Commodity	Grower	Sample	Total aerobic	Coliforms	Yeasts and Moulds	Fluorescent Pseudomonads
Snakebeans	1	1	1980	0	3060	0
		2	1530	49	943	0
		3	399000	2080	16000	0
		4	4870	67	4160	0
		5	20200	0	2700	189
	2	1	96700	3870	15300	54
		2	296000	26	12400	486
		3	145000	3820	7470	3960
		4	42200	1120	13900	898
		5	307000	1200	1600	18
	3	1	166000	22	8510	0
		2	145000	0	2820	0
		3	446000	137	12400	353
		4	202000	1380	8740	0
		5	3570000	1290	2950	5810

PROJECT: Optimising Storage Conditions for Selected Asian Vegetables

Project Officers: **M. Gosbee and S. Marte**

Location: BARC

Objective:

To determine optimum storage temperatures for some Asian Vegetable types.

This work was begun by TK Lim and sections of it have been reported in previous Annual Reports. The following is an adaptation of a paper 'Postharvest handling of Asian vegetables in the Northern Territory' by M. Gosbee and TK Lim. It summarises several years work and includes new information on sinqua, snake beans and kang kong.

Materials and methods:

Five types of Asian vegetables were chosen for this study. Bitter melon (*Momordica charantia*) and snake beans (*Vigna unguiculata* cv. Group Sesquipedalis) are among the most commonly grown Asian vegetables, and frequently have deterioration problems. Okra (*Abelmoschus esculentus*) also tends to have similar problems, presumably due to its high respiration rate (Kader 1992). Sinqua, or angled luffa (*Luffa acutangula*) was chosen to be representative of several types of melon which are considered by growers to be less sensitive to temperature. Kang kong (*Ipomoea aquatica*) was chosen as a representative of common leafy vegetables.

Vegetables were packed in boxes of 3 to 10 kg. Pack sizes were chosen to simulate current industry practices. They were either commercial size (for bitter melon and sinqua) or scaled down but still a representative size (snake beans, okra and kang kong). Produce packed in paper wrapping had a double thickness placed at the top and bottom of the carton. Plastic bags were made of low density natural polyethylene. Perforated bags had large holes (10 mm diameter) 20 mm apart over most of the area, while peakfresh® bags were microperforated plastic bags with gas exchange properties. Again, specific treatments were chosen depending on the type of vegetable and the types of packaging used by growers (Table 2). They were then placed in a coolroom at 5, 10, 15 or 20°C.

Vegetables were assessed twice a week for quality, and once a week for weight loss. Quality was scored on a 1 to 5 subjective scale of 1 = excellent, 2 = good, 3 = saleable, 4 = poor and 5 = very poor. Shelf life was determined as the number of days a product took from harvest to reach a score of less than 3. Ratings were continued until produced reached a score of less than 2. Weight loss is expressed as the percentage of initial fresh weight lost. This was determined with a slightly different sampling unit in each experiment (Table 1).

Two boxes of each packaging x temperature treatment were used. Unfortunately the effect of temperature could not be statistically analysed as only one coolroom was available at each temperature. Analysis of the effect of packaging on quality score was analysed using general linear models. Weight loss was significantly affected by packaging and data was analysed by analysis of deviance.

Table 1 Packaging and pack size used in the assessment of optimum storage life and temperature of five Asian vegetables

	Bitter Melon	**Okra**	**Sinqua**	**Snake beans**	**Kang kong**
Packaging					
Paper wrapping	✓	✓	✓	✓	✓
Perforated Bag	✓		✓	✓	✓
Peakfresh Bag		✓	✓	✓	✓
Plastic Bag	✓	✓	✓	✓	✓
Pack size	10 kg	5 kg	10 kg	5 kg	3 kg
Sample size for weight loss measurement	combined weight of 5 fruit	combined weight of 10 fruit	individual weight of 5 fruit	total weight of 5 kg box	total weight of 3 kg box

Results and Discussion:

Temperature had by far the greater effect on quality and shelf life than packaging. Differences in quality score of vegetables stored at different temperatures (Figure 1) were greater than that observed between vegetables stored in different types of packaging (Figure 1).

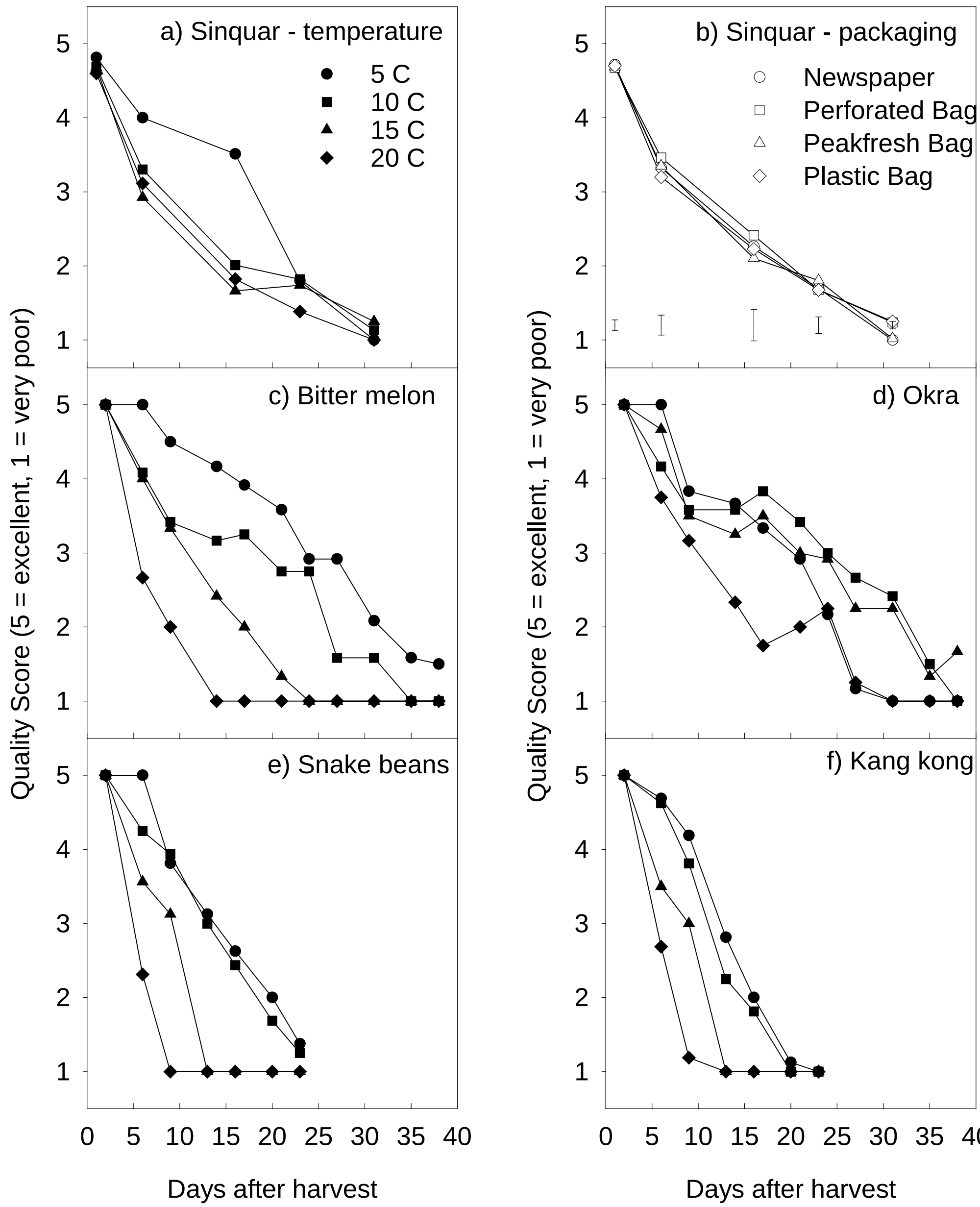

Figure 1. Effect of temperature (a, c - f) and packaging (b) on the quality of various 'Asian' vegetables during storage. Vertical bars (b) represent LSD (P<0.05)

Table 2. Weight loss (% initial fresh weight) after approx. two weeks in storage. Results are averaged across the four temperatures. Values within columns followed by different letters are significantly different ($P < 0.05$)

	Bitter Melon	Okra	Sinqua	Snake beans	Kang kong
Days after harvest:	14	14	16	13	13
Packaging					
Paper wrapping	97.61 a	91.76 a	93.97 a	89.59 a	85.39 a
Perforated Bag	97.81 a		95.03 a	94.14 b	93.27 b
Peakfresh Bag		98.54 b	97.90 b	99.56 c	99.91 c
Plastic Bag	99.12 b	98.20 b	98.71 b	99.59 c	100.44 c

At any one temperature, however, packaging had a distinct effect on the rate of water loss. Vegetables stored in plastic lost significantly less water than product stored without any plastic covering. Perforated bags were intermediate (Table 2). The rates for okra, <2% for produce in bags, and 8.2% for paper wrapping, were similar to that reported by Perkins-Veazie and Collins (1992). The use of peakfresh bags did not significantly increase the storage life of any of these products over the use of plastic bags. As peakfresh bags are considerably more expensive, this information should save the grower significant and unnecessary cost.

The simple conclusion that every vegetable is best stored at 5°C in a plastic bag was not true (Table 3). The use of plastic bags to reduce water loss is only recommended when the temperature can be accurately controlled. Warm produce packaged in plastic bags is difficult to cool, due to the decreased ventilation. If temperature is not well controlled during transport, produce in plastic bags is more likely to 'cook' due to the heat produced as the vegetables respire. For produce like snake beans with a very high respiration rate (Zong et al. 1992), we currently recommend the use of perforated plastic bags as they have greater air flow capacity when the product is being cooled. This also highlights the importance of completely cooling produce prior to packaging.

Table 3. Optimum storage temperature and packaging combinations for maximising shelf life for five selected vegetables

	Temperature	Packaging	Shelf Life
Bitter melon	5 °C	Paper wrapping	3 weeks
Okra	10°C	Plastic bag	3 weeks
Sinqua	5°C	Any	2.5 weeks
Snake beans	5 - 10 °C	Plastic bag	2.5 weeks
Kang kong	5°C	Plastic bag	2 weeks

The use of plastic bags for bitter melon poses a different problem. This vegetable is close to maturity at harvest, it produces ethylene and is also sensitive to ethylene (Zong et al. 1992). Optimum stage of harvest is difficult to determine, and is clouded by the desire of growers to harvest heavier and therefore more profitable vegetable. As the bitter melon ripens, the flesh rapidly turns a brilliant yellow and splits open. This may induce the rest of the melons in the box to likewise ripen. Bitter melon is consumed immature, and ripe fruit is unmarketable. Low temperature reduces the rate of ripening and loss of quality (Figure 1), but packing bitter melon in paper wrapping increases ventilation within the box and reduces the possibility ethylene triggering the fruit to ripen.

In this trial, okra stored in paper wrapping succumbed to fungal decay more readily than that in plastic bags. It may be that the paper wrapping was a source of inoculum, or that water loss from the okra predisposed them to decay. From these results, plastic packaging is more beneficial than paper wrapping (Table 3).

Sinqua was different because the shelf life of vegetables stored at 20°C were not greatly different to that of vegetables stored at 15 or 10°C. This would be why sinqua, and other melons, have a reputation among growers for longer shelf life. Sinqua stored at 5°C had a significantly longer shelf life than that stored at any other temperature (Figure 1).

Kang kong is a leafy vegetable with a very short shelf life. Low temperatures of 5 to 10°C were beneficial in prolonging shelf life (Figure 1). Water loss was significantly greater in paper wrapping and perforated bags from day 6, and the use of plastic bags is strongly recommended. At 15 and 20°C, breakdown in kang kong was seen as wilting and yellowing of the lower leaves and fungal decay. At lower temperatures colour and turgor were maintained for longer.

Chilling injury was observed in bitter melon and okra after three weeks at 5°C. Dark watery pits first appeared on the bitter melon at this time and increased with time in storage. Zong *et al* (1992) suggested that none of these vegetables should be stored at less than 10°C for more than two weeks, due to chilling injury. That observation is more accurate as the vegetables were removed to 20° and chilling injury observed after two to three days. This was not attempted in our experiment and symptoms may have been more obvious had we held the vegetables at 20°C after removal from cooler temperatures.

At the present time, most growers cool their produce to 4 to 8°C, and temperatures of 4 to 6°C are used in road freight for periods of four days. While these temperatures may seem a bit low, the lower temperatures reduce the possibility of the vegetables heating up within packaging. The transit time of four days to southern markets is short enough to minimise the risk of developing chilling injury. When vegetables are properly precooled, vegetable quality is maintained and produce reaches markets in a good condition.

Technology in terms of temperature and packaging exist for a range of vegetables. It is, however, important to match these not only to each vegetable in the case of its particular physiology but also to the capability of the growers and available transport options. Our recommendations may well change as the skill of the growers in postharvest handling and managing the cool chain increase.

Acknowledgments:

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