Effects of Temperature and Modified Atmosphere on Quality and Storage Life of Brussels Sprouts[1]

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ABSTRACT

The effects of temperature and modified atmosphere on Brussels sprouts (*Brassica oleracea* var. gemmifera) were studied in relation to their quality and storage life. Brussels sprouts in plastic baskets lost their weight and chlorophyll very rapidly at room temperature (31°C) while weight losses of those in sealed plastic bags were almost completely stopped but chlorophyll loss still took place. Chlorophyll loss was delayed at low temperature. High temperature caused Brussels sprouts in sealed plastic bags to develop internal browning and off-oder, and added CO_2 in sealed plastic bags increased the severity of disorders but had no effect at low temperature (1° and 5°C). Brussels sprouts in plastic baskets deteriorated very rapidly and had storage life only 3 days while those in sealed plastic bags and held at 1°C had storage life up to 5 weeks.

INTRODUCTION

Cabbage is well known among Thais for decades, but the baby cabbages obtained from the harvested cabbage's lateral buds appeared in the markets about 5 – 6 years ago. It has been gaining good attention from housewives. Brussels sprout is probably a very new item of exotic vegetable that people may take it as baby cabbage. However, one should be able to identify them if one receives Brussels sprout information. Preparation of Brussels sprout for the table in this part of the world is certainly different from the normal practice in the Western countries. The vegetable should be well accepted in the market when the price is right. In addition, it needs publicity and cooking recipes.

After harvest the vegetable deteriorates rapidly at tropical ambient temperature, particularly the outer leaves turn yellow. Lutz and Hardenburg (1968) reviewed that deterioration of Brussels sprouts – yellowing of the sprouts and discoloration of the stem end – is rapid at temperatures of 50°F and above. At the recommended storage temperature of 32°, Brussels sprouts can be kept in good condition maximum of 3 to 5 weeks. Longer storage may result in black specking of the leaves, loss of fresh bright-green color, decay, wilting, and discoloration of the cut stems. Rate of deterioration is twice as fast at 40° as at 32°. Loss of moisture through transpiration is rather high even if the relative humidity is kept at 90 – 95% RH. Film packaging is useful in preventing moisture loss. As with broccoli, sufficient air circulation and spacing between packages is desirable to allow good cooling and prevent yellowing and decay.

The results of this paper indicates that Brussels sprouts produced in the highlands can be successfully stored under MA conditions and at different temperatures.

MATERIALS AND METHODS

Plant Material. Brussels sprouts *(Brassica oleracea* var. gemmifera) were harvested and shipped on March 7, 1982 from the production site, Ang Khang, Chiang Mai to Bangkok.

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Upon arrival at Postharvest Laboratory, Horticulture Department, Kasetsart University, Bangkok on March 8, 1982, fresh Brussels sprouts without blemish were selected for the experiment.

Experimental Procedures. Each 120 grams of the vegetable was placed in plastic basket and sealed plastic bag. Brussels sprouts in sealed plastic bags were initially added with 0 (0.03%), 10, 20 and 50% CO_2. They were held at 1°, 5°, 10° and 31°C (room temperature). The experiment was carried out from March 9 to April 2, 1982. Each treatment consisted of 3 replications. Quality assessments were made on weight losses, yellowing, internal browning and off-odor at every week by using arbitrary units as indicated in figures.

RESULTS

Weight Losses. In general, Brussels sprouts held at room temperature lost their weight greater than those at lower temperature (Fig. 1). Those in plastic bags did show slight weight losses while those in plastic basket lost their weight rapidly and became shrivel within one week. Brussels sprouts in sealed plastic bags held at 1° and 5°C could be stored up to 5 weeks and were still in marketable condition.

Yellowing. The vegetable held at 1° and 5°C either without or with added CO_2 remained green throughout the experimental period. Brussels sprouts in plastic basket held at 10° and room temperature lost chlorophyll rapidly and became yellow within the third and the first week of the experimental period. However, those in the atmosphere with CO_2 lost chlorophyll slowly (Table 1). Yellowing apparently localized in the outer leaves.

Internal Browning and off-Odor. At both 10°C and room temperature, Brussels sprouts kept in sealed plastic bags but not in plastic baskets exhibited internal browning and off-odor. The severity of disorders at room temperature seemed to be greater than at 10°C (Table 2). Added CO_2 in closed atmosphere stimulated the severity of internal browning and off-odor but had no effect on Brussels sprouts held at 1° and 5°C (Fig. 2). The higher the concentration of added CO_2 the more the disorders developed. Leaves toward the growing point showed the discoloration. Color became darker when the severity increased and discoloration would spread.

Storage Life. Judging on the appearance, Brussels sprouts in plastic baskets held at room temperature deteriorated within 3 days while those in sealed plastic bags held at 1°C maintained their storage life up to 5 weeks (Fig. 3). Though added CO_2 could delay some degree of chlorophyll loss but the effect was small in term of storage life of Brussels sprouts particularly at 1°C and 5°C.

DISCUSSION

Temperature apparently plays an important role in maintaining quatity and storage life of Brussels sprouts as in other perishable commodities (Lutz and Hardenburg, 1968). Brussels sprouts lost their chlorophyll and weight rapidly at high temperature. Though closed atmosphere could stop weight losses but chlorophyll loss still took place at high temperature. Modified atmospheres have been used successfully in many vegetables but one has to realize the injury or disorder developed due to low O_2 and/or high CO_2 in closed or modified atmosphere (Dewey, 1977). Disorders of Brussels sprouts from our experiment are a good example of the vegetable easily induced disorders by modified atmosphere. Though, added CO_2 could increase the severity of internal browning and off-odor, but high temperature seem to be a primary factor rather than high CO_2 levels, because high levels of added CO_2 did not induce these disorders at low temperatures. High

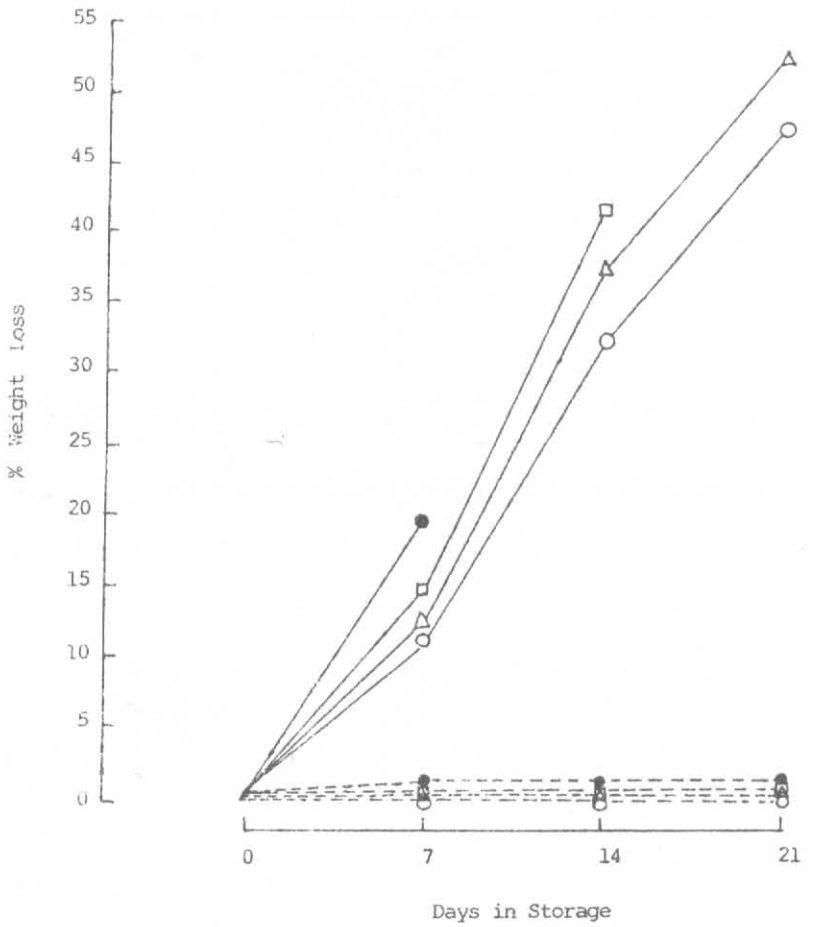

Figure 1 Weight losses of Brussels sprouts in sealed plastic bags (—) and plastic baskets (____) held at 1°C (0), 5°C (△), 10°C (□) and room temperature, 31°C (●)

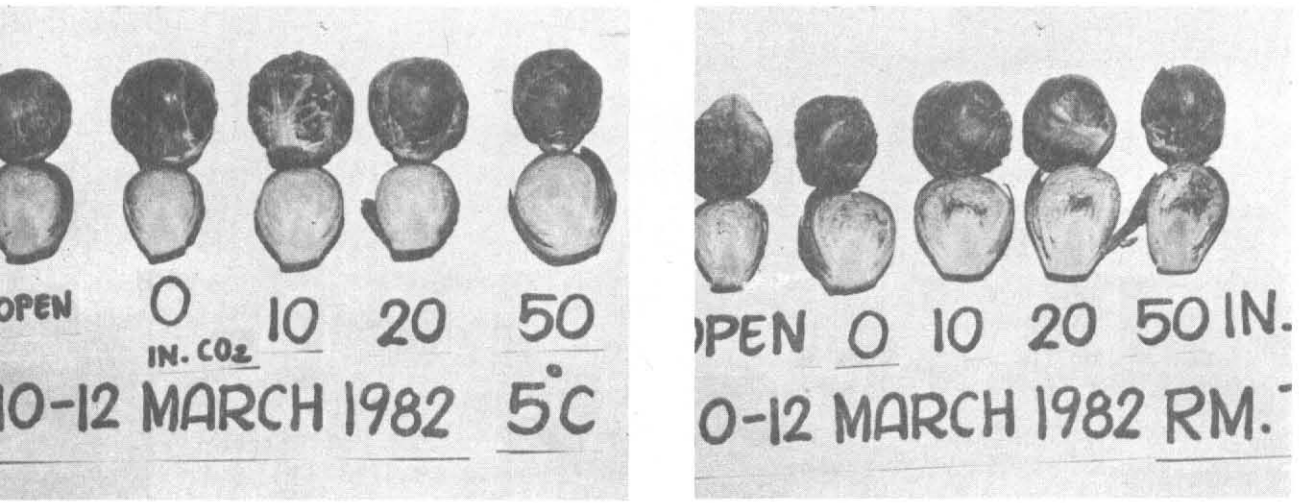

Figure 2 Effects of % CO_2 on internal browing of Brussels sprouts held at 5°C (left) and room temperature (right).

Table 1 1Effects of temperature and CO_2 on yellowing of Brussels sprouts in sealed plastic bags after 7 days in storage: G (green), SY (slightly yellow) and Y (yellow).

Temp. (°C)	% CO_2			
	0	10	20	50
1	G	G	G	G
5	G	G	G	G
10	SY	SY	SY	G
room temp.	Y	Y	Y	Y

Table 2 Effects of temperature and CO_2 on internal browning and off-odor of Brussels sprouts in sealed plastic bags and plastic baskets after 7 days in storage.

Temp. (°C)	Open	% CO_2			
		0	10	20	50
1	–	–	–	–	–
5	–	–	–	–	–
10	+	+	+ +	+ +	+ + +
room temp.	+	+ +	+ +	+ +	+ + +

+ + + severe
+ + moderate
+ slight
– none

temperature indeed increases the respiratory rate of Brussels sprouts and CO_2 accumulates in closed atmosphere. In this condition, CO_2 may induce disorders via enzymatic reactions which mainly depends on temperatures. Eventually, these enzymatic reactions may respond for the disorders. This speculation cannot be ruled out and it still remains for further research. Though Lyons and Rappaport (Lyons and Rappaport, 1962) reported that exposed Brussels sprouts to very high concentrations of CO_2 resulted in tissue injury. They did not mention the interaction of CO_2 and elevated temperatures on internal browning and off-odor in Brussels sprouts and the ineffectiveness of CO_2 at low temperature. Therefore, we believe that our result is a new finding in such phenomenon. Though internal browning of Brussels sprouts has been listed due to calcium-related disorder (Wills et al, 1981), but we did not find internal browning of freshly harvested Brussels sprouts. However, in this study it was shown that at 1°C was more effective in maintaining the quality of stored Brussels sprouts than any modified atmosphere treatments. The longer storage life can be obtained if the vegetable is immediately treated right after harvest.

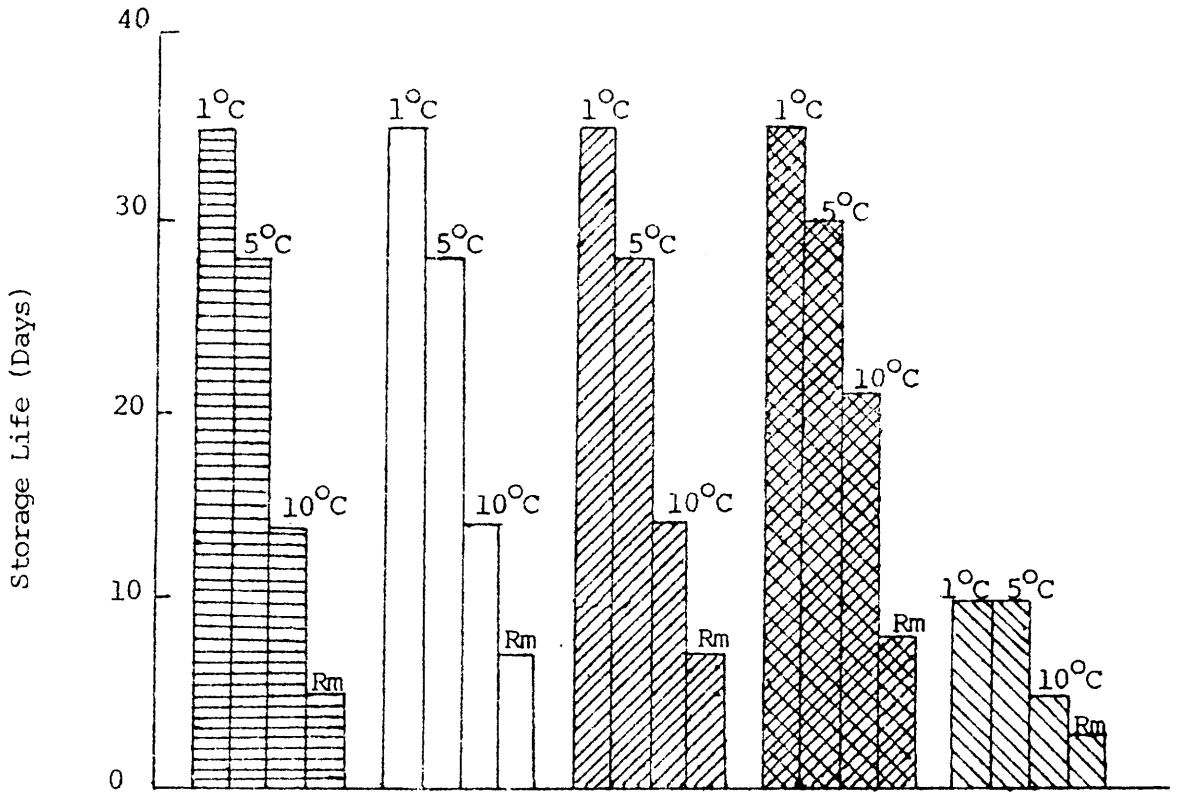

Figure 3 Effects of temperatures (°C and room temperature = Rm) and initial % CO_2 in sealed plastic bags (O = ▤, 10 = □, 20 = ▨ and 50 = ▩) and in plastic baskets (▧) on storage life of Brussels sprouts.

CONCLUSION

Based on the present finding Brussels sprouts should be stored in sealed plastic bag at 1°C. There is no need to add CO_2 in closed atmosphere.

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