time of the cotton decreases the value of yarn twist liveliness, which consequently increases the spirality. Figure 4 shows the shrinkage ratio in the wales direction of the fabrics knitted from different kinds of cotton; the Egyptian, the Sudanese, and their blend. It is noticed that the shrinkage of the fabrics knitted from the Sudanese cotton is less (better) than the fabrics knitted from the Egyptian cotton at some levels of yarn twist factor but only by a slight percentage of 2%. Therefore, the statistical analysis proved that the cotton type has no significant effect on shrinkage. Also, the effect of twist factor is slight as well as fluctuating. While the results reveal that the shrinkage of the dyed fabrics in the wales direction is less than that for the bleached fabrics by up to 8%.

Figure 5 shows the shrinkage ratio in the courses direction of the Egyptian and the Sudanese cotton fabrics. It is noticeable from the figure that the width of the dyed fabric increases after repeated washing, particularly in the fabrics knitted from the Egyptian cotton by up to 3% at some levels of twist factor. However, the statistical analysis proves that the cotton type and the twist factor have no significant effect on the shrinkage of knitted fabrics in the courses direction after repeated washing. While finishing process has a significant effect on the shrinkage. Results shown in Figure 5 indicate that the bleached fabric knitted from the Egyptian cotton records the lowest (best) shrinkage after repeated washing in the courses direction.

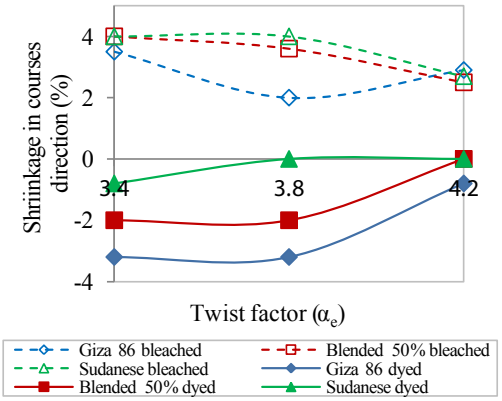

Figure 5: The shrinkage in the courses direction of the Egyptian and the Sudanese cotton fabrics.

As far as the color properties are concerned, Figure 6a-6c represent the influence of twist factor on the color properties; Lightness (L), Chroma (C), and Hue (h) respectively of both bleached and dyed fabrics knitted from different cottons; the Egyptian, the Sudanese, and their blend. It is evident from the figures and the statistical analysis that both yarn twist factor and cotton type have an insignificant effect on the color properties especially C and h. While only the dyed fabric knitted from the Egyptian cotton exhibited the highest Lightness values but only by slight ratios. The overall moisture management capacity (OMMC) is a term indicates how the fabric is capable of managing the moisture transfer. This can be described by three performance characteristics; the moisture absorption rate of the bottom side, one-way liquid transportability, and the moisture drying speed of the bottom side, which is expressed by the maximum spreading speed [8]. It is known that the higher the OMMC, the higher the overall moisture management ability of that fabric. It is obvious from Figure 7a, that the water content over the time period for one of the Sudanese samples inner layer is higher than that in the outer layer. Hence, the fabrics are slow in absorption as well as slow in drying, and therefore it is considered as a negative property to some extent. While in one of the samples produced from the same yarn twist factor 3.4 αe but from the Egyptian cotton, as shown in Figure 7b, the water content over the time period in the outer layer is higher than that in the inner layer. Hence, the fabric is quick in absorption and slow in drying while some samples are fast in absorption as well as fast in drying. This makes the Egyptian cotton has the advantage of being used as underwear, where it absorbs sweat quickly and dried quickly.

Generally, the effect of the finishing process on the overall moisture management is insignificant as demonstrated in Figure 8 and the statistical analysis shown in Table 1. While the cotton type has a significant effect on the overall moisture management, where the

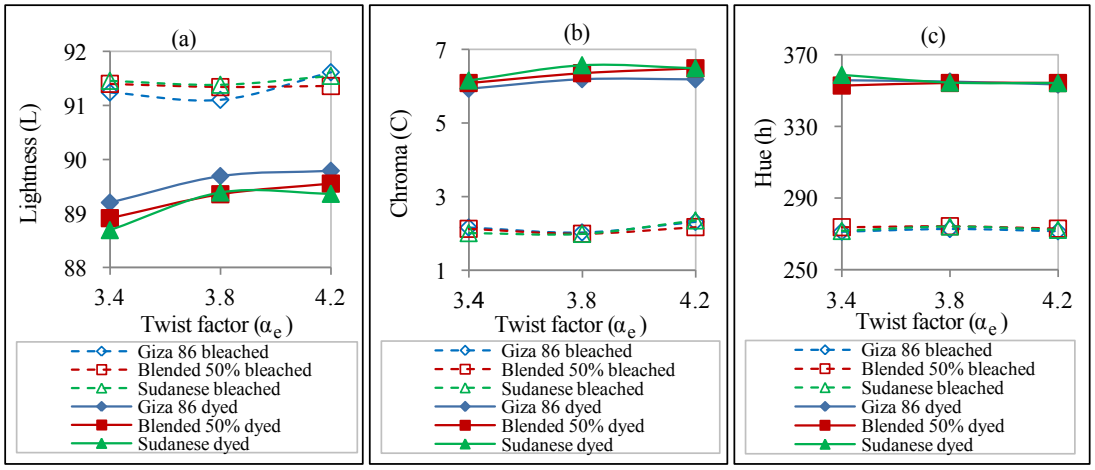

Figure 6: The color properties of the Egyptian and the Sudanese cotton fabrics at different levels of twist factor; (a) Lightness, (b) Chroma, and (c) Hue.

		Cotton type	Egyptian			Sudanese			50/50 Blend		
Fastness to	Fabric finishing	Yarn twist factor (α_e)	3.4	3.8	4.2	3.4	3.8	4.2	3.4	3.8	4.2
Abrasion	Bleached	Wet	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		Dry	5	5	5	5	5	5	5	5	5
	Dyed	Wet	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		Dry	5	5	5	5	5	5	5	5	5
Washing	Bleached	-	5	5	5	5	5	5	5	5	5
	Dyed	-	5	5	5	5	5	5	5	5	5
Perspiration	Bleached	Alkaline	5	5	5	5	5	5	5	5	5
		Acid	5	5	5	5	5	5	5	5	5
	Dyed	Alkaline	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		Acid	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Light	Bleached	-	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
	Dyed	-	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7

Table 2: The color fastness values of the single Jersey knitted fabrics.

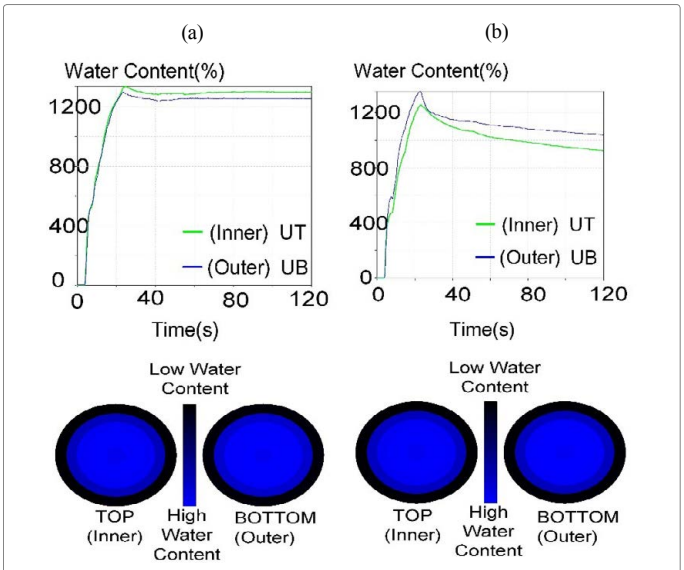

Figure 7: Water content and location versus time for bleached samples produced at the same yarn twist factor (3.4 αe) from (a) the Sudanese cotton, and (b) the Egyptian cotton.

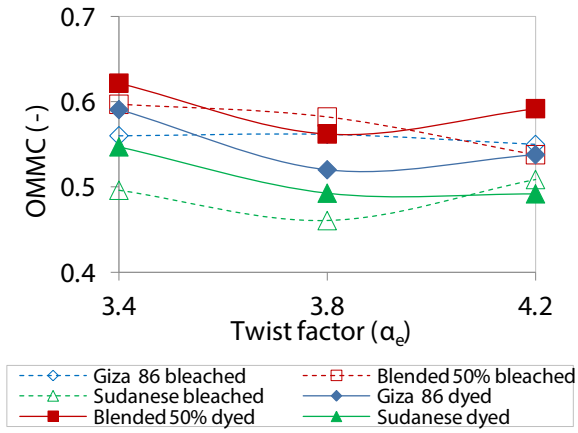

Figure 8: The Overall moisture management capacity of the Egyptian and Sudanese cotton fabrics.

value of the overall moisture management in the samples produced from the Egyptian cotton is higher than that for the corresponding Sudanese cotton by a ratio up to 10%. The samples produced from the blend records the highest values of the overall moisture management at all levels of yarn twist factor. This makes the fabrics knitted from the Egyptian cotton superior in terms of quick absorption and rapid drying.

Regarding the fabric color fastness characteristics, whether fastness to abrasion in its both cases; dry and wet, fastness to washing, fastness to perspiration in its both cases; alkaline and acid, or fastness to light, as shown in Table 2, all variables whether the cotton type, the yarn twist factor, or the finishing type have an insignificant effect on the fabric fastness characteristics, where the tests results are identical.

Conclusion

After knitting single Jersey fabrics according to the work plan from yarns spun from Egyptian cotton (Giza 86), Sudanese cotton (Acala), and their blend 50/50, with three levels of yarn twist factor in addition to bleaching and dyeing these fabrics, the most important results of this research are as follow:

As for the influence of the yarn twist factor

The results showed a significant influence of the yarn twist factor on the fabric bursting force, weight per square meter and spirality regardless the cotton type. Where the bursting strength of the knitted fabric improved, the weight of the square meter increased, and the spirality deteriorated. However, the results exhibited no significant effect of the twist factor on all other measured fabric characteristics.

As for the influence of the finishing type

Two types of finishing process were applied; bleaching and dyeing. The results disclosed the significant effect of the finishing type on many characteristics. The dyed fabrics were lighter than the bleached fabrics, and the spirality of the bleached fabrics was slightly higher than the dyed fabrics. As for the shrinkage, the effect of the finishing type was significant to a great extent either in the wales direction or courses direction. Certainly, the color difference was obvious between the bleached and the dyed fabrics, regardless the cotton type and the twist factor. The results also showed the insignificant effect of the finishing type on the bursting force, color fastness, and moisture management properties.

As for the influence of the cotton type

The results showed that the cotton type had a very significant effect on some characteristics. The Egyptian cotton fabric exhibited

high values of bursting force and weight of square meter at the same level of twist factor compared to the Sudanese cotton fabric. Also, it exhibited low values of Spirality compared to the Sudanese cotton fabric. The results of the study showed that the single Jersey knitted fabrics produced from the Egyptian cotton have a high ability to absorb sweat and quickly dry it and generally, they recorded better values for the Overall moisture management capacity OMMC compared to the fabrics produced from the Sudanese cotton. However, the effect of the cotton type had no significant effect on the other measured characteristics, mainly the color fastness and shrinkage.

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