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(54) **METHOD OF USING COMPOSITE ENZYME FOR DEGUMMING JUTE (2)**

(57) A method of degumming jute fibres with complex enzyme, wherein said complex enzyme comprises pectinase and laccase, comprises the steps of: a. Soaking the jute fibres in said complex enzyme water solution, wherein the weight proportion of said complex enzyme water solution and jute fibres ranges from 12:1 to 40:1; b. adjusting the PH value of said complex enzyme water solution to above 4.0, but below 5.0, and adjusting the temperature of said complex enzyme water solution to 35°C - 65°C, then keeping said complex enzyme water

solution at such temperature for 20-120 minutes; c. adjusting the PH value of said complex enzyme water solution to 7.5-9.5, and adjusting the temperature of said complex enzyme water solution to 40°C - 70°C; then, keeping said complex enzyme water solution with such temperature value for 20-120 minutes; d. conducting enzyme deactivation of the jute fibres processed with said complex enzyme.

EP 2 194 171 A1

Description**Technical field**

5 **[0001]** The present invention relates to a method of degumming jute fibres, in particular, relates to a method of degumming jute fibres with complex enzyme.

Background

10 **[0002]** Bast fabrics have gained more and more popularity with people, due to better Moisture absorption & Breathing , Low electrostatic susceptibility, and the antibacterial strength of bast fibres. For making the bast fabrics, the materials adopted can mainly be linen fibre, and ramie fibre, or the fibre combination of said fibres with other fibres, such as cotton fibres, wool fibres, chemical fibres, silk fibres after being blended spun. Linen or ramie is expensive, and this is also the reason why the bast-fabric clothing has not been applied widely. However, Jute, which is cheaper than linen and ramie, ,
 15 has better hygroscopicity and drapability than linen and ramie, and also has great antibiotic ability. Therefore, jute has huge potentiality and application value in clothing making industry. As the content of lignin within jute is relatively high (reaching 10-13%), which is several times as much as that within linen, it is not effective to degum jute fibres and remove the lignin from jute by using the existing degumming technology. And this greatly restrains the application of jute in making clothing. < The Effect of Enzyme Treatment on Jute fibres > published in «Journal of Tianjin Industrial University»
 20 volume 24 of August 2005 introduces the effect of cellulose, hemicellulase, ligninase and pectin depolymerise used in processing the jute fibres, but this article only introduces the method of processing jute fibres with single one of above mentioned enzymes. Although, there are some paragraphs in which the methods of complex enzyme treatment are mentioned, it only refers to the complex enzyme obtained via mixing laccase and cellulose enzyme or mixing hemicellulase enzyme and cellulose enzyme. However, it is testified in practice that it is not effective to remove lignin from jute fibres
 25 using the degumming method published in this article. Chinese Patent publication No CN 1232691C introduces a method of degumming jute fibres with complex enzyme. In the method, pectinase and laccase are used to produce a complex enzyme for degumming jute fibres, and the degmmed jute fibres, after blended spun or interlaced with other fibres such as cotton fibres and chemical fibres, can generally meet the requirements for clothing materials. However, the effect of removing lignin from jute fibres in the method, is still not good enough, as the removal rate is only about 76%. The
 30 content of lignin remaining in the jute fibres is still very high. There is a need of blended spinning or interlacing jute fibres with other fibres such as cotton fibres, and chemical fibres, when making the clothing materials. However, the quality of clothing materials made through blended spinning or interlacing jute fibres with other fibres such as cotton fibres, and chemical fibres still needs to be improved.

BRIEF DESCRIPTION OF INVENTION

[0003] The present invention relates to an effective method of degumming jute fibres with complex enzyme to remove pectin and lignin from said jute fibres.

40 **[0004]** In the present invention, a method of degumming jute fibres with complex enzyme, wherein said complex enzyme comprises pectinase and laccase, comprises the steps of:

- a. soaking the jute fibres in the water solution of said complex enzyme made from pectinase and laccase, wherein the weight proportion of said complex enzyme water solution and jute fibres ranges from 12:1 to 40:1;
- b. adjusting the PH value of said complex enzyme water solution to above 4.0, but below 5.0, and adjusting the
 45 temperature of said complex enzyme water solution to 35°C - 65°C, then keeping said complex enzyme water solution at such temperature for 20 - 120 minutes;
- c. adjusting the PH value of said complex enzyme water solution to 7.5 - 9.5, and adjusting the temperature of said complex enzyme water solution to 40°C - 70°C; then, keeping said complex enzyme water solution with such temperature value for 20 - 120 minutes;
- 50 d. conducting enzyme deactivation of the jute fibres processed with said complex enzyme.

[0005] The method, wherein said jute fibres are accumulation stored before the step d.

[0006] The method, wherein the duration for accumulation storing said jute fibres ranges from 6 to 24 hours.

55 **[0007]** The method, wherein the enzyme deactivation of jute fibres in the step d is through washing with hot water or adjusting the PH value of jute fibres, or through the combination of the two means.

[0008] The method, wherein the weight percentage of pectinase in said complex enzyme ranges from 30% to 90%.

[0009] The method, wherein the weight proportion of said complex enzyme and jute fibres ranges from 0.5:100 to 5:100.

[0010] The method, wherein the temperature of said hot water is above 75°C; the PH value of jute fibres is adjusted

to above 10.0 or below 4.0.

[0011] The method, wherein said jute fibres is pre-processed before the step a.

[0012] The method, wherein the pre-processing of said jute fibres is either through one of the means of water bath, acid bath, and soaking with hydrogen Peroxide, or through the combination of at least two of the three means.

[0013] The method, wherein that the temperature of water bath ranges from 30°C to 100°C; Said acid is sulphuric acid or acetic acid.

[0014] This invention also provides another method of degumming jute fibres with complex enzyme, wherein said complex enzyme comprises pectinase and laccase, said method comprises the steps of:

a. soaking the jute fibres in said complex enzyme water solution, wherein the weight proportion of said complex enzyme water solution and jute fibres ranges from 12:1 to 40:1;

b. adjusting the PH value of said complex enzyme water solution to 5.0 - 5.5, and adjusting the temperature of said complex enzyme water solution to 55°C - 60°C, then keeping said complex enzyme water solution at such temperature for 51 - 120 minutes;

c. adjusting the PH value of said complex enzyme water solution to 7.5 - 8.0, and adjusting the temperature of said complex enzyme water solution to 60°C - 70°C; then, keeping said complex enzyme water solution with such temperature value for 20 - 120 minutes;

d. conducting enzyme deactivation of the jute fibres processed with said complex enzyme.

[0015] The method, wherein said jute fibres are accumulation stored before the step d.

[0016] The method, wherein the duration for accumulation storing said jute fibres ranges from 6 to 24 hours.

[0017] The method, wherein the enzyme deactivation of jute fibres in the step d is through washing with hot water or adjusting the PH value of jute fibres, or through the both of the two means.

[0018] The method, wherein the weight percentage of pectinase in said complex enzyme ranges from 30% to 90%.

[0019] The method, wherein the weight proportion of said complex enzyme and jute fibres ranges from 0.5:100 to 5:100.

[0020] The method, wherein the temperature of said hot water is above 75°C; the PH value of jute fibres is adjusted to above 10.0 or below 4.0.

[0021] The method, wherein said jute fibres is pre-processed before the step a.

[0022] The method, wherein pre-processing said jute fibres is either through one of the means of water bath, acid bath, and soaking with Hydrogen Peroxide, or through at least two of the three means.

[0023] The method, wherein the temperature of water bath ranges from 30°C to 100°C; said acid is sulphuric acid or acetic acid.

[0024] In comparison with the prior art, the present invention has several advantages as follows:

(1) In the present invention, the process parameters that match with each other are used in treatment of degumming jute fibres using complex enzyme. For example, Laccase is in the highest activity when its PH value reaches about 4.5; adjusting the PH value of enzyme water solution to below 5.0 or keeping the enzyme water solution with a PH value that makes the enzyme water solution in a relatively high activity, prolonging the holding time of the enzyme water solution up to 50 minutes or more, and accordingly adjusting other process parameters, in order to gain the best effect of removing lignin. In addition, it is effective to remove pectin and lignin from jute fibres through accumulation storing the jute fibres before conducting enzyme deactivation of the jute fibres treated with complex enzyme via washing such jute fibres with hot water, or adjusting the PH value of such jute fibres, The removal rate of pectin can general reach about 90%, even up to 96% as the highest value, while the removal rate of lignin can generally reach about 78%, even up to 86% as the highest value. The jute fibres treated through above mentioned method have relatively high spinability.

(2) In addition, pre-processing jute fibres before being degummed can swell the jute fibres, so as to better reduce the interacting force among the single fibres, facilitate the contact between enzyme water solution and jute fibres, and remove the pectin and lignin from the jute fibres.

DETAILED DESCRIPTION OF INVENTION

Example 1

[0025] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, pre-processing the bits of jute fibres through water bath at

the temperature of 65°C, and the holding time is 2 hours; then, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 3:7, and the weight proportion of such complex enzyme and the jute fibres is 0.5:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 12 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 4.4 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 35°C and keeping the solution at such temperature for 20 minutes; after that, adjusting the PH value of the heated solution to 7.5 with sodium bicarbonate, heating the solution to 70°C, and keeping the solution at such temperature for 20 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 24 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with hot water at 80°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0026] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 2

[0027] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, pre-processing the bits of jute fibres through both acid bath and water bath, wherein the acid used for acid bath is concentrated sulphuric acid with the concentration of above 90%. The temperature of water bath is 30°C and the holding time is 1 hour; then, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 9:1, and the weight proportion of such complex enzyme and the jute fibres is 5:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 40 times in weight as much as the jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 4.9 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 40°C and keeping the solution at such temperature for 120 minutes; after that, adjusting the PH value of the heated solution to 9.5 with sodium bicarbonate, heating the solution to 55°C, and keeping the solution at such temperature for 40 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 6 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with hot water at 95°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0028] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 3

[0029] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, pre-processing the bits of jute fibres through acid bath, wherein the acid used for acid bath is acetic acid with the concentration of above 90%. then, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 1:1, and the weight proportion of such complex enzyme and the jute fibres is 1:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 15 times in weight as much as the jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 4.6 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 55°C and keeping the solution at such temperature for 40 minutes; after that, adjusting the PH value of the heated solution to 8.5 with sodium bicarbonate, heating the solution to 50°C, and keeping the solution at such temperature for 50 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 10 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with hot water at 85°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0030] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 4

[0031] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, pre-processing the bits of jute fibres through soaking the jute fibres in hydrogen peroxide with the concentration of 5g/L. then, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 3:1, and the weight proportion of such complex enzyme and the jute fibres is 2:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution

which is 30 times in weight as much as the jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 4.8 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 50°C and keeping the solution at such temperature for 50 minutes; after that, adjusting the PH value of the heated solution to 9.0 with sodium bicarbonate, heating the solution to 60°C, and keeping the solution at such temperature for 90 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 15 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with hot water at 90°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0032] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 5

[0033] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, pre-processing the bits of jute fibres through water bath at the temperature of 100°C, and the holding time is half an hours; then, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 5:1, and the weight proportion of such complex enzyme and the jute fibres is 3:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 20 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 4.1 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 45°C and keeping the solution at such temperature for 60 minutes; after that, adjusting the PH value of the heated solution to 8.5 with sodium bicarbonate, heating the solution to 40°C, and keeping the solution at such temperature for 70 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 20 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with water solution, the PH value of which is 11.0; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0034] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 6

[0035] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 4:1, and the weight proportion of such complex enzyme and the jute fibres is 4:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 16 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 4.2 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 50°C and keeping the solution at such temperature for 70 minutes; after that, adjusting the PH value of the heated solution to 9.0 with sodium bicarbonate, heating the solution to 45°C, and keeping the solution at such temperature for 80 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 12 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with water solution, the PH value of which is 3.0; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0036] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 7

[0037] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 2:3, and the weight proportion of such complex enzyme and the jute fibres is 1:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 13 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 4.0 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 60°C and keeping the solution at such temperature for 80 minutes; after that, adjusting the PH value of the heated solution to 8.0 with sodium bicarbonate, heating the solution to 65°C, and keeping the solution at such temperature for 100 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 8 hours; next, conducting enzyme deactivation of the accumulation stored

jute fibres by washing the jute fibres with hot water at 85 °C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0038] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 8

[0039] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 3:1, and the weight proportion of such complex enzyme and the jute fibres is 2:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 14 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 4.5 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 65°C and keeping the solution at such temperature for 90 minutes; after that, adjusting the PH value of the heated solution to 7.8 with sodium bicarbonate, heating the solution to 40°C, and keeping the solution at such temperature for 110 minutes; then, taking the jute fibres out of the solution; next, conducting enzyme deactivation of the jute fibres by washing the jute fibres with hot water, the PH value of which is 10.0 and the temperature of which is 75°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0040] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 9

[0041] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 2:1, and the weight proportion of such complex enzyme and the jute fibres is 1:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 16 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 4.3 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 45°C and keeping the solution at such temperature for 100 minutes; after that, adjusting the PH value of the heated solution to 9.3 with sodium bicarbonate, heating the solution to 55°C, and keeping the solution at such temperature for 120 minutes; then, taking the jute fibres out of the solution; next, conducting enzyme deactivation of the jute fibres by washing the jute fibres with hot water, the PH value of which is 3.5 and the temperature of which is 80°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0042] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 10

[0043] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, pre-processing the bits of jute fibres through water bath at the temperature of 65°C, and the holding time is 2 hours; then, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 3:7, and the weight proportion of such complex enzyme and the jute fibres is 0.5:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 12 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 5.5 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 55°C and keeping the solution at such temperature for 51 minutes; after that, adjusting the PH value of the heated solution to 7.5 with sodium bicarbonate, heating the solution to 60°C, and keeping the solution at such temperature for 20 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 24 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with hot water at 80°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0044] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 11

[0045] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, pre-processing the bits of jute fibres through both acid bath and water bath, wherein the acid used for acid bath is concentrated sulphuric acid with the concentration of above 90%. The temperature of water bath is 30°C and the holding time is 1 hour; then, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 9:1, and the weight proportion of such complex enzyme and the jute fibres is 5: 100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 40 times in weight as much as the jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 5.0 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 60°C and keeping the solution at such temperature for 120 minutes; after that, adjusting the PH value of the heated solution to 7.5 with sodium bicarbonate, heating the solution to 65°C, and keeping the solution at such temperature for 40 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 6 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with hot water at 95°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0046] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 12

[0047] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, pre-processing the bits of jute fibres through both acid bath, wherein the acid used for acid bath is acetic acid with the concentration of above 90%. then, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 1:1, and the weight proportion of such complex enzyme and the jute fibres is 1:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 20 times in weight as much as the jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 5.0 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 55°C and keeping the solution at such temperature for 60 minutes; after that, adjusting the PH value of the heated solution to 8.0 with sodium bicarbonate, heating the solution to 70°C, and keeping the solution at such temperature for 50 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 10 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with hot water at 85°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0048] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 13

[0049] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, pre-processing the bits of jute fibres through soaking the jute fibres in hydrogen peroxide with the concentration of 5g/L. then, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 2:1, and the weight proportion of such complex enzyme and the jute fibres is 2:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 30 times in weight as much as the jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 5.3 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 58°C and keeping the solution at such temperature for 90 minutes; after that, adjusting the PH value of the heated solution to 7.8 with sodium bicarbonate, heating the solution to 69°C, and keeping the solution at such temperature for 90 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 15 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with hot water at 90°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0050] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 14

[0051] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein

each bit of jute fibres weighs about 0.5 kilogram; secondly, pre-processing the bits of jute fibres through water bath at the temperature of 100°C, and the holding time is half an hours; then, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 5:1, and the weight proportion of such complex enzyme and the jute fibres is 3:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 12 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 5.0 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 55°C and keeping the solution at such temperature for 80 minutes; after that, adjusting the PH value of the heated solution to 7.7 with sodium bicarbonate, heating the solution to 65°C, and keeping the solution at such temperature for 70 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 20 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with water solution, the PH value of which is 11.0; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0052] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 15

[0053] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 4:1, and the weight proportion of such complex enzyme and the jute fibres is 4:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 14 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 5.0 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 60°C and keeping the solution at such temperature for 70 minutes; after that, adjusting the PH value of the heated solution to 8.0 with sodium bicarbonate, heating the solution to 65°C, and keeping the solution at such temperature for 80 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 12 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with water solution, the PH value of which is 3.0; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0054] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 16

[0055] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 2:3, and the weight proportion of such complex enzyme and the jute fibres is 1:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 13 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 5.2 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 57°C and keeping the solution at such temperature for 100 minutes; after that, adjusting the PH value of the heated solution to 8.0 with sodium bicarbonate, heating the solution to 60°C, and keeping the solution at such temperature for 100 minutes; then, taking the jute fibres out of the solution, and accumulation storing the jute fibres for 8 hours; next, conducting enzyme deactivation of the accumulation stored jute fibres by washing the jute fibres with hot water at 85 °C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0056] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 17

[0057] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 3:1, and the weight proportion of such complex enzyme and the jute fibres is 2:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 13 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 5.0 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 58°C and keeping the solution at such temperature for

110 minutes; after that, adjusting the PH value of the heated solution to 7.8 with sodium bicarbonate, heating the solution to 70°C, and keeping the solution at such temperature for 110 minutes; then, taking the jute fibres out of the solution; next, conducting enzyme deactivation of the jute fibres by washing the jute fibres with hot water, the PH value of which is 10.0 and the temperature of which is 75°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0058] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

Example 18

[0059] An experiment is conducted through the following steps: firstly, dividing the jute fibres into several bits, wherein each bit of jute fibres weighs about 0.5 kilogram; secondly, mixing the pectinase and laccase into complex enzyme, wherein the weight proportion of pectinase and laccase is 2:1, and the weight proportion of such complex enzyme and the jute fibres is 1:100; next, diluting the complex enzyme with water, in order to produce complex enzyme water solution which is 16 times in weight as much as jute fibres; after that, soaking the jute fibres in the diluted complex enzyme water solution; then, adjusting the PH value of the diluted complex enzyme water solution to 5.4 with acetic acid and sodium bicarbonate; next, heating the complex enzyme water solution to 56°C and keeping the solution at such temperature for 100 minutes; after that, adjusting the PH value of the heated solution to 7.6 with sodium bicarbonate, heating the solution to 55°C, and keeping the solution at such temperature for 120 minutes; then, taking the jute fibres out of the solution; next, conducting enzyme deactivation of the jute fibres by washing the jute fibres with hot water, the PH value of which is 3.5 and the temperature of which is 80°C; finally, the degummed jute fibres are obtained. The removal rate of pectin and lignin from jute fibres is indicated in the table 1.

[0060] Said degummed jute fibres will be highly spinnable, after being bleached, stamped, washed, dehydrated, and dried via the prior art.

[0061] The pectinase (Bioprep) and the laccase (Denilite) mentioned in above examples are produced by the a Danish company called Novozymes . Table 1 illustrates the removal rates of pectin and lignin from jute fibres of the different examples.

[0062] While this invention has been described as having several preferred embodiments, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from this present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

Table 1

Examples	1	2	3	4	5	6	7	8	9
Removal rate of pectinase	86%	96%	90%	92%	95%	96%	92%	91%	89%
Removal rate laccase	79%	79%	80%	80%	84%	86%	82%	81%	78%
Examples	10	11	12	13	14	15	16	17	18
Removal rate of pectinase	86%	96%	90%	90%	95%	96%	91%	91%	89%
Removal rate laccase	79%	80%	79%	80%	84%	86%	82%	81%	79%

Claims

1. A method of degumming jute fibres with complex enzyme, wherein said complex enzyme comprises pectinase and laccase, wherein comprising the steps of:

- soaking the jute fibres in the water solution of said complex enzyme made from pectinase and laccase, wherein the weight proportion of said complex enzyme water solution and jute fibres ranges from 12:1 to 40:1.
- adjusting the PH value of said complex enzyme water solution to above 4.0, but below 5.0, and adjusting the temperature of said complex enzyme water solution to 35°C - 65°C, then keeping said complex enzyme water solution with such temperature value for 20 - 120 minutes.
- adjusting the PH value of said complex enzyme water solution to 7.5 - 9.5, and adjusting the temperature of said complex enzyme water solution to 40°C - 70°C; then, keeping said complex enzyme water solution at such temperature for 20 - 120 minutes.

d. conducting enzyme deactivation of the jute fibres processed with said complex enzyme.

2. The method of claim 1, wherein that said jute fibres are accumulation stored before the step d.

3. The method of claim 2, wherein that the duration of accumulation storing said jute fibres ranges from 6 to 24 hours.

4. The method of claim 1-3, wherein that the enzyme deactivation of jute fibres in the step d is through washing with hot water or adjusting the PH value of jute fibres, or through the combination of the two means.

5. The method of claim 1-3, wherein that the weight percentage of pectinase in said complex enzyme ranges from 30% to 90%.

6. The method of claim 1-3, wherein that the weight proportion of said complex enzyme and jute fibres ranges from 0.5:100 to 5:100.

7. The method of claim 4, wherein that the temperature of said hot water is above 75°C; the PH value of jute fibres is adjusted to above 10.0 or below 4.0.

8. The method of claim 1-3, wherein that said jute fibres is pre-processed before the step a.

9. The method of claim 8, wherein that the pre-processing of said jute fibres is either through one of the means of water bath, acid bath, and soaking with hydrogen Peroxide, or through the combination of at least two of the three means.

10. The method of claim 9, wherein that the temperature of water bath ranges from 30°C to 100°C; Said acid is sulphuric acid or acetic acid.

11. A method of degumming jute fibres with complex enzyme, wherein said complex enzyme comprises pectinase and laccase, wherein comprising the steps of:

a. soaking the jute fibres in the water solution of said complex enzyme made from pectinase and laccase, wherein the weight proportion of said complex enzyme water solution and jute fibres ranges from 12:1 to 40:1.

b. adjusting the PH value of said complex enzyme water solution to 5.0 - 5.5, and adjusting the temperature of said complex enzyme water solution to 55°C - 60°C, then keeping said complex enzyme water solution with such temperature value for 51 - 120 minutes.

c. adjusting the PH value of said complex enzyme water solution to 7.5 - 8.0, and adjusting the temperature of said complex enzyme water solution to 60°C - 70°C; then, keeping said complex enzyme water solution with such temperature value for 20 - 120 minutes.

d. conducting enzyme deactivation of the jute fibres processed with said complex enzyme.

12. The method of claim 11, wherein that said jute fibres are accumulation stored before the step d.

13. The method of claim 12, wherein that the duration for accumulation storing said jute fibres ranges from 6 to 24 hours.

14. The method of claim 11-13, wherein that the enzyme deactivation of jute fibres in the step d is through washing with hot water or adjusting the PH value of jute fibres, or through the both of the two means.

15. The method of any of claim 11-13, wherein that the weight percentage of pectinase in said complex enzyme ranges from 30% to 90%.

16. The method of any of claim 11-13, wherein that the weight proportion of said complex enzyme and jute fibres ranges from 0.5:100 to 5:100.

17. The method of claim 14, wherein that the temperature of said hot water is above 75°C; the PH value of jute fibres is adjusted to above 10.0 or below 4.0.

18. The method of any of claim 11-13, **characterized in that** said jute fibres is pre-processed before step a.

EP 2 194 171 A1

19. The method of claim 18, wherein that pre-processing said jute fibres is either through one of the means of water bath, acid bath, and soaking with Hydrogen Peroxide, or through at least two of the three means.
- 5 20. The method of claim 19, wherein that the temperature of water bath ranges from 30°C to 100°C; said acid is sulphuric acid or acetic acid.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/001659

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: D01C1/00, D06M16/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNKI, CNPAT, WPI, EPODOC, PAJ, CA: jute, nalita w fib+, pectinase, pectase, pectolase, pect+ w enzyme, laccase, degum+, unglu+, boiling w off, degelatiniz+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y		1-10
Y	CN1827864A(UNIV ZHEJIANG SCI TECH), 06 Sep.2006(06.09.2006), claim 1, example 1	1-10
PX	CN101135063A(JIANGSU REDBUD DYEING TECHNOLOGY CO LTD), 05 Mar.2008(05.03.2008), claims 1-10	1-20
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/001659

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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PX	CN101130887A(JIANGSU REDBUD DYEING TECHNOLOGY CO LTD), 27 Feb.2008(27.02.2008), claims 1-9	1-20
PX	CN101135064A(JIANGSU REDBUD DYEING TECHNOLOGY CO LTD), 05 Mar.2008(05.03.2008), claims 1-10	1-20
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PX	CN101130888A(JIANGSU REDBUD DYEING TECHNOLOGY CO LTD), 27 Feb.2008(27.02.2008), claims 1-10	1-20
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Form PCT/ISA/210 (continuation of second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2008/001659

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CN101135065A	05.03.2008	None	
CN101130888A	27.02.2008	None	
CN101130889A	27.02.2008	None	
CN101130890A	27.02.2008	None	
CN101130892A	27.02.2008	None	
CN101130893A	27.02.2008	None	
CN101130894A	27.02.2008	None	
CN101130895A	27.02.2008	None	
CN101130896A	27.02.2008	None	
CN101167606A	30.04.2008	None	
CN101168432A	30.04.2008	None	
CN101172571A	07.05.2008	None	

Form PCT/ISA/210 (patent family annex) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/001659

CLASSIFICATION OF SUBJECT MATTER

D01C1/00 (2006.01)i
D06M16/00 (2006.01)i
D06M101/06 (2006.01)n

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REFERENCES CITED IN THE DESCRIPTION

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- *Journal of Tianjin Industrial University*, August 2005,
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