

Original Research Article

Analysis on the Development Feasibility of a High Quality Antibacterial Medical Material

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Abstract: The wet process antibacterial yarn and wet process. Knitted fabric of flax are made by using wet spinning technology and knitting manufacturing technology of flax, test the main properties of yarn and fabric, the research progress of the application of flax products in medical textiles was reviewed. This paper mainly analyzes the feasibility of flax wet process, antibacterial yarn and flax wet process and knitted fabric as flax wet process antibacterial medical materials from two aspects of strength and knitted structure.

Keywords: Flax Fiber; Antibacterial; Wet Spinning; Knitted Fabric; Medical Textile

Flax fiber has excellent properties such as good moisture and air permeability, sweat absorption, UV protection, *etc.*^[1] It is environmental friendly and degradable, with natural antibacterial properties and conditions for medical disinfection^[2], and suitable for high quality medical materials and has great market potential. When medical materials are used, they are in direct contact with the skin. In addition to the requirements of antibacterial properties, their comprehensive wearing properties such as moisture permeability, air permeability and softness will directly affect the user's feelings^[3]. Although flax fiber has many excellent properties, due to its high rigidity and poor elasticity, pure flax fabric is stiff^[4], the lack of softness makes it less comfortable and itchy. At present, common flax products are not suitable for direct application as the medical materials that fit the skin and even the wound.

Flax spinning process can be divided into dry spinning and wet spinning. The dry spinning process is simple and often used, but the wet spinning process

with boiling and bleaching process can improve the separation of flax fiber and produce softer and higher count yarn than the dry spinning process^[5]. At the same time, in order to solve the problem of stiff linen fabric and uncomfortable wearing^[6], the knitting process can be used to increase the tensile elastic recovery of the product, reduce the plastic deformation, improve the permeability of the product and facilitate wound healing^[7]. If flax yarn made by wet process and the knitted products woven on this basis is used in medical materials, the effect of environmental protection and high quality can be achieved.

In this paper, flax wet spinning technology and knitting manufacturing technology is used to make flax wet knitting yarn and fabric. The main properties of the yarn and fabric are tested and compared with some existing flax products. The feasibility of using flax to produce green and high-quality medical knitting antibacterial materials is explored.

1. Preparation of flax staple wet knitted fabric

1.1 Raw material

1.1.1 Raw material selection

Flax hemp, Length of dressed flax is 200-400 mm, length variation coefficient is 50%-100%, the average fineness is 3.33 dtex-1.67 dtex, the strength is 55 cn/dtex-80cn/dtex, the elongation is 2.7%-3.3%.

1.1.2 Description of antibacterial property of flax

The results of glial oblique flat hole of flax fiber. It can inhibit *Staphylococcus aureus*, *Escherichia coli*, *Candida albicans* and so on^[8]. According to the literature^[9], the antibacterial rate of flax fabric was 64.0% against *Escherichia coli* and 66.3% against *Staphylococcus aureus*.

1.2 Yarn weaving process

Flax fibril is thick, short in length and great in variation, which indicates that flax raw fiber cannot be spun smoothly^[10]. Therefore, it is processed into "scutched flax" by pressing and beating. The whole process of acquiring flax fiber is called preliminary processing, and its technological process is as follows:

Raw stem for fibre flax → stem selection → bundle binding → retting and degumming → drying → warehousing and health preservation (select as dry stem) → stem crushing → scutching → scutched flax and noil → carding and grading.

Part of impurities is removed by carding of the scutched flax through a hackling machine. The combed hemp fiber after carding is long, which is called long hemp. The technological process of wet spinning is as follows:

Combing long hemp → humidifying and leveling → discharging → selecting materials and matching hemp → hand splitting hemp strip → roughening → comber → pre combing (once) → combing → re combing → combing and drawing (4 passes) → long hemp roving → roving scouring and bleaching. The wet roving must be degummed, degummed or degummed before bleaching or dyeing.

Bleaching and boiling process: linen roving → scouring → (bleaching agent 1) bleaching → washing → (bleaching agent 2) bleaching → washing → pickling →

washing.

Bleaching process: pickling → washing → bleaching → washing.

1.3 Process parameters

The first process of final needle: 14 g/m, the second process of final needle: 13 g/m (8.62 times of draft), the third process of final needle: 6 g/m (8.67 times of draft).

The lxc-3525cvi automatic computerized flat knitting machine (Daojing Machine Co., Ltd.) is used to weave the yarn into a double rib fabric. The fabric specification is double 20 n * 20 n / 18 * 16.

2. Performance test and results

2.1 Performance test

According to the national standard of China, the breaking strength and yarn levelness are tested, the mechanical properties and yarn levelness were evaluated, and the moisture permeability, air permeability, wear resistance index, wrinkle recovery angle and bending rigidity of the fabric were tested to evaluate the comfort and shape retention of the fabric.

2.1.1 Yarn tensile fracture

According to GB/T 3916-1997 Determination of breaking strength and elongation of single yarn, the breaking strength, elongation at break and elongation at break of yarn are tested with xq-1c high strength and high modulus fiber strength extensometer, 30 times for each sample.

2.2.2 Yarn line and yarn levelness

According to JJG048-1991 Verification regulation of yarn hairiness tester, the test instrument is yg172a yarn hairiness tester.

According to GB/T 3292.1-2008 Test method for evenness of textile yarn - Part 1: capacitance method, test the coarseness, details, neps, evenness of blended yarn.

2.2.3 Moisture permeability and air permeability of fabric

According to GB/T 12704.1-2009 Test method for moisture permeability of fabrics Part 1: moisture absorption method, test the moisture permeability of blended yarn fabrics.

According to GB/T 5453-1997 Test method for air permeability of textiles and fabrics, the air permeability

of fabrics is measured 10 times for each sample with different parts.

2.2.4 Abrasion resistance of fabric

According to GB/T 19089-2012 Textiles - Determination of abrasion resistance of Martindale fabrics - Part 1: Martindale Abrasion Tester Method, the abrasion resistance of fabrics is tested.

2.2.5 Wrinkle and bending properties of fabrics

According to GB/T 29257-2012 Evaluation of

wrinkle recovery of textile fabrics, the wrinkle recovery angle of blended fabrics is tested.

According to GB/T 18318.5-2009 Textiles - Determination of flexural properties - Part 1: Bevel method, test the flexural rigidity of blended fabrics.

2.2 Test results

The breaking elongation, yarnlevelness and hairiness of flax wet knitting antibacterial yarn are tested, and the results are shown in **Table 1**.

Project	Flax wet antibacterial yarn
Average breaking strength (cN/tex)	26.381
Breaking strength (CV%)	9.078
Average breaking strength (cN)	362.833
Average elongation at break (%)	2.142
Elongation at break (CV%)	8.007
Yarnlevelness (CV%)	26.40
3mmHairiness index	1.60
5mmHairiness index	0.32

Table 1. Performance test results of flax wet antibacterial yarn

The moisture permeability, air permeability, wear resistance, wrinkle and bending properties of wet knitted

linen fabric are tested. The results are shown in **Table 2**.

Project		Linen wet knitted fabric	
Moisture permeability	Average/(m ² ·24h)	3039.45	
	Non-uniformity (CV%)	50.27	
Air permeability	Average (mm/s)	276.68	
	Non-uniformity (CV%)	46.23	
Abrasion resistance index Ai (time/mg)		21929.82	
Flexural rigidity (mN·cm)		0.25	
Wrinkle recovery angle(°)	Portrait	Resilience	1.17
		Slow elasticity	1.15
	Horizontal	Resilience	1.06
		Slow elasticity	1.01

3. Research progress and performance comparison of flax products used in medical textiles

3.1 Research progress of strength based flax fiber as medical textile reinforcement

Some medical textile materials, such as bone repair materials^[11] and fixed instruments, have certain requirements for strength. However, composite reinforced materials have advantages of strengthening performance and degradation in medical treatment. It has become one of the research hotspots in the world, among which the research on the preparation of plant fiber reinforced composite with flax fiber has been widely carried out in the United States, Europe, Japan, China and other countries, and some research results have also entered the practical use stage, showing good use effect^[12].

Liu Liyan *et al.*^[13] used needling technology of nonwovens to process flax fabric and evaluated its comprehensive properties. It was found that flax nonwovens have high strength and can be used as reinforcement of composite materials in automobile, building materials and other fields; The strength of flax used in this experiment is 18.36 cn/tex, and the strength of flax wet process antibacterial yarn is 26.381 cn/tex, which is better than that of flax non-woven fabric. It can be seen that wet spinning does not reduce its strength, the flax yarn made by wet spinning has advantages in strength when applied to medical spinning materials, which can be reasonably speculated. If flax wet antibacterial yarn is reinforced in the later stage, which can improve its mechanical properties and Fiber Cohesion density, its strength will be further improved and it is a high-quality reinforcement material.

Wang Chunhong *et al.*^[14] tested the mechanical properties of the fully degradable composite made of flax fiber and PLA fiber. It was found that when the fiber volume fraction was 40%, the longitudinal and transverse bending strength was the best, and the bending strength and impact strength of the material showed a positive correlation with the increase of the fiber length. Arbelaiz A. *et al.*^[15] found that flax PCL composite has higher flexural modulus and tensile strength than pure

PCL. The experimental results of mechanical properties of flax composite fiber provide a further basis for the use of flax wet antibacterial yarn in medical textiles.

3.2 Application of flax fiber based on knitted structure in medical textile

Medical fabrics include nonwovens, knitted fabrics, woven fabrics and knitted fabrics. Knitted fabrics are sufficiently flexible, elastic, porous and easy to design. They commonly use in the field of high-end and high-tech medical textiles^[16]. Flax wet knitted fabric can be used for medical dressing and medical devices through further experiments.

The function of medical dressing is to reduce the contact between the wound and external environment, prevent trauma, attach, absorb and transfer medicine. It needs to have good hygroscopicity, air permeability and comfortable touch with skin. Zhang Bingzhe *et al.*^[17] have found that the extensibility and water absorption of knitted medical dressings were better than those of conventional machine textile dressings. Flax has excellent moisture permeability and air permeability, and its knitting structure increases its air permeability, which is the material of medical dressing to be further explored.

Long Xiaoyun *et al.*^[18] developed a knitted medical dressing with 80% jute cell (raw material includes flax) and 20% cotton blended yarn, which can meet the clinical requirements, this provides a new idea for the application of wet knitted linen fabric in medical textile industry.

Li Yi *et al.*^[19] explored the possibility of applying knitted structural composite to the artificial tracheal support, and found that the radial strength of knitted structural composite can meet the requirements of the artificial tracheal support. Flax wet knitted fabric has not only strength, but also excellent antibacterial properties. Before the tracheal stent is implanted into the human body, it needs to be coated and sterilized. The selection of flax material has potential advantages, it can be seen that flax wet knitted fabric is an attempt material in the field of medical device research and development.

4. Conclusion

This paper analyzes the strength and knitting structure of flax wet knitting antibacterial material,

which is represented by flax wet knitting fabric and flax wet knitting yarn. The feasibility of its application in medical textile was discussed. In order to expand the application of flax, promote the progress and development of textile technology and medical science.

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