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A Study of Wearabilities of Milk Protein Fiber Fabric

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Abstract: With the improvement of people's living standard, more and more new functional fibers aroused people's wide concern. Milk protein fiber is one of new functional fiber which is produced by milk. In order to know its wearabilities, tensile property, appearance property and abrasive resistance of milk protein fiber plain knitted fabric were tested in this paper. Results showed that milk protein fiber fabric has good wearability, especially the drapability. Tensile property and abrasive resistance can meet our needs for knitted underwear.

Keywords Milk protein fiber fabric; Tensile property; Drapability; Stiffness; Abrasive resistance

INTRODUCTION

Milk protein fiber is a new type of functional fiber which is produced by milk. It is different from both natural fiber and chemical fiber. It comes from the protein element of milk grafted with some kind of large element compound.[Zheng, *et al*., 2006]In the process of milk fiber production, both biological chemical industry and modern textile processing technology are used. By dehydration, oil removal, degreasing, separation, purification, the milk protein has become a kind of linear macromolecule structure of casein, and then by copolymerization with polymer grafted, prepared by wet spinning an alternative to a new generation of regenerated protein fiber and natural fiber, recycled fiber and synthetic fiber.[Li, *et al*., 2006, He, *et al*., 2007, Lu, 2013, Ding, 2012] Milk protein fiber has both advantages of synthetic fiber and natural fiber. It is high-strength but soft, low-shrink and skin-friendly, good in moisture absorption and air permeability.

In this paper, the main wearabilities of milk protein fiber knitted fabric were investigated, drapability, stiffness, tensile property, and abrasive resistance were tested, experimental data were analyzed, and experimental investigation showed that milk protein fiber fabric has good drapability, a certain mechanical strength and good abrasive resistance.

MATERIALS AND METHODS

Materials

The specimens used in this study were milk protein fiber fabrics which were provided by Qingdao Huajin Group Limited Company. The fabric construction is plain knit. The fabric thickness is about 0.488 [mm][20cN/cm^2].

Methods

Three properties of wearability including mechanical, appearance performance and durability were measured by different instruments under the standard condition (temperature, 20±2[℃], humidity, 65±2 %). Details of the experiments are given in Table 1.

Table 1. Experiments of milk protein fiber fabric

Testing contents	Types of experiment instrument	
Appearance performance	Drapability	YG(L)811-DN fabric dynamic drapability tester
	Stiffness	LFY-22 electronic softness instrument
Mechanical property	Tensile property	YG065H computerized tensile tester
Durability	Abrasive resistance	Y522 Disc type fabric abrasion resistance meter T328A analytical balance

RESULTS AND DISCUSSION

Statistical Analysis of Appearance Performance

Fabric's appearance performances include drapability, stiffness and crease recovering, etc. In this study, the drapability and stiffness were tested as key points.

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Drapability

Drapability is one of the most important quality which can be evaluated by draping degree and draping shape. Drape coefficient is proposed for draping degree and ripple number is for draping shape. [Shang, *et al*., 2013] Experimental data of drapability of milk protein fiber fabric are showed in Table 2.

Table 2. Drapability of milk protein fiber fabric

Sample symbol	State	Drape coefficient[%]	Ripple number[number]	Aesthetic coefficient[%]
1	static	91.18	10	82.66
	dynamic	90.69	10	
2	static	92.35	12	83.11
	dynamic	92.18	12	
3	static	92.59	10	83.87
	dynamic	92.33	10	

It shows clearly in Table 2 that static drape coefficient is greater than dynamic drape coefficient. Drape coefficient can be calculated by the equation that is showed in Eq. 1 and Eq. 2, respectively.

Static drape coefficient：

$$F_0 = [(S_f - S_0) / (S_f - S_d)] \times 100\% \quad (1)$$

Dynamic drape coefficient：

$$F_1 = [(S_f - S_1) / (S_f - S_d)] \times 100\% \quad (2)$$

Where, S_f is specimen area(452.16[cm^2]), S_0 is static projected area of specimen[cm^2], S_d is specimen platform area(113.04[cm^2]), S1 is dynamic projected area of specimen[cm^2]. As it is known to all, when the sample rotating, S_1 is greater than S_0, so F_0 is greater than F_1. Therefore static drapability is better than dynamic drapability.[Shang, *et al*., 2013]

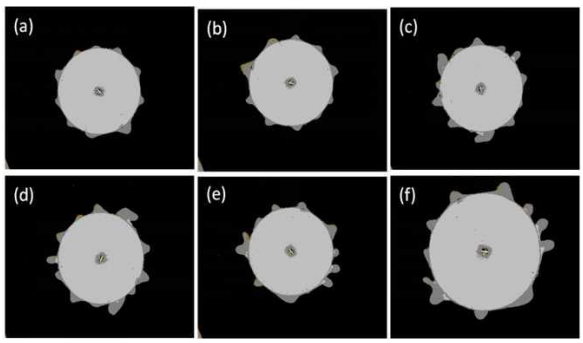

Figure. 1 Static and dynamic state drape graphics of samples, (a), (c), (e) are static drape graphics of sample 1, 2, 3, respectively; (b), (d), (f) are dynamic state drape graphics of sample 1, 2, 3, respectively.

The different draping shapes are shown in Fig. 1. Fig. 1 (a), (c) and (e) are static drape graphics of sample 1, 2, 3, respectively; (b), (d) and (f) are dynamic state drape graphics of sample 1, 2, 3, respectively. As the same sample, the ripple number is also the same either static or dynamic. Therefore, there is little difference between static drapability and dynamic drapability from the aspect of draping shape. Drapability is mainly related to rigidity and softness, the rigidity is more, the drapability is worse. The average ripple number is ten which is more than most other knitted fabrics. Experimental result showed the drapability of milk protein fiber fabric is fine whether from draping degree or draping shape.

Stiffness

The stiffness of fabric can also be called rigid-flexibility. It refers to the flexural rigidity and softness of fabric. The ability to fight its bending the shape change is known as the bending stiffness. Many methods can be used to test the bending stiffness of fabric, one of the most simple and easy method is inclined plane method, and in this study inclined plane method is used. Experimental data of stiffness of milk protein fiber fabric are showed in Table 3.

Table 3. stiffness of milk protein fiber fabric

Sample number	Stiffness(cm)	
	Warp-direction	Weft-direction
No. 1	1.35	1.50
No. 2	1.32	1.43
No.3	1.38	1.46
No.4	1.37	1.45
No.5	1.35	1.48
Average	1.35	1.46

It can be seen clearly that the average stiffness of warp-direction is 1.35 cm, the average stiffness of weft-direction is 1.46 cm. So stiffness of weft-direction is better than stiffness of warp-direction.

Statistical Analysis of Mechanical Property

Tensile Property

The tensile property can be explained as the relationship between the applied force and tensile strain, or the resulting tensile force, when a fabric is stretched in a certain direction. [Kim, *et al.*, 2008] Measured tensile strength of the milk protein fiber fabric in different directions is given in Table 4 and Table 5, respectively. The average breaking strength in warp direction is 92.50[N], and in weft direction it is 84.50[N]. All tensile properties showed that the weft part is higher than the warp part except breaking elongation. As for other most knitted fabrics, warp

breaking elongation is much less than weft ones because of fabric texture.

Table 4. Mechanical property of milk protein fiber fabric (warp direction)

Times	Breaking strength [N]	Breaking elongation [mm]	Elongation at break [%]
No.1	81.00	180.15	36.03
No.2	96.00	182.45	36.49
No.3	83.00	177.80	35.56
No.4	110.00	194.65	38.93
Average	92.50	183.76	36.75
Max	110.00	194.65	38.93
Minimum	81.00	177.80	35.56

Table 5. Mechanical property of milk protein fiber fabric (weft direction)

Times	Breaking strength [N]	Breaking elongation [mm]	Elongation at break [%]
No.1	90.00	210.10	42.02
No.2	99.00	247.50	49.50
No.3	70.00	206.75	41.35
No.4	79.00	202.00	40.40
Average	84.50	216.59	43.32
Max	99.00	247.50	49.50
Min	70.00	202.00	40.40

Abrasive resistance

The abrasive resistance of fabric refers to the performance of resistance to abrasion under certain experiment condition. It has very important significance to evaluate the durability of fabric. Generally speaking, if the fabric has good wear resistance, its durability is also good. The abrasive resistance of milk protein fiber fabric is given in table 6.

Table 6. The abrasive resistance of milk protein fiber fabric

Quality(g)	No.1	No.2	No.3	Average
Before experiment	2.4972	2.5778	2.3832	2.486067
After experiment	2.4812	2.5619	2.3602	2.467767
Reduced quality	0.0160	0.0159	0.0170	0.0163

It can be seen clearly that the average reduced quality of milk protein fiber fabric is 0.0163 g after grinding 100 rotation under pressure of 500g. The reduction rate of quality is about 6.56%. So the abrasive resistance of milk protein fiber is good.

CONCLUSION

In summary, as a new functional textile material, milk protein fiber fabric has caused more and more attentions. In this study, the essential wearabilities such as drapability, stiffness, tensile property and abrasive resistance of the plain knitted fabrics made from milk protein fiber were tested. Appearance performance, mechanical property were analyzed. Milk protein fiber fabric has certain breaking strength, good drapability, poor stiffness and certain abrasive resistance.Iit can be regarded as an ideal fiber fabric used as underwear in spring, autum and winter.

REFERENCES

Cheng Longdi, Zheng Yu, 2006 “The features, application and qualitative test of milk protein fiber” Shanghai textile science ＆technology, Vol. 34, No. 6, pp 56-57.

Cui Shizhong, He Jianxin, Li kejing, 2006 “Structure and properties of milk protein fiber”, Journal of textile research, Vol. 27, No. 8, pp 57-60

Ding Yanmei, 2012 ”Properties and applications of milk protein fiber”, Shandong Textile Science ＆Technology, Vol. 53, No.1,pp 44-46

He Wenyuan, 2007 ”Research on wear behaviors of milk fiber fabric”, Shanghai textile science ＆technology. Vol. 35, No. 11, pp 57-59

Hyun-Ah Kim, Hyo-Seon Ryu, 2008 ”Hand and mechanical properties of stretch fabrics”, Fibers and Polymers, Vol.9 (2008), No.5, pp 574-582.

Lu Haibin, 2013 ”Comparison on study performance between milk protein fiber fabric and cotton fabric”, Progress in textile science ＆technology,Vol.4, pp 29-31.

Shang Lei, Zhang Yujuan, 2013 ”A study of wearabilities of softwarm heating warm fiber fabric”, Advanced Materials Research, Vol. 709, pp 233-237