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Absorption of Methyl Bromide by Gas-Absorbent Sheets

Fusao Kawakami and Yukihiro Soma
Chemical & Physical Control Laboratory
Research Division, Yokohama Plant Protection Station
1-16-10, Shinyamashita, Naka-ku, Yokohama 231, Japan

Abstract : Three sizes of gas-absorbent sheet (ACS) with activated carbon powder (ACP) were used for confirming the efficacy of absorption of methyl bromide (MB) desorbed from fruit. Fumigated apples (40-50 g/m^3 of MB for 2 hours at 10℃) and satsuma mandarins (30 g/m^3 of MB for 2 hours at 15℃) were put in a polyethylene bag with ACS1a (22.5 cm^2 in size=0.25 g of the ACP), ACS4a (90 cm^2 =one gram of the ACP) and the ACS16a (360 cm^2 =4 g of the ACS) and MB gas was monitored during the storage at 0℃ or 5℃. The results were that the gas concentrations were 10 ppm or below in the ACS16a and 40 ppm or below in the ACS4a, and that the ACS16a was the most effective, but the ACS4a was also sufficient efficacy of absorption. It is therefore recommended that apples (10 kg), grapes (4 kg), satsuma mandarins (3 kg) and persimmons (0.2 kg) packed in the commercial air-tight box or polyethylene bag would be used 900 cm^2, 360 cm^2, 270 cm^2 and 18 cm^2 in size of the ACS, respectively.
Key words : methyl bromide, sorption, desorption, activated carbon, gas-absorbent sheet

Introduction

Methyl bromide (MB) sorbed to fruit in gas phase gradually diffuses from the fruit after fumigation (MONRO, 1969). KAWAKAMI et al. (1991a, 1991b) and Soma et al. (1991) reported that MB desorbed from fumigated fruit was one of factors on chemical injuries of fruit, such as apples, persimmons and grapes during the storage and the damage was extremely prevented by graniform activated carbon (AC) coating with a 10% (v/v) of amine compounds. Later, the AC was ground into powder (ACP) and improved on a gas-absorbent sheet (ACS) of nonwoven fabric for increasing the efficacy of absorption. SOMA et al. (1994), IKEDA et al. (1995) and NAKAMURA et al. (1995) confirmed that the ACS was more effective than the AC in phytotoxicity tests for apples, persimmons and grapes.

Our objective was to study the relationship between the amount of MB desorbed from the fruit and the size of the ACS which would be used for fumigated fruit packed in commercial air-tight or non air-tight carton boxes or polyethylene bags.

Materials and Methods

Test Fruit and Fumigation

Apples produced in Fukushima Prefecture and satsuma mandarins grown in the greenhouse in Sizuoka Prefecture in September were used for the test.

These fruit were placed in 40 ℓ fumigation chamber and then fumigated with doses of 40 - 50 g/m^3 of MB for 2 hours at 10℃ with 30% (v/v) loading (apples) and of 48 g/m^3 for 2 hours at 15°C with 30% (v/v) loading (satsuma mandarins), respectively. A circulation fan was kept on

throughout fumigation. Following fumigation, the gas was exhausted for 1.5 hours by a ventilation fan.

MB Gas-Absorbent Sheets

Three sizes of the ACS were prepared for the test as follows: ACS1a (22.5 cm^2 in size=0.25 g of the ACP/kg of fruit) as a standard size in the test, ACS4a (90 cm^2 in size=one gram of the ACP/kg of fruit) and ACS16a (360 cm^2 in size=4 g of the ACP/kg of fruit). Four grams of the AC /kg of fruit was also prepared for comparing with the ACS. The standard size was determined on the basis of the data, ie. one gram of the ACP absorbed approximately 80 mg of MB (Sanko Kagaku Co., Ltd., unpublished data) and the total amounts of MB desorbed from the fruit after fumigation were 10-20 mg/kg (SOMA et al., 1995). It was therefore calculated that 0.25 g of the ACP absorbed almost MB desorbed from one kilogram of fruit and 20 g of the AC were also necessary for 16 apples (5 kg) to be prevented chemical damages (SOMA et al., 1994).

Fruit Storage and Monitoring Gas Concentration

Following exhausting, 6 apples (1.6 kg) or 20 satsuma mandarins (1.6 kg) were put in a polyethylene bag (0.05 mm in thickness) with the ACS or the AC. Apples and satsuma mandarins were then stored at 0 °C or 5 °C, respectively. During the storage, MB gas in the polyeth-

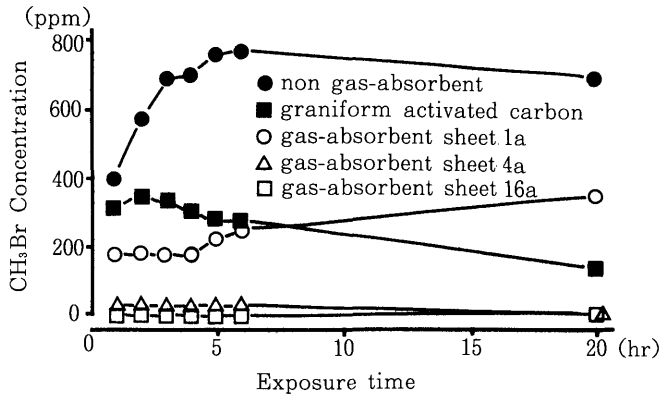

Fig. 1. Efficacy of absorption of methyl bromide desorbed from apples by gas-absorbents. Apples were fumigated with a dose of 40g/m^3 of methyl bromide for 2 hours at 10 °C with 30% loading followed by storage at 0°C.

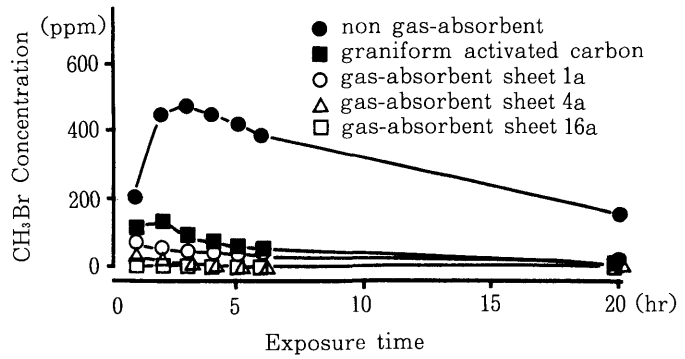

Fig. 2. Efficacy of absorption of methyl bromide desorbed from satsuma mandarins by gas-absorbents. Satsuma mandarins were fumigated a dose of 48 g/m^3 of mehtyl bromide for 2 hours at 15°C with 30% loading followed by storage at 5°C.

ylene bags was monitored with gas chromatograph (FID: GC 8AF, Shimazu) at intervals of one hour in the first 6 hours and then 14-48 hours for 14 consecutive days.

Results and Discussion

Efficacy of Absorption of MB

The results of gas monitoring during the storage are shown in Figure 1 (apples) and Figure 2 (satsuma mandarins). MB concentration in the ACS16a and the ACS4a were 10 ppm or below and 40 ppm or below in both fruit, respectively. Seventy ppm or below were in the ACS1a in Satsuma mandarins. The concentration in the ACS1a in apples increased after 4 hours and reached 300 ppm or more after 20 hours. This was because of being saturated with MB. The efficacy of absorption in the AC (4 g/kg of fruit) delayed at first 2 hours with 120-350 ppm and after then gradually decreased.

These results indicated that the ACS16a was the most effective of others, the ACS4a, however, was also sufficient efficacy of absorption of MB with one fourth size of the ACS16a.

Determination of Size of Gas-Absorbent Sheets

From the results of the test, it could be said that the ACS4a (90 cm^2 = 10 g of the ACP) was the standard, ie. one gram of the ACP absorbed MB from one kilogram of apples and satsuma mandarins. SOMA et al. (1995) reported on MB gas reducing curbs for fumigated grapes and persimmons during the storage and total amounts of MB sorbed to the fruit (grapes; 70.6 mg/kg, satsuma mandarins 69.6 mg/kg, persimmons; 55.2 mg/kg and apples; 45.2 mg/kg) and those of MB desorbed from the fruit (grapes; 17.1-18.9 mg/kg, apples; 15.0-15.5 mg/kg, satsuma mandarins; 12.8-13.0 mg/kg and persimmons; 9.5-10.8 mg/kg).

Table 1. Relationship between total amounts of methyl bromide desorbed from each fruit and sizes of gas-absorbent sheet.

Fruit	Package	Capacity of package (ℓ)	Weight of fruit per package(kg)	Storage Temp.(℃)	Amount of MB from fruit(mg/kg)	Gas-absorbent Size (cm^2)*	Sheets per package quantity(g)**
Apples	Styroform box	43	10	0	150	900	10
Satsuma mandarins	Carton box	9	3	15	36	270	3
Grapes	Carton box	15	4	0	76	360	4
Persimmons	Polyethylene bag	0.5	0.2	0	2	18	0.2

* Sizes of gas-absorbent sheet were showed for fruit packed in air-tight carton boxes or bags.
** Quantity of activated carbon powder containing gas-absorbent sheet.

Table 1 shows the size of the ACS which would be used for apples, satsuma mandarins, grapes and persimmons packed in the commercial size of air-tight carton box or polyethylene bag. It is recommended that apples (10 kg), satsuma mandarins (3 kg), grapes (4 kg) and persimmons (0.2 kg) in the commercial air-tight carton box or polyethylene bag would be used 900 cm^2, 360 cm^2, 270 cm^2 and 18 cm^2 in size of the ACS, respectively, and that one fourth to a half size of the ACS might be used for the regular type carton box or non air-tight carton box.

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