X-ray Analysis of Tyrosine in Growing Stage of Bamboo (*Phyllostachs edulis* A. & C. Riviere)*

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Abstract——The content of tyrosine in different parts of a growing bamboo shoot was determined by x-ray and an automatic aminoacid analyzer. The results of x-ray analysis and of an aminoacid analyzer were in good coincidence with each other. Tyrosine content in each internode at a growing stage was different and it had the maximum value in the most active part of elongation of the bamboo shoot. Tyrosine content was about 30 % based on dry weight in the 17th internode of the bamboo shoot which was 349 cm in height and was in the fourth week growing stage.

Introduction

This paper describes about the distribution of tyrosine content in the bamboo stored for 5 months in 70 % methanol.

It happened to find a different and remarkable diffraction pattern of x-ray on the crystallinity measurement of the cellulosic substance.

Tyrosine has been shown to be incorporated into lignin of a few families of higher plants such as Gramineae and the Compositae. HIGUCHI *et al.*[1] showed that tyrosine was present in the highest amount at any stage of growth compared with other aminoacid, and was highest in the tissue at the top of the bamboo shoot, decreasing rapidly toward lower parts of the shoot.

We have studied these phenomena by x-ray and found a large amount of tyrosine in the growing internode.

Materials and Methods

Materials used were each internode of two young bamboo shoots at 4 and 5 weeks growing stage, whose height were 349 and 865 cm respectively. They were collected from the experimental farm of Kansai Branch of the Goverment Forest Experiment Station. After the bamboo-sheath was stripped from the bamboo shoot, the internode length and the culm diameter were measured. Then the sample with suitable length was cut off at a node and stored in 70 % methanol. After 5 months, the samples were dried and crushed into powder with a Willey mill. The powder was passed through 200 mesh screen and dried at room temperature. Three hundred mg of the powder was compressed in a disc, 20 mm in diameter and about 0.85 mm in thickness.

X-ray diffraction patterns was obtained by the reflection method, using a Rotarflex, RU-3L x-ray diffractometer (Rigaku Denki Co., Ltd.). The source of x-ray was Cu-Kα radiation with Ni filter. It was operated at 50 kV and 80 mA. The recordings of the scattered intensities along the equatorial plane were made by scintillation counter scanning from $2\theta=5°$ to $30°$ (where θ is the scattering angle).

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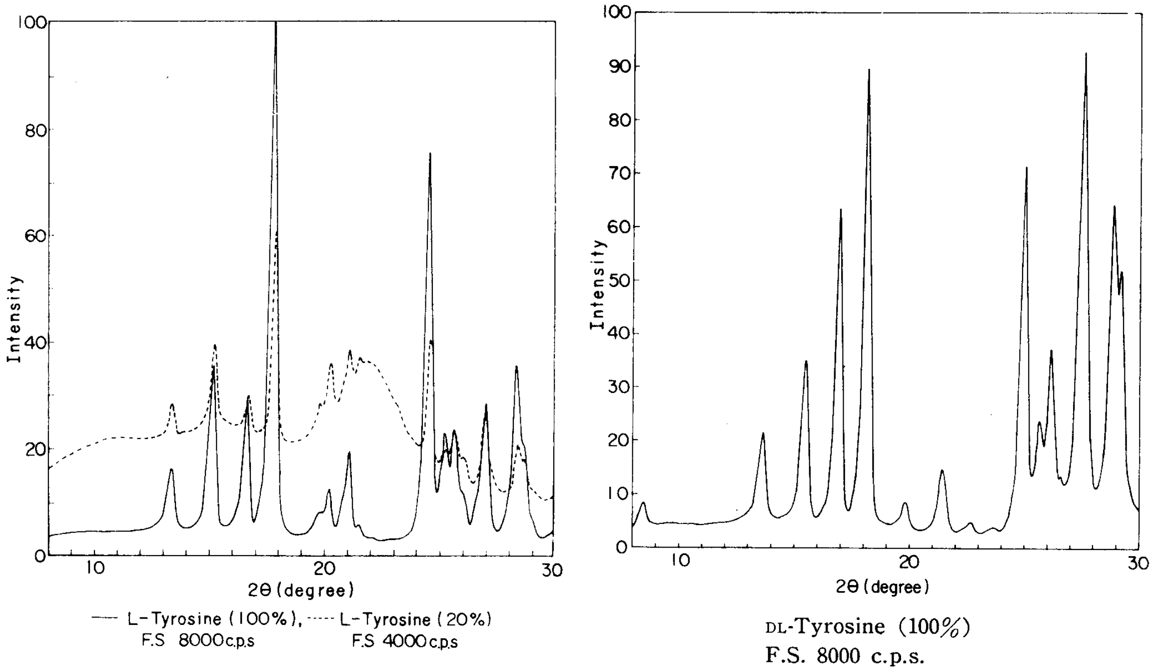

Fig. 1. X-ray diffraction pattern of L- and DL-tyrosine. (F.S.=full scale)

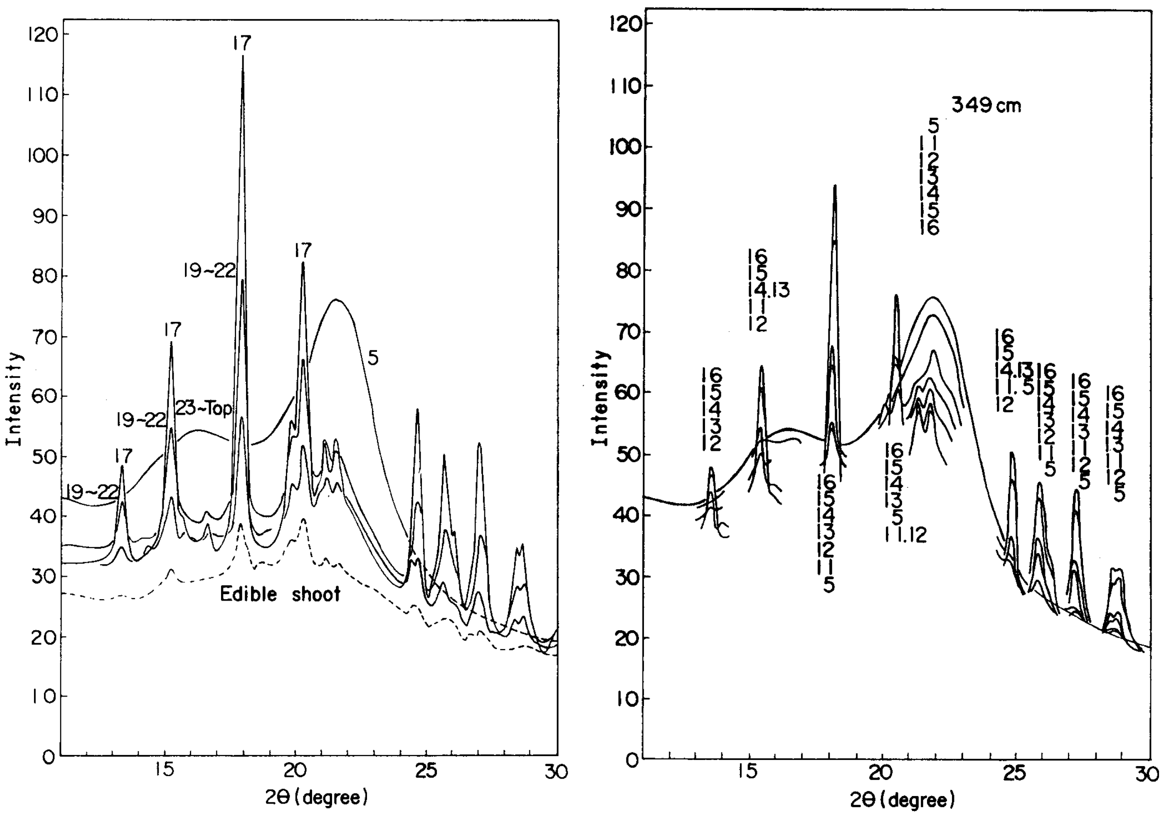

Fig. 2. X-ray diffraction pattern in each internode of bamboo shoot (4 weeks, 349 cm). F.S. 2400 c.p.s.

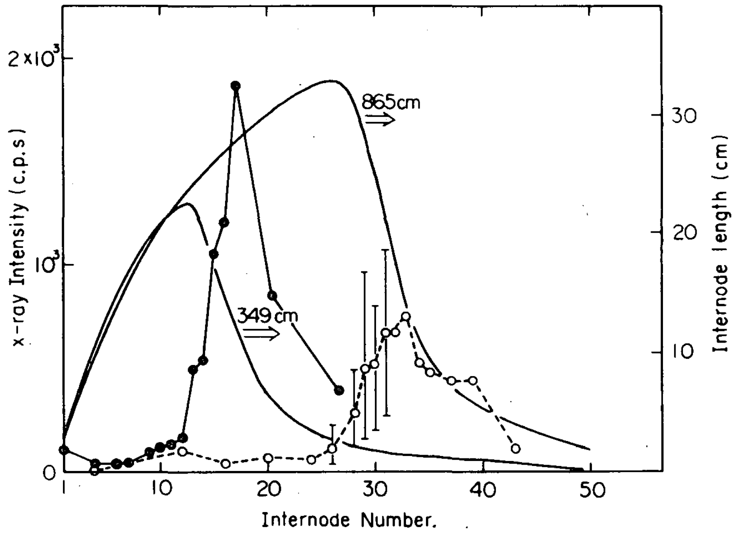

Fig. 3. Distribution of internode length of two growing stages and of the intensity at $2\theta=17.9°$. —●— ; 349 m, —○— ; 865 cm.

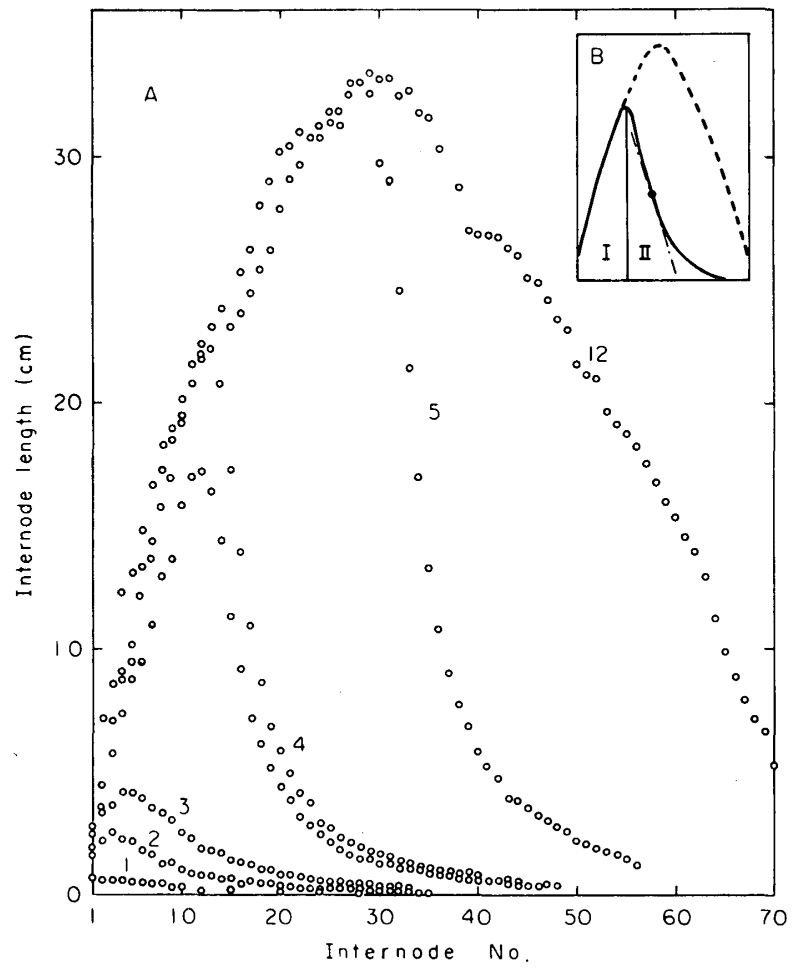

Fig. 4. The distribution of internode length in some growing stages of bamboo shoot and the schematic description of two state. ●: inflextion point.

Results and Discussion

Fig. 1 shows the diffraction pattern of L- and DL-tyrosine.

Fig. 2 shows the x-ray diffraction pattern in each internode of the bamboo shoot grown for four weeks.

Comparing the diffraction pattern of L-tyrosine with that of Fig. 2, it was shown that the patterns were in very good agreement with each other, so the diffraction pattern of Fig. 2 was identified as L-tyrosine.

Tyrosine content in each internode was different in a growing stage. It had a maximum value in the 17th internode of the bamboo shoot which was 349 cm in height and was in the fourth week growing stage.

Fig. 3 shows the distribution of internodial length of two growing stages and that of the intensity at $2\theta=17.9$ from which is subtracted the base line.

The distribution of the internode length in some growing stages of the bamboo shoot are

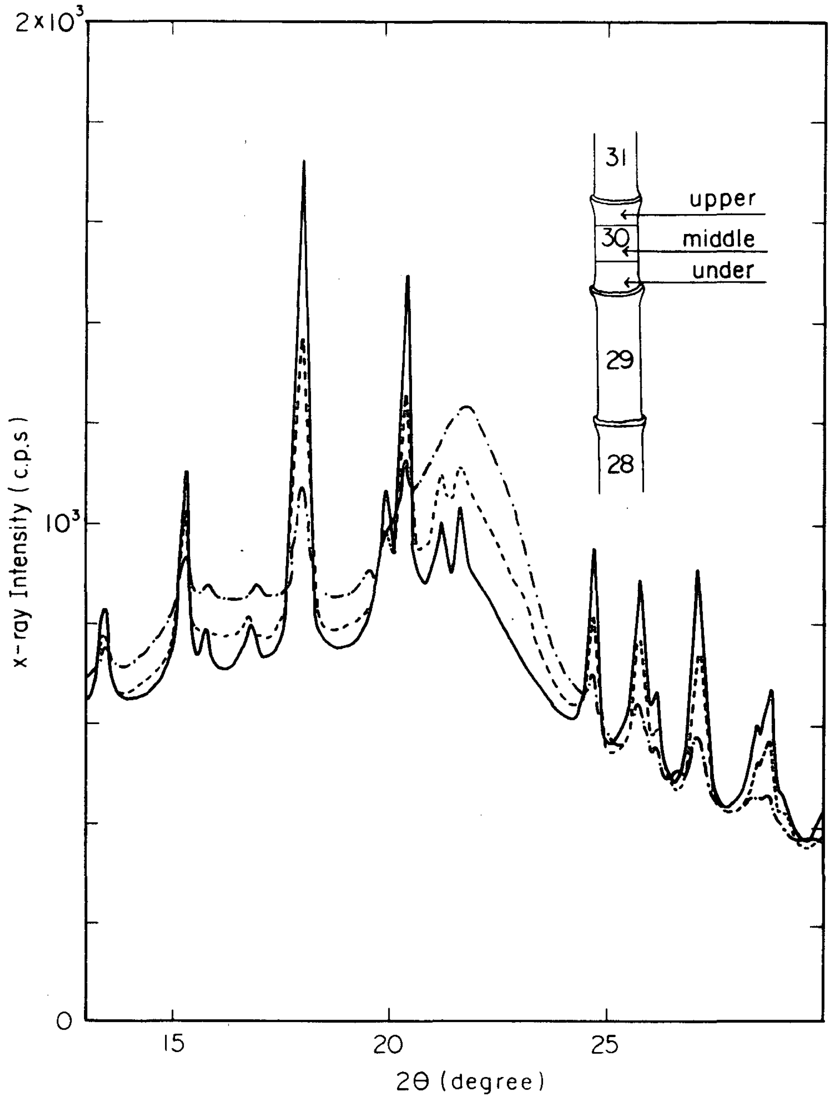

Fig. 5. X-ray diffraction, the 30th internode of the bamboo shoot 856 cm in height. (—·—; upper, ······; middle, ——; under)

shown in Fig. 4A. The internodial growth was completed stepwisely as the bamboo shoot was getting higher. From this figure, it was shown that the peaks in each growing stage was at the internode in which the internodial growth had been over. So, there were two different states in the internodial growth, that is, state I and II shown in Fig. 4B also. State I is the state in which the internodial growth has ceased and only the lignification are taking place. State II is the state in which all the lignification, cell elongation and meristematical activity were carried out. It was then conceivable that the inflexion point on the distribution curve of internode length in state II corresponded to the position of the most active elongating internode.

The position of the internode having the highest diffraction peak, the maximum content of tyrosine, appeared between the fourth and sixth internode counted upward from the internode which had ceased its internodial growth, that is, the inflexion point of the distribution curve of internode length.

Fig. 5 shows the x-ray intensity change of tyrosine in the three parts of a internode, upper, middle and lower part, in the 30th internode of the 5th weeks sample. In an internode, tyrosine content changed from the upperpart to the lowerpart and was the highest at the lowerpart.

Fig. 6 shows the x-ray intensity of tyrosine at the upper, middle and lowerpart in each internode which is in the active elongating state.

These results seem to indicate that the peak of tyrosine content always exist in the most active elongating part of the internode.

In order to give quantitative support to the fact resulting from x-ray diffraction, the quantitative analysis of tyrosine was carried out with an automatic aminoacid analyzer. The result is shown in Table 1. The results of x-ray analysis and of an aminoacid analysis are shown in

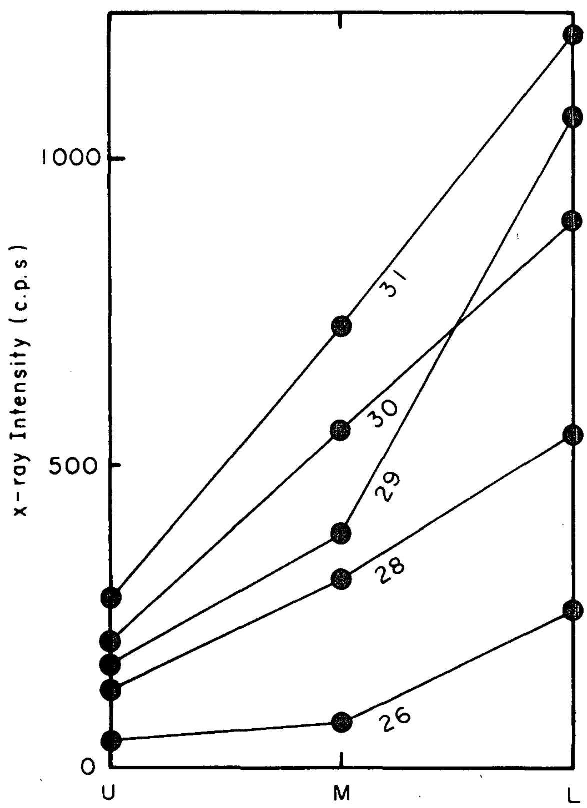

Fig. 6. X-ray intensity of tyrosine at the upper (U), middle (M) and lowerpart (L) in each internode which is in the active elongating state for the 5 weeks bamboo shoot. (The numbers show the internode number)

Table 1. Quantitative analysis of tyrosine in each internode of 4 weeks stage sample (349 cm in height).

Internode No.	mg/g	Internode No.	mg/g
1	20.7	11	32.4
2	3.79	12	64.7
3	5.05	13	
5	3.24	14	148.9
6	3.21	15	235.0
7	3.34	16	247.9
8	8.41	17	324.5
9	10.1	19—22	257.4
10	24.5	23—Top	102.3

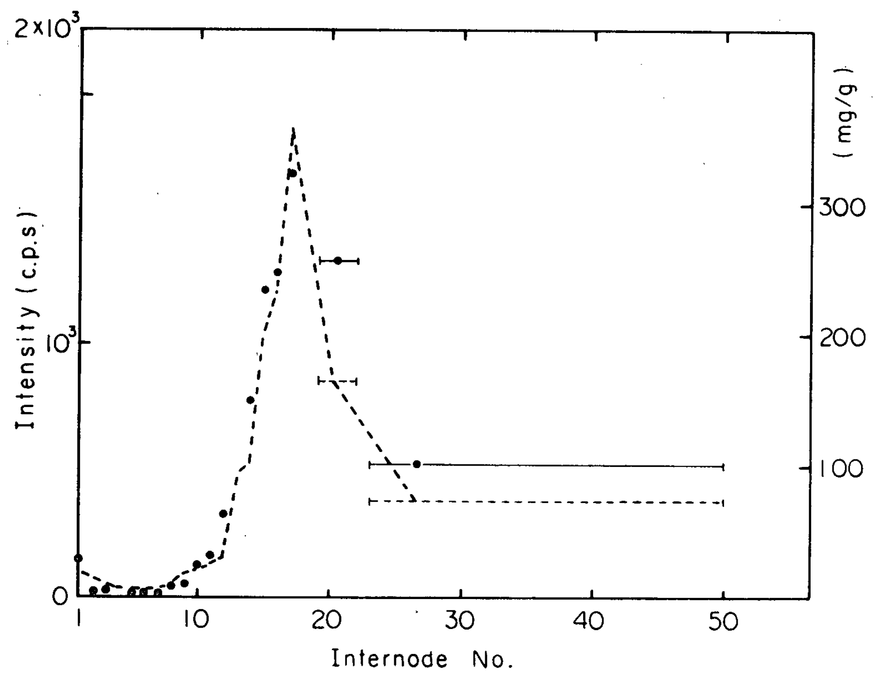

Fig. 7. X-ray intensity and the amount of tyrosine of the 4 weeks bamboo shoot. ··· ; X-ray intensity, ● ; tyrosine content.

Fig. 7. These results were in good coincidence with each other. Tyrosine in the active elongating part of the internode was found to be 20 to 30 % based on dry weight (2 to 3 % on fresh weight).

Since tyrosine is known to serve as a precursor for grass lignins, including bamboo, it might be expected that some variation in the metabolism and amount of tyrosine would take place as lignification proceeds. During the growth of bamboo, however, marked variation in content are found for tyrosine, the amount of which has the maximum in the most active elongating part of the internodial growth of the shoot. Though the reason for the accumulation of tyrosine, which mainly takes place in the active elongating part of internode, has not yet been elucidated, it may be suggested from our experiment that a large amount of tyrosine is necessary for the process of tremendously rapid lignification in the bamboo shoot, that is, tyrosine is the most important precursor for lignin in the bamboo formation.

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References

1) T. HIGUCHI and M. SHIMADA, Phytochemistry, 8, 1185 (1969).