Enzymic Browning and Free Tyrosine in Potatoes as Affected by Level of Treatment with Pentachloronitrobenzene

A study of seven potato varieties demonstrated that varieties highest in free tyrosine had the highest enzymic browning. However, there were large differences within a variety that could be related to locality or year of growth. Three varieties, Pungo, Irish Cobbler, and Kennebec were grown in soil treated with pentachloronitrobenzene (PCNB) at 25 pounds per acre. Results indicated that PCNB at that level tended to lower free tyrosine in the potatoes. In Pungo potatoes, reduction in enzymic browning was also indicated. Decreases in both free tyrosine and enzymic browning in potatoes treated with PCNB at 25 pounds per acre were not as great as those previously reported for potatoes grown in soil treated with PCNB at 50 pounds per acre.

The fungicide, pentachloronitrobenzene (PCNB) has been reported to be effective against potato scab (*Streptomyces scabies*) and black scurf (*Rhizoctonia solani*). Menzies (1957) has reported that an application of 10 to 20 pounds of active ingredient per acre will effectively control *rhizoctonia*. For control of scab, three times as much fungicide was required.

A study of two potato varieties grown in soil treated with PCNB, at 50 pounds per acre, revealed that the PCNB treatment significantly lowered the free tyrosine content of the potatoes. For the Pungo potatoes, significant reduction of enzymic browning was also indicated (Sweeney and Simandle, 1968). The work reported here was carried out to determine whether PCNB applied at a lower level, 25 pounds per acre, would reduce free tyrosine and enzymic browning of potatoes.

MATERIALS AND METHODS

In 1966, Pungo potatoes were grown in Virginia in untreated soil and in soil treated with PCNB at 50 pounds per acre. Irish Cobblers treated in the same manner were obtained from Minnesota. In 1967, seven potato varieties were grown in Maine in soil receiving no PCNB. Three of these varieties were selected for further study: Irish Cobbler, a high tyrosine potato; Pungo, a variety relatively low in tyrosine; and Kennebec, about intermediate in tyrosine content. In 1968, these three varieties were grown in Maine in soil treated with PCNB at 25 pounds per acre active ingredient. Control potatoes were grown in soil receiving no PCNB. Since it is known that tyrosine is not uniformly distributed in the potato, the bud and stem ends were investigated separately. All work was carried out during the 4-week period immediately after harvest. Potatoes were stored at 55° F. and no significant changes in tyrosine or enzymic browning occurred during this period. Alternate quarters were taken from 4 potatoes; the samples were diced, mixed, and an aliquot portion was taken for investigation. Each value in Tables I and II represents a mean of 12 replications.

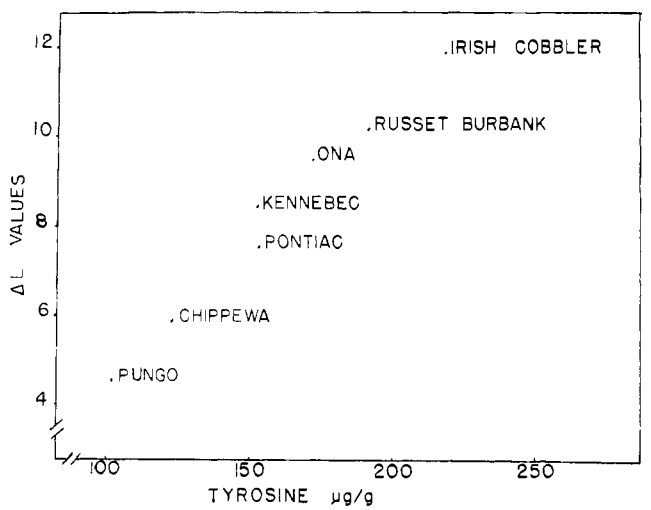

Figure 1. Tyrosine content and enzymic browning values for seven potato varieties, no PCNB treatment

Free Tyrosine. The colorimetric procedure of Ceriotti and Spandrio (1957) as modified by Sweeney and Simandle (1966, 1968) was used.

Enzymic Browning. Potatoes were pared, cut into one-quarter inch cubes, and a glass dish, 9 cm. in diameter and 5 cm. in height, was filled with the cubes randomly distributed. Color was evaluated with a Gardner color difference meter (Gardner Laboratory, Bethesda, Md., 1955). The color standard used was L 79.2, a_L 1.7, b_L 22.6. Five readings were taken turning the sample dish about 72° between readings. One hour later, the readings were taken again. The decrease in L reading, ΔL, was taken as a measure of enzymic browning of the sample.

Statistical Treatment. Student's t test (Student, 1908) was applied to the data to determine significance of mean differences between control and treated samples.

RESULTS AND DISCUSSION

Variety Effects on Enzymic Browning and Free Tyrosine. In Figure 1 are shown free tyrosine and enzymic browning values obtained on seven potato varieties investigated in 1967. A relationship between the two factors was demonstrated since varieties highest in free tyrosine content had the greatest enzymic browning.

Effect of Season and Locality of Growth. In Table I are given free tyrosine and enzymic browning values for potatoes

Table I. Free Tyrosine and Enzymic Browning of Three Potato Varieties as Affected by Locality and Year of Growth[a,b]

	Pungo		Irish Cobbler		Kennebec	
Year	Tyrosine, μg./g.	ΔL	Tyrosine, μg./g.	ΔL	Tyrosine, μg./g.	ΔL
1966	168	4.6	390	12.4	—	—
1967	102	4.9	210	12.1	154	8.7
1968	92	5.8	208	10.4	109	6.7

[a] Data for 1966 are mean of values published previously. Pungos were grown in Virginia and Irish Cobblers in Minnesota. [b] All varieties grown in Maine in 1967 and 1968. Values are for control samples receiving no PCNB.

Table II. Free Tyrosine and Enzymic Browning of Three Potato Varieties as Affected by Treatment with PCNB[a,b]

Treatment[c]	Pungo				Irish Cobbler				Kennebec			
	1966		1967		1966		1967		1966		1967	
	Tyrosine, μg./g.	ΔL	Tyrosine, μg./g.	ΔL	Tyrosine, μg./g.	ΔL	Tyrosine, μg./g.	ΔL	Tyrosine, μg./g.	ΔL	Tyrosine, μg./g.	ΔL
					STEM PORTION							
Control	200 *a*	6.1 *a*	104 *a*	6.9 *a*	444 *a*	13.4 *a*	230 *a*	12.1 *a*	—		120 *a*	7.5 *a*
PCNB	151 *b*	3.0 *b*	92 *ab*	6.0 *a*	384 *a*	13.4 *a*	197 *b*	11.7 *a*	—		98 *b*	6.3 *b*
					BUD PORTION							
Control	136 *a*	3.1 *a*	81 *a*	4.6 *a*	335 *a*	11.4 *a*	186 *a*	8.6 *a*	—		97 *a*	5.8 *a*
PCNB	116 *a*	1.8 *b*	70 *a*	3.6 *ab*	259 *b*	9.4 *a*	157 *b*	8.7 *a*	—		98 *a*	5.0 *a*

[a] *a* differs significantly from *b* at 1% level. *a* differs significantly from *ab* at 5% level. Comparisons are between treated and untreated samples of the same variety, portion, and year.
[b] In 1966, Pungos grown in Virginia and Irish Cobblers in Minnesota. All varieties grown in Maine in 1968.
[c] PCNB treatment at 50 pounds per acre in 1966 and at 25 pounds per acre in 1968.

grown over a three-year period in soil receiving no PCNB. In 1966, Pungos were grown in Virginia and Irish Cobblers in Minnesota. Potatoes investigated in 1967 and 1968 were grown in Maine. Tyrosine values for Pungos and Irish Cobblers from Maine in 1967 and 1968 were much lower than for those grown elsewhere in 1966. Despite the high tyrosine values obtained in 1966, the ΔL values for 1966 did not differ greatly from those obtained in 1967 and 1968. This indicates that within a variety, enzymic browning values could be related to free tyrosine only for potatoes grown in the same locality. For the Kennebec potatoes, both tyrosine and ΔL values were higher in 1967 than in 1968.

Work by Mapson *et al.* (1963) has demonstrated that the rate of enzymic browning of potatoes is affected by the locality of growth and variation in climate. He reported that despite this the relative order of browning rate of varieties remained the same. Results obtained in our laboratory would appear to confirm these findings.

Level of PCNB Treatment and Tyrosine Content of Potatoes. The effects of level of PCNB treatment on free tyrosine content of potatoes are given in Table II. In 1966 potatoes were grown in soil treated with PCNB at 50 pounds per acre. In 1968 the level of treatment was 25 pounds per acre. As previously reported (Sweeney and Simandle, 1968), the stem portions of the potatoes were higher in free tyrosine content than were the buds. For the Pungos and Irish Cobblers, both treated and control potatoes were higher in tyrosine content in 1966 than in 1968. The effect of PCNB in lowering tyrosine content when applied at 50 pounds per acre has been reported previously (Sweeney and Simandle, 1968). PCNB treatment at 25 pounds per acre also appears to lower tyrosine in most cases investigated. Results were highly significant for both stem and bud portions of the Irish Cobblers and for the stems of the Kennebec variety. For the stem portion of the Pungo variety, the decrease was significant. Tyrosine decreases in the bud portion of this variety were nonsignificant. For the bud portion of the Kennebec potatoes, no difference in free tyrosine was obtained that could be related to PCNB treatment. In general, decreases in free tyrosine resulting from PCNB treatment at 25 pounds per acre were somewhat less than those previously reported for the treatment level of 50 pounds per acre.

Level of PCNB Treatment and Enzymic Browning. There appeared to be some reduction of enzymic browning of the Pungo potatoes treated with PCNB at 25 pounds per acre (Table II). Differences were significant only for the bud portion of the potatoes. For both bud and stem portions of this variety, PCNB treatment at 25 pounds per acre was less effective in reducing enzymic browning than was treatment at 50 pounds per acre. The PCNB treated Kennebec potatoes also appeared to be lower in enzymic browning than were the controls. However, differences were not statistically significant. For the Irish Cobblers, PCNB treatment at 25 pounds per acre did not appear to decrease enzymic browning. Similar results were obtained for this variety in 1966 when the level of treatment was 50 pounds per acre.

The results indicated that potatoes grown in soil treated with PCNB at 25 pounds per acre contained less free tyrosine and, in some varieties, had less enzymic browning than did control potatoes. However, reductions in both tyrosine and enzymic browning were not as large as those previously reported for potatoes grown in soil treated with PCNB at 50 pounds per acre. Since the potatoes treated at 25 pounds were not grown in the same area or in the same year as those treated at 50 pounds, these factors also might have had some effect on the results obtained.

ACKNOWLEDGMENT

The author expresses his appreciation to Robert V. Akeley, Plant Industry Station, Beltsville, who made arrangements for growing the potatoes used in 1967 and 1968.

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Received for review March 6, 1969. Accepted June 25, 1969.