HCN with forced aeration in imported oranges

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INTRODUCTION: Korea has been imported total amount of 126,000 tone oranges from USA and other counties in 2005. For important reasons of economic and biosecurity to Republic of Korea, the most imported oranges (93%, 118,000 t) required to be treated in mandatory fumigation with methyl bromide (MB) in order to meet National Plant Quarantine Service (NPQS) requirement. Approximately, 10% (average 100 tone of MB/year) consumption of MB was just used to treat imported oranges for QPS purpose. In certain case, MB treatments caused phytotoxic damage to oranges before delivering to the end of users. Currently, the cold treatment is as a worldwide recommended MB alternative method for imported oranges during the shipment. From point view of increasing cost, the cold treatment is not suitable in Korea. The research we reported here aims to develop alternative method - HCN with forced aeration for replacement of MB on quarantine treatment in order to reduce phytotoxic damage of oranges as well as reduction of MB use under Montreal Protocol Agreement.

EXPERIMENT: Hydrogen cyanide (HCN) applied into fumigation chambers (the capacity of 0.5 m^3) at dosage of 2 g/m^3 and 18°C with different filling ratio (11, 21 and 32 w/v%) of orange for 1 hr exposure respectively. After application of HCN, electric fan which is located inside chambers for stirring gas was operated about 30 minutes. In comparison with MB which is current registered in Korea, the fumigation with MB was also conducted at dosage of 40.5 g/m^3 and 2 hrs exposure period. The bioassay of fumigation was tested on 3 quarantine pest: spotted spider mites (*Tetranichus urticae*), citrus mealybug (*Planococcus citri***),** citriculus mealybug (*Pseudococcus cryptus***).** After 1 hr fumigation, the chambers were opened and aired with forced aeration for 2 hrs. During aeration, the concentrations of HCN were measured at the timed interval in each treated chambers for OHS (Occupational Health and Safety) purpose**.** The effect of

quality on oranges by treatments was visually evaluated at 5 and 10 days after fumigation.

RESULTS: The loss of HCN in the each chamber with different filling ratios (f.r.) of orange at different exposure times is shown in Figure 1 where C/Co is the ratio of concentration at different exposure time to total applied concentration. During the fumigation with 30 min forced aeration in low concentration of HCN (2 g/m^3), 90% of HCN was quickly disappeared in fumigation chamber containing 21 and 32% f.r. of orange. The mortalities of three tested quarantine pests at the different filling ratios are shown in Figure 2. The applied dosage of 2 g/m^3 HCN with forced aeration could achieve 96% kill of tested pests. During the period of aeration, the concentrations of HCN in the fumigation chamber at different filling ratio of orange are shown in Table 1. After 2 hr forced aeration, HCN concentrations in fumigated chambers are less than 5ppm which is possible to set in occupational exposure limit (10ppm) in Korea. The effect of quality on orange by treatments is listed in Table 2. In comparison with MB, HCN treatments are provided a more predictable product response in terms of less effect of orange quality. Although use of HCN is limited regarding its acute toxicity, however, HCN is still used as fumigant in quarantine purpose in ASEAN region because it has lower phytotoxic effects. The data obtained from this study showed that HCN can promise as a MB replacement for treatment of imported oranges in terms of efficacy to against target pests and overcoming regulation issues. The large-scale fumigation trials of application HCN combined with forced aeration are to be conducted, in order to satisfy Korea quarantine protocols.

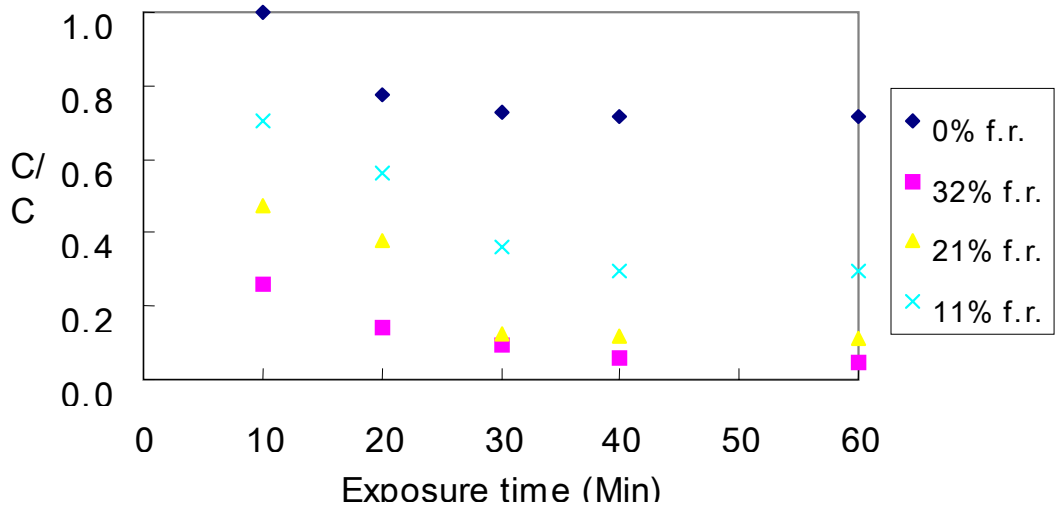

Figure1. The loss of HCN during the exposure to different filling ratios (11, 21 and 32 w/v %) of oranges fumigation

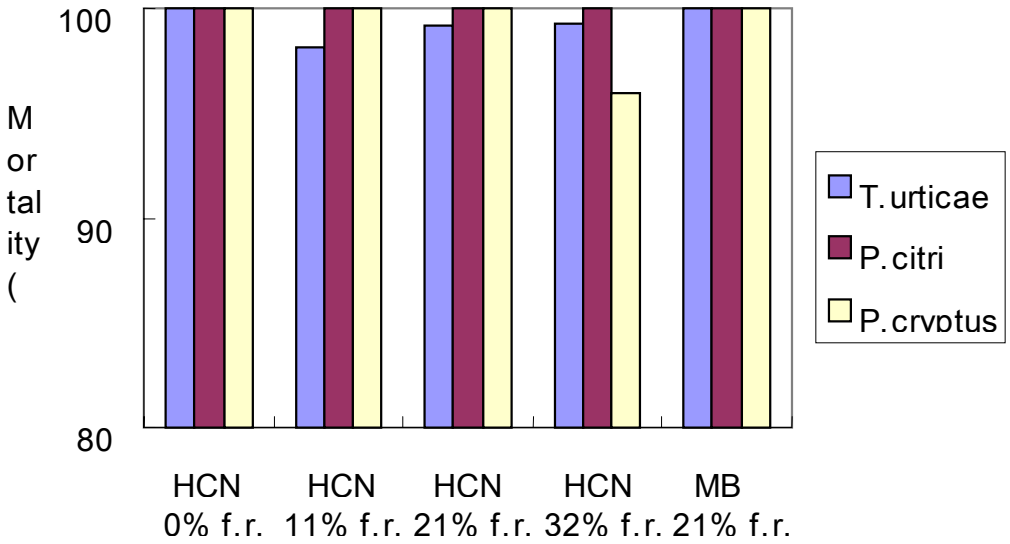

Figure 2. Efficacy of HCN and MB with forced aeration to different filling ratio (11, 21 and 32%) of oranges fumigation HCN (2 g/m^3 and 1hr), MB (40.5g/m^3 and 2hr)

Table 1. Concentration of HCN in fumigation chambers at different filling ratio of orange after different period of aeration

Filling ratio	HCN concentration (ppm) after aeration	
(%)	1 hr	2 hr
0	N.D.	N.D.
10	15	5
30	11	2.5
50	19	5

Table 2. The effect of quality on oranges by treatments was visually evaluated at 5 and 10 days after fumigation.

Treatment	Filling ratio	The rate of quality effect (%)*	
	(%)	5 days	10 days
Control		0	4.0
HCN	0	-	-
HCN	11	1.5	4.0
HCN	21	1.3	4.0
HCN	32	0	1.3
MB	21	0	5.3

* Visual evaluation was conducted to observe 75 oranges from upper layer of each box.