A Study on Mould Resistance Properties and Different Pretreatment Methods for *Moso Bamboo*

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***Abstract* — Because *moso bamboo's* starch mainly exists in the elongated parenchyma cells, it is difficult for amylase to enter *moso bamboo* interior to dissolve it. In this paper, *moso bamboo* blocks were first treated with seven levels of hydrochloric acid or sodium hydroxide solvents. All cases showed that the main mechanical properties of *moso bamboo* clearly decreased when the percentage of hydrochloric acid or sodium hydroxide pretreatment solvents increased from 0% to 3%. In order to ensure the quality of the final product of *moso bamboo*, we deliberately chose to treat the *moso bamboo* blocks with 0.5% hydrochloric acid or 0.5% sodium hydroxide pretreatment solvents. The results showed that these pretreatment solvents could improve the permeability and absorption qualities of *moso bamboo* blocks, allowing the amylase to enter the interior and dissolve the starch and sugar nutrients, thus the starch and reducing sugar content of *moso bamboo* samples clearly decreased. Furthermore, in the mould resistance test, *moso bamboo* blocks were treated with three traditional types of *moso bamboo* mould: *Aspergillus niger, Penicillium citrinum, and Trichoderma viride*. The results revealed that *moso bamboo* have great mould resistance properties when treated with 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents pretreatment and amylase treatment. No mycelia existed on *moso bamboo* blocks within a 30 days period. The bamboo pretreatment method will become an economic, efficient new technique for the protection of bamboo from mould.**

Keywords-*moso bamboo*; starch; reducing sugar; pretreatment; amylase treatment; mould resistance capability

I. INTRODUCTION

There are over 1200 varieties of bamboo, most of which are concentrated in Asia. Ninety percent of the bamboo in Asia is found in Southeast Asia [1]. The bamboo industry has been developing rapidly in China since the 1990s as an important forest resource alternative to wood due to its fast growing rate, high strength and stiffness, easy workability, and local availability [2,3]. In contrast to timber, bamboo could be much more easily attracted by fungi due to high content of starch and sugar, which act as feeds for fungi, thus resulting in degraded performances, shortened service life, and reduced value. Therefore it is necessary to protect *moso bamboo* from mould or fungi [4,5]. *Moso bamboo* culm consists of about 45 to 55% parenchyma cells, which are filled with nutritious starch (2 to 6%), sugar (2%), protein (1.5 to 6%), fat (2 to 4%) [6]. All of these nutritions, especially the starch and sugar, are believed to be the main factors leading to the mould of bamboo [7,8,9,10,11]. However, there is not an report on the relationships between the above mentioned bamboo components and mould resistance. Though treatments such as heat treatment [12], solvent or chemical reagents treatment have been applied in the protection of bamboo from mould [13,14,15], a simpler and faster process for a more environmental, industrial, an economical available technique for the protection of bamboo from mould has so far not been found [16].

As we know, the mature *moso bamboo*'s cellulose measures at 40%~60%. The hydroxyl groups in cellulose molecules could be much more easily led to the formation of a hydrogen bond between the oxygen-containing groups by each other or itself. These hydrogen bonds combine to make a lot of cellulose molecules form a crystalline structure [2,17]. The crystalline structure of the cellulose polymer is rigid and highly water insoluble. The key of *moso bamboo* antifungal properties lies in the proper destruction of the cellulose's crystalline structure. Loose cellulose structures make it easier for enzymatic hydrolysis. Thus, in this study, *moso bamboo* blocks were treated with acid and alkali solvents with different concentrations before being treated with amylase or hot water. The effects of acid and alkali amylase treatment on the starch and reducing sugar content were first investigated; And then the growth of fungi on *moso bamboo* surfaces with respect to the starch and reducing sugar content was revealed. The object of this study was to evaluate acid and alkali amylase treatment on the mould resistance of *moso bamboo*.

II. EXPERIMENTAL

A. Materials

Moso bamboo were collected from Subtropical Forestry Research Institute Chinese Academy of Forestry, Zhejiang, China. The size of laboratory antifungal tests specimens is 50mm (length) × 20mm (width) × 5mm (thickness) with green and yellow faces planed off. 12 specimens per concentration of an acid and alkali amylase treatment solvent were chosen for laboratory tests, of which, half were with knots and half were without knots. Mechanical properties of bamboo specimens were chosen and machined according to GB/T 15780-1995.

Three kinds of mould fungi products(*Aspergillus niger*, *Penicillium citrinum*, and *Trichoderma viride*) applied in the laboratory mould resistance tests were purchased from the Chinese Academy of Forestry, Beijing, China. The amylase product was purchased from the Sigma-Aldrich Co. Ltd. Its enzyme activity is 40000u/g.

B. Moso Bamboo Sample's Pretreatment and Amylase Treatment Methods

In previous studies, we found that with this bamboo sample, the optimal amount of enzyme activity is 120u/ml and the optimal pretreatment temperature is 100°C [16]. In this study, *moso bamboo* samples applied in the laboratory mould resistance tests and mechanical properties testing were first treated with seven levels hydrochloric acid solvents (0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5%, and 3.0%) and seven levels sodium hydroxide solvents (0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5%, and 3.0%) for 3 hours, respectively. All pre-treated bamboo samples were cleaned in cold distilled water for 10 minutes. The moisture content of the mechanical properties testing samples were adjusted in the constant temperature and humidity box. It must be ensured that the moisture content of the mechanical properties testing bamboo sample is 12%. All the mechanical properties testing bamboo samples must be done according to GB/T15780-1995 in order to confirm the optimal pretreatment solvent's concentration. The second typical treatment combined the laboratory mould resistance tests samples and the optimal pretreatment solvent's concentration into the 1000-ml beaker which was heated at 100°C for 3 hours. All pre-treated bamboo samples were cleaned in cold distilled water at once. Then the laboratory mould resistance tests samples were treated with amylase solvent or hot water at seven levels of treatment durations (0h, 0.5h, 1.0h, 1.5h, 2.0h, 2.5h and 3.0h) according to the experiment plan. All pretreated *moso bamboo* blocks were placed into the fume hood for about two weeks before the mould resistance test.

C. Starch and Reducing Sugar Content Analysis

All bamboo samples having finished the pretreatment, amylase treatments or hot water treatments were cleaned in cold distilled water for 10 minutes, followed by 24 hours drying at 105°C in an oven. The oven-dried bamboo samples were milled, and the particles with 40-60 mesh were collected in a sealed bag. The starch and reducing sugar content analyses were according to TAPPIT 419 and 3.5-Dinitrosalicylic acid method, respectively.

D. Mould Resistance Test

For laboratory tests, *moso bamboo* samples were treated with 0.5% hydrochloric acid solvent or 0.5% sodium hydroxide solvent for 3 hours. All pretreated bamboo samples were cleaned in cold distilled water; And then these bamboo samples were treated with 120u/ml or 0u/ml enzyme activity amylase solvent at seven lengths of treatment durations (0h, 0.5h, 1.0h, 1.5h, 2.0h, 2.5h, and 3.0h) according to the experiment plan. All pre-treated *moso bamboo* blocks were placed into the fume hood for about two weeks before the mould resistance test. The pre-treated *moso bamboo* blocks were placed on a 3-day culture of the test fungus malt agar (2% malt extract and 2% agar) in petri dishes and incubated for 30 days at 25°C ± 2°C under controlled humidity between 85% and 90% (ASTM: D4445-03).

E. Evaluation of the Test

The growth of fungi in the laboratory test was visually analyzed and scored twice daily. When the samples began to mildew, vernier caliper was applied to measure the length and width of the moldy part. Mould resistance of samples in the laboratory test was evaluated by the infection area (*IA*), which was calculated as follows:

$$LA = \frac{\sum_{i=1}^{12} LAi}{2700 \times 12} \times 100\ \% \qquad (1)$$

Where IA is the percentage of infection area; *IAi* is the infection area of sample *i* (mm^2); 2700=50×20×2+ 50×5×2 +20×5×2 is the constant for the area of each sample (mm^2), and 12 is the number of replicate samples.

III. ANALYSIS AND DICUSSION

A. Bamboo Sample's Hydrochloric Acid or Sodium Hydroxide Solvents Pretreatment

The effect of pretreatment on the mechanical properties of *moso bamboo* samples was investigated, and the results are shown in Fig.1 and Fig.2. As shown in Fig.1 and Fig.2, the main mechanical properties of *moso bamboo* had decreased obviously when the percentage of pretreatment hydrochloric acid or sodium hydroxide solvents increased from 0% to 3%. Under hydrochloric acid pretreatment conditions, the tensile strength parallel to grain of *moso bamboo* decreased from 19.72KN/cm^2 to 11.63KN/cm^2 when the percentage of hydrochloric acid solvents increased from 0% to 3%. Bending strength decreased from 14.87 KN/cm^2 to 5.35 KN/cm^2 when the percentage of hydrochloric acid pretreatment solvents increased from

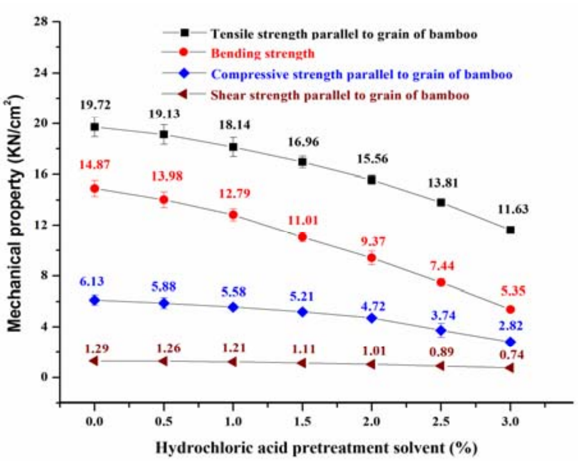

Figure1. The mechanical properties of *moso bamboo* samples were treated with seven concentrations of hydrochloric acid solvents

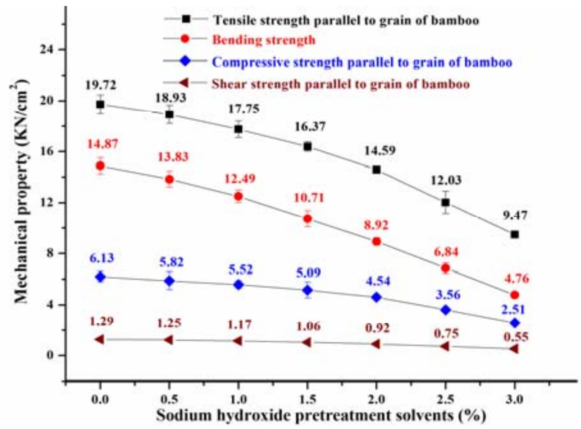

Figure2. The mechanical properties of *moso bamboo* samples were treated with seven concentrations of sodium hydroxide solvents

0% to 3%. Compressive strength parallel to grain of bamboo decreased from 6.13KN/cm^2 to 2.82KN/cm^2 when the percentage of hydrochloric acid pretreatment solvents increased from 0% to 3%. Shear strength parallel to grain of bamboo decreased from 1.29KN/cm^2 to 0.74KN/cm^2 when the percentage of hydrochloric acid pretreatment solvents increased from 0% to 3%. Under sodium hydroxide pretreatment conditions, the tensile strength parallel to grain of *moso bamboo* decreased from 19.72KN/cm^2 to 9.47 KN/cm^2 when the percentage of sodium hydroxide solvents increased from 0% to 3%. Bending strength decreased from 14.87KN/cm^2 to 4.76KN/cm^2 when the percentage of sodium hydroxide pretreatment solvents increased from 0% to 3%. Compressive strength parallel to grain of bamboo decreased from 6.13KN/cm^2 to 2.51KN/cm^2 when the percentage of sodium hydroxide pretreatment solvents increased from 0% to 3%. Shear strength parallel to grain of bamboo decreased from 1.29KN/cm^2 to 0.55KN/cm^2 when the percentage of sodium hydroxide pretreatment solvents increased from 0% to 3%. This information illustrates that the main mechanical properties of *moso bamboo* treated with sodium hydroxide solution have greatly decreased compared to the main mechanical properties of *moso bamboo* samples treated with hydrochloric acid solution under similar conditions.

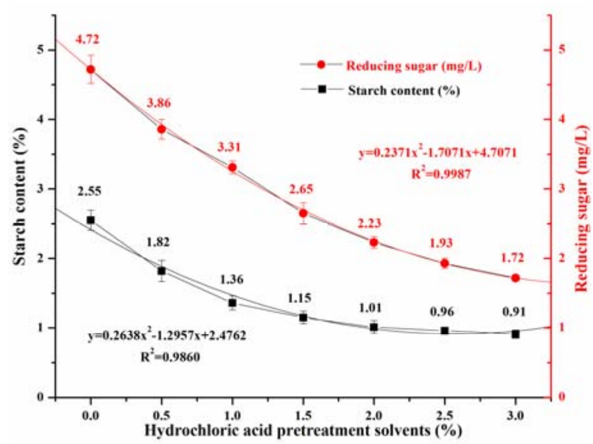

Figure3. The starch and reducing sugar content of *moso bamboo* samples were treated with seven levels of hydrochloric acid solvents

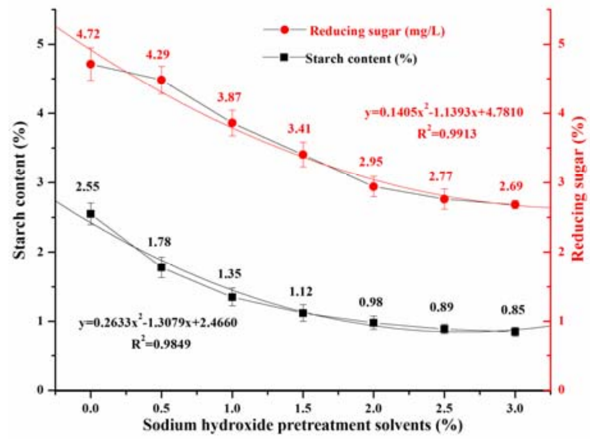

Figure4. The starch and reducing sugar content of *moso bamboo* samples were treated with seven levels sodium hydroxide solvents

The effect of hydrochloric acid and sodium hydroxide pretreatment on the starch and reducing sugar content of *moso bamboo* samples are shown in Fig.3 and Fig.4. Under hydrochloric acid pretreatment conditions, the starch content of *moso bamboo* samples decreased from 2.55% to 0.91% when the percentage of hydrochloric acid pretreatment solvents increased from 0% to 3%. The reducing sugar content of *moso bamboo* samples decreased from 4.72mg/ml to 1.72mg/ml when the percentage of hydrochloric acid pretreatment solvents increased from 0% to 3%. We determined two curvilinear equations of the seven levels hydrochloric acid pretreatment solvents and the starch and reducing sugar content of *moso bamboo* samples by analyzing the experimental data. Hydrochloric acid pretreatment solvents curvilinear equation's interesting finding were the high correlation coefficient of the hydrochloric acid pretreatment solvents and starch content (R^2=0.9860); hydrochloric acid pretreatment solvents and reducing sugar content (R^2=0.9987).

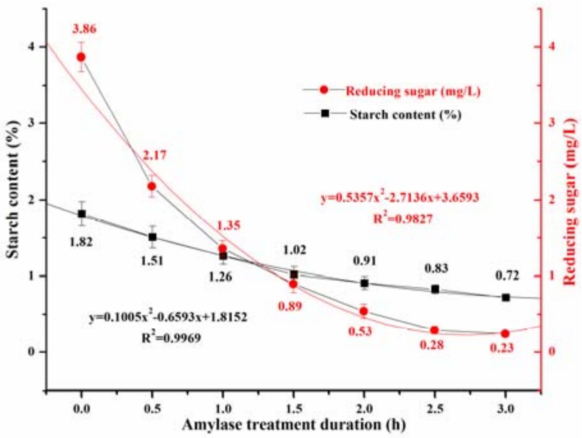

Figure5. The starch and reducing sugar content of *moso bamboo* samples were treated with seven lengths of amylase treatment durations (0.5% hydrochloric acid pretreatment)

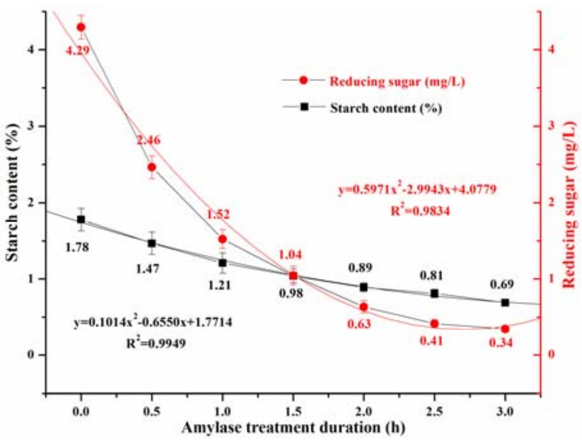

Figure6. The starch and reducing sugar content of *moso bamboo* samples were treated with seven lengths of amylase treatment durations (0.5% sodium hydroxide pretreatment)

Under the sodium hydroxide pretreatment conditions, the starch content of *moso bamboo* samples decreased from 2.55% to 0.85% when the percentage of sodium hydroxide pretreatment solvents increased from 0% to 3%. The reducing sugar content of the *moso bamboo* samples decreased from 4.72mg/ml to 2.69mg/ml when the percentage of sodium hydroxide pretreatment solvents increased from 0% to 3%. We determined two curvilinear equations of the seven levels sodium hydroxide pretreatment solvents and the starch and reducing sugar content of *moso bamboo* samples by analyzing the experimental data. Sodium hydroxide pretreatment solvents curvilinear equation's interesting finding was the high correlation coefficient of the sodium hydroxide pretreatment solvents and starch content (R^2=0.9849); sodium hydroxide pretreatment solvents and reducing sugar content (R^2= 0.9913). This information illustrates that the starch content of *moso bamboo* samples treated with sodium hydroxide solution have dropped a little more than when it is treated with hydrochloric acid solution; but the reducing sugar content of *moso bamboo* samples treated with hydrochloric acid solution have greatly decreased than when it is treated with sodium hydroxide solution under the same conditions.

And then having finished 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents pretreatment, *moso bamboo* samples were treated with seven lengths of amylase and hot water treatment durations, and the seven lengths of amylase treatment results of the starch and reducing sugar content of *moso bamboo* samples are shown in Fig.5 and Fig.6. As shown in Fig.5, the starch content of the 0.5% hydrochloric acid solvents pretreatment *moso* bamboo decreased from 1.82% to 0.72% when the amylase treatment durations increased from 0h to 3h. Its curvilinear equation has a high correlation coefficient of the amylase treatment durations and the starch content (R^2=0.9969). The reducing sugar content of *moso bamboo* samples decreased dramatically from 3.86mg/ml to 0.23mg/ml when the amylase treatment durations increased from 0h to 3h. The curvilinear equation has the high correlation coefficient of the amylase treatment durations and the reducing sugar content (R^2=0.9827); As shown in Fig.6, *moso bamboo* samples with 0.5% sodium hydroxide solvents pretreatment decreased the starch content from 1.78% to 0.69% when the amylase treatment durations increased from 0h to 3h. The curvilinear equation has the high correlation coefficient of the amylase treatment durations and the starch content (R^2=0.9949). The reducing sugar content of *moso bamboo* samples decreased dramatically from 4.29mg/ml to 0.34 mg/ml when the amylase treatment durations increased from 0h to 3h, the curvilinear equation has the high correlation coefficient of the amylase treatment durations and the reducing sugar content (R^2=0.9834).

The seven lengths of hot water treatment results of the starch and reducing sugar content of *moso bamboo*

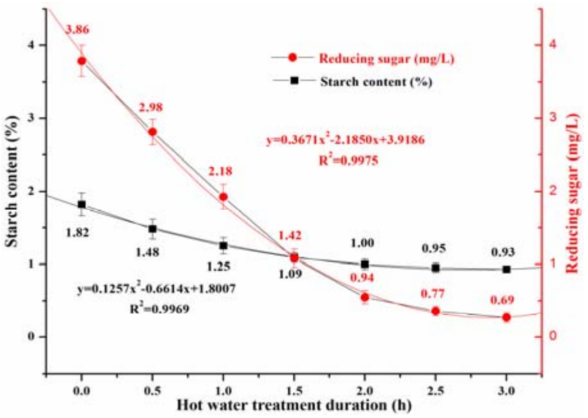

Figure7. The starch and reducing sugar content of *moso bamboo* samples were treated with seven lengths of hot water treatment durations (0.5% hydrochloric acid pretreatment)

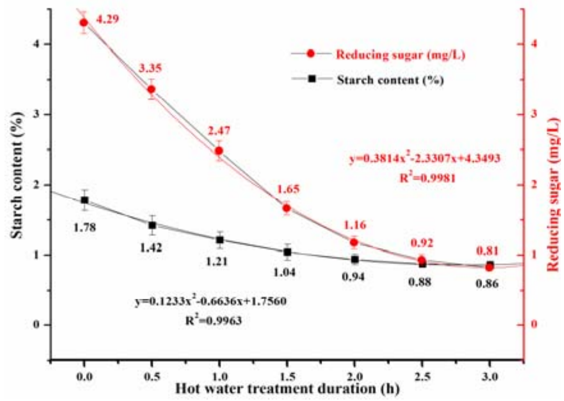

Figure8. The starch and reducing sugar content of *moso bamboo* samples were treated with seven lengths of hot water treatment durations (0.5% sodium hydroxide pretreatment)

samples are shown in Fig.7 and Fig.8. As shown in Fig.7, the starch content of the 0.5% hydrochloric acid solvents pretreatment *moso bamboo* decreased from 1.82% to 0.93% when the hot water treatment durations increased from 0h to 3h. Its curvilinear equation has a high correlation coefficient of the hot water treatment durations and the starch content (R^2=0.9969). The reducing sugar content of *moso bamboo* samples decreased from 3.86mg/ml to 0.69mg/ml when the hot water treatment durations increased from 0h to 3h. The curvilinear equation has the high correlation coefficient of the hot water treatment durations and the reducing sugar content (R^2=0.9975); As shown in Fig.8, *moso bamboo* samples with 0.5% sodium hydroxide solvents pretreatment decreased the starch content from 1.78% to 0.86% when the hot water treatment durations increased from 0h to 3h. The curvilinear equation has the high correlation coefficient of the hot water treatment durations and the starch content (R^2=0.9963). The reducing sugar content of *moso bamboo* samples decreased from 4.29mg/ml to 0.81mg/ml when the hot water treatment durations increased from 0h to 3h, the curvilinear equation has the high correlation coefficient of the hot water treatment durations and the reducing sugar content (R^2=0.9981).

The reason for the starch and the reducing sugar content of *moso bamboo* sample's rapid decline may involve multiple factors. As we know, amylase treatment not only could dissolve the starch and sugar nutrients of *moso bamboo* blocks required for mould fungi, but could also change the starch into reducing sugar and dissolve the reducing sugar in water. The distribution of *moso bamboo*'s main vascular tissue system is longitudinal, with no horizontal transmission system. With this in mind, traditional *moso bamboo* block antifungal processes and the internal immersion of chemical reagents in *moso bamboo* blocks are always a difficult problem. Moreover, *moso bamboo*'s starch mainly exists in elongated parenchyma cells, making it difficult for amylase to enter *moso bamboo* and react under normal conditions; Second, *moso bamboo* consist of 55 percent cellulose, 20 percent hemicellulose and 25 percent lignin from micro-economics standpoints. When *moso bamboo* blocks were treated with 0.5% hydrochloric acid solvents treatment at 100°C, hemicelluloses were hydrolyzed into simple sugars and the crystalliferous region of cellulose formed porous or swelling type structures. This is conducive to the occurrence of enzymatic hydrolysis; Third, there is a correlation between the enzymatic hydrolysis and the content of lignin in *moso bamboo*. The higher the lignin removal rate, the better the performance of enzyme hydrolysis to some extent. The specific surface area of cellulose is increased with *moso bamboo* removal of lignin facilitating contact and reaction of *moso bamboo* interior starch with amylase. Moreover, *moso bamboo* removal of lignin reduced its physical absorbed capability of the amylase, so that more amylase is absorbed by *moso bamboo* interior starch, this is conducive to the occurrence of enzymatic hydrolysis.

Having finished 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents pretreatment, *moso bamboo* samples were treated with seven lengths of hot water treatment durations, The most interesting finding were that the reducing sugar content of *moso bamboo* samples decreased dramatically from 3.86mg/ml to 0.69mg/ml when the hot water treatment durations increased from 0h to 3h (0.5% hydrochloric acid pretreatment), or the reducing sugar content of *moso bamboo* samples decreased dramatically from 4.29mg/ml to 0.81mg/ml when the hot water treatment durations increased from 0h to 3h (0.5% sodium hydroxide pretreatment). The main reason for the reducing sugar content of *moso bamboo* sample's rapid decline was that bamboo's horizontal transmission system was partial opened with the hydrochloric acid or sodium hydroxide pre-treatment, because the reducing sugar was easily soluble in water, eventually led to the rapid decline of *moso bamboo*'s reducing sugar.

Then, to the surprise of the researchers, the combination of 0.5% hydrochloric acid solvents pretreatment and amylase could reduce the starch (0.72%) and reducing sugar (0.23mg/L) contents of *moso bamboo* blocks to far below the 36 h of only amylase treatment levels (1.18% and 0.92 mg/L) in 3h as was shown in Fig.5, 0.5% sodium hydroxidesolvents pretreatment and amylase could reduce the starch (0.69%) and reducing sugar (0.34mg/ml) contents of *moso bamboo* blocks to far below the 36 h of only amylase treatment levels in 3h was shown in Fig.6. This combination of 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents pretreatment and amylase treatment's method can save a lot of amylase treatment time and become an economic, efficient new technique for the protection of bamboo from mould.

B. Bamboo Sample's Mould Resistance in the Laboratory Test

Resistances of the samples against *Aspergillus niger*, *Penicillium citrinum*, and *Trichoderma viride* are shown in Fig.9, Fig.10 and Fig.11. Seven types of *moso bamboo* samples tested included untreated *moso bamboo* blocks, treatment only with 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents, and the combined effect of 120u/ml enzyme activity or hot water and 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents pretreatment. Both the treated and untreated *moso bamboo* blocks were placed into the fume hood for about two weeks before mould resistance testing. The results revealed that the untreated *moso bamboo* blocks (0u/ml, 36h) had no resistance against the three test fungi, the mycelia spread rapidly once it climbed onto *moso bamboo* blocks (2 days), and all surfaces were covered with mycelia by 9 days.

In order to study the new method of the pretreatment on the mould resistance of *moso bamboo* blocks, we treated *moso bamboo* blocks with 0.5% hydrochloric acid or 0.5% sodium hydroxide solvents. The results showed that *moso bamboo* blocks had similar resistances against the three test fungi under the same treatment conditions. Mycelia spreaded slowly once they climbed onto *moso bamboo* blocks (3 days to 4 days), and all surfaces became covered with mycelia after at least 15 days and 17 days at most.

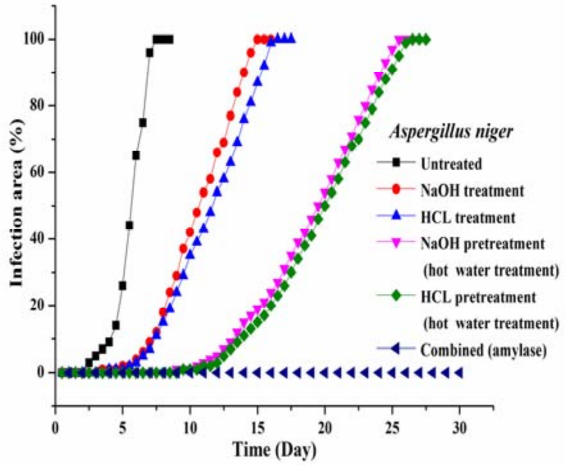

Figure9. Mould resistance of *moso bamboo* blocks against *aspergillus niger* during one month of cultivation

Having finished 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents pretreatment, in order to study the best efficiency method on the mould resistance of *moso bamboo* blocks, *moso bamboo* samples were treated with seven lengths of hot water or amylase treatment durations, The results showed that with the hot water treatment time increasing, the capability of three species of mould resistance of *moso bamboo* blocks have obviously increased. Mycelia spreaded slowly once they climbed onto *moso bamboo* blocks (9 days to 10 days), and all surfaces became covered with mycelia after at least 26 days and 28 days at most. Then, to the surprise of the researchers, *moso bamboo* have great mould resistance properties when treated with 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents pretreatment and amylase treatment. No mycelia existed on *moso bamboo* blocks within a 30 days period.

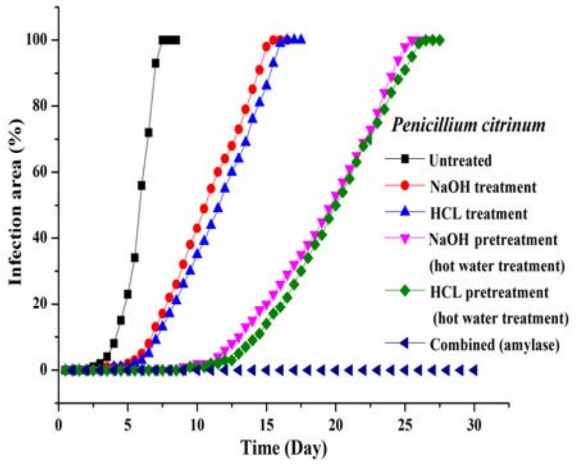

Figure10. Mould resistance of *moso bamboo* blocks against *penicillium citrinum* during one month of cultivation

The reason for the change of the mould resistance properties of *moso bamboo* blocks treated with 0.5% hydrochloric acid or 0.5% sodium hydroxide solvents might involve multiple factors. 0.5% hydrochloric acid or 0.5% sodium hydroxide solvents pretreatment not only could create the crystalliferous region of cellulose's porous or swelling type structure, but also hydrolyze the hemicelluloses into simple sugars and dissolve the simple sugar in water. Therefore, pretreatment solvents have a high concentration of reducing sugar. Because *moso bamboo* blocks were immersed in high concentrations of pre-treatment solvents, the reducing sugar content of *moso bamboo* samples is also relatively higher. These results are shown in Fig.3 and Fig.4. As we know, the reducing sugar contents play an important role in improving the mould resistance capability of *moso bamboo* blocks. *Moso bamboo* blocks have obviously decreased in the mould resistance capability caused by the rise of the reducing sugar content.

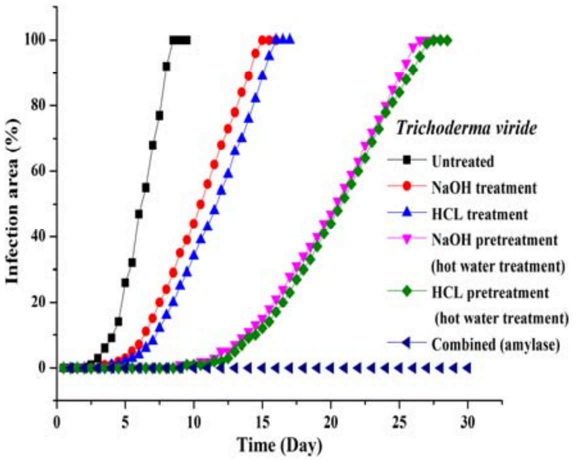

Figure11. Mould resistance of *moso bamboo* blocks against *trichoderma viride* during one month of cultivation

Three species of mould resistance of *moso bamboo* sample have been obviously improved when *moso bamboo* samples were treated with 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents pretreatment and hot water treatment. The most interesting finding were that the no mycelia existed on *moso bamboo* blocks within a 30 days period when *moso bamboo* samples were treated with 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents pretreatment and amylase treatment. Main reason for the improvement was that *moso bamboo*'s pretreatment can improve the capability of permeability and absorbed bamboo blocks, allowing the amylase to enter the inside and dissolve the starch and sugar nutrients of *moso bamboo* blocks, this is conducive to the occurrence of enzymatic hydrolysis. As are shown in Fig.5, Fig.6, Fig.7 and Fig.8, because the reducing sugar was easily soluble in water, so the reducing sugar content of *moso bamboo* was obviously decreased.

IV. CONCLUSIONS

The main mechanical properties of *moso bamboo* decreased differently when the percentage of hydrochloric acid or sodium hydroxide pre-treatment solvents increased from 0% to 3%. In order to ensure the quality of the final product of *moso bamboo*, 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents are the suitable concentration of *moso bamboo* pretreatment.

0.5% hydrochloric acid solvents pretreatment not only could form the crystalliferous region of cellulose's porous or swelling type structure, but also hydrolyze the hemi-celluloses into simple sugars and dissolve in water.

0.5% sodium hydroxide solvents pretreatment process could increase the removal of the lignin from *moso bamboo* blocks and increase the specific surface area of *moso bamboo*'s cellulose facilitating contact and reaction of enzymatic hydrolysis.

0.5% hydrochloric acid or 0.5% sodium hydroxide solvents pretreatment can improve the permeability and absorbed of *moso bamboo* blocks, allowing the amylase to enter internally and dissolve the starch and sugar nutrients of *moso bamboo* blocks, so the starch and reducing sugar content of *moso bamboo* samples were obviously decreased.

The mould resistance test results showed that *moso bamboo* have great mould resistance properties when treated with 0.5% hydrochloric acid solvents or 0.5% sodium hydroxide solvents pretreatment and amylase treatment. No mycelia existed on *moso bamboo* blocks within a 30 days period.

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