Biodegradation of moso bamboo with special references to some chemical and physical properties

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Bamboo had been used as a building material for centuries in Japan. Japanese traditional buildings use many bamboo materials for wall-supporting materials or interior materials. Recent changes in people's life-style and in architectural design have resulted in the decrease of bamboo usages in Japan [1]. However, new housing materials made from bamboo have been developed and new building methods employing bamboo have also been proposed.

To explore the trends and changes in the modern utilization of bamboo, a postal questionnaire survey on the architectural uses of bamboo in Japan was carried out. In general, there was a big opinion gap between architects and dealers regarding the architectural uses of bamboo. The majority of the architects regarded the ornamental aspects of bamboo as important, but most of the dealers pointed out that the mechanical and biological aspects should be considered in using bamboo as a housing material. The architects also claimed that improvements in bamboo processing have made it easier to work with. On the other hand, the dealers pointed out that the susceptibility to insect attacks and the occurrence of cracks were the most important problems to be solved [2]. In this dissertation, the bio-deterioration characteristics of bamboo were investigated.

The biologically perishable properties of bamboo are assumed to be mainly caused by its high sugar and starch contents, which are excellent foods for fungi or insects. Therefore, a simpler and faster method for analyzing the sugar and starch contents of moso bamboo is designed. Many methods have been proposed to extract sugar and starch from plants. Among them, the Ethanol extraction - Perchloric Acid hydrolysis method (EPA method), which extracts sugars from plants by using 80 % ethyl alcohol and solubilizing starch by using dilute perchloric acid, is commonly used for estimating the sugar and starch contents of bamboo [3]. However, this method takes a lot of time and is reported to be relatively unreliable. A facile but reliable method is thus strongly needed. The performance of the Alkaline extraction - Glucoamylase hydrolysis method (AG method), which extracted sugars and starch by using sodium hydroxide and hydrolyzed starch by using glucoamylase and α-amylase, was compared with that of the EPA method for analyzing the sugar and starch contents of moso bamboo (*Phyllostachys pubescens* Mazel) and the author concluded that the AG method was superior to the EPA method by taking into account of the time performance [4].

When the free glucose and starch contents of moso bamboo were determined by this newly designed method [4], the free glucose contents were generally lower in the upper culms, and the starch contents were highest in the middle culms (6 m-section). Both contents were generally higher in the inner part of each culm. This characteristic localization of free glucose is likely to be associated with the distribution of the particular nutrient storage cells, i.e., parenchyma cells. On the other hand, it is suggested that the starch content of moso bamboo depends not only on the ratio of parenchyma cells but also on the density of starch grains in the cells [5].

Some reports have indicated that bio-deterioration of bamboo depends on the season when it is cut [6]. Previous investigations mainly focused on the damage to bamboo caused by the attack of mold or *Dinoderus minutus* Fabricius, a serious insect pest to bamboo [7]. Termites and decay fungi cause serious damages to building and construction materials in Japan. However, no detailed study on the biological degradation of bamboo by termites and decay fungi has been conducted so far. There fore, the potential of termite and fungal attacks against moso bamboo in correlation with the seasonal changes in the free glucose content and starch contents, which were measured by the AG method were evaluated. Regarding the seasonal fluctuation of the free glucose and starch contents of moso bamboo, the free glucose contents were generally lower in autumn and winter than those in spring and summer, whereas the lowest starch contents were obtained in August and the contents increased almost linearly up to February and March. There was no special correlation between the free glucose or starch contents and the consumption by the pest termite, *Coptotermes formosanus*, even though higher mortalities were obtained in the bamboo-fed termites than in the wood fed ones. On the other hand, a positive correlation between the free glucose contents and mass losses of the samples at the 4 m- and 8 m-heights from the bottom by the decay fungus, *Trametes versicolor* was observed. For the starch, no influence on fungal attack was found [8].

Workers of *C. formosanus* attacked only the radial section of the moso bamboo by laboratory no-choice tests. Previous studies indicated the damages of bamboo by *D. minutus* only appeared on the inner side of bamboo, which was soft and contained starch [3]. Therefore, evaluation of the potential of termite attack against moso bamboo in relation to two surface characteristics, hardness and roughness was conducted. As a result, it was suggested that termite attack against moso bamboo was closely related to the surface roughness of the material [9].

In Japan, a traditional drying method called "hagarashi" in Japanese have been applied to wood for improvement of the biological durability and heartwood color after drying. In this method, wood is felled down and retained for a long period without lopping until drying by the water transpiration. Some reports stated that this process reduced the moisture and starch content of wood [10]. The "hagarashi" process was applied to moso bamboo specimens to evaluate its potential for bamboo drying. The free glucose content of the "hagarashi" samples decreased faster than that in the samples stored at room temperature, but the starch content of the "hagarashi" samples decreased slower. The application of this process showed both the positive and negative effects on the biological characteristics of moso bamboo [11].

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