In the Northern Territory there are 65 Vietnamese vegetable growing families. The project commenced on 1 June 2000 with the appointment of Ms Kim Thi Búi as communication officer to the Asian NESB growers in Darwin. Results since then include:

- formation of the Asian Vegetable Growers Association (AVGA), currently with 32 grower members involved. AVGA meets monthly.
- training areas identified as priority are: 1) nutrition 2) pest and disease identification and control.
- negotiation has led to changed receival times with the NT's only freight (road) company.
- first project team meeting held.
- compilation of growers' and skills database commenced.
- organisation of an Asian vegetable display for the Darwin Show.
- grower trip to the Sydney and Melbourne Markets.
- bimonthly summary information sheet for local growers.
- identification of pest and disease at growers' property with NT DPIF experts.

COLD STORAGE TO EXTEND SHELF-LIFE AND IMPROVE QUALITY OF CHINESE WATERCHESTNUT (Project UCQ-8A)

Volker Kleinhenz, David Midmore, Geoff Lodge & Bruce Tomkins

A traditional vegetable in Asia, Chinese waterchestnut [*Eleocharis dulcis* (Burm. f.) Hensch] is emerging as a new commodity in Australia with potential for export. Postharvest storage protocols are sought by farmers to extend the shelf-life and thereby extend availability for domestic and future overseas markets. Since 1997, the Plant Sciences Group of Central Queensland University (Rockhampton, Qld), Eco-lodge-ic (Murchison Nth, Vic) and the Institute for Horticultural Development (Knoxfield, Vic) have studied the effects of packaging and storage temperatures on shelf-life and quality of waterchestnuts.

While some quality factors are principally affected by the growing environment and cultivation practices (eg. corm size, corm colour, and bruises), other quality parameters are more closely connected with postharvest storage. These parameters include weight loss, sprouting, growth of moulds on the external peel, discolouration and development of rots in internal tissues, and changes in sugar content of corms. Once one parameter falls below a critical level the shelf-life of waterchestnuts is essentially terminated. For example, if weight loss causes shrivelling of the peel of corms, they would be unacceptable to consumers even though there might be no signs of moulds and internal rots.

Although recommendations for postharvest storage have been published as early as 1955 (HODGE & BISSET, 1955), only a few systematic studies have been conducted to determine the shelf-life of waterchestnuts under various storage conditions. KAYS & SANCHEZ (1984) recommended storing corms in NaCl solution to minimise changes in weight loss, visual quality, and sugar content. However, a 'salty' taste due to increased concentration of sodium ions in corms is not acceptable to Australian customers so such overseas preservation methods cannot be adopted here. The same may apply to storage of waterchestnuts in sodium hypochlorite solution which was promoted by KANES & VINES (1977).

A few studies (eg. BRECHT *et al.*, 1992) have tested the effect of storage temperature on weight loss, sprouting and sugar content of waterchestnuts. As in other tuber crops, higher storage temperatures shortened shelf-life by increasing weight loss through transpiration and respiration, and induced sprouting. In tuber crops such as potato, with starch as the primary carbohydrate storage compound, low-temperature storage causes 'sweetening' of tubers that is not acceptable to consumers. This process of formation of sugars from starch has been found to accompany four circumstances: (1) low temperatures (particularly below 10°C), (2) sprouting, (3) senescence, and (4) decay following wounding and fungal infection (BURTON et al., 1992). However, 'sweetness' is appreciated in Chinese waterchestnut. Therefore, to minimise weight loss in stored waterchestnuts and to promote sweetness, we tested different packaging materials, storage temperatures, and storage duration. We collected data on the effects of storage temperature and storage period on 'total soluble solids' (TSS) content which is an indicator of sugar content in many other agricultural commodities.

We considered corms which had lost more than 10% of their fresh weight as visually unacceptable. When stored in the open, waterchestnuts lost this proportion of their fresh weight within one week. However, when corms were packaged in low-density polyethylene (LDPE) film (ie. 'snap-lock' bags) or microperforated LDPE film (ie. 'Longlife' vegetable bags), loss of fresh weight was within the acceptable level over a five-

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month storage period regardless of storage temperature (1° and 9° C). Packaging materials did not differ in their efficacy in reducing fresh weight loss in stored waterchestnuts.

Respiration is the breakdown of plant material into carbon dioxide and water to produce energy for maintenance of cellular integrity. Compared with some other horticultural products we measured low to very low respiration rates in waterchestnut (0.6-1.2 ml CO_2 kg^{-1} h^{-1}). Based on this we calculated weight loss caused by respiration to comprise only 3% of fresh weight loss of corms when stored for one month at 1°C. Therefore, weight loss of openly-stored waterchestnuts is primarily confined to transpiration which can be successfully reduced by using packaging materials which are minimally permeable to water-vapour transfer.

Waterchestnuts stored in a snap-lock bag

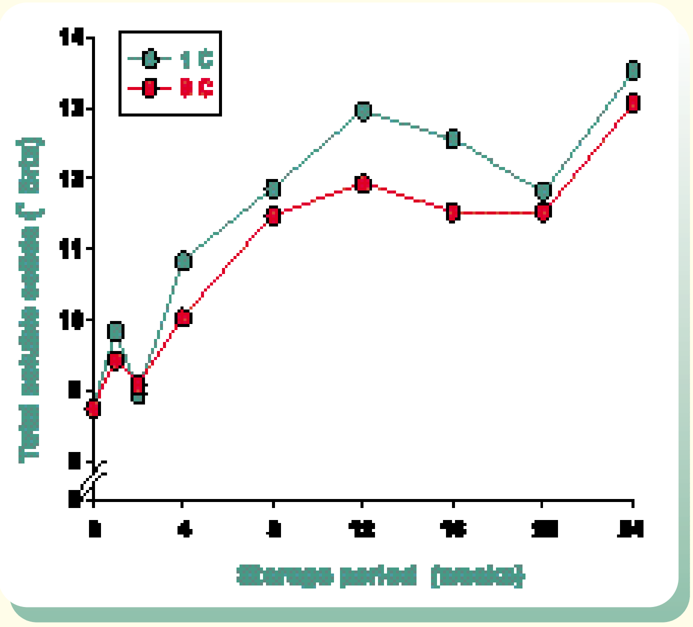

Figure 1. Effect of storage temperature & storage period on sugar content (as indicated by TSS)

Although weight loss of waterchestnuts did not differ across the two storage temperatures tested, difference in storage temperature did eventually affect development of moulds and rots. Not surprisingly, superficial fungal growth was accelerated at the higher storage temperature of 9°C but internal rots developed more rapidly at 1°C. This latter might have been due to fluctuations in storage temperatures which could have decreased corm temperature to below 0°C and, hence, caused chilling injury and associated rots. Moulds and rots shortened shelf-life of waterchestnuts to 3-4 months at either storage temperature.

With the exception of the value for the 2-week storage period, sugar content as indicated by TSS invariably increased over the first 12 weeks of storage (Figure 1). This was accelerated by the lower storage temperature showing that the same (as yet incompletely understood) processes that cause 'low-temperature sweetening' in potato are also active in Chinese waterchestnut. At present, we have no explanation for the subsequent drop in TSS after 12 weeks and then the rise after 20 weeks. However, preliminary results from our current research indicate that apart from the process of sugar formation at low temperature, the other processes which can explain sweetening in potato have no or only limited validity in waterchestnuts. At higher storage temperatures sprouting was accelerated but sweetening did not occur; corm senescence was hastened by higher temperatures but this inhibited sweetening and decay after wounding and fungal infection did not enhance sugar content.

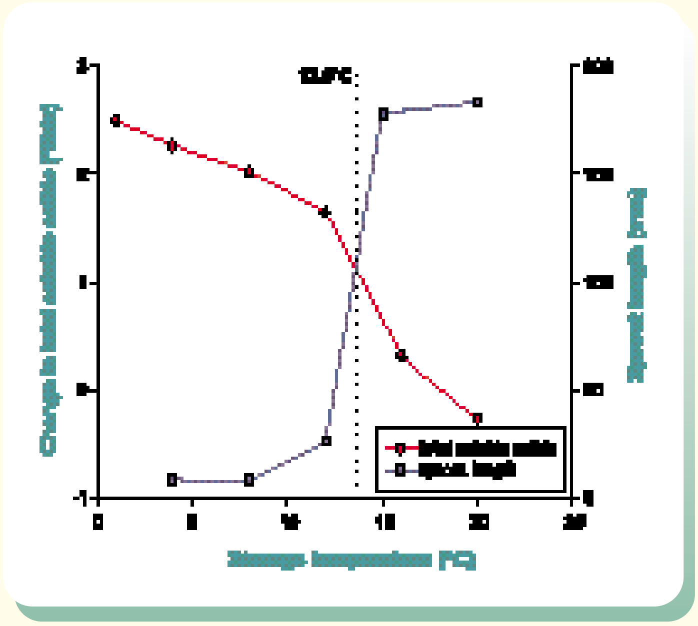

Figure 2. Relationship between storage temperature, change in total soluble solids & sprout length

In our current research on postharvest storage of Chinese waterchestnut we have concentrated on testing a wider range of storage temperatures (4, 5, 8, 12, 15 and 20°C) to determine 'critical' temperatures below which sweetening and above which sprouting occurs. Data presented in Figure 2 show this temperature to be 13.6°C. We are also trying to calculate a 'TSS per cold unit' value (ie. the inverse of heat units). This would make it possible to estimate the content of total soluble solids of waterchestnuts when the sum (or perhaps product) of time and temperature at which waterchestnuts were exposed

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to temperatures below the 'critical' temperature is known. Possibly, exposure duration is independent of whether it occurs during the growing period in the field or in postharvest cold storage. To understand this we have harvested and tested for TSS in corms during different growth stages, and now are studying their development of TSS under subsequent cold storage. CHAND (1990) found that application of growth hormones hastened sprouting in waterchestnut grown in soil under ambient temperature. That study indicated that growth hormones might also enhance sugar content of stored waterchestnut and, therefore, we are currently testing the effects of gibberellic acid ('GA_3') on corm quality at different storage temperatures.

On October 6, a workshop on cultivating Chinese waterchestnuts will be held at the Brisbane Market, QFVG building. Contact Volker for details.

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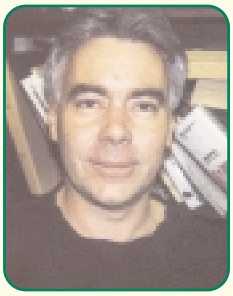

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