**Photocatalytic decomposition of ethylene released from agricultural products**

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**Highlights**

* The present reactor can reduce the ethylene concentration to below 40 ppb.
* Agricultural products releasing ethylene at a low speed can be kept fresh at least for 9 days.
* It is difficult to maintain the quality of fruit synthesizing ethylene quickly by only its decomposition.

**1. Introduction**

Ethylene released from fruits greatly lowers the quality of not only themselves but also agricultural products in their neighbourhood [[1](#_ENREF_1)], which causes a serious problem when one stores the agricultural products or conveys them kept in containers by ship or truck. For solving the problem, it is necessary to keep the ethylene concentration in air at a low level. Although the extent of decrease in the ethylene concentration is different according to the kind of agricultural products, it should be fundamentally set as low as possible [[2](#_ENREF_2)]. Unfortunately, there is no promising technique by which the ethylene concentration can be decreased to a very low concentration level.

 Application of UV-excited titanium dioxide (TiO2) to air purification has been actively investigated in the past two decades. One of the advantages of this application is that the VOC concentration can be reduced to almost zero (for example, below 40 ppb for toluene) if the reaction field on the TiO2 surface is precisely controlled [[3](#_ENREF_3)]. It is thus natural to apply the photocatalytic technique to the decomposition of ethylene released from agricultural products. It is known that this decomposition is strongly influenced by the moisture in the air. Therefore, this fact should be taken into consideration in applying photocatalytic technique.

 In the present study, based on our accumulated knowledge and experience, we attempt to develop a photocatalytic reactor to rapidly decompose ethylene released from agricultural products. A photocatalytic reactor with three coiled glass tubes and six 6-W UV lamps was used to maintain the quality of agricultural products and the performance of the reactor was investigated.

**2. Methods**

An nanosized TiO2 (Degussa P25)-coating solution containing H2PtCl6 was prepared by the same method as described elsewhere [[4](#_ENREF_4)]. This solution was poured into a coiled Pyrex glass tube and applied to its inside surface, which was then heated in an electric maffle furnace at 300 °C for 30 min. The same operation was repeated three times, so that a TiO2 film was formed on the inside surface. Three coiled glass tubes with TiO2 were prepared in the same manner. A 6-W blacklight blue fluorescent lamp with a wavelength range of 300–400 nm was inserted into the center of each coiled glass tube. Three immobilized TiO2 glass tubes thus prepared were vertically arrayed in a triangular framework. Furthermore, three UV lamps were put between the glass tubes to enhance UV irradiation. The photocatalytic reactor constructed was connected to an acrylic box (1.17×105 cm3) via an air pump to circulate the air in the container. An apple, banana, persimmon, cucumber and cabos were put in the container. The UV lamps were switched on to start the decomposition. The experiment was performed over 9 days. A similar experiment was performed using an atemoya over 7days. For comparison, the experiment without treatment was carried out simultaneously. The temperature in the container was always kept at about 20 °C. The ethylene concentration was measured with a gas chromatograph equipped with a flame ionization detector. The detection limit of ethylene was 40 ppb for this analytical system.

**3. Results and discussion**

When the air was photocatalytically treated, ethylene released from agricultural products (mainly from the apple) was always kept at a very low level (below 40 ppb). Consequently, the qualities of all products were kept high at about 20 °C, at least, for 9 days. When no air was treated, on the other hand, the ethylene concentration constantly increased, attaining to 2.7ppm, which significantly lowered the qualities of persimmon and cucumber. Although the apple did not change apparently, it lost sweetness completely.

 The atemoya was found to release ethylene five-times as fast as the apple did. The present reactor decreased the ethylene concentration to below 350 ppb, but the atemoya changed its surface color from green to brown after one week regardless of treatment. This result suggests that it is difficult to maintain the quality of fruit that synthesizes ethylene at a very high speed, by only decomposing ethylene.

**4. Conclusions**

The photocatalytic reactor with three coiled glass tubes is useful to reduce the concentration of ethylene released from agricultural products to a very low level, thereby making it possible to keep the qualities of agricultural products at a high speed over a long period of time. By contrast, for the agricultural products synthesizing ethylene quickly, the use of the present treatment technique is probably difficult to apply to even when the ethylene concentration is significantly reduced. In this case, we consider that the products should be kept refrigerated.

**References**

[1] M. L. V. de Chiara et al., Biosys. Eng. 132 (2015) 61-70.

[2] S. P. Burg, E. A. Burg, Plant. Phys. 37 (1962) 179-189.

[3] F. Shiraishi, D. Maruoka, Y. Tanoue, Sep. Purif. Technol. 175 (2017) 185-193.

[4] Y. Tanoue, F. Shiraishi, Eco-Eng. 29 (2017) 39-44.