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SHORT COMMUNICATION

EFFECT OF HEXYL COMPOUNDS ON SOFT SCALD OF APPLES

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Abstract—Various hexyl compounds were injected into Jonathan apples to examine their effect on soft scald Hexanol was the most effective compound for inducing the disorder. Hexyl acetate, hexyl butyrate and hexanal also increased the level of soft scald. Sixteen other compounds had no effect.

INTRODUCTION

SOFT SCALD (syn: deep scald) is a physiological disorder which affects certain varieties of apples when they are stored at about 0°.[1] It affects patches of skin and the underlying flesh and there is a clear demarcation between the brown skin or flesh and unaffected tissue, which is characteristic of the disorder.

The metabolic changes associated with the disorder are not known, but Wills and Scott[2] found that hexanol and hexyl acetate induced the disorder when they were injected into the core of the fruit. This paper reports studies which extended this finding by examining the effect of a wide range of hexyl compounds on the incidence of soft scald in Jonathan apples.

RESULTS AND DISCUSSION

The results in Table 1 show that four compounds markedly increased soft scald. Hexanol induced the highest level of soft scald in the fruit while hexyl acetate and hexanal produced more than hexyl butyrate. The other compounds had no effect on the incidence of the disorder.

The compounds which induced soft scald all have similar structures in that they contain a straight chain alkyl radical of six carbons with the reactive group on the terminal carbon atom. As hexanol is the compound most effective in producing soft scald it would seem to be more likely to be more directly involved in the production of soft scald than the other compounds. The other effective compounds could act by being converted to hexanol by the apple. The amount of soft scald produced by these compounds would then be a measure of their conversion to hexanol. A causative role for hexanol is feasible as Wills[3] found that hexanol was one of the main volatile compounds produced by similar apples from the Batlow district. Hexyl acetate was also produced by these fruit but hexanal and hexyl butyrate were not found in any quantity.

Other compounds examined which have a straight chain, six-carbon alkyl group with a terminal reactive group are hexyl chloride, hexylamine, hexanoic acid and ethyl hexanoate.

[1] F. KIDD and C. WEST, *Functional Diseases of Apples in Cold Storage*, Br. Dep. Sci. Ind. Res. Food Invest. Spec. Rept. No. 23 (1925).
[2] R. B. H. WILLS and K. J. SCOTT, *Phytochem.* **9**, 1035 (1970).
[3] R. B. H. WILLS, *J. Sci. Food Agric.* **19**, 354 (1968).

Their inability to induce soft scald would suggest that they cannot be converted to hexanol by the apple.

The ability of a compound to induce soft scald was eliminated when the hexanol structure was slightly modified by either placing the alcohol group on a non-terminal carbon atom or destroying the straight chain configuration (e.g. 1,2-hexanediol, cyclohexanol and 4-methylpentan-2-ol). Similarly, 2-hexanone was inactive whereas hexanal was active. The unsubstituted hydrocarbons (e.g. hexane, 1-hexane, 1-hexyne, hexycyclohexane) were also inactive.

TABLE 1. SOFT SCALD IN APPLES INJECTED WITH VARIOUS HEXYL COMPOUNDS

Compound	Year	Soft scald (%) 1970	1971
Hexanol		61[a]	66[d]
Hexyl acetate		51[b]	55[e]
Hexanal		51[b]	51[e]
Hexyl butyrate		24[c]	
1,2-Hexandiol			2
Cyclohexanol			1
sec-Hexanol (4-methylpentan-2-ol)		1	
2-Hexanone		1	
Hexylamine			4
Hexyl chloride			1
Hexane			3
1-Hexene			3
1-Hexyne			1
Hexanoic acid		1	
Ethyl hexanoate		4	
Hexylcyclohexane			3
Octanol		5	
Octyl acetate		3	
Hexyl ether			2
Dodecanol			2
Ethanol (control)		1	5

Each value is the mean of 150 fruit (6 replicates × 25 fruit).

a–e indicate values which are significantly different from each other at the 5% level.

No suggestion can yet be made as to the metabolic pathway by which hexanol induces soft scald. However, it would not be by a normal 2-carbon addition to hexanol which produces octanol, nor by a dimerisation type reaction producing hexyl ether or dodecanol.

EXPERIMENTAL

Mature Jonathan apples were harvested from a commercial orchard at Batlow, N.S.W. and randomly distributed into units, each of 25 fruit. The fruit were stored at −1° for 1 week when they were injected in the core area with 60 μmole of the compounds dissolved in 0·2 ml EtOH. The fruit were stored at −1° for a further 8 weeks, transferred to 20° and examined for soft scald after 7 days.

The percentages of fruit affected with soft scald, for the compounds which produced appreciable amounts of the disorder, were transformed to angles by the arcsin transformation and the standard errors were calculated. A *t*-test was used to determine whether the compounds produced different levels of soft scald. The standard errors were −1·8° on 20 *d.f.* (1970) and 2·2° on 15 *d.f.* (1971).

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Key Word Index—Malus pumila; Rosaceae; apple; soft scald induction; hexanol; hexyl esters.