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VARIOUS CHANGES OF STARCH CONTENT IN THE CULMS OF SELECTED BAMBOO SPECIES, *BAMBUSA BAMBOS* (L.) VOSS AND *DENDROCALAMUS STRICTUS* NESS AT DIFFERENT STORAGE METHODS

***R. SANTHOSHKUMAR AND K .V. BHAT**

Kerala Forest Research Institute Peechi, Kerala, India

**Assistant Professor, Post Graduate and Research Department of Botany*
Mahatma Gandhi College, Thiruvananthapuram, Kerala, India.
Email: *santhoshkumar30576@gmail.com*

The starch content in bamboo culms is an important influencing factor for its utilization. Various changes of starch content in the culms *of Bambusa bambos* (L.) Voss and *Dendrocalamus strictus* Ness were observed in a systematic way. In some of the rural areas, the people followed some conventional practices such as water soaking and boiling for increasing the durability of bamboo culms. However, the scientific reason of boiling of bamboo culms was not earlier reported. The present study shows that the starch content in control sample had accumulation of small individual grains within the cell, while samples subjected to boiling showed crowding and lump formation of starch within the cells. Thus, it is probable that boiling can result in physical modification namely, swelling and gelatinization of starch grains within the cells. After felling the culms were stored at normal room temperature for one week. During this period amylase activity was observed and its results showed that amylase activity initially increases to a higher level followed by a decline. This showed that the starch content in bamboo culms may reduce without any physical treatment.

Keywords: Starch, Amylase, Traditional, Utilization.

Bamboo is a viable alternative to wood. In fact, bamboo is also one of the oldest building materials used by mankind (Latif *et al.* 1990). In many densely populated countries of the tropics, certain bamboos supply at least one suitable material that is sufficiently economical and plentiful to meet the extensive need for economical housing (McClure 1966). The starch content in bamboo culms is an important factor influencing susceptibility to insect borers (Plank 1950; Plank and Hageman 1951). Damage caused by borer attack has been found proportional to the starch content in the bamboo culm (Purushotham *et al.* 1953; Beeson 1961; Liese 1980; Tomalang *et al.* 1980). Different reports were available in connection with traditional practices followed for the protection of bamboo from borer damage and increase the durability of bamboo culms. The most commonly used methods are water soaking and boiling of bamboo culms. The present study is also an attempt to look into these aspects in a more systematic way. Another important part of this study observed that the degradation of starch content in bamboo culms during storage. In connection with this amylase activity was tested for one about one week from the date of harvesting.

MATERIALS AND METHODS

Histochemical analysis

Starch : For localization of starch in the tissues of the bamboo culm, Iodine – potassium iodide (I_2KI) solution was used. The sections were mounted in a solution containing 1g iodine and 1g potassium iodide in 100 ml of distilled water. Starch grains stained dark blue (Johansen 1940).

Biochemical estimations

Starch : Starch content in the culm was estimated using the procedure described by Humphreys and Kelly (1961). The samples were powdered in a Wiley Mill and the materials were sieved through a 200-mesh sieve (British Standard Size) for analysis. The powder was then treated with perchloric acid and centrifuged. The aliquot (10 ml) was placed in a 50 ml volumetric flask and made alkaline with sodium hydroxide. Acetic acid was used for decolorization and further 2.5 ml was added according to the standard procedure. The colourless solution was allowed to react with potassium iodide and potassium iodate for 15 minutes and made up to 50 ml volume. The optical density of the solution was then measured by photoelectric colorimeter. The standard curve was prepared using pure starch.

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Figure 1. Starch content before the treatment with water

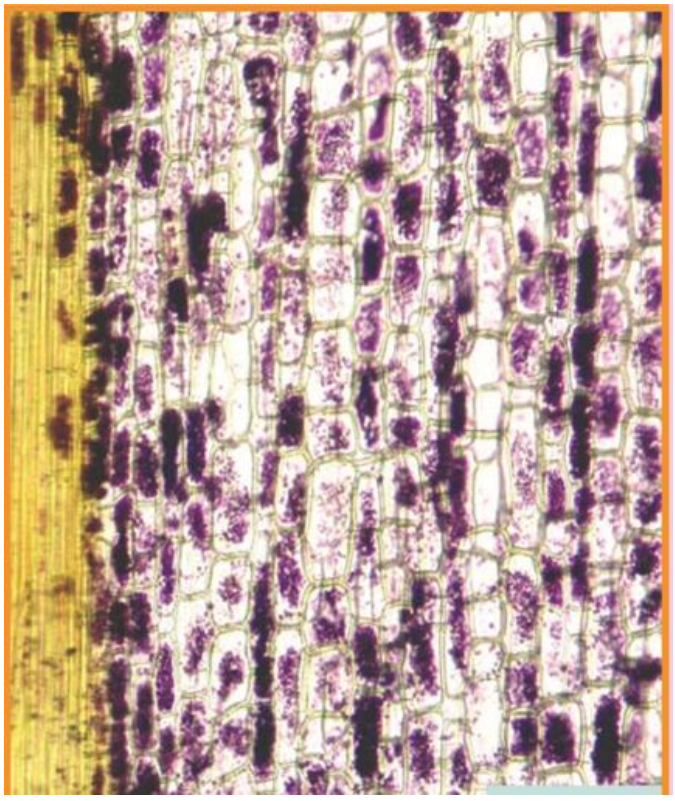
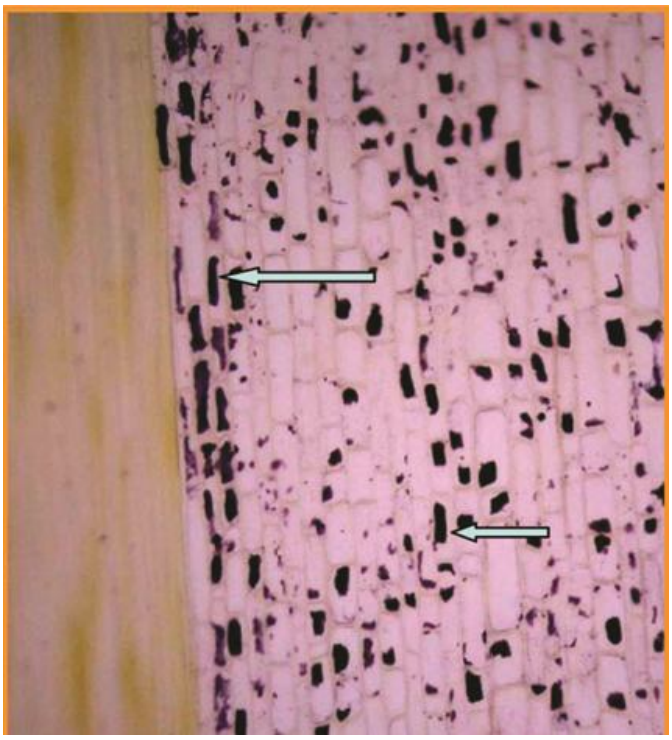


Figure 2. Starch content after the boiling of the culms with water. Arrows show gelatinized form of starch content in bamboo culm after boiling of culms.



Amylase : The amylase activity in the culm tissue was determined on consecutive days after harvesting as per the procedure given by Sadasivam and Manickam (1992). The fresh culm tissue of bamboos was homogenized in phosphate buffer (pH 7) and centrifuged. One ml of aliquot was mixed with 1 ml of 1 per cent starch solution and allowed to react at room temperature for 15 minutes. Then this solution was allowed to react with 2 ml of Dinitrosalicylic acid reagent (DNSA reagent) and kept on a boiling water bath for five minutes and made up to volume (10 ml) by addition of distilled water. The optical density of the solution was measured at 560 nm. The reaction was terminated by addition of DNSA reagent at zero time for control. A standard curve was prepared using maltose. A unit of amylase was calculated as one mg of maltose produced from 1 g of oven–dry tissue during 5-minute incubation with 1% starch.

Experimental studies : A separate laboratory experiment was conducted to evaluate the changes in starch content of harvested bamboo culms due to the treatment. Freshly harvested bamboo culms cross cut into small discs which were soaked in muddy water (run-off water) for three months and the starch content was estimated. A portion of the same sample was analyzed for starch content before soaking in water which served as control. A comparison was used for judging the changes of starch before and after boiling. A sample disc boiled with water for 15 minutes was sectioned and stained with iodine – potassium iodide (1:1). An unboiled portion of the same sample was used as control.

Photomicrographs : Photomicrographs were made with the help of Nikon- photomicroscope (NIKON DIGITAL CAMERA – CoolPiX 4500, Microscope – ECLIPSE EE 200) and Leica Image Analysis System.

Statistical Analysis : One-way Analysis of variance (ANOVA) was used to compare the difference in structure and properties between age, height levels, and radial positions. For some parameters site-wise comparison was also done. If the F-value of ANOVA was found to be significant pair-wise comparison was done using least significant difference (LSD) to find out which pairs were significantly different.

RESULTS

Figure 3. Bamboo split showing starch content in freshly harvested culms

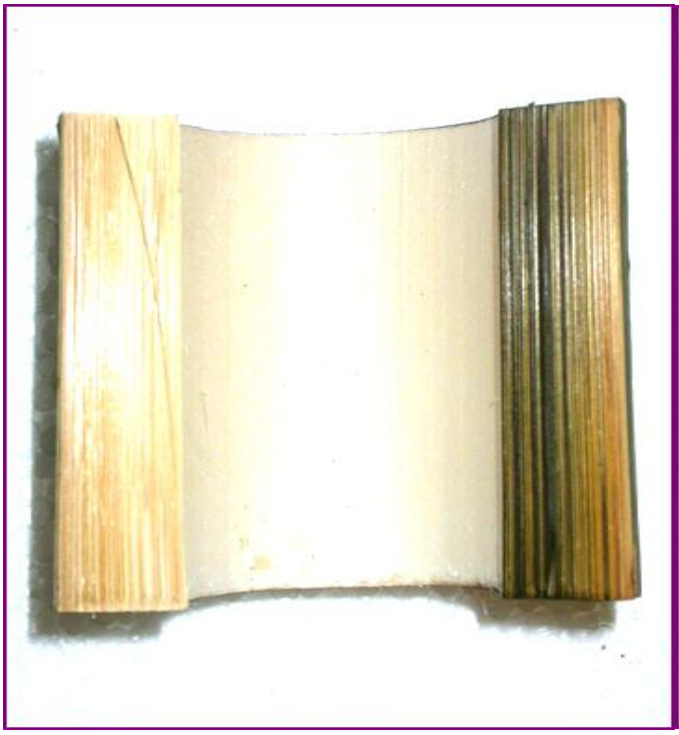


Figure 4. Bamboo split showing starch content after three days of harvesting

Changes of starch content in different traditional practices : Bamboos are more susceptible to biodegrading agents mainly borers as compared to other timber species. Rural people follow different practices for the protection of bamboo culms from borer attack. The most commonly used methods are water soaking and boiling of culms. The starch content was found decreased due to soaking in stagnant water. The mean starch content (sample disc) in freshly harvested culm of *B. bambos* was 3.61%, which was reduced to 3.04% after soaking the sample for one-month period. Similarly in case of *D. strictus* the starch content was 16.25% in freshly harvested culm, which reduced to 7.81% after soaking in stagnant water for one-month period (Table 1). However the results of t-test showed no significant difference in starch percentage between treated and control samples.

The changes of starch content in boiling and control samples are shown in Figures 1, 2. Starch content in control sample had accumulation of small individual grains within the cell (Figure 1) while samples subjected to boiling showed crowding and lump formation of starch within the cells (Figure 2). Thus it is probable that boiling can result in physical modification namely, swelling and gelatinization of starch grains within the cells.

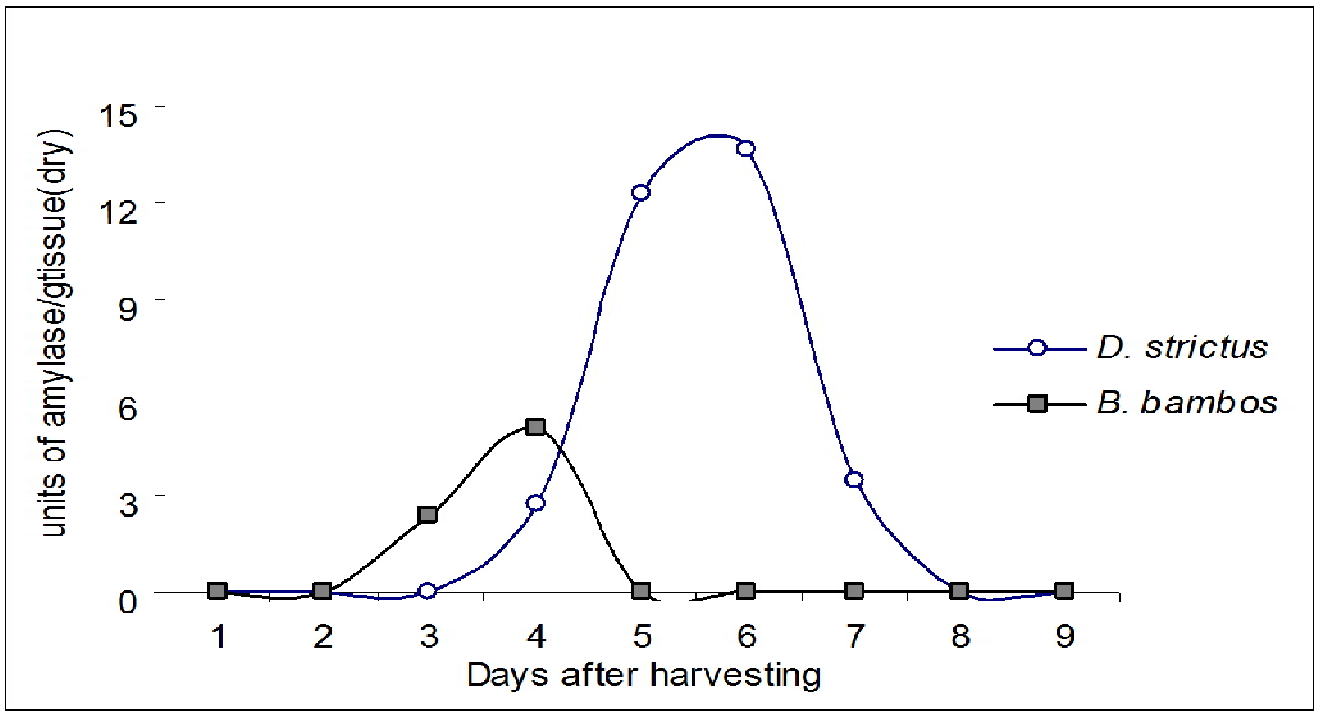
Reduction of starch from the harvested bamboo

Table 1. Changes in starch content in *B. bambos* and *D. strictus* due to soaking with muddy water

SP	TREAT	Mean	Std. Deviation	Std. Error Mean	t-value
B. bambos	Control	3.61	1.66	0.74	0.586^{ns}
	Treated	3.04	1.41	0.63	
D.strictus	Control	16.25	15.51	10.97	0.713^{ns}
	Treated	7.81	6.29	4.45	

Note : ns– non significant at 5 % level

Figure 5. Amyase activity in the culms of *B. bambos* and *D. strictus* at different days



culm : During the period of study it was found that the stainability of the tissues with iodine reagent gradually declined as days passed after harvesting. Freshly harvested material showed intense staining (Figure 3). But the stainability was reduced few days later as there was a decrease in starch content (Figure 4). The possibility of starch reduction was explored and the activity of starch hydrolyzing enzyme was analyzed on different days following culm harvesting.

Starch hydrolysis due to amylase activity : Samples from harvested bamboo were used for the estimation of amylase activity for seven days from the date of harvesting. Figure 5 shows the extent of amylase activity during the period of post -harvest storage of bamboo culms at room temperature. The amylase activity gradually increased from the date of harvesting and subsequently decreased and reached a negligible level in both the species. This indicates that the starch content in bamboo culms reduced after the harvesting due to the activity of amylase.

This result indicates that the amylase activity is the main reason for the degradation of starch in harvested bamboo culms. The beetle damage in bamboo culm is a major problem during post harvest period. Many studies revealed that starch directly influence the beetle damage in bamboo culms during post harvest-period. The low starch content may help to minimizing the borer damage. This result indicates that the starch content in bamboo culm may degrade without any physical treatment.

DISCUSSION

Water soaking is a non-chemical traditional method of preservation practiced quite often in different parts of the world especially in many Asian and African countries to prevent the post harvest borer damage (Sulthoni, 1987). This method is applied by soaking the cut bamboo culms under the muddy water for a few months. The water soaking method was scientifically proved earlier by Sulthoni (1987). The method of water soaking is commonly used in many Asian and African countries and it consists of submerging freshly harvested bamboo culms for 1-12 weeks in stagnant or running water, or mud (Sulthoni, 1987). It has been observed that during the period of soaking of bamboo culms in water, the starch content is reduced which makes it less attractive to borers as reported by several authors (Plank, 1950; Beeson, 1961; Liese, 1980, Tomalang *et al*., 1980). Sulthoni (1987)

studied the variation in starch content of four bamboo species *Bambusa vulgaris, Dendrocalamus asper, Gigantochloa apus* and *G. atter* and its influence on damage by borers. He concluded that the percentage of starch content was reduced after submersion in water. Thus the traditional method was effective for *G. apus* and *G. atter* but was ineffective in *B. vulgaris*. According to Liese (1998) the traditional preservation methods of soaking fresh culms in muddy water reduces the starch content by bacterial degradation and thus reduces their susceptibility to beetle attack.

Boiling of bamboo culms is another traditional method followed for the protection of bamboo culms. For basket weaving, the slivers of bamboo culms are boiled in water before weaving. The physically modified starch content in bamboo culms may do not favored beetles and this may be the reason for the less activity in boiled bamboo culms as compared to freshly harvested culms. The reduction of starch content in bamboo culms during the period of storage at normal room temperature may be effective, because there is no physical or chemical treatment was given to that period. There was no earlier reports were available in relation to this type of experiment.

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REFERENCES

Beeson CFC 1961 *The ecology and control of the forest insects of India and neighboring countries.* Government of India. First Reprint. Pp 767.

Latif Abid M, Wan Tarmeze WA and Fauzidah A 1990 Anatomical features and mechanical properties of three Malaysian bamboos. *Journal of Tropical Forest Science* 2(3) 227-234.

Liese W 1980 Preservation of bamboos. *In* Lessard G, Chouinard A (ed.), Bamboo research in *Asia, Proceedings of a workshop held in Singapore*, 28 – 30 May 1980. International Development Research Center, Ottawa, Canada, 165-178.

Liese W 1998 *The Anatomy of Bamboo Culms*. Technical Report No. 18, International Network for Bamboo and Rattan, Beijing China. 208pp.

McClure FA 1966 *Bamboos: a fresh perspective*, Harvard University press. Cambridge, Massachusetts, USA. 347pp.

Plank H K 1950 Studies of factors influencing attack and control of the bamboo powder post beetle. *Fed. Agric. Exp. Sta. Mayaguez, Puerto Rico Bull.* No. **48** 39pp.

Plank H K, Hageman RH 1951 Starch and other carbohydrates in relation to the powder – post beetle infestation in freshly harvested bamboo. *J. Econ. Entom.* **44** 73–75.

Purushotham A, Sudan S K and Vidya Sagar 1953 Preservative treatment of green bamboos under low pneumatic pressure. *The Indian For.* **79(12)** 652–672.

Sadasivam S and Manickam A 1992 *Biochemical methods.* Wiley Eastern Limited, New Delhi, 246pp.

Sulthoni 1987 Traditional preservation of bamboo in Java, Indonesia. *In* Rao AN, Dhanarajan G and Sastry C B (eds.). *Recent research in Bamboos: Proc. International Workshop*, Hangzhou, China, 6-14, October, 1985. Chinese Acad. For., Beijing, China and IDRC, Ottawa, Canada. 349–357.

Tomalang FN, Lopez FR, Semara J A, Casin R F and Espiloy,ZB 1980 *Properties and utilization of Philippine bamboos.* In Lessard G and Chouinard A (eds.). *Bamboo Research in Asia. Proc.* Workshop held in Singapore 28 – 30 May, 1980. IDRC, Ottawa, Canada. 189-200