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# METABOLISM OF ADDED GIBBERELLIC ACID IN *MALUS PUMILLA* IN RELATION TO COOL STORAGE BREAKDOWN

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**Key Word Index**—*Malus pumilla;* Rosaceae; apple; low temperature breakdown; effect of gibberellic acid.

**Abstract**—Gibberellic acid ($GA_3$) that was injected into the core of apples to reduce internal breakdown, was found to accumulate in the cortical tissue during cool storage only to a limited extent and never exceeded 0·5% of the added dose. Limitations on the commercial use of $GA_3$ would appear to be associated with the low level of incorporation into susceptible tissue.

LOW TEMPERATURE breakdown is a physiological disorder of cool stored apples that results in browning of cortical tissue and hence causes severe economic losses in susceptible varieties. The incidence of the disorder can be reduced by post-harvest application of $GA_3$[1,2] but the commercial use of $GA_3$ is limited by its high cost.

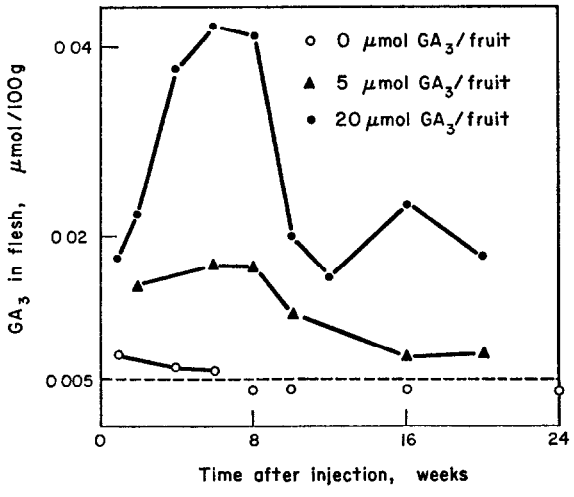


FIG. 1. LEVELS OF $GA_3$ IN CORTICAL TISSUE OF APPLES THAT HAVE BEEN INJECTED WITH $GA_3$ IN THE CORE.
Values determined by fluorometry. Limit of detection was $5 \times 10^{-3}$ μmol/100 g tissue.

The results in this paper (Fig. 1) show that the level of $GA_3$ in the cortical tissue of Jonathan apples during cool storage was increased by injection of $GA_3$ into the core but that the maximum level accumulated never exceeded 0·5% of the added dose. While the inci-

[1] WILLS, R. B. H. and PATTERSON, B. D. (1971) *Phytochemistry* **10**, 2983.
[2] WILLS, R. B. H. and SCOTT, K. J. (1972) *J. Hort. Sci.* **47**, 389.

dence of breakdown (22% in untreated fruit) was reduced significantly ($p = 0{\cdot}05$) by the addition of $GA_3$, there was no difference in breakdown between fruit with 5$\mu$ mol (13%) and 20 $\mu$mol (14%) added. This suggests that maximum inhibition of breakdown is achieved by relatively small increases in the level of $GA_3$ ($<0{\cdot}015$ $\mu$mol/100 g tissue).

Thus, the amount of $GA_3$ that would need to be applied to fruit for maximum inhibition of breakdown could be greatly reduced if more efficient methods of transporting $GA_3$ could be found. Commercial use of $GA_3$ would then become economically possible.

## EXPERIMENTAL

*Treatment of fruit.* Mature Jonathan apples were distributed into 60 units each with 5 fruit/unit. The fruit from 20 of the units were each injected in the core area with a solution containing 5 or 20 $\mu$mol $GA_3$ in 0·2 ml EtOH. All fruit were then stored at $-1°$. At various intervals, a 50-g sample of cortical tissue was obtained from each of 2 units/treatment. The samples were frozen in liquid nitrogen and assayed for $GA_3$. The effect of $GA_3$ on breakdown was determined by distributing Jonathan apples from the same orchard into 36 units each with 25 fruit/unit. The units were injected with $GA_3$ as above and stored at $-1°$ for 22 weeks. All fruit were then transferred to 20° and after 7 days were examined for presence of breakdown.

*Extraction of $GA_3$.* The frozen sample was blended with $CH_2Cl_2$ (100 ml) for 5 min. The $CH_2Cl_2$ layer was removed, dried ($Na_2SO_4$) and filtered. The apple residue was washed with $CH_2Cl_2$ (100 ml) which was removed, dried (using the same $Na_2SO_4$) and filtered. The $Na_2SO_4$ residue was washed with $CH_2Cl_2$ (50 ml) and filtered. The combined filtrate was evaporated to dryness and the residue was re-dissolved in $CH_2Cl_2$ (5 ml).

*Estimation of $GA_3$.* $GA_3$ was isolated by TLC using a modification of the method reported by Jones *et al.*[3] This involved a 2-D separation on silica gel G with (a) EtOAc, then (b) an iso-PrOH–$H_2O$ (5 . 1). The $GA_3$ was detected on the plate by its fluorescence under UV-light after treatment with $H_2SO_4$. The $GA_3$ spot was eluted with EtOH which was then evaporated off. $H_2SO_4$ (85%) (5 ml) was added and the solution was allowed to stand for 2 hr. The fluorescence of the solution was measured in a Coleman Photofluorometer (Model 12C with filters No. 12–221 (source) and No. 14–211 (counter). The amount of $GA_3$ was determined from a standard curve prepared with pure $GA_3$.

[3] JONES, D. F., MACMILLAN, J. and RADLEY, M. (1963) *Phytochemistry* **2**, 307.