NATURAL SPROUT INHIBITORS - WHAT DO TREATED POTATOES TASTE LIKE?

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Potato storage is a necessity for maintaining a source of raw product for the industry, allowing for a significant increase in the value of the crop. Effective potato storage should minimize moisture loss, respiration, rot and sprouting. Generally our industry has dealt with long term storage of potatoes by combining temperature control with the use of chemical sprout inhibitors. While several sprout inhibitors have been used in the US, isopropyl N-(3-chlorophenyl) carbamate (CIPC) has been the dominant chemical inhibitor. However, concerns regarding the toxicity of CIPC exist and regulatory and customer acceptance will continue to be an issue in use of the compound. While a number of countries accept potato products derived from CIPC treated tubers, regulatory status is uncertain for the fresh and value-added potato industry. Japan, Korea and Taiwan currently lack codified CIPC tolerance levels (Wehr, 1992). In addition, certain overseas customers are demanding potato products from CIPC-free tubers. Because of these concerns, natural, effective alternatives to CIPC are highly desirable to expand markets and to protect and enhance existing markets for processed potato products.

Several natural alternatives to CIPC have been suggested (Filmer and Rhodes, 1984; Meigh, 1969; Vaughn and Spencer, 1991; Vaughn and Spencer, 1992). These natural sprout inhibitors include monoterpenes, aromatic aldehydes and alcohols that are components of essential oils and have Generally Accepted as Safe (GRAS) status. Alkyl naphthalene derivatives are also possible alternatives but do not have GRAS status. The effectiveness of these compounds as inhibitors has been observed and antifungal activity on potatoes for some also noted. Salicylaldehyde, cineole, cinnamaldehyde, cuminaldehyde, thymol, linalool, terpinen-4-ol, and fenchone in particular have been shown to combine sprout inhibitor activity with fungitoxicity (Vaughn and Spencer, 1991; Vaughn and Spencer, 1992).

Our work has been aimed at evaluation of selected natural sprout inhibitors in terms of their effects on tuber quality. More specifically, we have begun work to examine the sensory and flavor effects of these compounds on potatoes and potato products.

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Materials and Methods

All chemicals used were reagent grade. Initial application of sprout inhibitors was done by equilibration of tubers with the terpene or aromatic aldehyde compounds. For example, we held tubers in a tightly closed 5 gallon bucket with 50 ml of cineole, menthol, or salicylaldehyde (and 100 ml water to provide humidity) for 6 days at room temperature. At the end of the 6 day period only control tubers had sprouted. The tubers were transferred to a 50°F system with continuous air flow and observations made periodically.

Based on our preliminary observations concerning the effectiveness of salicylaldehyde as an inhibitor, we exposed tubers to salicylaldehyde vapors in closed containers for 1, 3, or 6 days. Three days after removing the tubers from the closed containers a duo-trio difference sensory panel was done. The tubers were wrapped in aluminum foil and baked 105 min at 400°F. Baked tubers were divided into wedges and served warm after holding for no longer than 20 min. Panelists were asked to indicate if they could detect a difference when comparing each of two test samples to a reference sample, one test sample being identical to the reference. Panelists were provided with unsalted crackers and water for clearing the palate between samples.

Tubers were also received from the University of Idaho, Kimberly. In 1993, these were restricted to salicylaldehyde treated tubers. These tubers were subjected to a difference panel as noted above. We compared the salicylaldehyde treated tubers to both a CIPC treated sample as well as a no treatment control. In 1994, we also received tubers from UI, Kimberly. Because we had gained human subjects approval, we were able to test naphthalene derivative treated tubers as well as salicylaldehyde treated tubers. Tubers had been treated by thermofogging with 300 ppm salicylaldehyde, dimethylnaphthalene (DMN) or diisopropylnaphthalene (DIPN), using a single or split application. Tubers were received in April and examined by difference panel. A second series of samples were received in May from the same treatment lots and were evaluated by a preference panel.

The same protocol was used for preparation of samples for the preference panel as was used for the difference panels. Panelists were asked to indicate on a 9 point scale their preference for flavor, texture and acceptability of the baked tuber piece.

To determine threshold of detection of cineole, dimethylnaphthalene and salicylaldehyde these compounds were added to rehydrated potato granules and served in an ascending duo-trio test. In this test, panelists were served a series of mashed potatoes (from dehydrated) to which increasing amounts of the compound was added. At some point in the series, the individual could identify the sample that is different from the reference (control, no chemical added). This level of chemical is the individual threshold.

RESULTS

In our initial work, we noted that at the end of the 6 day treatment period only control tubers had sprouted.

The tubers were transferred to a 50°F system with continuous air flow and observations made periodically. After 33 days all treatments (menthol, cineole and salicylaldehyde) showed less sprouting than the controls. However, only the salicylaldehyde treated tubers had no sprouting at all. These observations were in agreement with the work originally reported by Vaughn. A sample of tubers from the same treatment set were evaluated for sensory differences 6 days after treatment and only cineole treated tubers were judged significantly different from the untreated controls (19 of 20 correct). In a follow-up experiment with salicylaldehyde, we exposed tubers to salicylaldehyde for 1, 3 or 6 days. We noted that the 6 day exposed tubers darkened on the surface at/near previously healed wounds. A similar observation was made with the 3 day tubers. The 1 day treated tubers were overall lighter in color than the tubers treated for the longer periods. When baked and tasted three days after treatment, the 6 day treated tubers were judged objectionable by laboratory workers. These samples were not further evaluated by a sensory panel. Both 1 and 3 day treatments were significantly different from the untreated control (16 of 21 judgments were correct; sign at 5%). While these samples were different from the controls, our laboratory group in an informal tasting felt that the baked tubers were not objectionable.

We repeated the experiment using tubers exposed to salicylaldehyde for 1 day followed by 1 month and two month storage (48°F, 95% RH). The salicylaldehyde treated tubers were judged not significantly different from the untreated controls. Thus, there seems to be a dissipation of the flavor during storage. We have substantiated the loss of salicylaldehyde from the tubers using gas chromatography.

However, the salicylaldehyde treated tubers received in July 1993 from the University of Idaho, Kimberly (G. Kleinkopf, M. Lewis) were judged to be significantly different from both the non-treated control as well as the CIPC treated tubers, with 16 of 22 and 19 of 22 correct judgments, respectively. We were not surprised that the treated tubers were identified as being different from the non-treated tubers as the untreated controls had not stood up well in storage.

After receiving approval to taste the naphthalene compounds, our UI cooperators provided us with tubers in April 1994 treated with both dimethyl and diisopropylnaphthalenes as well as salicylaldehyde. These tubers were treated with 300 ppm either once or twice and were compared to a CIPC control. The three single application treatments were judged significantly different by the panel. The DMN, DIPN, and salicylaldehyde were correctly identified 19, 16, and 16 times in 21 judgments. However, only DMN was found to be significantly different from the CIPC control when two applications were used.

Because of the differences detected by the panel, we further examined the DMN, DIPN, and salicylaldehyde samples for preference. As shown in Figure 1, there were no significant effects of these treatments on texture, flavor or acceptability of the baked tubers.

Our threshold experiments using the dehydrated potato matrix gave group threshold values of 0.094, 1.41 and 0.043 ppm for salicylaldehyde, DMN and cineole, respectively. Based on reported amounts need to prevent sprouting, we can expect that these compounds will not be directly detectable in cooked potato.

Very recently (Feb. 1995) a 1,4 dimethylnaphthalene product has received EPA registration for use as a potato sprout inhibitor at a recommended rate of 20 ppm.

LITERATURE CITED:

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Figure 1. Preference data for tubers treated with one or two applications of 300 ppm of dimethylnaphthalene (DMN-1, DMN-2), 300 ppm diisopropyl naphthalene (DIPN-1, DIPN-2) or 33 ppm isopropyl-N-(3chlorophenyl) carbamate (CIPC). Data are not significantly different (P>0.05).