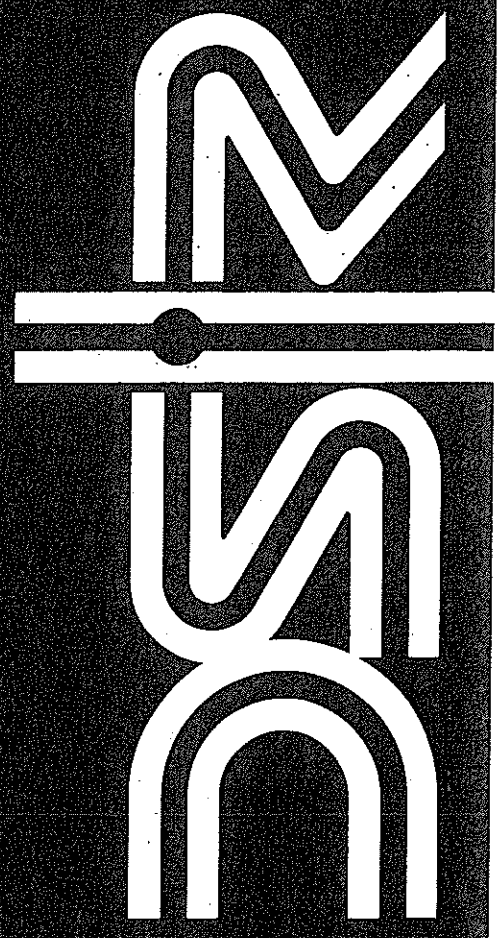
DSIR Crop Research

Internal Report No. 31

Sensory evaluation of squash

W J Harvey &
A J Graham

September 1991



NEW ZEALAND
DEPARTMENT OF
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CRD

DSIR Crop Research
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Contents

1 Summary

The breeding programme for hybrid squash at Crop Research, Pukekohe, had produced two promising cultivars with improved storage life. These two cultivars, CRSQ4 and CRSQ7, had been assessed by trained taste panel and by a Japanese consumer panel in 1990, and problems with differences between fruit of the same cultivar had occurred. Fruit from the 1991 season was assessed in comparison with the standard cultivar, Delica, so that differences between cultivars as well as differences between fruit of the same cultivar might be established. Information on the sensory properties of the cultivars were required for marketing purposes, as differences between fruit of the same cultivar confused the 1990 data.

The differences between fruit of the same cultivar was believed to be caused by maturity differences at harvest. Further research was carried out in conjunction with MAF Technology, where fruit of a range of maturities were tasted by a trained panel one week and four weeks after harvest . The two assessments were performed to establish what changes could be expected in fruit of different maturities when stored for a period simulating the time between harvest and retail purchase in Japan.

Results showed marked sensory differences between fruit of the same cultivar from the breeding programme. These differences were similar to the differences found between fruit of different maturities. Fruit improves in sweetness, flavour and texture with maturity, and although improvements occurred in these characteristics with storage, the fruit picked too immature did not improve.

Further research is planned to ensure that fruit is harvested at optimum maturity. It is planned to tag flowers, to harvest at a series of dates from flowering, and to assess the sensory differences of the fruit.

A new cultivar could be badly received by the market if it is harvested immature so this problem, and the associated one of the effect of post-harvest storage conditions on sensory properties must be addressed to safeguard this valuable crop.

2 PART 1 - Breeding lines

2.1 Introduction and method

Two cultivars, CRSQ4 AND CRSQ7, grown in Pukekohe (sown 6 November 1990, and harvested 20 February 1991, flowering dates not recorded), were compared with Delica by a trained panel using the taste panel form in the Appendix of this report. The method used was as recorded in DSIR Crop Research Internal Report No. 1 " Sensory Evaluation of Squash:1990".

Two fruit of each cultivar (six fruit in total) were tasted by ten trained panellists in a fully balanced design such that each fruit was tasted twice by each panellist and each fruit was compared with each other fruit the same number of times. Panellists received four samples of fruit at each sitting, three identified by random numbers and a labelled control sample of Delica to which fruit were compared. To check for differences between the two Delica fruit other samples of Delica were also included in the design as random numbered samples.

Table 1 Identification of fruit.

Cultivar	Breeders ID	Weight	Fruit no.
Delica	35-6	1826.1 g	1
Delica	41-8	1761.6 g	2
CRSQ4	40-4	1426.8 g	3
CRSQ4	36-6	2275.9 g	4
CRSQ7	42-4	1890.0 g	5
CRSQ7	35-7	1737.9 g	6

3 Results

Table 2 Mean scores for each fruit for each attribute.

Fruit	N	Colour	Sweetness	Flavour	Coarseness	Fibre	Dry
1	5	73	80	73	71	48	71
2	5	111	63	67	68	69	77
3	20	57	34	35	74	107	96
4	20	73	69	73	74	64	66
5	20	76	41	39	68	84	100
6	20	92	62	66	63	55	74
Pooled std. dev.		23	20	20	25	23	20

3.1 Colour

The colour of the two Delica samples was very different, the second fruit being considerably darker than the first. This could have meant that the figures for fruit compared with one of the Delica fruit as standard would be different from the figures for fruit compared with the other Delica fruit. However, when the two sets of data were analyzed separately there were no significant differences so all data was analyzed together. The $LSD_{.05}$ for fruits 3,4,5,and 6 is 14.7, so there are differences in the colour of fruit of the same cultivar, and differences between cultivars. Fruits 3 and 5 were paler than fruits 4 and 6 respectively. CRSQ7 is darker than CRSQ4 as found in the previous study (1990), referred to above.

3.2 Sweetness

The $LSD_{.05}$ for fruits 3,4,5, and 6 is 12.25. Thus there are differences again between the two fruit of the same cultivar but not between cultivars. Fruits 3 and 5 were also significantly ($LSD_{.05}$ = 19.8) less sweet than Delica.

3.3 Flavour

The $LSD_{.01}$ for fruits 3,4,5, and 6 is 16.33. Thus there is a significant difference between the two fruit of the same cultivar but not between cultivars. Fruits 3 and 5 also had significantly ($LSD_{.01}$ = 25.8) less flavour than Delica.

3.4 Smoothness/coarseness

A higher score indicates that the fruit flesh was more coarse.

There was no significant difference between fruit for this attribute.

3.5 Fibrousness

A higher score indicates that the fruit flesh was more fibrous.

As occurred with the taste attributes, fruits 3 and 5 were significantly ($LSD_{.01}$ = 18.8) more fibrous than the other fruit of the same hybrid, and also more fibrous ($LSD_{.01}$ = 29.7) than Delica.

However, there are no between cultivar differences.

3.6 Dryness/moistness

Here a higher score indicates a more moist or watery fruit.

We have the same effect here with fruits 3 and 5 being significantly ($LSD_{.01}$ =16.4) more watery than the other fruit of the same hybrid. There is also a significant ($LSD_{.05}$ =19.5) difference between fruits 3 and 5 and Delica.

4 Conclusions

Because of the large differences between fruit of the same hybrid, it is difficult to detect differences between hybrids except for colour where CRSQ7 appears to be darker than CRSQ4.

If it is assumed that the differences between fruit are caused by differences in maturity, then this would tie in with the observed attribute differences. From maturity studies, conducted this year and included in Part 2 of this report, it has been observed that less mature fruit is paler in colour, is less sweet, has less flavour, is smoother, more fibrous and more watery than more mature fruit. This description fits fruits 3 and 5 in all attributes except smoothness/coarseness and so is most probably the cause of the difference. If fruits 4 and 6 are considered alone and compared with Delica, they are both very similar to Delica in every attribute.

If the scores for these fruit are compared with the scores for other years and with the fruit in the maturity experiment (which was a different cultivar), fruits 3 and 5 have scores comparable with fruit of very low maturity.

5 Recommendations

For future quality assessments of squash, it is essential that the maturity of the fruit be known. Differences in maturity, or the export of immature fruit could cause a new cultivar to be rejected by the buyer, which could damage the reputation of a new cultivar for many years. The buyer would not necessarily realise that the poor quality of the fruit was the result of immaturity and could assume that this poor quality was an attribute of the new cultivar. There will always be fruit of different maturity in a crop from one paddock as the flowers set at different times. Would there be any future in trying to breed a cultivar which had only one set of female flowers? MAF Technology have conducted research on maturity for the Squash Council this year to get a better index of maturity of a crop, and these recommendations could be applied to CRD squash breeding.

If these differences between fruit are not caused by maturity differences then it must be of primary importance to investigate the cause. It should be a relatively simple matter to sample a large number of fruit and to test the variability in maturity using a penetrometer. If this is not available, cutting and looking at the colour of the flesh should give an idea of differences.

The differences observed between fruit of the same hybrid have occurred in two years of testing. To prove that this is a maturity difference new fruit could be labelled at flowering and the fruit harvested at a series of days from flowering to give fruit of a range of maturities for sensory evaluation.

The other possibility is that this difference could be a post-harvest effect. The conditions in which the two fruit from the same hybrid were kept post-harvest could have differed. Post-harvest conditions need to be the same for all fruit.

Last season, fruit grown at Pukekohe differed considerably from fruit grown at Lincoln. This was attributable in some respects to a size difference. Fruit of similar weight should be used in this research. The other differences could well be environmental: day length, season length, etc. If squash is being bred for Canterbury then it should be grown in Canterbury during the assessment stage to ensure the right decisions on quality are made.

6 PART 2 - Squash maturity and its effect on sensory quality

6.1 Introduction

Buttercup Squash varies in its sensory quality depending on the stage of maturity at which it is harvested. Immature fruit do not taste as good as mature fruit. Squash growers like to harvest their crops as soon as possible to gain access to early markets but do not want to harvest too soon and risk having low quality fruit. A reliable method of estimating maturity is at present under study.

The aim of this research was to:

1. Perform sensory assessments on squash with a range of maturities as assessed by penetrometer (a method for maturity determination being assessed in current research), to determine how the sensory characteristics change with maturity.

2. To hold fruit of a range of maturities for a period of four weeks at laboratory (15-20 °C) temperatures (to simulate the time between harvest and retail purchase in Japan) and to perform sensory evaluations on the fruit after storage. This was carried out to find out how the fruit changed and whether the fruit would improve with storage and reach an acceptable level of quality even if picked immature.

7 Method

Buttercup Squash, variety Nishiki, were harvested from a growers field in Canterbury on 24 April (Crop sown 7.12.90, mid-flowering date 10.2.91.). Penetrometer readings, corking scores, and colour readings on the inside flesh were performed on these fruit and a range of fruit selected for this experiment to give a range of maturities. The weight of each fruit was recorded, and moisture content and brix tests done on selected fruit.

Half the fruit were tasted one week after harvest (1st May) and half were stored, uncovered, in a plastic bin, at 15-20°C for four weeks and then tasted. Weights were recorded again after storage, and brix measurements, and moisture content tests performed on selected fruit.

Colour tests were also performed using a Minolta Chromameter and Image analysis equipment.

Squash were tasted by a trained panel of 9 people. Four fruit were selected with penetrometer readings of approximately 5,7,9 and 11 respectively to cover the maturity range. A selection of four more fruit of similar penetrometer readings was kept for four weeks as described above and tasted by the panel. Panellists were each given a piece of each of the four fruit. Fruit were presented in a different order to each panellist to avoid bias. Each fruit was tasted twice by each panellist.

8 Results

8.1 Physical Measurements

Table 3 shows the fruit tested, their weights (in grams), corking scores (corking is a maturity index indicating the extent to which the stem has shrivelled; 10=max. corking, 1=min. 75% corking has been considered necessary for maturity.), Brix readings, dry matters(%), and penetrometer readings.

Table 3: Identification of fruit and maturity differences.

Fruit no	Penetro-meter	Corking	Weight	Weight after 4wk	Brix	% Dry matter
IST PANEL						
12	11.4	9	2080		15.2	31.5
6	10.8	9	1752			
3	9.7	9	1680		15.4	31.1
9	7.4	9	1850		11.8	26.3
17	5.1	2	2150		8.9	21.4
2ND PANEL - FRUIT STORED FOR FOUR WEEKS						
14	10.6	9	1920	1726	19.2	29.8
4	9.7	9	1410	1251	17.1	26.4
10	7.4	9	1464	1309	13.3	22.9
1	6.0	5	1497		11.1	19.0
16	5.2	2	1491	1390	7.9	13.0

From the figures presented in the above table some interesting facts emerge:

1. Brix scores are higher for fruit with higher penetrometer readings i.e. for more mature fruit. Cedenco pick squash at 14-15 Brix and leave the fruit on the vine for two to three weeks longer than the usual pick date. Fruit would need to have a penetrometer reading of about 9 to have a Brix reading in this range. After four weeks of storage the Brix readings appear to have increased about 2 points for fruit of penetrometer reading of 7 or higher but the fruit with a penetrometer reading of 5.1 which also had a low corking score, did not increase its Brix reading with storage. However, as different fruit were tested (with and without a storage period) it is difficult to be

certain of this. It is interesting to note that these fruit were all harvested on the same day from one paddock and yet they have a range of maturities. There will always be a range of maturity in fruit from one field but it appears that a penetrometer reading of at least 7 is required for individual fruit to give acceptable maturity. Squash sweeten up with storage but not if picked too immature.

2. The dry matter increases with maturity. A dry matter of 25-30% is considered by the industry as about right for maturity. The dry matter results appear to have decreased with storage, but as they are for different fruit this is not clear. A penetrometer reading of 8-10 was assumed by MAF Technology to be ideal and to be approximately equivalent to a dry matter of 30-35%. Only a few fruit have been measured here but none have dry matters as high as 35% so this may not be correct.

8.2 Colour testing

Table 4 shows the colour measurements made on the fruit of different maturity (as shown by the penetrometer readings) and on stored and un-stored fruit. Colour measurements were made by image analysis, giving R,G & B and average optical density readings, and by two different Minolta Chromameter instruments giving the colour in L* a* b* colour co-ordinates.

Table 4: Colour Measurement of Squash Flesh

Fruit no	Penetro-meter	Average Optical Density	Red	Green	Blue	L*	a*	b*
1st Panel								
12	11.4	.57	16	8	1	68.5	9.7	73.2
6	10.8	.61	15	7	1	66.4	12.3	72.6
3	9.7	.57	16	8	1	69.7	7.7	74.8
9	7.4	.54	17	9	1	72.8	6.43	76.9
17	5.1	.52	17	10	1	76	3.12	73.2
2nd Panel - fruit stored for four weeks								
14	10.6	.59	26	14	3	67.9	23.1	77.8
4	9.7	.59	25	13	3	65.3	22.6	74.4
10	7.4	.65	24	12	3	69.4	22.6	78.1
1	6.0	.59	27	14	3	70.4	20	75.5
16	5.2	.56	28	15	4	72.1	20.8	72.5

Looking at the L* a* b* values, the larger the L* value the paler is the colour. The less mature fruit is very slightly paler, and all fruit become slightly less pale with storage. The a* value is a measurement of the red/green colour. The lower the a* value the more green and the higher the a* value the more red is the fruit. The a* value increases with increasing maturity and is accentuated by storage. The b* and c* values do not show differences between maturities or between stored and un-stored fruit.

With the image analyzer, the co-ordinates of colour showing the most differences between fruit are the red and green values. These compare with the Minolta a* reading. Both the R value and the G value increase with storage but differences between maturities are not as clear. The average optical density shows the paleness/darkness of the colour, with smaller values indicating paler colours.
As a comparison between instruments, the image analyzer gives a reasonable measure of darkness of colour, but is not as good as the Minolta at describing differences in hues of the same colour.

8.3 Taste panel results

The following tables give the mean scores over all tastings of each fruit. Fruit numbers 3,9,6,12 and 17 were tasted without a storage period, and fruit numbers 4,10,14 and 16 after 4 weeks. Standard errors are given for each set of data and for each value of N.
t may be taken as 2 for $LSD_{.05}$ calculations.

1 Colour

Fruit tasted without storage			Fruit tasted after 4 weeks storage		
Fruit no.	N	mean score	Fruit No.	N	Mean
12	9	103			
6	18	108	14	18	104
3	18	96	4	18	95
9	9	80	10	18	81
17	9	30	16	18	49
Pooled s.e. = 7.2_{18}, 10.1_{9}			Pooled s.e.= 4.7		

There are no significant differences in colour between stored and un-stored fruit, but there are differences between the colour of fruit of different maturities. Fruits 9 and 10 are significantly paler than fruits 12, 6 & 14, and 3 & 4. Fruits 16 & 17 are significantly paler

than all other fruit. However, the perceived colour of fruit once it gets to a penetrometer reading of near 10 does not appear to change.

2 Sweetness

Fruit tasted without storage			Fruit tasted after 4 weeks storage		
Fruit no.	N	mean score	Fruit No.	N	Mean
12	9	52			
6	18	56	14	18	91
3	18	42	4	18	79
9	9	27	10	18	76
17	9	31	16	18	37
Pooled s.error = 6.2_{18},8.8_{9}			Pooled s.error = 4.9		

There is a significant decrease in sweetness at the lower maturities and a marked increase in sweetness with storage except for the very lowest maturity which did not increase in sweetness.

3 Flavour

Fruit tasted without storage			Fruit tasted after 4 weeks storage		
Fruit no.	N	mean score	Fruit No.	N	Mean
12	9	52			
6	18	60	14	18	85
3	18	44	4	18	79
9	9	42	10	18	66
17	9	31	16	18	40
Pooled s.error=5.5_{18}, 7.8_{9}			Pooled s.error = 4.9		

6 Dryness/moistness

A higher score means the sample was more moist.

Fruit tasted without storage			Fruit tasted after 4 weeks storage		
Fruit no.	N	mean score	Fruit No.	N	Mean
12	9	22			
6	18	30	14	18	45
3	18	16	4	18	54
9	9	29	10	18	60
17	9	48	16	18	89
Pooled s.error = 3.9_{18}, 5.5_{9}			Pooled s.error = 5.2		

Samples 16 & 17 were significantly more moist than the other fruit of higher maturity. The more mature fruit were very dry but improved significantly with storage.

9 Conclusions

This was a small preliminary experiment, so conclusions drawn from it could be premature without further study. However some trends emerge.

If squash is harvested at too low a maturity (e.g. with a penetrometer reading of less than 7, or a corking score of less than 5) it will lack flavour and sweetness, and will be less dry, more fibrous and less coarse than fruit picked at a higher maturity.

With storage, fruit will improve in sweetness, moistness and flavour and will become less coarse but this will not happen to fruit picked too immature (i.e. with a penetrometer reading of 6 or less.).

Squash does improve in its organoleptic qualities with storage and a balance between loss of quality by fungal deterioration, gain in organoleptic quality, and an optimisation of the economics of the market dynamics should be the aim.

Although immature fruit may store better, if it is too immature it may never improve in its tasting quality. From the evidence gathered in this experiment the cut off point appears to be at a penetrometer reading of about 7 for individual fruit.

If a mean score for a crop is being considered this reading would need to be higher - nearer 8 - because of the range of maturities found in a crop and the need to ensure that those harvested at the low end of the range were not too immature.

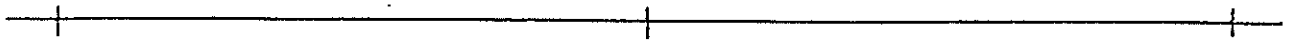
SQUASH SENSORY EVALUATION

NAME : _____ TIME : _____

DATE : _____ BOOTH : _____

Please evaluate the following squash. Eat only the orange flesh, do not eat the yellow rind for your evaluations. Place an "X" on the scale to indicate the level of each characteristic and label with the appropiate sample number.

1. Colour



Pale yellow-orange | Bright orange | Dark brown-orange

Comments:

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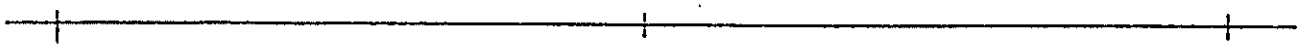
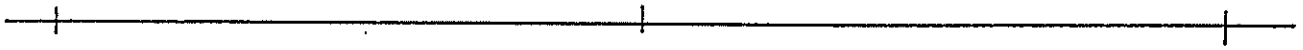
2. Flavour



Not sweet | Average sweet | Very sweet



No squash flavour bland | Average squash flavour | Strong squash flavour

Comments:

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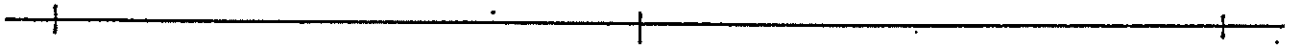
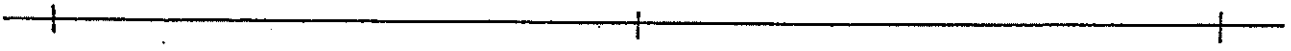
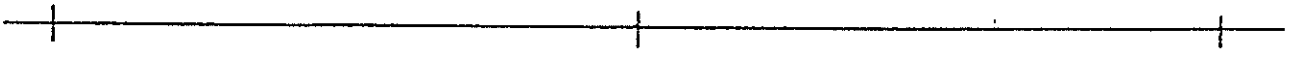
3. Texture



Smooth | Coarse, granular



Not at all fibrous | Very fibrous



Dry | Moist

Comments:

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