

## CONTROLLED ATMOSPHERE STORAGE OF JONATHAN APPLES

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### SUMMARY

The incidence of soggy breakdown in Queensland-grown Jonathan apples was too high in both air storage and controlled atmosphere storage to permit storage for 5 months.

The effects of temperature and maturity on the storage behaviour of Queensland-grown Jonathan apples were investigated in 1963 and 1964 by Carroll (unpublished data), and 36°F was established as the most satisfactory storage temperature.

In 1964, work on the controlled atmosphere storage of this variety was commenced, one controlled atmosphere and one storage temperature being used. Since Trout, Tindale, and Huelin (1940) in Victoria and van der Meer (1963) in the Netherlands recommended an atmosphere containing 16% oxygen plus 5% carbon dioxide for long storage of Jonathan apples, this atmosphere was used for the Queensland fruit; and 36°F was used as the storage temperature.

### Methods and Materials

The experimental fruit was obtained from five orchards in the Granite Belt. Pickings were made at three maturities, viz. February 24 (M1), March 5 (M2) and March 18 (M3).

After transport to the Food Preservation Research Laboratory, the fruit was stored at 36°F in nine 44-gal gas-tight drums, each containing one half-bushel of fruit from each of the five orchards. Control fruit consisting of three half-bushel cases from each maturity from each orchard was also held at 36°F. The storage atmospheres used were 16% oxygen plus 5% carbon dioxide, and normal air storage. The mixture of oxygen and carbon dioxide was maintained by restricting the flow of air to the drums using manometric flow meters. The storage atmosphere was analysed twice daily and adjustments made to the flow rate as necessary.

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Samples of fruit were removed from store on July 21 (R1), August 4 (R2) and August 14 (R3), 1964. After 7 days at 70°F, all fruit was inspected for storage disorders.

Firmness readings were made on 10 fruit taken at random from each case, using a Magness penetrometer with the  $\frac{7}{16}$  in. plunger. Readings were taken on opposite sides of each apple and the mean of 10 readings was recorded.

### Results

The results are summarized in Table 1.

The incidence of soft scald and bitter pit was slight, irrespective of the atmosphere in which the fruit was held. Superficial scald occurred only in the fruit held in the controlled atmosphere and was of importance only in fruit of the first maturity. No analysis of variance was carried out on the figures for the occurrence of these disorders.

TABLE 1  
MEAN PERCENTAGES OF DEFECTS IN JONATHAN APPLES AFTER REMOVAL FROM COOL STORE

	Superficial Scald	Soft Scald	Jonathan Spot	Mould	Soggy Break-down	Bitter Pit	Total Disorders	Firmness (lb)
<i>Removal 1</i>								
<i>Maturity 1</i>								
Normal air storage	0.00	2.73	25.40	10.38	16.16	0.00	46.45	10.75
16% O <sub>2</sub> + 5% CO <sub>2</sub>	11.12	2.12	1.30	1.19	15.88	0.30	32.29	10.06
<i>Maturity 2</i>								
Normal air storage	0.00	2.67	29.69	16.53	38.94	1.08	66.02	10.07
16% O <sub>2</sub> + 5% CO <sub>2</sub>	0.00	1.34	1.58	8.45	34.85	0.85	39.75	10.21
<i>Maturity 3</i>								
Normal air storage	0.00	0.51	40.20	35.18	83.34	0.00	93.90	7.96
16% O <sub>2</sub> + 5% CO <sub>2</sub>	0.00	0.00	1.64	16.33	66.41	0.00	70.62	10.05
<i>Removal 2</i>								
<i>Maturity 1</i>								
Normal air storage	0.00	1.52	23.41	10.12	24.52	1.56	47.43	12.26
16% O <sub>2</sub> + 5% CO <sub>2</sub>	20.66	0.68	0.56	2.68	24.56	0.45	47.89	13.08
<i>Maturity 2</i>								
Normal air storage	0.00	3.14	28.71	18.40	43.83	0.51	65.46	11.06
16% O <sub>2</sub> + 5% CO <sub>2</sub>	0.00	0.00	2.12	8.49	35.32	0.00	41.08	11.73
<i>Maturity 3</i>								
Normal air storage	0.00	0.63	47.41	33.71	87.33	0.74	97.15	9.98
16% O <sub>2</sub> + 5% CO <sub>2</sub>	0.00	0.00	15.89	18.37	68.45	0.30	74.47	11.54
<i>Removal 3</i>								
<i>Maturity 1</i>								
Normal air storage	0.00	3.59	29.54	12.27	28.36	2.36	53.43	12.14
16% O <sub>2</sub> + 5% CO <sub>2</sub>	18.41	0.25	0.00	3.82	20.09	0.00	40.28	12.39
<i>Maturity 2</i>								
Normal air storage	0.00	1.28	32.71	24.30	49.54	1.32	71.25	11.06
16% O <sub>2</sub> + 5% CO <sub>2</sub>	0.67	0.22	0.61	6.37	32.62	0.00	39.03	11.52
<i>Maturity 3</i>								
Normal air storage	0.00	0.56	49.37	40.83	84.29	0.89	95.38	10.79
16% O <sub>2</sub> + 5% CO <sub>2</sub>	0.00	0.00	2.27	20.36	80.15	0.00	82.06	11.18

No analysis of variance carried out for soft scald, bitter pit or superficial scald

*Jonathan Spot*

No significant difference between removals.  
16% O<sub>2</sub> + 5% CO<sub>2</sub> significantly less than air storage (1% level).  
Maturity 1 significantly less than maturity 3 (1% level).  
Maturity 2 significantly less than maturity 3 (1% level).

*Mould*

No significant difference between removals.  
16% O<sub>2</sub> + 5% CO<sub>2</sub> significantly less than air storage (1% level).  
Maturity 1 significantly less than maturity 2 (1% level).  
Maturity 1 significantly less than maturity 3 (1% level).  
Maturity 2 significantly less than maturity 3 (1% level).

*Soggy Breakdown*

No significant difference between removals.  
16% O<sub>2</sub> + 5% CO<sub>2</sub> significantly less than air storage (1% level).  
Maturity 1 significantly less than maturity 2 (1% level).  
Maturity 1 significantly less than maturity 3 (1% level).  
Maturity 2 significantly less than maturity 3 (1% level).

*Total Disorders*

No significant difference between removals.  
16% O<sub>2</sub> + 5% CO<sub>2</sub> significantly less than air storage (1% level).  
Maturity 1 significantly less than maturity 2 (5% level).  
Maturity 1 significantly less than maturity 3 (1% level).  
Maturity 2 significantly less than maturity 3 (1% level).

*Firmness*

Removal 2 significantly firmer than removal 1 (1% level).  
Removal 3 significantly firmer than removal 1 (1% level).  
16% O<sub>2</sub> + 5% CO<sub>2</sub> significantly firmer than air storage (1% level).  
Maturity 1 significantly firmer than maturity 2 (1% level).  
Maturity 1 significantly firmer than maturity 3 (1% level).  
Maturity 2 significantly firmer than maturity 3 (1% level).

Wastage from Jonathan spot was significantly affected by maturity and storage atmosphere. There was significantly less in fruit stored in the controlled atmosphere than in fruit stored in air. Fruit of the third maturity had significantly more Jonathan spot than that from the first or second maturity. There was no significant difference in wastage between the three removals.

Fruit of the third maturity had significantly more mould than that from the second maturity, which in turn had significantly more mould than fruit of the first maturity. Mould was significantly higher in fruit in air than in fruit stored in the controlled atmosphere. There was no significant difference in mould incidence between the three removals.

Wastage from soggy breakdown was significantly affected by maturity and storage atmosphere. Fruit of the third maturity had significantly more breakdown than fruit of the second maturity, which in turn had significantly more breakdown than fruit of the first picking. There was significantly less breakdown in fruit stored in the controlled atmosphere than in fruit stored in air.

Wastage from all storage disorders was significantly affected by atmosphere and maturity. There was significantly less wastage in fruit in the controlled atmosphere than in fruit stored in air. Fruit of the third maturity had a significantly higher percentage of wastage than fruit of the second maturity, which in turn had a significantly higher percentage of wastage than fruit of the first maturity. There was no significant difference in wastage between the three removals.

The firmness of the fruit as measured by the Magness penetrometer was significantly affected by atmosphere, removal and maturity. Sound fruit of the second and third removal was significantly firmer than fruit from the first removal. Also, sound fruit of the second and third maturity was significantly firmer than fruit of the first maturity. Because of the high incidence of soggy breakdown in the later removals, only certain fruit could be selected for firmness measurement. Thus firmness readings made under these conditions give no indication of the true condition of the fruit.

### Discussion

These results indicate that soggy breakdown is a serious storage disorder in Queensland-grown Jonathan apples. Although fruit stored in the controlled atmosphere had significantly less wastage than fruit stored in air, the incidence of the disorder in both treatments was too high to allow economic storage for five months.

The results obtained in the present experiment supported the findings of Trout, Tindale, and Huelin (1940) and Smock and van Doren (1941) in relation to Jonathan spot reduction in controlled atmosphere storage.

### REFERENCES

- SMOCK, R. M., and VAN DOREN, A. (1941).—Controlled-atmosphere storage of apples. Bull. Cornell Agric. Exp. Sta. No. 762.
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