Using hot-water dips to retain skin colour in heat-treated squash

A report prepared for
NZ Buttercup Squash Council

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1 EXECUTIVE SUMMARY

The taste of squash has been identified by the NZ Buttercup Squash Council as a priority area for research. Improving sweetness is seen as particularly important for the Japanese market. In previous research funded by the Council, we demonstrated that squash, heat-treated at 30°C for five days, had a higher sucrose content and were sweeter than those treated at 12°C. However, the skins of heat-treated fruit were lighter and yellower than those which were not heat-treated. In the present study, we investigated the use of hot water dips prior to heat treatments, to maintain the skin colour of squash.

The hot-water dips had no positive effect on the skin colour change of the fruit and possibly caused the loss of the waxy coating of the fruit and allowed the skin to be invaded by fungi.

2 INTRODUCTION

In studies funded by the New Zealand Buttercup Squash Council in 1994 and 1995, we increased the level of sucrose in harvested buttercup squash by treating them at 30°C for up to seven days, compared to fruit stored at 12°C. A close relationship between sucrose content and taste panel perception of sweetness was also established. However, more rapid yellowing of the skin resulted, possibly due to loss of chlorophyll. Fruit with yellow skins are described in the market as 'tired' and their marketability can be affected.

Tian et al. (1996) maintained greenness in broccoli heads by dipping them in hot-water baths. Furthermore, Arvayo-Ortiz et al. (1994) increased the total chlorophyll content of buttercup squash by dipping them in 50°C water baths for three to twelve minutes and subsequently storing them at 10°C. As chlorophyll is one of the main components of the green colour in the skin of squash, it is likely that these hot water dips would have also resulted in retained green colour.

In this study, we tested the effectiveness of using a combination of hot-water dip treatments to retain green skin colour and subsequent high temperature treatment to increase sucrose content in the flesh of buttercup squash.

3 METHOD

On three separate occasions, we collected export grade buttercup squash from a packhouse at Longburn, near Palmerston North. At Levin Research Centre, we weighed all the fruit, then immersed four squash in water baths at 12°C, 40°C, 45°C or 50°C for five or ten minutes. These treatments were conducted in plastic 80 litre bins containing immersion heaters and pumps to circulate the water. Temperatures were controlled to within ± 1°C. The fruit were then held for four days at either 12°C or 30°C in temperature controlled rooms (conventional storage and recommended heat treatment temperatures respectively), then five weeks at 12°C (to simulate shipment to Japan). Fruit were held in 20 litre plastic vegetable bins during heat treatment and simulated shipment.

We measured skin and flesh colour, dry matter content and sucrose content at harvest and after the five weeks at 12°C. We also re-weighed the fruit after the treatments to assess weight loss. Skin and flesh colour changes were measured using a Minolta CR200 chromameter and the CIE L*a*b* colour co-ordinate system. 'L*' is a measure of colour intensity, from dark to light, 'a*' measures colour on a green-red scale and 'b*' measures colour on a blue-yellow scale.

4 RESULTS AND DISCUSSION

4.1 Carbohydrate analysis

As in the two previous seasons, mean sucrose levels increased after harvest and they were also higher after treatment at 30°C than at 12°C, on all sampling occasions (Figure 1). However, there was no difference in sucrose levels between the hot-water dip treatments.

4.2 Dry matter content

The dry matter content of the squash declined after harvest and there was no difference between heat-treated and conventionally stored squash (Figure 2).

4.3 Skin and flesh colour

The skin L*-values and b*-values responded in very similar manners to the treatments (Figures 3 and 4). Both increased (the skin colour was lighter and more yellow) after harvest. Fruit dipped at 45°C and 50°C had lighter coloured, yellower skins than those dipped at lower temperatures.

As in previous years, the heat-treated fruit had redder flesh (higher a*-value) than those fruit measured at harvest and those fruit which were stored but not heat-treated (Figure 5). However the dipping treatments had no effect on flesh colour.

4.4 Weight loss

Weight loss increased with increasing dip and air temperature, ranging between 7.6% for fruit hot-water dipped and air-treated at 12°C and 13.6% for fruit dipped at 50°C and air-treated at 30°C (Figure 6).

4.5 Incidence of rots

A total of 49 of the 192 fruits treated suffered rots, with 37 of these being in the second replicate. Of these 37, 30 appeared to have lost a portion of the waxy cuticle layer on the surface of the squash, which probably allowed the growth of non-invasive mycelia and affected the appearance of the fruit. This loss was possibly due to free surface water dissolving the wax on fruit placed in the 30°C room.

All other rots had invaded the flesh of the fruit.

5 CONCLUSIONS

The heat-treated squash in this study had higher levels of sucrose than those treated to 12°C. However, the hot-water dip treatments had no effect on the change in skin colour of the heat-treated fruit. The hot-water dip treatments may have contributed to the high incidence of disease and increased weight loss. We do not recommend using hot-water dips to prevent skin colour change in buttercup squash.

6 ACKNOWLEDGEMENTS

We acknowledge the assistance of Alan Cadwallader of BayCrop Packing Ltd, who supplied squash used in this study. We also thank Donald Irving and Paul Hurst for making helpful comments on the draft report.

7 APPENDICES

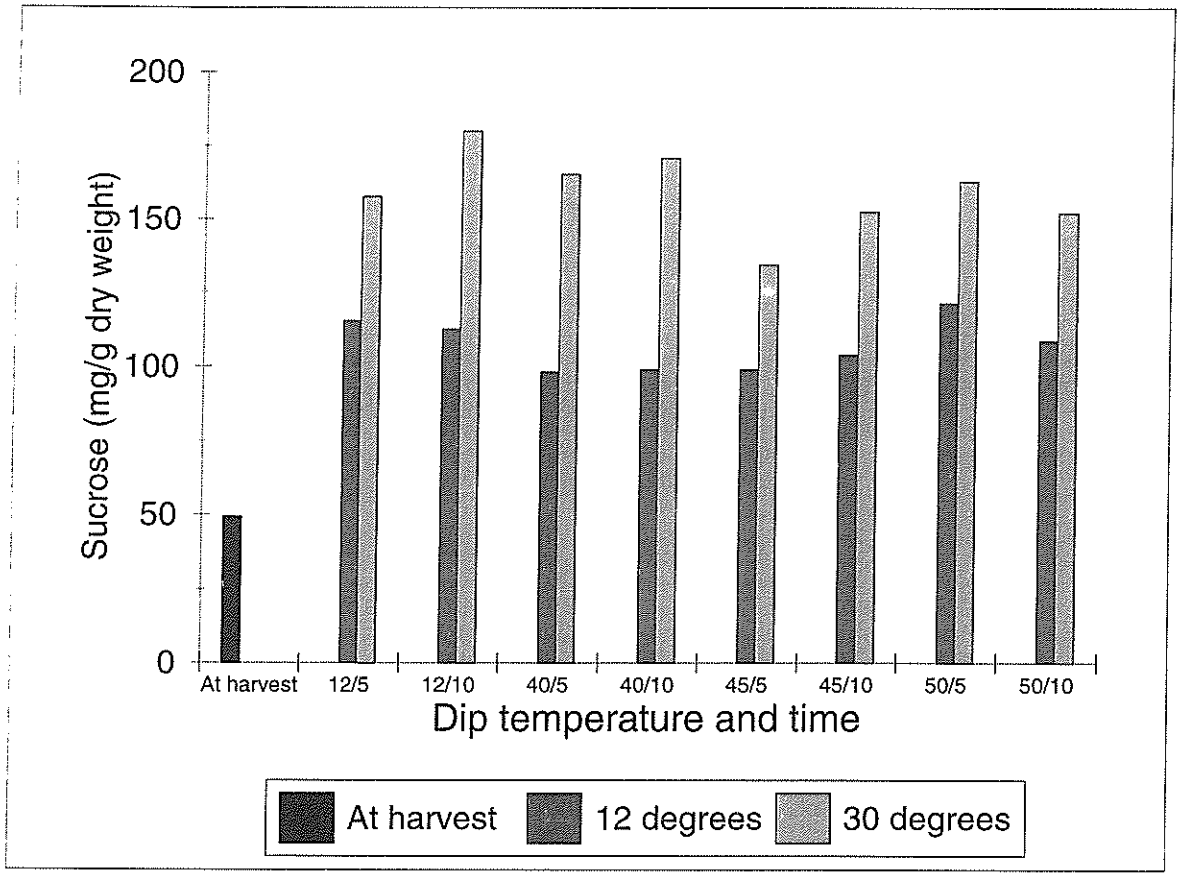

Figure 1: Sucrose content of dipped and heat-treated squash, after treatment and five weeks of storage at 12°C. Legend indicates heat treatment temperature.

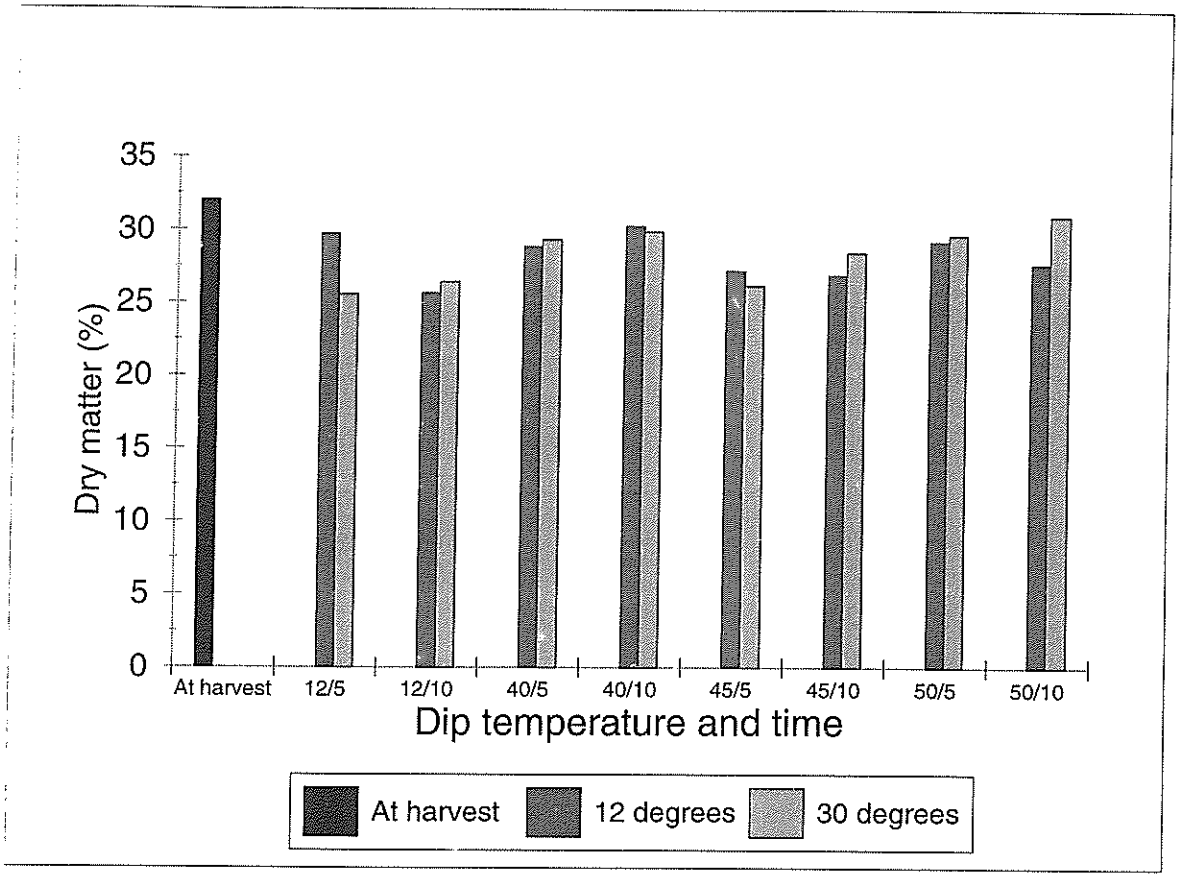

Figure 2: Dry matter content of dipped and heat-treated squash, after treatment and five weeks of storage at 12°C. Legend indicates heat treatment temperature.

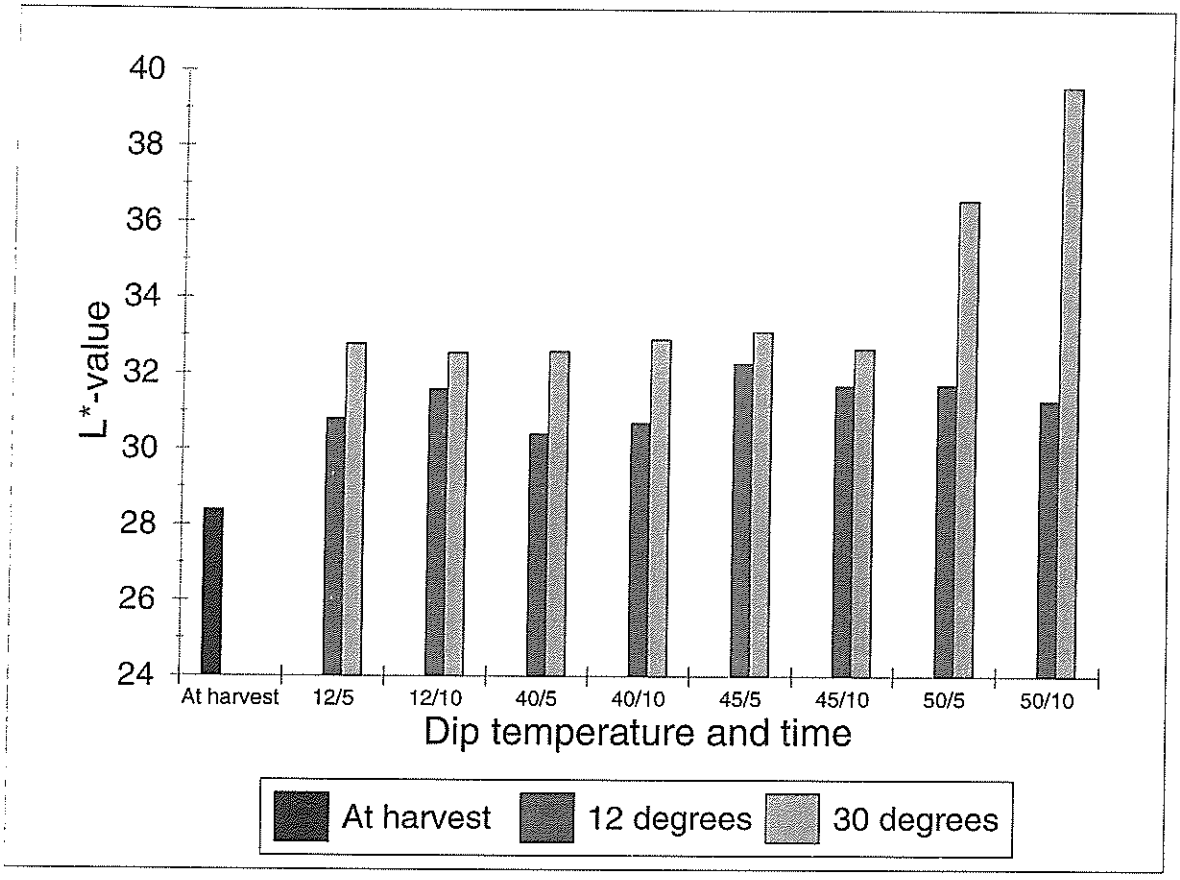

Figure 3: Skin colour (L*-value) of dipped and heat-treated squash, after treatment and five weeks of storage at 12°C. Legend indicates heat treatment temperature.

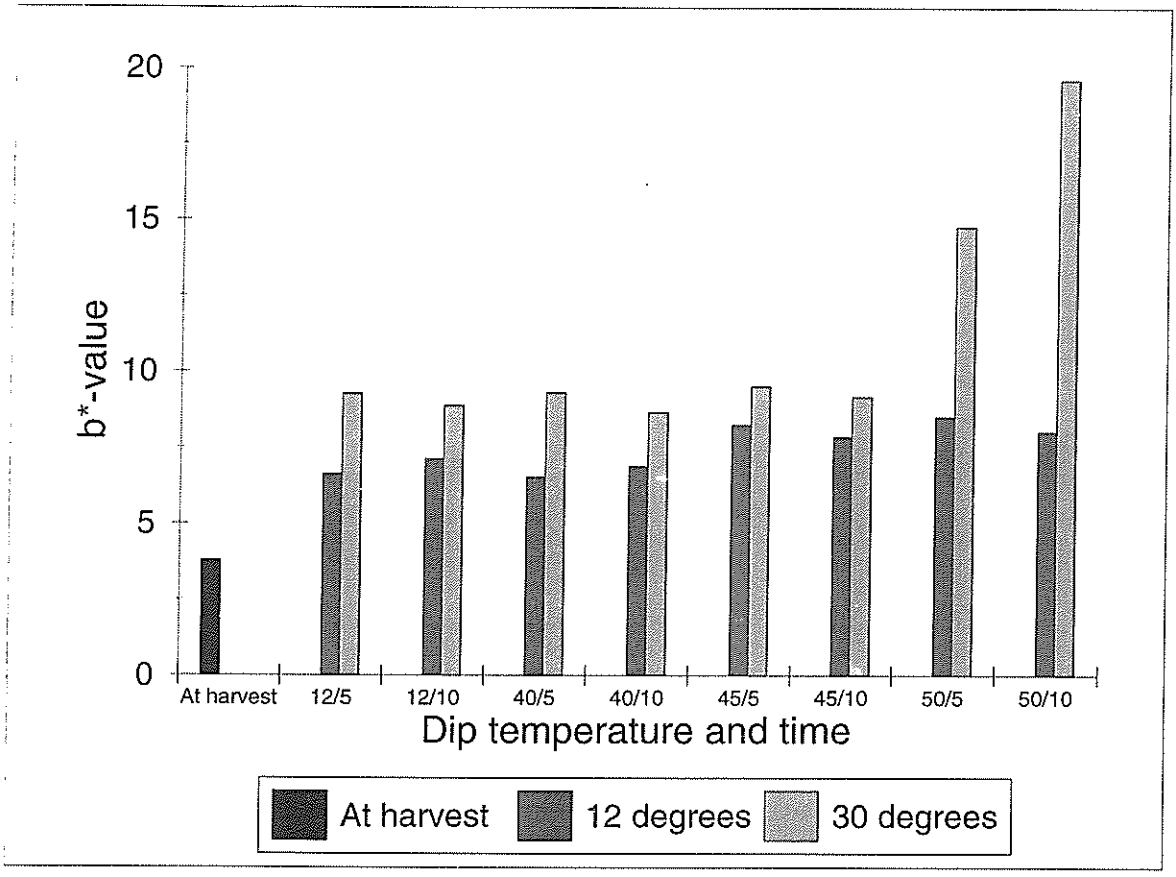

Figure 4: Skin colour (b*-value) of dipped and heat-treated squash, after treatment and five weeks of storage at 12°C. Legend indicates heat treatment temperature.

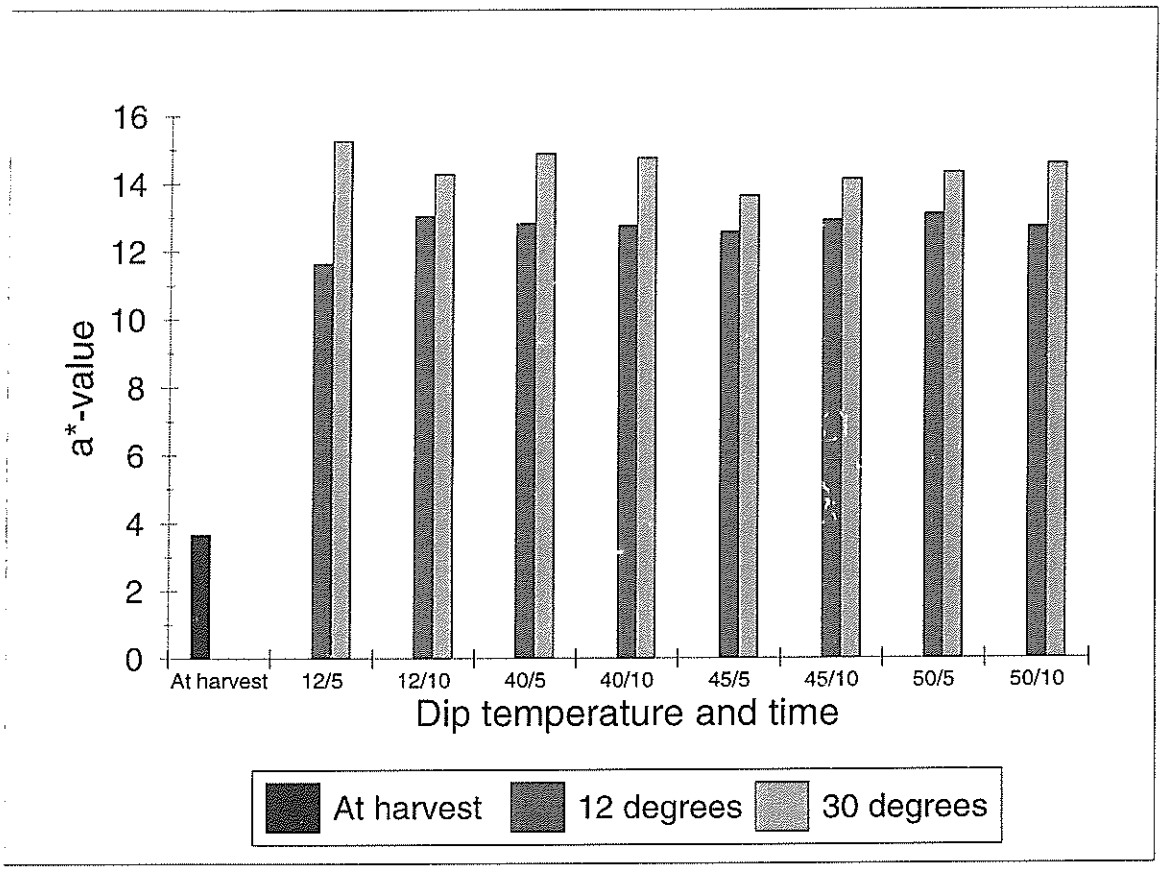

Figure 5: Flesh colour (a*-value) of dipped and heat-treated squash, after treatment and five weeks of storage at 12°C. Legend indicates heat treatment temperature.

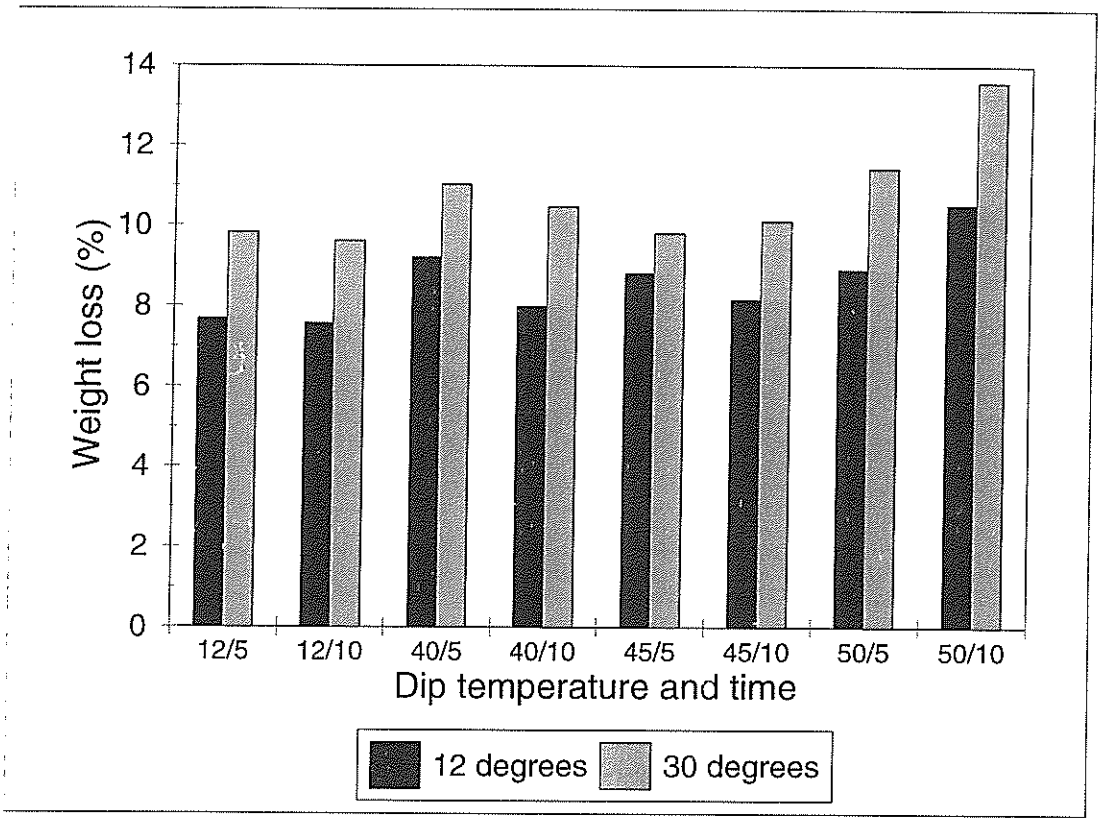

Figure 6: Weight loss of dipped and heat-treated squash, after treatment and five weeks of storage at 12°C. Legend indicates heat treatment temperature.