

Quality of Fresh-Cut Galangal Harvested at Different Maturity Stages

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Abstract

Galangal ('Kha Tar Daeng', *Alpinia nigra* [Gaerth.] B. L. Burt., Zingiberaceae) rhizome (including aerial pseudostem) were harvested for fresh-cut product at 3 maturity stages (1, 3 and 5-leaf) between April and May (dry season) and July and August 2004 (rainy season) to determine the optimum maturity stage and storage temperature. One-leaf galangal rhizome harvested in dry season showed less weight, size (height and circumference) of aerial pseudostem and rhizome circumference ($P<0.05$), except for rhizome diameter, than 3 and 5-leaf stage. Similarly, the 1-leaf rhizome harvested during the rainy season exhibited less weight and size (height and circumference) of aerial pseudostem ($P<0.05$), but presented a similar rhizome size (circumference and diameter). Fresh-cut galangal prepared from 1-leaf rhizome harvested in dry season showed similar firmness (8.9 N in average), lower crude fiber (14.3%), but had higher dry matter (8.6%) and total antioxidant activity (65.3 mM ascorbic acid equivalent / 100 g fresh weight) than that prepared from 3-leaf stage. During the rainy season, fresh-cut galangal prepared from 1-leaf rhizome had lower firmness (7.1 N) and crude fiber (15.8%), similar quantity of dry matter (7.5% in average), but had higher total antioxidant activity (46.3 mM ascorbic acid equivalent / 100 g fresh weight). At 5 °C storage, fresh-cut galangal prepared from the rhizome harvested in both seasons showed less browning, as indicated by normalized L^* value and visual rating score, and consequently a longer (2.1 days, overall mean) storage life, than that stored at 10, 15 and 25 °C. Fresh-cut galangal prepared from the rhizome harvested in dry season lost greater weight (4.7%) and exhibited a shorter storage life (1.3 days), as determined by the number of days that the rhizome quality score decreased to 4.0, than that harvested during the rainy season. Storage life at 5 °C of the fresh-cut galangal prepared from 1-leaf rhizome harvested in dry season was 1.7 days, compared to 1.6 and 0.9 days of those prepared from 3 and 5-leaf shoots, respectively, while the storage life of the fresh-cut product prepared from 1, 3 and 5-leaf rhizome harvested during the rainy season was 4.1, 3.1 and 3.2 days, respectively.

Keywords: fresh-cut galangal, maturity, browning

Introduction

Harvested immature galangal (cv. 'Kha Tar Daeng', *Alpinia nigra* [Gaerth.] B. L. Burt., Zingiberaceae) rhizome (including aerial pseudostem with leaves attached) is produced as a fresh-cut vegetable for local markets, mostly in northeastern Thailand. Fresh-cut galangal is produced both in the dry season as well as in rainy season, which ranged from February to October. Most of the growers harvested galangals with 2-3 and 3-5 leaves attached in the dry season and in the rainy season, respectively. This is possibly due to the difference in galangal quality (e.g. rhizome firmness, crude fiber, etc.) harvested in different growing season. Shelf life of fresh-cut galangal is limited by the browning of cut-surface rhizome, even though they are treated with antibrowning solution [0.2-1.0% alum ((NH₄)₂SO₄·Al₂(SO₄)₃·24H₂O)] prior to marketing (Chinwong *et al.* 2003). The limitation of the shelf life was due to the nonexistent use of cold storage during postharvest handling and/or marketing. The purpose of this research was to investigate the appropriate stage of galangal maturity for good quality of commercially fresh-cut products in both, the dry and the rainy season, and to determine the longevity of the fresh-cut galangal during continuous cold storage.

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Materials and Methods

Galangal rhizomes cv. 'Kha Tar Daeng' were harvested with aerial pseudostem and leaf attached from one commercial farm in Huay Ka Yung, Ubon Ratchathani province at 3 maturity stages (1, 3 and 5-leaf) in the dry (April and May) and in the rainy season (July and August 2004). The rhizomes were cleaned and re-sorted to obtain the right stage of maturity and to ensure the absence of defects.

Experiment 1: Quality attributes of galangal rhizome and of fresh-cut galangal

Each maturity stage, consisting of 3 replications of 10 rhizomes, was determined for physical properties (weight, and size of aerial pseudostem and rhizome) at the production area. The other harvested galangals containing 3 replications of 3 rhizomes were prepared for fresh-cut galangal (by the local growers) for evaluation of physio-chemical quality on the rhizome of the fresh-cut product. Firmness and dry matter (%) were determined immediately after harvest. The dry rhizome was used for analysis of crude fiber, using method 978.10 of the AOAC (1990). Total antioxidant activity was determined using DPPH method (Brand-Williams *et al.* 1995). Ascorbic acid was used as a standard.

Experiment 2: Storage life of fresh-cut galangal

Fresh-cut galangal with a 60 cm-long aerial pseudostem prepared from 3 maturity stages as above were held at 5, 10, 15 and 25 °C using three temperature controlled refrigerators and an air-conditioning room, respectively. The experiment was arranged in a Factorial in Completely Randomized Design, each treatment combination consisted of 3 replications of 5 fresh-cut galangals.

The color of cut-surface rhizomes (browning) was measured using a CR-300 Colorimeter (Minolta, Osaka, Japan). The higher normalized L^* value, indicated a progressive browning. The cut-surface rhizome was visually inspected for browning using a 1 to 9 scale. The averaged score of 4.0 indicated the limit of marketability. Storage life was defined as the number of days that the rhizome color score decreased to 4.0. Fresh weight of the fresh-cut galangal was recorded every other day during storage and expressed as accumulative weight loss.

Results and Discussion

Quality attributes of galangal rhizome and of fresh-cut galangal

The 1-leaf galangal rhizome harvested in both, the dry and the rainy seasons, had less ($P < 0.05$) weight and size of aerial pseudostem (height and circumference) than 3 and 5-leaf stages (Table 1). The size of rhizome portion, as indicated by circumference, of the 3-leaf stage, was greater (1.5 cm) than that of the 1-leaf stage (Table 1). The 5-leaf stage was the most mature as indicated by weight and height (Table 1). The aerial pseudostem of the 5-leaf stage had an extremely hard texture at the part proximal to the rhizome (~20 cm long from the rhizome). Additionally, there was a young large shoot developed from the rhizome of the 5-leaf stage. These characteristics limit its marketability as fresh-cut product. The leaves attached to the rhizome of the 5-leaf stage may be a source of photosynthate for the new developed shoot. Regardless of the smaller size of the rhizome, 1-leaf galangal rhizome presents a possibility for production as a premium grade fresh-cut product in both seasons, due to the least firmness (7.5N in average), lowest crude fiber quantity (15.1% in average), and highest level of total antioxidant activity (55.8 mM ascorbic acid equivalent / 100 g FW, in average) (Table 2).

Storage life of fresh-cut galangal

Storage at 5 °C reduced browning, as indicated by a gradually increase in normalized L^* value and in the visual rating score, of the fresh-cut galangal prepared from the rhizomes harvested in both, the dry (Fig. 1a,b) and the rainy (Fig. 2a,b) seasons, compared to higher storage temperatures of 10, 15 and 25 °C. Fresh-cut galangal prepared in both, the dry and the rainy seasons, and stored at low temperatures (5, 10 or 15 °C) lost less weight during storage for 2 days, than that at 25 °C, approximately 2.5 and 3.6 folds in the dry and in the rainy season,

respectively (Fig. 3a,b). A relative high rate of weight loss of fresh-cut galangal occurred during 25 °C storage, or significant difference, respectively.

Table 1 Physical properties of galangal rhizome (including aerial pseudostem) harvested at 3 maturity stages in the dry (April and May) and in the rainy season (July and August 2004)¹

Maturity Stage	Weight (g)	Aerial pseudostem		Rhizome	
		Height (cm) ²	Circumference (cm) ³	Circumference (cm)	Diameter (cm)
		Dry season:			
1-leaf	51.80 c	66.33 c	3.09 c	7.21 b	1.48
3-leaf	68.37 b	79.33 b	3.33 b	8.73 a	1.64
5-leaf	110.20 a	104.55 a	3.74 a	8.41 a	1.76
F-test	**	**	*	*	ns
Rainy season:					
1-leaf	50.60 b	67.62 c	3.11 b	8.77	2.19
3-leaf	103.80 a	122.37 b	3.82 a	9.03	2.19
5-leaf	119.20 a	144.01 a	4.01 a	8.85	2.19
F-test	**	**	**	ns	ns

¹ values in each column of each season followed by a different letter, were significantly different at P<0.05, according to LSD testing.

² from the top of rhizome to the terminal of the unfolded leaf.

³ measured at a height of 25 cm.

*, **, ns indicate significant difference at P<0.05 and 0.01, and non-

Table 2 Physio-chemical qualities of galangal rhizome (including aerial pseudostem) harvested at 3 maturity stages in the dry (April and May) and in the rainy season (July and August 2004)¹

Maturity Stage	Firmness (N)	Dry matter (%)	Crude fiber (%)	Total antioxidant activity (mM ascorbic acid equivalent/100 g FW)
1-leaf	7.92	8.63 a	14.30 b	65.34 a
3-leaf	10.10	7.82 b	16.03 a	41.21 b
5-leaf	8.80	8.94 a	14.45 b	43.64 b
F-test	ns	*	*	**
Rainy season:				
1-leaf	7.06 b	7.32	15.82 b	46.29 a
3-leaf	8.62 a	7.51	16.87 b	37.69 b
5-leaf	9.27 a	7.80	18.94 a	35.48 b
F-test	*	ns	*	*

¹ values in each column of each season followed by a different letter, were significantly different at P<0.05, according to LSD testing.

*, **, ns indicate significant difference at P<0.05 and 0.01, and non-significant difference, respectively.

when prepared from the rhizome harvested in dry season (Fig. 3a). Reduction in weight loss of fresh-cut galangal during storage could be reduced by low temperature storage (e.g. 5 °C) in combination with appropriate packaging (Allende, *et al.* 2004; Jacobsson, *et al.* 2004).

The storage life at 25 °C of fresh-cut galangal prepared from all maturity stages harvested in both seasons was shortest (<1.0 day) (Fig. 4a,b). At 5 °C storage, the fresh-cut galangal prepared in rainy season, had a longer storage life (3.5 days in average) than that prepared in the dry season (1.4 days in average) (Fig. 4a,b). Storage at 10 and 15 °C could not extend the storage life of the fresh-cut galangal prepared from all maturity stages harvested in the dry season, as compared to those stored at 25 °C. This is due to the browning of cut-surface rhizome of the fresh-cut product stored at 10, 15 and 25 °C (Fig. 1). Therefore, the fresh-cut galangal prepared in the dry season, needed reducing the rhizome browning (e.g. dipping in an antibrowning solution) prior to storage or marketing. This practice may be required for the fresh-cut galangal prepared in the rainy season for a long distance market.

Conclusions

The 3-leaf galangal rhizome was the optimum maturity stage for marketing fresh-cut products. The fresh-cut galangal prepared in the rainy season had a longer storage life at 5 °C (3.5 days in average), than that prepared in the dry season (1.4 days in average).

Acknowledgements

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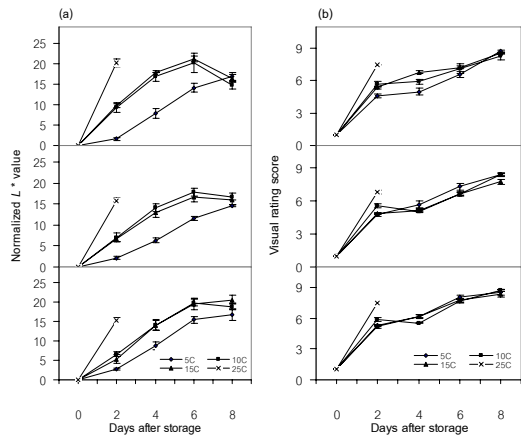


Figure 1 Normalized L^* value (a) and visual rating score (b) of fresh-cut galangal prepared from the rhizome of three different maturity stages, harvested in the dry season during storage at 5, 10, 15 and 25 C for 8 days.

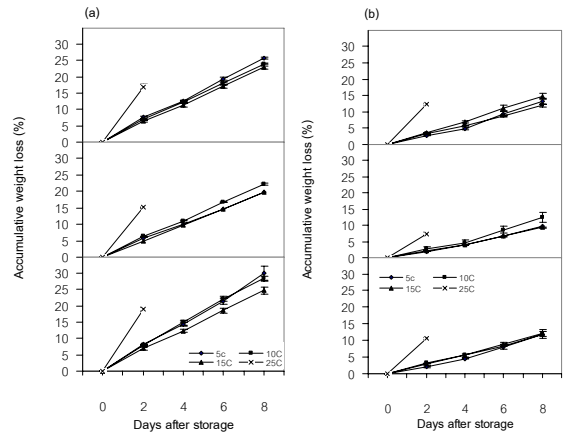


Figure 3 Accumulative weight loss of fresh-cut galangal prepared from the rhizome of three different maturity stages, harvested in the dry (a) and in the rainy season (b) during storage at 5, 10, 15 and 25 C for 8 days.

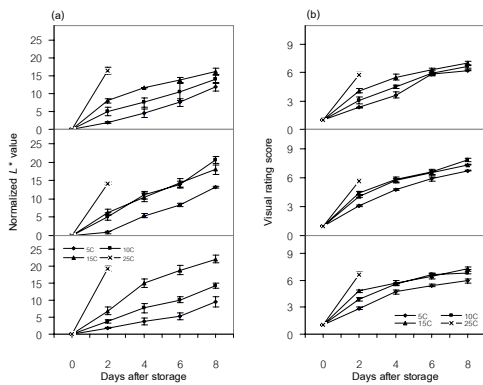


Figure 2 Normalized L^* value (a) and visual rating score (b) of fresh-cut galangal prepared from the rhizome of three different maturity stages, harvested in the rainy season during storage at 5, 10, 15 and 25 C for 8 days.

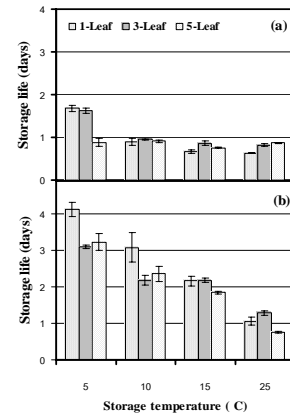


Figure 4 Storage life of fresh-cut galangal prepared from the rhizome of three different maturity stages, harvested in the dry (a) and in the rainy season (b) during storage at 5, 10, 15 and 25 C

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