

Biological Treatment of Raw Flax with Fungus

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Abstract: Flax is preferred by consumers and used widely in clothing and garments owing to its merits, such as fast moisture absorption and carry-off, natural grain, unique style, etc. While flax, as one kind of natural bast fiber, not only includes cellulose but also includes gum consisting of pectin, hemicellulose and lignin, these materials glue cellulose into stiff sheet bundle fiber, thus, gum must be removed before spinning, through retting process, therefore, retting is the treatment that degrades the pectin-rich middle lamella connecting adjacent fiber cells to release bast fibers, which is the predominant problem in preparation. The original processing of flax is dew retting, which is time-consuming and results in unstable quality of flax. Therefore, Microbe treatment of raw flax is studied in this paper. One strain of fungus screened from soil is used in experiments, and pretreatment of flax is also involved. The evaluation is based on modified Fried Test. Treated and non-treated flax is tested by infrared spectrum and X-ray diffraction. The results manifest that ammonium oxalate is an effective pretreatment chelator to remove calcium, which loosens the tight structure of gum. Therefore, the method in which raw flax is pretreated with chelator followed by treatment with fungus is feasible; furthermore, bast fiber and xylem can be separated fully in 5h.

Keywords: Raw flax, retting; chelator, pretreatment, ammonium oxalate, fungus-treatment.

1. Introduction

Flax, as one kind of bast fibers, is preferred by consumers and used widely in clothing and garments because its fabric has many virtues [1,2], such as, fast moisture absorption and carry-off, natural grain, bland color, unique style, etc. Therefore, the production scale in China is expanded constantly that it has been listed the second globally, next only to Russia now. But the processing technology in China is deficit to meet textile industry's requirements and about seventy percents of flax materials are imported. Retting, the treatment to degrade the pectin-rich middle lamella connecting adjacent fiber cells to release bast fibers [3], is the major limitation in preparation. The original processing of flax is dew retting [4] with the drawbacks of low efficiency and instable quality. As a result of poor quality fibers, considerable effort has been expended to improve dew-retting. The improved retting is water retting and enzyme treatment [5,6], bundles of flax stems were immersed in water (e.g. rivers, ponds), and fermentation by anaerobic bacteria degraded pectins and matrix components in the plant cell wall, thereby retting the flax [7]. The fermentation product constituted such a significant ecological problem that water-retting is no longer practiced, while cost appears to be one major disadvantage in enzyme-retting [8-11]. With the environmental protection being paid more and more attention in the

world, use of pollution-free method in textile industry is inevitable. Therefore, we try to develop an environment-benign, efficient retting processing of flax in our research.

2. Experimental

2.1 Materials

Raw flax is from Zhengjiang province all samples are from middle straw and are cut into 10cm. All samples' diameters are more than 0.75mm.

2.2 Experimental design

2.2.1 Pretreatment Experiments

Chelators are used in pretreatment of raw flax to remove calcium in pectin. Ethylene diamine tetraacetic acid, sodium tripolyphosphate, oxalic acid and ammonium oxalate are involved in the pretreatment experiments. Different chelators are used in different temperatures, pH varied from 3 to 10, and temperature from 32°C to 62°C. Control sample is also treated at different temperatures, pH and treatment time.

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2.2.2 Microbe retting of flax

Standard microbiological techniques are used in screening retting microbe. The pH of culture medium, different carbon source, nitrogen source, cultivation temperature, cultural time, the speed of shaker and the aerobiosis of microbe were involved in experiments. Lastly, a strain of fungus was separated from retted water, it was also proved that it is effective in retting in kenaf [12], the conidial fructification of fungus is listed in Figure 1. Therefore, the fungus is used in the treatment of raw flax. Furthermore, pretreatment and microbe treatment are used in flax simultaneously, then comparisons are done between microbe retting and pretreatment-microbe treatment of flax.

2.2.3 Test criterion

Evaluation of retting is based on mended Fried Test [13,14], a 10cm long straw of flax was put in a test tube and 10mL boiling water was added. The tube was shaken on a vortex in full speed for 10 seconds and thereafter manually shaken in vertical direction 4 times, the samples were then visually graded in a scale from 0-6 based on the fraction length, that is, bast fibers length separated from woody core. The score criterion is listed in table 1. "0" means no bast fibers released, "1" means bast fibers were separated from 0 to 10mm long straw, "2" means fibers released from 10 to 25mm, "3" means 25 to 50mm, "4" means 50 to 75mm, "5" means fibers released from more than 75mm, but still joined in some area, "6" means all bast fibers were released from core. To avoid bias, all the samples were tested thrice and the average was regarded as the final results.

Lastly, control sample and treated sample are tested with infrared and X-ray diffraction.

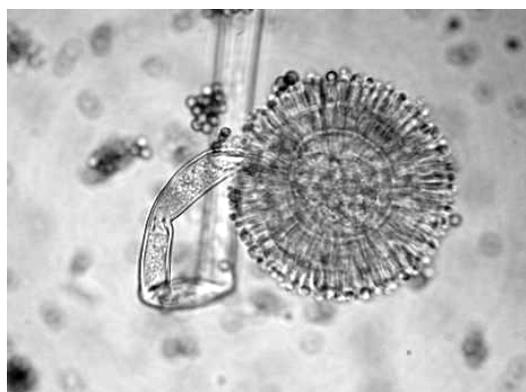


Figure 1 Conidial fructification of fungus.

Table 1 Score criterion

Score	0	1	2	3	4	5	6
Separate length (mm)	0	0-10	10-25	25-50	50-75	>75	100

2.2.4 Test methods

Infrared test is potassium bromide disk prepared under high pressure. Sample and potassium bromide powder of 1~2mg weight are tested at the style of disk.

Powder of sample is tested with X-ray diffraction. The test conditions are as follows: Ni filtration, electric voltage 40kV, electric current 300mA, scanning velocity 2o/min, scanning angle 6°-60°.

3. Results and discussion

3.1 Control sample test

Raw flax is treated in water with no agents at different temperatures and different time, respectively. The scores are listed in Table 2 and Table 3. The results prove that rise in temperature does not improve separation of bast fibers from core, the score is still "0", so does extension of time, which indicates that retting of raw flax is not finished without agents or other factors. Therefore, agents are involved in the following experiments.

Table 2 Scores of control sample at different temperatures

temperature(°C)	32	42	52	62
score	0	0	0	0

Table 3 Scores of control sample at different time

time(h)	2	3	3.5	4	4.5	5
score	0	0	0	0	0	0

3.2 Pretreatment of raw flax

Raw flax is treated with EDTA of different concentrations, different pH at 62 for 6h and different temperatures at 0.2g/L for 6h, then the treated flax was scored based on modified Fried Test, the scores are listed in Table 4 and Table 5. It is obvious that score does not change with increase of concentration of EDTA, which shows that EDTA is not suitable for pretreatment of flax. The trend of temperature experiments are similar to that of concentration (listed in Table 6). Therefore, EDTA is not an effective agent for pretreatment.