Effect of $\gamma$-Irradiation on Development of Lachrymator of Onion

Hiroyuki NISHIMURA and Junya MIZUTANI

Department of Agricultural Chemistry,
Faculty of Agriculture,
Hokkaido University,
Sapporo, Japan

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In connection with the sprout-inhibition of onion by $\gamma$-irradiation, we have studied $\gamma$-radiolysis of sulfur-containing amino acids such as S-alkyl-L-cysteines and their sulfoxides,$^{1,2}$ and the effect of $\gamma$-irradiation on the development of onion flavor components.$^{3}$ In the latter paper,$^{2,3}$ we examined the correlation between the lachrymatory character of onion and the development of propionaldehyde, because Bredenberg et al.$^{4}$ have reported that the lachrymator quickly decomposes to form propionaldehyde. Later, the lachrymator, which is one of the most important flavor components of onion, was identified as thiopropanal S-oxide (2).$^{4}$ Thiopropanal S-oxide is enzymatically produced from S-(trans-1-propenyl)-L-cysteine sulfoxide (1) as follows.

\[
\text{C-S lyase} \quad \text{H}_2\text{O}
\]

\[
\begin{align*}
\text{CH}_3\text{C}=\text{C}-\text{S}-\text{CH}_2\text{CHOH} & \quad \text{H}_2\text{O} \\
\text{CH}_3\text{CH}_2\text{CH}=-\text{S}--\text{O}+\text{CH}_3\text{COCOOH}+\text{NH}_3
\end{align*}
\]

It is very important to examine the effect of $\gamma$-irradiation on the development of thiopropanal S-oxide of onion in terms of food irradiation.

This paper deals with the determination of thiopropanal S-oxide in irradiated onions.

Sapporo Yellow Onions (7-9 cm in diameter) were dried for two weeks and then two weeks later they were irradiated. Irradiations were carried out with $\gamma$-rays from cobalt-60 at room temperature. About 40 kg of onions were irradiated at the total doses of 0, 3, 7, 15 and 70 krad, respectively. After irradiation, each of them was put into opening boxes and stored at ambient temperatures (15-24°C).

Cut pieces of onions, 100 g, from four skin- and disk-free bulbs were blended in 50 ml of water for 30 sec. Methylene chloride (100 ml) was added in the homogenized onion and 30 ml of methylene chloride extract was dried over anhydrous sodium sulfate. The solvent was carefully removed at 8-10°C under the reduced pressure (120-130 mmHg), and further 10 $\mu$l of methylene chloride was added. The extract (1 $\mu$l) was injected into a gas chromatograph (FID). The relative amounts of thiopropanal S-oxide in onions stored for 0, 0.5, 1, 2 and 3 months, respectively, after irradiation were estimated from peak areas of gas chromatograms. These measurements were repeated three times.

The gas chromatographic separation of flavor components of onion is shown in Fig. 1. The components 2 and 4 were identified as $n$-propyl mercaptan and thiopropanal S-oxide, respectively, by comparing with mass spectra and gas chromatographic retention times.

FIG. 1. Gas Chromatogram of Onion Extract.

Column, 5% SE-30 (1 m x 3 mm i. d.). Oven temperature, 40°C.
1, Solvent (CH$_2$Cl$_2$) etc.; 2, $n$-propyl mercaptan; 3, unknown; 4, thiopropanal S-oxide.

FIG. 2. Effect of Irradiation Dose and Storage Period on the Amount of Thiopropanal S-Oxide in Onions.

○-○, 0 krad; ×-×, 3 krad; ●-●, 7 krad; △-△, 15 krad; ▲-▲, 70 krad

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The gas chromatographic separation of flavor components of onion is shown in Fig. 1. The components 2 and 4 were identified as $n$-propyl mercaptan and thiopropanal S-oxide, respectively, by comparing with mass spectra and gas chromatographic retention times.
of authentic compounds. Authentic thiopropanal S-oxide was synthesized by the method of Brodnitz and Pascale\textsuperscript{4} from \textit{n}-propylsulfinyl chloride, which was prepared from \textit{di-\textit{n}}-propyl disulfide according to the method of Sheppard and Diekmann.\textsuperscript{5}

It was observed that the lachrymatory character had been decreased by \(\gamma\)-irradiation (remarkably at 70 krad). In this connection, the amount of thiopropanal S-oxide was decreased with increasing radiation dose and storage period at ambient temperature as shown in Fig. 2. However, in dosage of 3 krad, both the lachrymatory character and the development of thiopropanal S-oxide were little affected by \(\gamma\)-irradiation. Kawakishi \textit{et al.}\textsuperscript{6} have reported that the C-S lyase of onion was gradually decreased with increasing storage period after irradiation. Therefore, when onions are irradiated, it seems that decrease in the amount of thiopropanal S-oxide is not mainly due to decomposition of S-(trans-1-propenyl)-L-cysteine sulfoxide (I) but damage of the C-S lyase.

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\textbf{REFERENCES}


