organic phases were conc. under N_2. The solid was redissolved in either 200 μl of EtOAc or 2 ml of the HPLC mobile phase. The TLC conditions have been defined elsewhere [6–8].

A Bioanalytical Systems Model LC-30 liquid chromatograph (West Lafayette, Indiana) was used with a 'slurry packed' 15 cm microparticulate C_{18} (Waters Associates) column. The mobile phase consisted of a mixture of 400 ml of 0.1 M ammonium acetate, 20 ml of spectrograde MeOH, and 8 ml of 0.1 M octyl sodium sulfate. The potential of the amperometric detector was controlled at +950 mV vs S.C.E.

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SUGAR ACCUMULATION IN CHEMICALLY DEBUDDED POTATO TUBERS DURING COLD STORAGE

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Key Word Index—*Solanum tuberosum*; Solanaceae; potato; starch–sugar conversion at low temperature; chemical debudding; tuber aging.

Abstract—Potato tuber buds may be excised by immersion of the tubers in a mixture of EtOH–Me_2CO (1:1) for 4 hr. This enabled the study of the effect of tuber aging (at 17°) on the starch-to-sugar conversion during storage at 4°, in the absence of complications due to sprouting. Sugar accumulation during a two-week period of storage at 4° decreased with increasing time of prior storage at 17°.

INTRODUCTION

For a variety of reasons it is considered best to store potatoes at 4° [1]. Storage of potato tubers at such low temperatures, however, is associated with starch degradation and concomitant sugar accumulation. This phenomenon is not only interesting from a biochemical and physiological standpoint [2–4], but it also has important implications in the commercial processing of potatoes [5].

In the course of our study of the control of starch–sugar conversion in the local 'Up-to-Date' potato variety, it was difficult to maintain a continuous supply of tubers because of the appearance of sprouting during storage at 17°. Attempts to overcome this by spraying the growing plants with maleic hydrazide, treating the stored tubers with CIPC, or excising the sprouts by hand, were unsuccessful because of undesirable side effects. This paper describes a new chemical debudding technique and its use in a study of the effect of tuber aging on starch–sugar conversion at low temperature.

RESULTS AND DISCUSSION

Attempts to debud potato tubers with 95% EtOH, which has been used successfully to debud cucumber plants [6], delayed tuber sprouting for a short period only. Absolute EtOH delayed sprouting for two months, apparently due to its effect as a dehydrating agent.

In an attempt to improve the effectiveness of EtOH, the effect of other compounds (urea, Me_2CO) known to aid penetration into plant tissues [7] was tested. Mixtures of EtOH and urea caused brown patches and sunken areas on the tuber surface, but mixtures of EtOH and Me_2CO did not produce such side effects and were very effective in debudding the tubers (Table 1). Better results were obtained with mixtures of EtOH–Me_2CO; immersion in this mixture debudded the tubers completely. Such chemically debudded tubers were kept at 17° and 90% rel. humidity for up to 9 months without noticeable changes in appearance.

Analysis showed that for *ca* 110 days storage at 17° the level of sugar was comparable in intact and in chemically

Table 1. Effects of ethanol and acetone on debudding of potato tubers

Treatments	Immersion time (min)	Storage period (days) 60	90	120	150	180	210
		(% of sprouting tubers*)					
Control		40	100	100	100	100	100
H_2O	240	80	100	100	100	100	100
EtOH–Me_2CO (1:1)	30	—	—	—	—	30	70
	60	—	—	—	—	60	100
	120	—	—	—	—	10	20
	240	—	—	—	—	—	—

Harvest date 28 December 1974; Storage at 17°, 90% relative humidity; each treatment was applied to ten tubers.
* 'Sprouting tuber' refers to the appearance of the first sprouts; (—) denotes no sprouting.

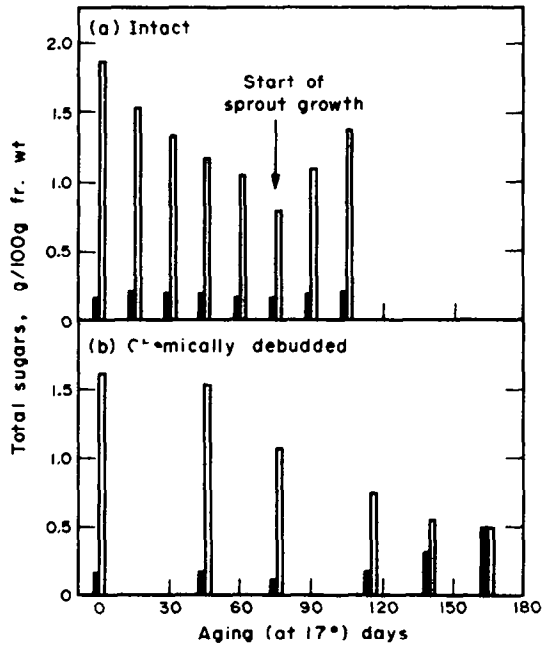

Fig. 1. Long-term kinetic experiment with intact and with chemically debudded tubers. Potatoes were harvested in December and divided into two groups. Tubers in group a were left intact and those in group b were chemically debudded. The tubers were aged at 17° for the times shown on the abscissa. At the indicated times, tubers were transferred to storage for 15 days at 4°. Sugar analysis was performed before and after 15 days of storage at 4°.

debudded tubers (Fig. 1, filled blocks). Elevation in sugar content was noticed in chemically debudded tubers after *ca* 120 days (Fig 1b, filled blocks), a phenomenon which is recognized in the literature as 'senescent sweetening' [3]. In both groups, sugar content increased in a similar manner as a result of storage at 4° for 15 days (Fig. 1, empty blocks). After *ca* 45 days storage at 17° this response to storage at 4° in both intact and in chemically debudded tubers decreased slowly.

Once sprouting occurred in intact tubers (after storage for *ca* 80 days at 17°), there was a renewed increased accumulation of sugar in response to cold storage; the magnitude of this response increased with further storage the tubers (Fig 1). In chemically debudded tubers, where no sprouting occurred at all, the amount of sugar accumulating in the tuber following 15 days of cold storage declined continuously throughout storage at 17°. (Fig 1). On the basis of the above results, it can be concluded that the prevention of sprouting by this simple chemical debudding technique has many implications both for the commercial handling of potatoes and as a tool in studies of the effects of storage at low temperature on tubers in the absence of complications due to sprouting.

EXPERIMENTAL

The commonly grown local potato (*Solanum tuberosum* L.) variety 'Up-to-Date' was harvested at the Gilat Experiment Station, Israel, in the autumn (December) and spring (May). Undamaged tubers, *ca* 125–150 g each, were washed, dried, and stored for two weeks at 17° and 90% rel. humidity, to ensure good suberization. The potatoes were then divided into two groups, one of which was chemically debudded while the other was left intact. Both groups were further stored at 17° and 90% rel. humidity.

Chemical debudding. After the technique was developed and tested (see Results), the routine preparation of debudded tubers for extended storage at 17° involved immersion of the tubers in EtOH–Me_2CO (1:1) for 4 hr followed by drying. No sign of injury was detected on the skin (periderm) of the tubers except for a blackening of the bud surface.

Sugar determination. Peeled potato (10 g) was homogenized in an Ommi-mixer blender for 3 min. The sugars were extracted for 1 hr with 80% EtOH in a Soxhlet extractor (using a filter glass timble). Reducing sugars were determined by the method of ref. [8]. Sucrose was hydrolyzed to reducing sugars by invertase and the amount of total reducing sugars was determined (as above). The difference between total reducing sugars and reducing sugars (after and before invertase hydrolysis, respectively) was used as a measure of sucrose content. The data presented regarding sugar content are the average of samples taken from three tubers: standard errors were less than ±7% of the mean.

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