



Research Article

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**Research progress on the modification of bamboo**

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**ABSTRACT**

*Bamboo, one of the world's famous fast-growing fertility plants, can be widely used in instruments, furniture and other fields. But in the process of processing and use of which, bamboo is easy to produce flaws such as crack, deformation, mildew, moth, severely restricts the high quality and efficiency of use of bamboo. By summing up the status of bamboo research at home and abroad, we focused on the current situation of bamboo's modification to look forward to the emphasis of the modification of bamboo for further research.*

**Key words:** Bamboo; Modification; Highly effective use; Prospect

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**INTRODUCTION**

Bamboo is one of the famous fast-growing productive plants in the world, and is one of the fast-growing afforestation plants in preferred tropical and subtropical regions. At present, bamboo is mainly distributed in Asia, the Americas, Africa and other places, especially in countries such as China, India, Japan, plantation area reach 20 million hectares, annual output of bamboo are 18 million tons, the area of bamboo which are more than 10000 hectares of the county (city) in China has more than 130. with a total area of 7 million hectares, most species are bamboo, Bamboo plantation timber cycle is short, high yield, trunk straight, dense material, can be widely used in instruments, furniture, floor, the structure of the villa building, packaging materials, engineering materials, such as container floor), pulp and paper industry, etc [1]. In the processing, bamboo can easily form serious defects such as crack and deformation; In the process of modified, the permeability is difficult, the distribution of reagent is Uneven, It is difficult to attain the goal of improvement. Once ,the theory Studies thought, bamboo contains a large amount of starch, sugar, protein and other salt substances, and there structure is different, and thus lead to more serious defects in bamboo processing [2]. However, their research mostly focused on bamboo anatomical structure, mould-proof and moth-proofing, bamboo man-made board quality [3]. Therefore, strengthening the research of bamboo's modification can make up the defects of bamboo in the processing and use, which could effectively improve the quality of bamboo products and the use value, and also could provide a strong technical support to improve the bamboo processing and utilization.

**BAMBOO RESEARCH STATUS**

Bamboo has many unique properties which are quite different from each other. The impact on bamboo processing and utilization are also different, such as Zhuqing precipitated with silica, calcium and other Inorganic extract could improve the corrosion resistance of bamboo [4]. Crusts often appears in the area where deposited proteins and polyphenols, this would block the penetration channel [5] and can prevent the bacteria invasion.

As early as 2000 years ago, our country began to use the natural characteristics of bamboo. Using bamboo apply on Bamboo tube, papermaking, Musical Instruments, household utensils, construction and other aspects, in the folk, also have prescriptions for the treatment of disease. which made by bamboo [2], in 1948,zhangwei Published the test results which is about bamboo part of the physical and mechanical properties, then Zou Shize study the composition of bamboo, but due to restricted by technology at that time, only determined the bamboo's components.

In 1986, Du fuyuan researched the method to use blast in manufacturing bamboo fiber; in the same year, Edashigewith other found the branches of bamboo' hemicellulose was dominated byarabinoxylan AX, polydextrose, Polyglucosan, preliminary explored the enzymolysis products; In 2005, and 2006 Jiang Zehui, etc analysis different parts and different processing methods which would have different influence on the surface wettability of bamboo, and compare the bamboo age and areas which could affluencethe chemical composition of bamboo; Ji Weibing studied gradient mechanics of the direction of cell wall's thickness of *Dendrocalamus giganteus*; Tu daowu analysis the anisotropic of bamboo's hygroscopic expansion and thermal expansion. which provides a theoretical basis for bamboo crack; Some scholars studied the pyrolysis characteristics of bamboo, to provide a theoretical basis. On bamboo which could product bamboo charcoal and bamboo vinegar liquid based on the analysis of mechanical properties of the bamboo [6]. In 2008 Cheng Sulin demonstrates the feasibility of bamboo which could applied to the villa building, and in 2006, Jiang Zehui also points out that bamboo is completely feasible used on building wall material in technology, but use it to build houses, has to be modified, especially antibacterial insect-resistant [7]. In 1998, Tong researched the dry sliding wear performance of bamboo on the ring iron machine. Then Chand studied the anisotropy of bamboo wear and initially revealed the mystery. Amada thought that the fracture toughness of bamboo stalks are closely related to the volume fraction of the fibers, what's more the compression strength was dependent on the diameter and age of bamboo [8]. Yu et al preliminary developed the test methods of full-scale bamboo scaffolding, and provided a test method of the building materials of Bamboo. Yamashita et al studied the rheological properties of bamboo in 2007 using a capillary rheometer. The literatures show that the researches are focused on the material properties of bamboo [9], the aspects of bamboo intensive processing and improvement should be strengthened.

### RESEARCH PROGRESS OF THE MODIFICATION

In order to fully play the advantages of bamboo and overcome the natural defects, there has been a long-term research on the bamboo modification by the foreign and domestic scholars. To protect the bamboo natural colour and luster, Chromicphosphate, phosphorus copper and alanine copper are used in the treatment of bamboo to keep the bamboo cyan. However, because of mold, the processing effect is reduced [10]. Wada et al used hydrogen ion beam to irradiated bamboo to enhance the wettability of bamboo surface in 2003; Sulaiman et al found that palm oil used as heating medium could penetrate part of the cell wall to enter the cell in 2006. While domestic scholars had carried out the study more widely. In 1972, a scholar discovered the cracking phenomenon and tested the bamboo anti-cracking Performance; In 2007, Yu Wenji with electron spectroscopy and infrared spectroscopy revealed the affect law of treatment methods on the surface properties of bamboo; Du Guan ben treated the bamboo surface with microwave plasma to improve the surface wettability of bamboo; Chen Ri xi obtained the process parameters of bamboo retardant impregnation treatment; Xu Ming researched the affect the pyrolysis properties of bamboo on temperature, H<sub>2</sub>O<sub>2</sub>, H<sub>2</sub>SO<sub>4</sub> and NaOH. Although some achievements of bamboo modification have been achieved, there are still serious quality problems in bamboo processing, especially bamboo is easy to mold, Moth and crack [11]. Such disadvantage reduced the quality and value of bamboo products severely.

There are lots of natural impurities such as oil, wax, pigments and bacteria, etc on bamboo surface and in bamboo interior, which leads to mold and moth. To solve this problem, many scholars have carried out researches on bamboo mildew, mold and pest infestation. Wu kaiyun conducted the study of morphological taxonomy and moldy appearance characteristics, based on 15 fungal which could induce mildew. Zhao Guihua considered the most common fungal are *Alternariaviticola*, *Aspergillusrestrictus*, *Cladosp -oriumherbarum* and *Penicillium*. But Wu Guangjin thought that the fungal are *Penicillium*, *Aspergillus*, *Fusarium* and *Trichotheciumroseum*. Then in 2000, Wang Wenjiu Identified 52 species of fungi, and discusses the relationship among bamboo mildew rotting, fungal species and chemical constituents. Since 1956, scientists began to study the bamboo borer, but because of the difference in study area, there were discrepancies between different scholars' researches, such as experts from the Southern China Institute of tropical crops believed that *chlorophorusannularis*, *Chlorophorusdiadema*, *Purpuricenustemminckii* *Guerin-Meneville* and *Niphonafurcata* would damage bamboo seriously. Du Fuyuan believed that the main moths which damaged bamboo and bamboo products were *Cyrtotracheluslongimanus*, *Harmolitaphyllostachitis* *Gahan* and bamboo moth. Xia Chuanguo investigated the moths appeared in the bamboo articles used in Dai family. In 2008, Lin Feng carried out a preliminary investigation on the species of Bamboo pests in Fuzhou area. However, because the bamboo resources are mainly distributed in the China, there are several systemic researches by foreign scholars. The above results suggest that, the overall knowledge and systemic researches are lacked for molds and pests.

Although the research on bamboo mold and pests is far from system, but the research of antibacterial insect-resistant modified bamboo is more, such as du recover the BPP - 841 aqueous solution impregnation process of bamboo have mould inhibition; Zhou Huiming such as found in an 0.2% phoxim processing material after 3 min anti-insect effect can maintain a year, but was unable to achieve long-term antimicrobial mothproof; Ma Lingfei think peroxides and hypochlorite on bamboo in addition to mould effect, then found DP aqueous solution has good mould proof effect. Shang Yizhuang studied three kinds of methods on processing and seven kinds of preservatives which would influence the mould proof effect of bamboo and henon bamboo, Liu Xiuying and others use bamboo as test material to

filter four kinds of efficient low concentration mould inhibitor; Wang Guoping thought compound B mould inhibitor that can be used for bamboo and its products of mildew; Shi Zhenhua using eight kinds of mould inhibitor to study them on bamboo and the toxicity of blue stain fungus. Song Zhen's test showed that ACB preservative is a kind of ideal mould inhibitor of bamboo. Qin Daochun made a contrast of the fixation rate of preservatives which contain copper. Deng Shaoping studied the craft of bamboo mould proof and dyeing. In 2007, Sun Fangli found extraction processing can improve performance of bamboo's mould proof, and studied the erosion resistance and corrosion resistance of Chitosan-cu. In 2008, Wang Yamei compared the five kinds of ACQ preservative from the effect of corrosion resistance and leaching resistance. In 2007, Xiao Yu et al tried to use white rot fungus *versicolor* B1 to pre-treat bamboo and achieved mildew by accelerating the saccharification, but the effect is not ideal. In 1999, Cheng Wenzheng preliminarily studied the effect and mechanism of microwave kill bamboo worms and fungal killing by microwave. Lai Chungeng treated bamboo using water extracts of wild plants, preliminarily studied the effect of antifungal. Li Yanwen raised some control methods according to the habits of bamboo pests. Some academics have suggested the use of biological predators to anti bamboo bark beetles, but it was possible to damage the natural ecological balance and cause predator disasters. These research findings on mildew and pest control have made important contributions for the development of bamboo industry. However, the effect of chemical fungicide are better but environmentalists are poor; while the mildew of plant extracts is still in the exploratory stage, and the antifungal effect by pretreatment are poor.

### CONCLUSION

Domestic and foreign scholars studying on bamboo mainly focus on the property of bamboo, although they have obtained certain research achievements on the modification research of bamboo, especially there are a lot of research results in the study of bamboo's mould proof and insect-resistant modification. But the research on the modification of bamboo has not been systemic, there are still many aspects need to further research, which just as follows:

- (1) To analyze on the physical structure and chemical structure of bamboo from the level of nanometer and molecular to reveal the inner mechanism of bamboo defects such as deformation, mildew and moth.
- (2) To establish a comprehensive evaluation index of mould proof, insect-resistant, crack resistance and weather resistance to effectively evaluate the all kinds of performances of modified bamboo.
- (3) To explore new methods to realize multi-effective bamboo modification making bamboo mould proof, insect-resistant, crack resistance and weather resistance simultaneously.
- (4) To strengthen analysis on the effective cost of bamboo modification to improve the modification technology and scientific control.

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