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Effects of process time on the textural and sensory characteristics of Malaysian commercial bamboo shoots

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Abstract: Four commercial edible bamboo species of Malaysia, *viz.*, *Gigantochloa* sp. (*buluh brang*), *G. scortechinii* (*buluh semantan*) and *G. levis* (*buluh beting*) and *Dendrocalamus asper* (*buluh betong*) were chosen for this study to select the optimum process time and evaluate consumer acceptability. The shoots were cut into apical and basal portions, canned and processed for 25, 35 and 45 min at 121°C and 1 kg/cm^2. The effect of process time on the textural and sensory characteristics of the shoots was ascertained. Shoots of *Gigantochloa* sp. were the hardest when fresh or when processed while *G. levis* showed the most softening after being processed for 45 min. For sensory characteristics, there were no outstanding preferences for any particular species.

Key words: Edible shoots, process time, textural properties, sensory characteristics, processing.

INTRODUCTION

Asia has been the major producer of edible bamboo shoots in the world. Production of bamboo shoots in the continent reached more than 200,000 tonnes in 1986 and has been increasing every year. Asia accounts for over 90 per cent of the international trade in bamboo shoots and the bulk of this is produced in Thailand, Taiwan, China and Indonesia, while Japan is a major importer. However, Malaysia has not commercialized its potential in production of bamboo shoots, even though it has almost all of the edible species such as *Bambusa blumeana, B. vulgaris, B. vulgaris* var. *striata, Dendrocalamus asper, Gigantochloa levis, G. ligulata, G. wrayi, G. gigantus, Schizostachyum brachycladum* and *Thyrsostachys siamensis* (Razak *et al.*, 1995). No detailed study has been done on the Malaysian commercial bamboos for value added products such as edible shoots.

The objectives of the study were to analyze the effect of process time on the textural

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and sensory characteristics of canned bamboo shoots, to select the optimum process time and to conduct sensory evaluation for their consumer acceptability.

MATERIALS AND METHODS

Harvesting

Samples of bamboo shoots were obtained from the Golden Hope Bradwall Estate, Siliau, Negeri Sembilan, Malaysia. The shoots were harvested at 10 to 14 days of maturity. Four species of bamboo shoots were selected for this study: *D. asper, Gigantochloa* sp., *G. scortechinii* and *G. levis*. Sampling was done once at a time in order to avoid browning of harvested shoots that occurs soon after harvesting. Samples were processed immediately after harvesting. No delay interval greater than 24 h was allowed between harvesting and processing.

Processing of bamboo shoots

Apical and basal portions of bamboo shoots were processed separately for different lengths of process time. Initially, the shoots were peeled and washed. Then, they were divided into apical and basal portions. The apical portions were cut at about 7.0 cm from the tip, while the basal portions were cut at 7.0 cm from the first cut. They were soaked in 10 per cent brine for three days to reduce the lysine content, which is responsible for a defect known as surface whiteness. It was also helpful to remove portion of the bitter principles, which come from cyanogenic glycosides (Yamaguchi, 1983). After three days of fermentation in brine, the shoots were soaked in pure water for one day, to reduce the saltiness and the excessive odor resulting from fermentation. After soaking in water, the bamboo shoots were washed and filled in the pre-sterilized cans containing hot water. The shoots were evacuated for 7 min and then sealed and sterilized for different lengths of process time. According to A. Malek (personal communication), bamboo shoots should be processed at 121 °C and 1 kg/cm^2 for at least 20 min. In this study the shoots were processed for 25, 35 and 45 min. The canned shoots were then cooled under tap water and stored at room temperature.

Textural measurement

The texture analyzer, TA-XT2i was used to determine the effect of process time on the hardness of canned bamboo shoots, using five test conditions as follows: a) pre-test speed = 1.5 mm/s, b) test speed = 1.5 mm/s, c) post-test speed = 10.0 mm/s, d) distance = 2.0 mm and e) data acquisition = 200 pps.

The texture of fresh bamboo shoots was also analyzed in order to determine the percentage of softening. Texture was analyzed on four different parts of each portion and the means were recorded.

Sensory evaluation

Sensory evaluation was conducted in the sensory laboratory, Universiti Teknologi MARA. Each panelist was assigned to receive 28 g of sample. The samples were placed in clean Petri dishes. Panelists were also provided with water as a rinsing agent. Each panelist was asked to do an acceptance test by using the 9-point Hedonic scale. They were asked to rate their level of liking of the samples in terms of hardness and fibrousness. The results were analyzed using Statistical Analysis System (SAS) package.

RESULTS AND DISCUSSION

Hardness and sensory preference of apical portions

Table 1 shows the hardness of the apical portions of canned bamboo shoots at different process times, and Figure 1 indicates the percentage of softening. It can be observed that fresh *G. scortechinii* showed the highest value of hardness, followed by *D. asper, Gigantochloa* sp. and *G. levis*. There were no significant differences between fresh shoots of *Gigantochloa* sp. and *D. asper* in terms of hardness.

After being processed for 25 min, *Gigantochloa* sp. was the hardest, followed by *G. scortechinii, D. asper* and *G. levis*. The most important change when heat is applied to foods containing cells is the destruction of the selective permeability of cell membranes (Yamaguchi, 1999). As soon as the permeability of the cells is lost, the internal pressure is permanently reduced. Some cell distension may still be present because of hydrophilic but non-diffusible substances in the cell and may contribute to perceived texture. However, crispness and similar textural properties will no longer exist (Yamaguchi, 1999). According to Yamaguchi (1983), if the tissue is immersed in water, the solution is diluted and more solutes are washed out of the cells. This treatment has an effect on texture, but the extent of the change is difficult to predict. According Ferreira (1990), soaking and cooking would affect the texture of canned bamboo shoots.

After processing, all the species showed significant decrease in hardness calculated as percentage of difference with respect to the fresh shoots (Fig. 1). Percentage of softening from 25 to 35 min of process time showed an increase for all species. As found by Smout (2005), the texture degradation is related to the degree of esterification of pectin.

After 35 min of process time, *G. scortechinii* showed the highest degree of softening followed by *D. asper, G. levis* and *Gigantochloa* sp. The highest value of hardness was recorded for *Gigantochloa* at 35 min of process time (Table 1) and therefore it showed the least softening. At 45 min of process time, *G. levis* showed the highest

percentage of softening (Fig. 1), while *D. asper* showed the least softening. From the results it is evident that only *Gigantochloa* sp. and *G. levis* softened gradually as the process time increased. *D. asper* and *G. scortechinii* showed fluctuating values of hardness. Theoretically, all species would soften as the process time is increased.

Lignin is an important component in toughening the fibrous elements and supporting tissues of the plant. According to Yamaguchi (1999), lignification increases as the fruits mature. Therefore, the fluctuation of hardness in processed bamboo shoots might be due to difference in maturity level of bamboo shoots used. This was because the exact maturity of the shoots could not be determined at harvest time, as their age after emergence varied from 10 to 14 days.

The sensory evaluation results for hardness of the apical portions are shown in Table 2. From the sensory evaluation session conducted, it was evident that irrespective of the species, most of the panelists liked slightly the bamboo shoots processed for 25 min. However, data gathered from the SAS showed that there were no significant differences among species or treatments received.

Hardness and sensory preference of basal portions

From Table 1, it can be seen that the basal portion of fresh *G. scortechinii* had the highest value for hardness, followed by *Gigantochloa* sp., *D. asper* and *G. levis*. There was significant difference between species in hardness of fresh shoots.

After being processed at 25 min, *G. scortechinii* showed the highest value of hardness

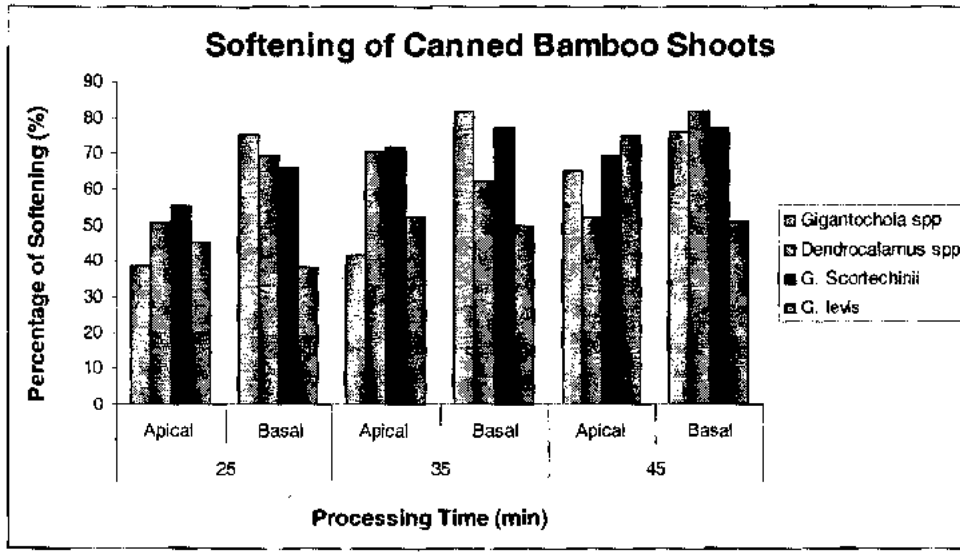

Figure 1. Percentage of softening of apical and basal portions of canned bamboo shoots at different process times.

Table 1. Hardness (g force) of apical and basal portions of canned bamboo shoots at different process times

Species	Hardness							
	Fresh		25 min		35 min		45 min	
	Apical	Basal	Apical	Basal	Apical	Basal	Apical	Basal
Gigantochola sp.	2337.09±149.36^{aB}	3849.38±84.69^{aB}	1439.74±44.2^{bA}	0948.07±39.49^{bC}	1361.59±19.48^{bA}	0702.11±29.75^{cC}	820.6±17.40^{cC}	0926.93±64.80^{bC}
Dendrocalamus sp.	2374.90±117.79^{aB}	3216.88±54.47^{aC}	1173.18±27.73^{bC}	0991.17±19.49^{cC}	704.42±28.03^{cD}	1214.85±18.49^{bAB}	1138.24±55.89^{bA}	0589.76±8.09^{dD}
G. scortechinii	3022.86±108.91^{aA}	4767.02±108.30^{aA}	1345.62±26.77^{bB}	1625.45±35.21^{bA}	852.78±22.77^{cC}	1097.89±156.58^{cB}	922.44±30.94^{cB}	1097.66±25.11^{cB}
G. levis	2006.83±78.00^{aC}	2506.46±136.00^{aD}	1098.94±10.42^{bD}	1554.11±30.25^{bD}	960.05±49.51^{cB}	1259.92±40.63^{cA}	505.20±57.82^{dD}	1226.05±17.21^{cA}

Note: a-d: Means with the same small letter across rows were not significantly different at ($p \leq 0.05$) according to Duncan's Multiple Range test (Note: Data for apical and basal portions are analyzed differently)

A-D: Means with the same capital letter down column were not significantly different at ($p \leq 0.05$) according to Duncan's Multiple Range test.

Table 2. Preference values for hardness of the apical and basal portions of canned bamboo shoots at different process times

Species	25 min		35 min		45 min	
	Apical	Basal	Apical	Basal	Apical	Basal
Gigantochola sp.	6.44±0.92^{aA}	6.24±1.13^{aA}	6.08±1.15^{aA}	5.64±1.38^{aA}	6.12±1.42^{aA}	5.83±1.31^{aA}
Dendrocalamus sp.	5.84±1.37^{aA}	5.88±1.39^{aA}	5.72±1.34^{aA}	5.56±1.47^{aA}	5.60±1.32^{aA}	5.80±1.19^{aA}
G. scortechinii	6.04±1.46^{aA}	5.72±1.28^{aA}	5.52±1.48^{aA}	5.60±1.47^{aA}	5.32±1.49^{aA}	5.64±1.60^{aA}
G. levis	5.76±1.33^{aA}	5.76±1.33^{aA}	5.48±1.53^{aA}	5.48±1.53^{aA}	5.80±1.61^{aA}	5.80±1.61^{aA}

Note: a-d : Means with the same small letter across rows were not significantly different at ($p \leq 0.05$) according to Duncan's Multiple Range test (Note: Data for apical and basal portions are analyzed differently)

A-D : Means with the same capital letter down column were not significantly different at ($p \leq 0.05$) according to Duncan's Multiple Range test.

Score: 9=Like extremely. 8=Like very much, 7= Like moderately, 6= Like slightly, 5= Neither like or dislike, 4=Dislike slightly, 3=Dislike moderately, 2=Dislike very much, 1= Dislike extremely

as compared to *G. levis, D. asper* and *Gigantochloa* sp. Prolonging the process time to 35 min caused the highest value of hardness for *G. levis*, followed by *D. asper* and *G. scortechinii*, and *Gigantochloa* sp. At 45 min of process time, *G. levis* was the hardest among all species, while *D. asper* was the softest.

It was found that fresh *Gigantochloa* sp. showed significantly higher value of hardness as compared to shoots processed for 25 and 45 min, followed by 35 min of process time. *D. asper* showed significant differences among all treatments received, while *G. scortechinii* and *G. levis* showed significant differences between fresh and processed shoots at 25 min followed by 35 and 45 min of process time.

The percentage of softening of the basal portion of bamboo shoots is shown in Figure 1. All species of bamboo shoots showed decrease in hardness and *Gigantochloa* sp. showed the highest softening among all species at 35 min of process time. It was significantly different from *D. asper, G. scortechinii* and *G. levis*. As the process time was prolonged to 45 min, *D. asper* showed the highest percentage of softening, followed by *G. scortechinii*, *Gigantochloa* sp. and *G. levis*.

Table 2 shows the preference values of hardness of the basal portions of canned bamboo shoots at different lengths of process time. There were no significant differences between species for each treatment received. However, it appeared that most panelists preferred *Gigantochloa* sp., *D. asper* and *G. scortechinii*, which were processed for 45 min. Based on the score noted, the hardness of the basal portions of canned shoots was liked slightly more by the panelists.

For sensory characteristics, the results obtained showed that the panelists neither liked nor disliked the odour of the canned bamboo shoots. Most panelists liked the appearance of both the apical and basal portions of canned *Gigantochloa* sp. at every process time. However, they scored significantly lower for canned *G. levis* processed at 35 and 45 min. For fibrousness of the apical and basal portions of canned bamboo shoots, *Gigantochloa* sp. was preferred at each process time.

CONCLUSIONS

From this study, it can be concluded that the optimum processing time for canned bamboo shoots that gave the highest consumer preference was 25 min. Overall, instrumental texture analysis data showed that the apical portion of *Gigantochloa* sp. was the hardest or second hardest at 25 or 35 min process time (or when fresh). Panelists, however showed no significant preference for hardness for any particular species. However, for fibrousness, *Gigantochloa* sp. was significantly preferred to *G. levis, D. asper* or *G. scortechinii*. For the basal portions, *Gigantochloa* sp. was either the second hardest or the softest based on instrumental texture analysis results. When compared to the sensory data on fibrousness, *Gigantochloa* sp. was found to be

significantly preferred at 25 min of process time and no preference was indicated for hardness. Thus it could be concluded that preference for fibrousness could be related to the harder texture of canned bamboo shoots.

It is hoped that the Malaysian manufacturers will be benefited from this study; they can commercialize production of canned bamboo shoots. So far, canned bamboo shoots from China have been available in the local market. Results from this study show that the basal portions of the bamboo shoots could also be utilized for consumption. This could increase the profit margin for bamboo shoot manufacturers.

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