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THE COMPOSITION OF THE EXPRESSED SAP FROM COLD STORED POTATOES

FREDERICK A. ISHERWOOD and MICHAEL G. H. KENNEDY

Agricultural Research Council, Food Research Institute, Colney Lane, Norwich, NOR 7OF

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Key Word Index—*Solanum tuberosum*; Solanaceae; potato; expressed sap; composition; temperature; sweetening.

Abstract—Analysis of the chemical composition of expressed sap from potatoes stored at low temperatures (2°) indicates that an increased amount of inorganic phosphate is present in the juice from the cytoplasm and vacuole.

The sap expressed from unfrozen plant tissues by direct pressure in an hydraulic press consists of a mixture of fluids from different parts of the cell, and while a sharp separation between the fluids derived from the cytoplasm and the vacuole is not possible [1], it seems likely that a large part of the liquid removed at low pressure is derived from the vacuoles [2, 3]. The technique has been used in the past as a crude method of compartment analysis. The results obtained are in marked contrast to those found when the tissue is first frozen, then thawed and pressed. In this case a much larger amount of sap can be expressed at low pressure but the composition approximates to that calculated for the whole cell. Because of the almost complete disorganization of the tissue, there is little possibility of sequential expression of the sap from the various compartments of the cell.

Assuming that the composition of the sap expressed from unfrozen potatoes gives a rough indication of the contents of the vacuole and cytoplasm, it was of interest to measure the effect that cold storage has upon the contents of the cytoplasm and vacuole, particularly the amount of orthophosphate present. Orthophosphate is known to have a pronounced effect on a number of carbohydrate enzymes and on the activity of mitochondria and changes in the amount present could well explain the "sweetening" of potatoes at low temperature and the corresponding rise in respiration.

In the present experiments, potatoes (cv. King Edward) from which the peel and cortex had been removed, were diced, and 100 g wrapped in nylon cloth, and crushed in an hydraulic press (maximum pressure 250 kg/cm^2 in 15 min). The expressed juice was collected sequentially in fractions of 10 ml. In some experiments the potato tissue was frozen and thawed before being crushed. The results are shown in Fig. 1 for potatoes which have been stored at 10° and also for those transferred to 2°. Only the figures for P$_i$ are given but the curves for K^+, Cl^- and protein show a similar characteristic shape [1]. The shape of the curves for frozen material are quite different.

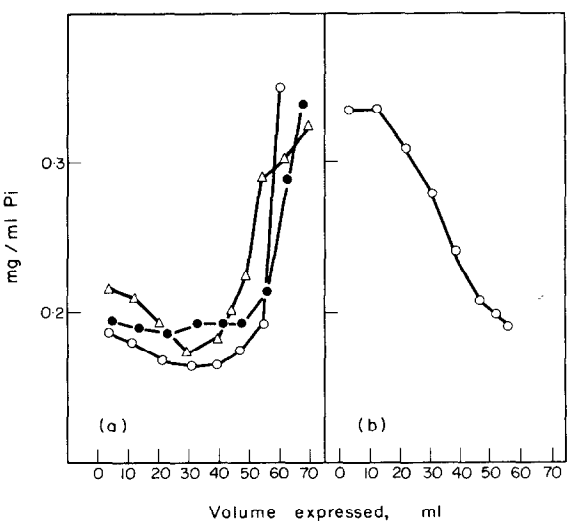

Fig. 1. Composition of the sap expressed from potatoes stored at 10° and 2°. (a) Pi —○— 10°; —●— storage for 4 days at 2° after transfer from 10°; —△— 7 days at 2° after transfer from 10°. (b) Pi —○— after freezing and thawing.

It is noticeable that the sap expressed in the earlier increments from potatoes which had been stored at 2° contain more P_i than from potatoes stored at 10°. The amount is greater the longer the potatoes have been stored at 2°. This suggests that P_i is either being transported into the cytoplasm and vacuole from another organelle or is being produced enzymically from a phosphate compound. Discs cut from potatoes stored at 2°, as compared with similar discs cut from potatoes stored at 10°, show a several-fold greater leakage of salts into both water and 0·25 M sucrose, suggesting that either the salt concentration of the cytoplasm or vacuole is higher or that the membranes are more "leaky". It is significant that recent work in this laboratory in which amyloplasts have been isolated by a non-aqueous method has shown that they contain high concentrations of K^+, Cl^-, citrate and P_i. It is therefore possible that the P_i leaks from the amyloplast under cold storage conditions and induces changes in the sugar levels and respiration of the cold stored potato.

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