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Comfort and Mechanical Properties of Smart Clothes Made of Collagen Peptide Fibers (Umorfil)

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Abstract: ***Aesthetic and functional properties are the most important requirements that the consumer needs of clothing during use in daily activities. Nowadays, Sportswear based on natural fibers and biodegradable fabrics are mostly considered for knitted fabrics and clothing designs with a sustainable consumer manner. Collagen peptide added fibres are recently regenerated to enhance cellulosic fibres which are known to be providing a skin friendly texture. This research aims to investigate the physical and mechanical properties of two knitted fabrics to be able to estimate and compare the performance for these fabrics during practice various sports activities. The research samples made of 100 % Umorfil and 100 % Cotton. Some performance properties were evaluated such as, Tenacity, Elongation, Pilling, air permeability, bursting strength, water vapor permeability, Bacterial and microbe resistant test and UV Resistance test. The result shows that the Umorfil fabric is perfect for sportswear as it absorbs the sweat easily and allows the air flow due to its high air permeability.***

Keywords: Smart clothes, Collagen Peptide, Umorfil, mechanical properties, Comfort

1. Introduction

Clothing plays an inseverable role for human life. Clothing comfort and durability became a very important when making selection decision among the world. Durability of fabrics is measured by the mechanical properties such as abrasion, pilling, and bursting strength [1, 2].

Clothing comfort became one of the key criteria in consumers' attraction of apparel products [3], and it is described as the user's feeling of being physically and psychologically comfortable within the current conditions of user [4]. Clothing comfort involves thermal, sensorial (tactile), body movement and psychological (aesthetical) comfort [5]. Thermal comfort of clothes consist of thermal resistance, water vapor resistance, moisture management and air permeability properties of fabrics [6].

Nowadays, fiber blends are enriched and developed to combine unique properties such as thermal comfort and bacterial properties with its smooth surface [7-9] such as collagen peptide. Collagen peptide based raw material has inherited properties such as antimicrobial efficiency, wound healing accelerating property and its sustainable characteristic. Collagen can be extracted from fish wastes and purified to be used in cosmetics, medical, sports, and nutrition, etc [10].

Figure 1: UMORFIL® unique features.

UMORFIL® is an upcycled, skin friendly new developed fiber. Its name is combined from the Latin "Umor" and French "fil". Umor means moisture and fil means yarn. UMORFIL® is generated using supramolecular technology that integrates fish cell collagen peptide with textile materials like viscose or filament chips hence creating the bionic functional fibre Figure 2. These bionic fiber series have special properties, such softness, higher moisture regain, anti-static, nature deodorizing, unti-UV and eco-friendly. In addition, it provides comfort with a skin-friendly nature, all UMORFIL® materials passed the medical level of skin sensitization and irritation testing (ISO 10993) as shown in these unique fibers can be used as many blends such: cellulose fiber (UMORFIL® Beauty fiber "viscose"), polyester (UMORFIL® T) and nylon (UMORFIL® N6U®) [11, 12].

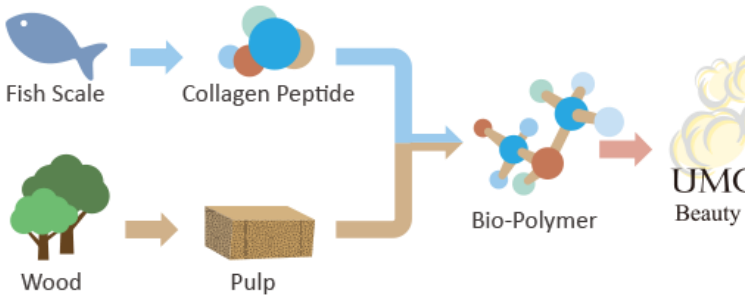


Figure 2: UMORFIL production process [11]

UMORFIL® Applications

UMORFIL® is suitable for all kinds of textile product starting from next-to-skin such as innerwear, leggings, yoga clothes, sheet, jeans, home textiles and shoe materials. In addition, UMORFIL's exceptionally soft hand feel, and when blend with polyester or wool, it can produce much softer fabrics than traditional suiting fabrics. It is also very suitable for growing high-quality loungewear market.

UMORFIL® N6U®

UMORFIL® N6U® is a novel integrated solution, it is a bionic nylon that created by bonding peptide amino acid with regular nylon via supermolecular technology *Figure 3*. This bionic nylon has permanent amazing features such better hand-feeling, deep dyeability feature in lower temperature which can absorb the dyes more efficiently, reduce the effluent issue, and makes it more environment friendly. In addition it contains other UMORFIL® properties such higher moister regain, natural cooling effect and anti-UV function. So, UMORFIL® N6U® provides a skin friendly and better protection textile material [13, 14].

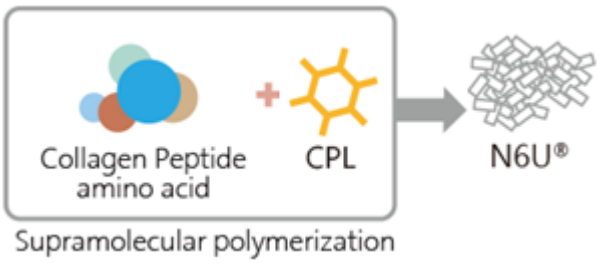


Figure 3: Manufacturing process of UMORFIL® N6U® [13]

2. Experimental Work

2.1 Fabric specifications

Fabrics which used in the study are Single jersey plain knitted fabrics were separately produced from Umorfil (86% Nylon-14%Lycra) and Egyptian Cotton. Cotton and Umorfilfibres were separately produced by using TTM-4 model single plated circular knitting machine with a gauge of 28. Detailed specifications of fabric are mentioned in Table1.

Table 1: Specifications of fabric

Fabric structure	Fiber type	Courses/ Cm	Wales/ Cm	Weight (gm/m^2)	Thickness (mm)
Single jersey	Cotton	20.6	14.8	138.2	0.403
	Umorfil	19.3	13.96	135.4	0.381

2.2. Experimental tests

Several tests, determining performance and function were used.

All tests were done in conditioned atmosphere of 20ºC ± 2 and 65% ± 2 RH.

Average of three readings has been obtained for each property. Mass (Weight) obtained using digital sensitive scale according to (ASTM D3776-96-2003). [13] Thickness obtained using thickness tester according to (ASTM D1777-96-2003). [14] Tenacity and Elongation obtained using tensile tester according to (ASTM 1682-82). [15] Air permeability test was carried out by using electronic air permeability tester according to (ASTM D737-86). (16) Pilling test was carried out according to (ASTM D 3512). (17) Water vapour permeability test was carried out according to (ASTM D583). (18) Bursting strength test was carried out according to (ASTM D3786). (19) Bacterial and microbe resistant test was carried out by using Colony Counter Tester, according to (ASTM F2944-12). (20) UV Resistance test was carried out by using UV-VIS double beam spectrophotometer according to the American standard (ASTM D6604-2000).

3. Results and Discussion

The following tables show the Experiment of the studied factors and the results obtained from the fabric testing. Functional properties of comfort, Bacterial and microbe resistant test and ultraviolet protection test are shown in the Figures.

3.1. Tenacity and Elongation

Tenacity is defined as the specific stress corresponding with the maximum force on a force/extension curve.

Elongation is specified as a percentage of the starting length. The elastic elongation is of decisive importance since textile products without elasticity would hardly be useable. They must be able to deform and also return to shape.

The tenacity was determined directly by the tenacity gauge, while the elongation was calculated by using the following equation:

$$\text{Elongation\%} = \frac{\text{Recorded Elongation Reading}}{\text{Original Sample Length}} \times 100\%$$

Table (2) Results of Tenacity and Elongation

Functional properties	Cotton	Umorfil
Tenacity (cN/tex)	14.93	15.03
Elongation (%)	11.37	14.27

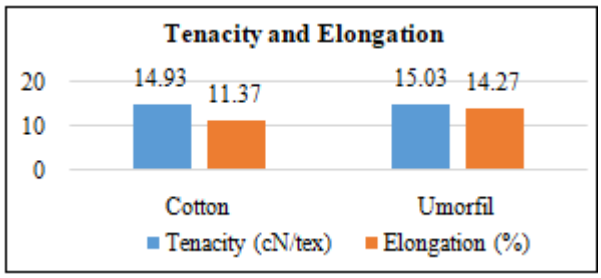


Figure 4: Tenacity and Elongation

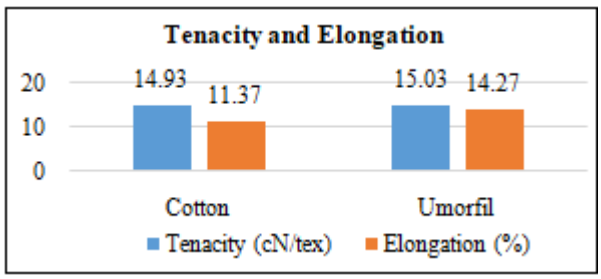


Table (2) and

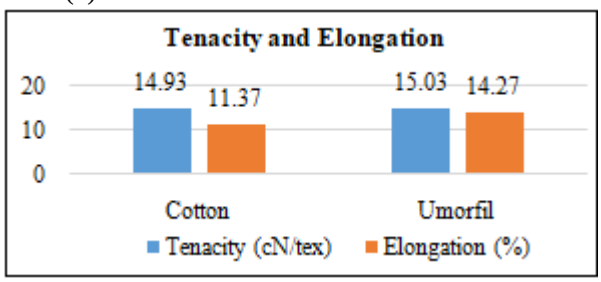


Figure 4, clarify that there is a little increase in the tenacity and elongation of the Umorfil fabric compared to the cotton fabric. It means that the Umorfil has better durability than cotton.

3.2 Air permeability and water vapour permeability

Air permeability is defined as the rate of airflow passing perpendicularly through a known area under a prescribed air pressure differential between the two surfaces of a material.

Water Vapour permeability is a material's ability to allow a water vapour to pass through it. To be more precise it is a measure of how much vapour is transmitted through the fabric under a given set of circumstances. The higher the values of the permeability of the material, the more rapidly vapour can pass through it. And the results were as the following table:

Table 3: Results of Air permeability and water vapour permeability

Functional properties	Cotton	Umorfil
Air permeability	1327	2096
water vapour permeability	59.03	62.80

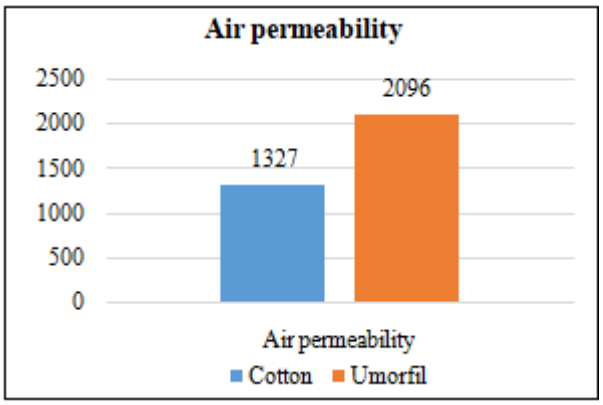


Figure 5: Air permeability

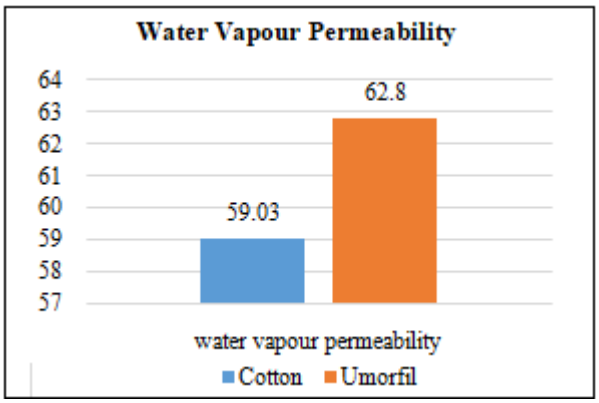


Figure 6: Water vapour permeability

It's clear from table 3 and **Error! Reference source not found.** & **Error! Reference source not found.** that Umorfil fabric gives better Air and water vapour permeability than cotton fabrics. This makes Umorfil a comfortable fiber and a perfect garment to wear in summer as it allows the air flow through the fabric and also absorb the sweat rapidly.

3.3. Bursting strength and pilling

When the fabric is subjected to pressure, the fabric begins to expand in all the possible directions at the same time. When the applied pressure increases gradually, the fabric begins to burst after crossing a pressure limit. This pressure limit is called bursting strength.

Pilling is a fabric surface fault characterized by little 'pills' of entangled fibre clinging to the cloth surface and giving the garment an unsightly appearance. It is bunches or balls of tangled fibres which are held to the surface of a fabric by one or more fibres. The pills are formed during wear and washing by the entanglement of lose fibres which protrude from the fabric surface.

Table 4: Results of Bursting strength and pilling

Functional properties	Cotton	Umorfil
Bursting strength	549.35	367.67
pilling	2.42	4.5

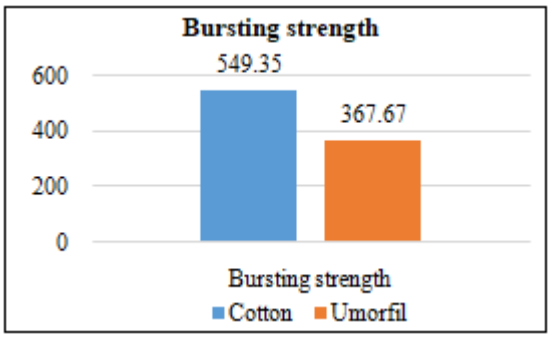


Figure 7: Bursting strength

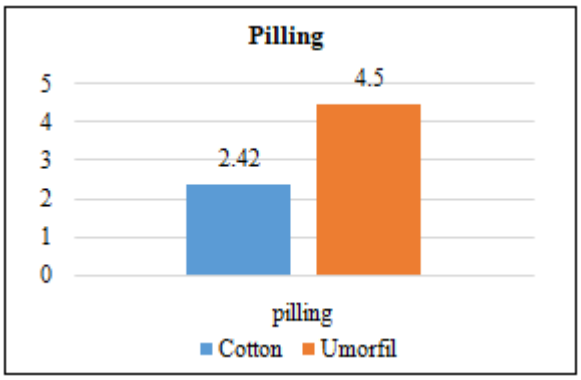
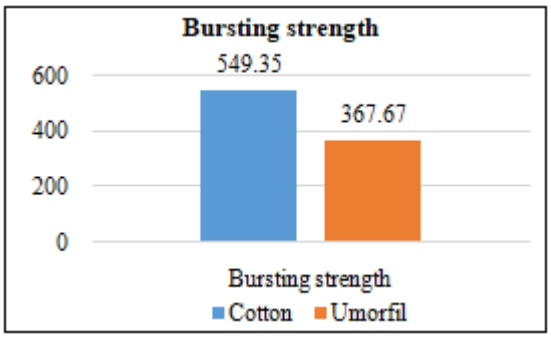


Figure 8: Pilling



As shown in table4 and

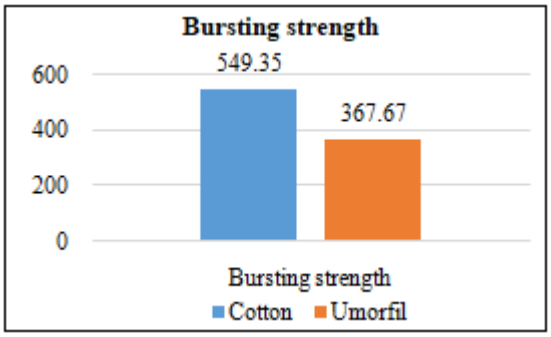
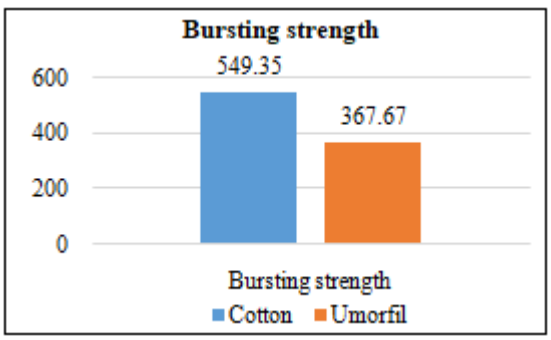


Figure 7, Bursting strength test result was 549.35 in cotton fabric but in Umorfil it was 367.67, this means that the samples made of cotton yarn provided the highest bursting strength while samples made of Umorfil yarn indicated the lowest bursting strength. This result may be attributed to high fibre and yarn strength of cotton fibre owing to its high crystallinity which reflects in fabric bursting strength.



Pilling of the tested fabrics are indicated in

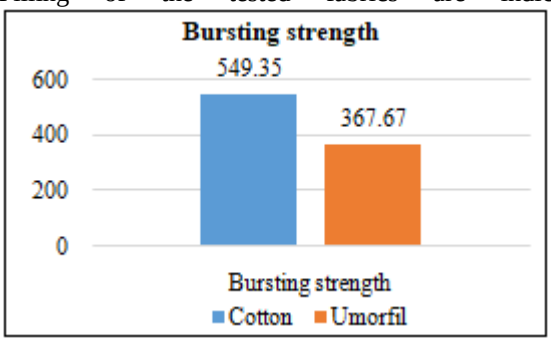


Figure 7: Bursting strength

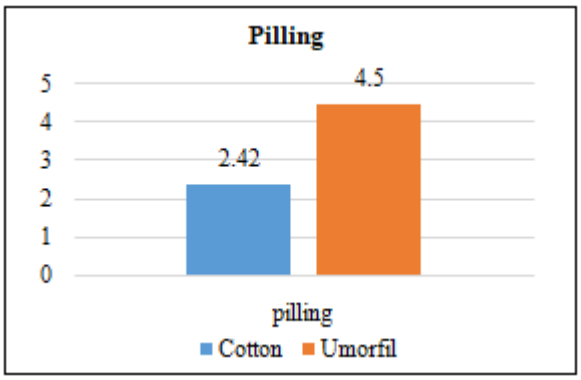


Figure 8, it can be noticed that the samples made of Umorfil yarn provided the highest pilling grade compared to the samples made of cotton. Pilling is one of the major problems of cotton fibre in knitted fabric.

3.4. Ultraviolet protection factor

UPF was measured using UV-VIS double beam spectrophotometer according to the American standard (ASTM D6604-2000) and AATCC test method [AATCC 183-2000]. The UPF was calculated using equation:

$$UPF = \frac{\sum_{280\ nm}^{400\ nm} E,S,\Delta_\lambda}{\sum_{280\ nm}^{400\ nm} E,S,T,\Delta_\lambda}$$

Ultraviolet protection factor was measured by using UV-VIS double beam spectrophotometer, and we measured the undyed test samples, and the results were as the following:

Table 5: Results of Ultraviolet protection factor of fabric

Functional properties	Cotton	Umorfil
UPF	27.39	231.44

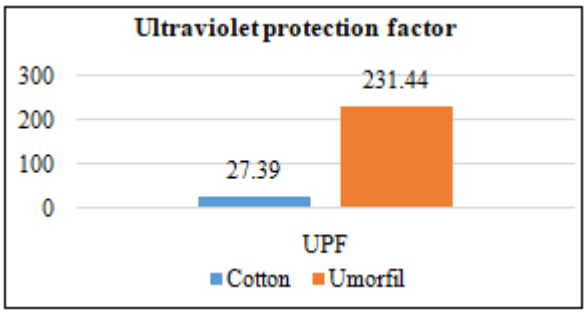


Figure 9: Ultraviolet protection factor of fabric

It's very obvious from table (5) and

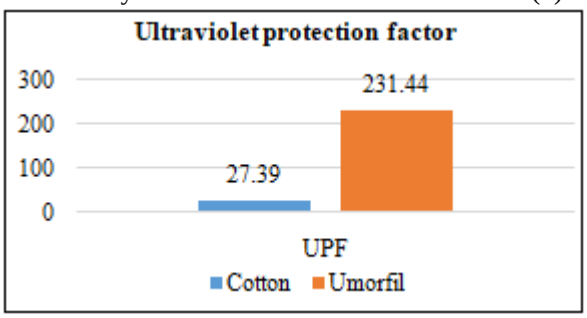


Figure *9*, that the UPF values of the cotton fabric decreased when compared with Umorfil fabric. This is favored as it gives sufficient protection for summer clothes against UV harmful rays.

3.5. Bacterial and microbe resistant test

The resistance of clothes to bacteria and microbes is one of the most important characteristics that must be provided in order to resist the unpleasant odors that result from sweating and to resist yellowing or pigmentation resulting from the growth of bacteria, in addition to being clothes that help heal wounds to discourage the growth or kill microbes, and resistance to eczema and fungi. The test was performed by using a modified Kirby-Bauer disc diffusion method, and the results are as shown on the below table:

Table 6: Results of Bacterial and microbe resistant test

Functional properties		Cotton	Umorfil
Inhibition zone diameter (mm / 1 cm Sample)	Escherichia coli (G^-)	0	16
	Staphylococcus aureus (G^+)	0	14

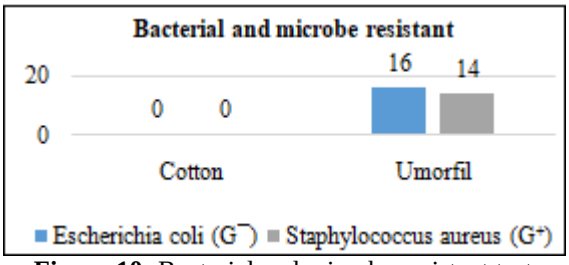
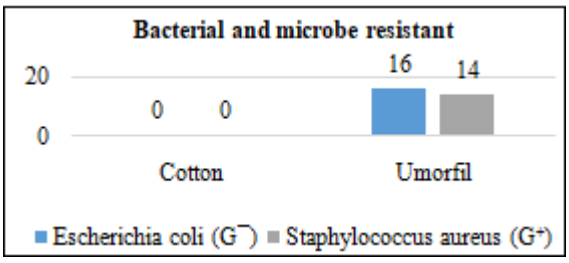


Figure 10: Bacterial and microbe resistant test



As shown from the results for the two samples in table (6) and

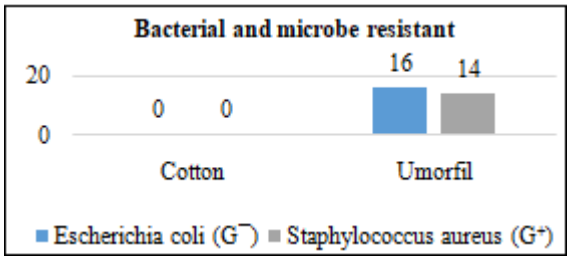


Figure *10*, Umorfil sample revealed the maximum resistant of bacteria and microbe while fabric made of cotton yarn provided the minimum resistant. we can see the diameters of the inhibition zones measured in millimeters was ranging from 14 – 16 mm indicates high resistant in antimicrobial activity for the Umorfil samples.

4. Conclusion

In this work, studying the performance of one of the cellulose fabric and Fish Cell Collagen Peptide fabric has been investigated in order to estimate the durability and characteristics of the fabric in the end use garment. The study involves the evaluation of some comfort properties such as Tenacity, Elongation, Pilling, air permeability, bursting strength, water vapour permeability, Bacterial and microbe resistant test and UV Resistance test. It was obvious that Umorfil fabric provided higher mechanical and comfort properties of most samples under investigation. Results show that there is a little increase in the tenacity and elongation of the Umorfil fabric compared to the cotton fabric and gives better Air and water vapour permeability than cotton fabrics. Which makes Umorfil a comfortable fiber as it allows the air flow through the fabric and also absorb the sweat rapidly. On the contrary the samples made of cotton yarn provided the highest bursting strength while samples made of Umorfil yarn indicated low bursting strength. This result may be attributed to high fibre and yarn strength of cotton fibre owing to its high crystallinity which reflects in fabric bursting strength. But it can be noticed that the samples made of Umorfil yarn provided the highest pilling grade compared to the samples made of cotton. Pilling is one of the major problems of cotton fibre in knitted fabric. the UPF values of the cotton fabric decreased when compared with Umorfil fabric. This is favored as it gives sufficient protection for summer clothes against UV harmful rays. The highest resistance of to bacteria and microbes was obtained from Umorfil fabric.

Optimizing the response of studied properties show that umorfil fabric gave the best ranking. From these results it can be seen that Umorfil fabrics are perfect to wear in summer and will be very comfortable in sportswear.

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