Effect of Sprout Inhibitor Isopropyl N-(3-Chlorophenyl)carbamate (CIPC) on Phenolic and Ascorbic Acid Content of Potatoes

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The effect of the sprout inhibitor isopropyl N-(3-chlorophenyl)carbamate (CIPC) on phenolic and ascorbic acid contents of Katahdin and Chipbelle potatoes, stored for 2 months at 5 and 25 °C, was investigated. The tubers were grown at Cornell Research Farms at Freeville, NY, and Riverhead, Long Island. The phenolic content was higher in CIPC-treated tubers than their respective controls. CIPC-treated Katahdin tubers stored at 5 °C were significantly ($p < 0.05$) higher in phenolic content than CIPC-treated tubers stored at 25 °C. A similar trend was observed when controls were compared at these storage temperatures. CIPC-treated tubers stored at 5 °C were significantly ($p < 0.05$) lower in ascorbic acid content in both cortex and pith tissues than the controls. All tubers stored at 25 °C had higher ascorbic acid content than those stored at 5 °C. Katahdin tubers were significantly ($p < 0.05$) higher in phenolic and ascorbic acid contents than Chipbelle tubers.

INTRODUCTION

Sprouting markedly reduces the acceptability of stored potatoes due to weight and nutrient loss, as well as softening. Sprouted tubers are highly susceptible to bruising. Large sums of money are spent annually to prevent or delay sprouting. Methods that have been used to prolong the dormancy period of the potato tuber include (1) low-temperature storage, (2) chemical sprout inhibitors, and (3) irradiation of tubers.

Isopropyl N-(3-chlorophenyl)carbamate (CIPC) is one of the most widely used sprout inhibitors, and CIPC can be applied through circulation in the air or as dust over the tuber. An emulsifiable formulation is also used to treat potatoes coming out of storage and to control sprouting in marketing channels (Talburt and Smith, 1975).

CIPC influences many aspects of tuber metabolism while effectively inhibiting sprout growth (Koch, 1978; Klein, 1982). Previous work in our laboratory has shown that CIPC treatment increased enzymatic discoloration and phenolic content and reduced crude and phospholipid contents of potato tubers stored at 5 °C for 1 month (Koch, 1978). Phenolic content of tubers was found to be positively correlated with enzymatic discoloration (Mondy et al., 1967), and enzymatic discoloration was found to increase with maleic hydrazide (MH), another sprout inhibitor that is commonly used in the U.S. (Mueller and Mondy, 1977).

Another important chemical constituent in the potato tuber related to enzymatic discoloration is ascorbic acid. Ascorbic acid is also important to the nutritive value and has been used to delay enzymatic discoloration of cut surfaces of fruits and vegetables. Ascorbic acid inhibits discoloration by reducing o-quinones to o-diphenols. The ascorbic acid content of tubers is related to variety and storage (Birecki et al., 1964). Tubers stored at 20 °C resulted in higher ascorbic acid than the tubers stored at 4.4 °C (Panalaks and Palletier, 1960). Ascorbic acid is more concentrated at the bud end of the tuber (Baird and Howatt, 1948).

Many countries lack cold storage facilities and must rely on other methods of sprout control. Even in countries where cold storage is available, sprout inhibitors are used frequently. Therefore, it is important to know the effect of sprout inhibitors such as CIPC on the phenolic and ascorbic acid content of tubers.

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This study was undertaken to investigate the effect of CIPC on phenolic and ascorbic acid contents of potato tubers stored at two different temperatures.

MATERIALS AND METHODS

Two cultivars, Katahdin and Chipbelle, grown at the Cornell Vegetable Research Farms at Freeville, NY, and Riverhead, Long Island, were used in this study. The tubers were harvested 23 weeks following planting and were stored at 5 °C in the dark for 1 month prior to CIPC treatment. Eighty medium-sized tubers were randomly divided into four groups. Two groups were dipped for 5 min in a 1% CIPC aqueous emulsion, and the other two groups were dipped in water and served as controls. After dipping, the tubers were allowed to air-dry for 20 min, and each group was placed in kraft paper bags. All four groups were stored at either 5 or 25 °C in the dark for 2 months and then analyzed.

Tubers were cut longitudinally from bud to stem end in order to include both apical and basal portions. Slices were subsequently separated into cortex and pith sections. Cortex tissue including the periderm was used for the determination of phenols since this is the area of highest metabolic activity. Duplicate determinations were made on the controls as well as CIPC-treated tubers. For ascorbic acid analysis, both cortex (including the periderm) and pith tissues were used.

Determination of Phenols. Phenolic content of the tubers was determined colorimetrically using the method described by Mondy et al. (1966) using tannic acid as a standard.

Determination of Acid. L-Ascorbic acid content was determined by using the indophenol method (AOAC, 1970).

Statistical Analysis. Completely random design was employed, and statistical significance of the data was determined using 2 × 2 or 2 × 2 × 2 factorial analysis of variance with protected LSD test described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Phenols. At both storage tempertures the phenolic content of cortex tissue was higher in the tubers treated with CIPC than their respective controls (Figure 1). Previous work in our laboratory showed that treatment with CIPC increased significantly the phenolic content of the tubers when stored at 5 °C for 1 month (Koch, 1978).

Katahdin tubers stored at 5 °C showed a significant ($p < 0.05$) increase in phenolic content when compared to the tubers stored at 25 °C. This was true for both the controls and those treated with CIPC. The Chipbelle cultivar,

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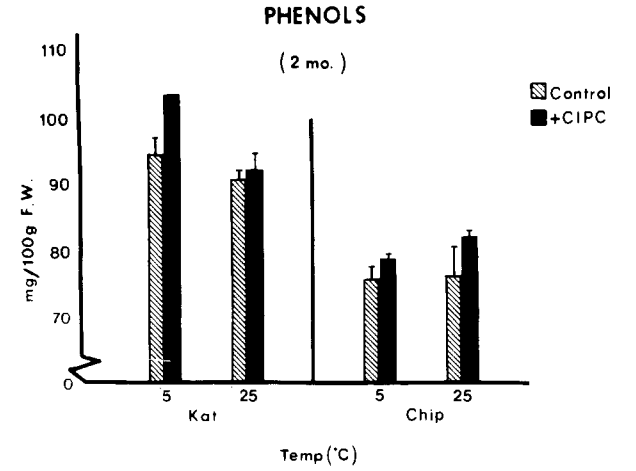

Figure 1. Effect of CIPC on phenolic content of cortex tissue of Katahdin and Chipbelle tubers stored at 5 and 25 °C for 2 months.

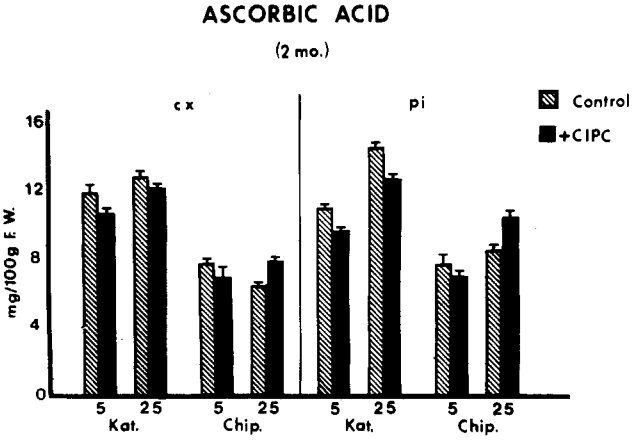

Figure 2. Effect of CIPC on ascorbic acid content of Katahdin and Chipbelle tubers stored at 5 and 25 °C for 2 months: cx, cortex; pi, pith.

however, did not show significant differences in phenolic content with different storage temperatures.

Varietal differences in phenolic content were significant. Katahdin tubers were sigificantly ($p < 0.05$) higher in phenolic content than Chipbelle.

Koch (1978) reported that CIPC treatment increased enzymatic discoloration and phenolic content and reduced crude and phospholipid contents of potato tubers stored at 5 °C for 1 month. CIPC is reported to inhibit cell activity at all stages of cell division (Bystrova, 1974), and numerous reports have been published on the accumulation of phenolic compounds in plant tissues in response to infection (Kosuge, 1969) or stress (Mueller and Mondy, 1977). Perhaps the increase in phenolic content in CIPC-treated tubers was due to a cellular stress response to CIPC.

Ascorbic Acid. Tubers treated with CIPC and stored at 5 °C were significantly lower ($p < 0.05$) in ascorbic acid than the controls (Figure 2). Katahdin tubers treated with CIPC showed the same trend when stored at 25 °C, but Chipbelle tubers increased significantly ($p < 0.05$) in ascorbic acid following CIPC treatment.

Tubers stored at 25 °C resulted in higher ascorbic acid content than the tubers stored at 5 °C. This was true for the controls as well as those treated with CIPC. Panalaks and Pelletier (1960) also found that ascorbic acid retention was higher in tubers stored at the higher temperature, but no CIPC treatment was included in their study.

Katahdin tubers stored at 5 °C had significantly ($p < 0.05$) lower ascorbic acid in the pith than the cortex tissue, but cortex and pith tissues of Chipbelle tubers stored at 5 °C showed no significant differences. In both Katahdin and Chipbelle varieties, tubers stored at 25 °C had higher ascorbic acid content in the pith than the cortex tissue.

Varietal differences were significant. Katahdin tubers were significantly ($p < 0.05$) higher in ascorbic acid content than Chipbelle.

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