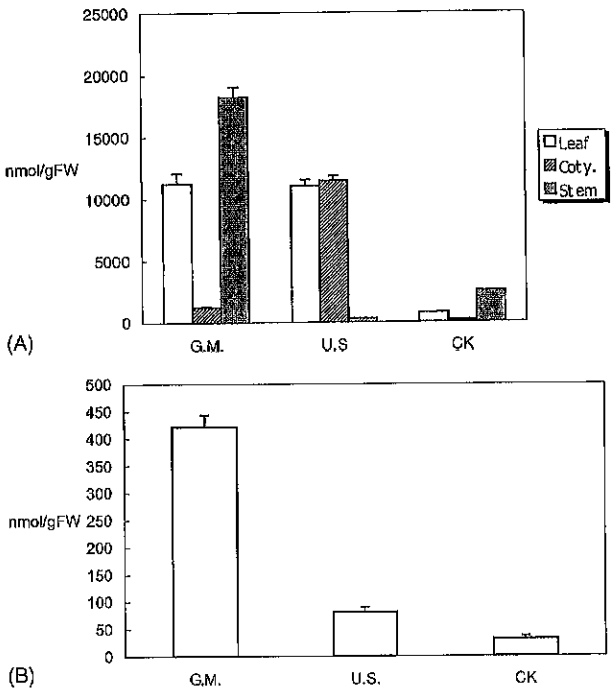

Fig. 1. Polyamine content (nmol/gFW) of Chinese cabbage seedlings: (A) 15 d and (B) mature plant (70 d) as a result of different acoustic treatments. Error bars represent the standard deviations of the means of polyamine contents.

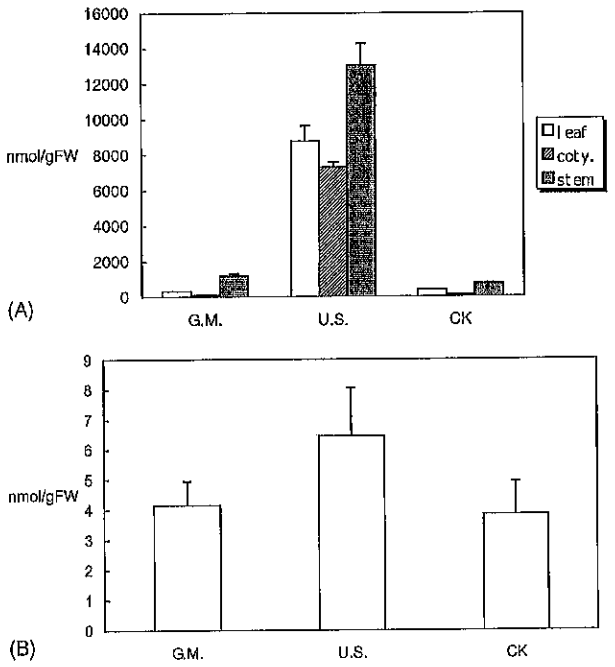

Fig. 2. Polyamine content (nmol/gFW) of cucumber seedlings: (A) 15 d and (B) mature plant (70 d) as a result of different acoustic treatments. Error bars represent the standard deviations of the means of polyamine contents.

In Fig. 2 the results related to cucumber 15-d seedling and 70-d mature plant are summarized. It shows that after the exposure to 20 kHz acoustic wave, the observed PAs content for both cucumber seedling and mature plant was significantly higher than that measured after the exposure to green music and control (genuine leaf: $F = 475.43$, df $= 2, 12$, $P < 0.01$; cotyledon: $F = 3673.51$, df $= 2, 12$, $P < 0.01$; stem: $F = 477.63$, df $= 2, 12$, $P < 0.01$; and mature plant: $F = 7.20$, df $= 2, 12$, $P < 0.01$). Again, the main PAs detected were the conjugated spermidines (Spd).

The results presented in Figs. 1 and 2 indicate that both green music and 20 kHz ultrasound exposures can promote the vegetables to secrete polyamines, especially Spd (spermidine). PAs level in the sonic treated seedlings, including cotyledon, genuine leaf and stem was determined to be significantly higher than that observed in control or sham samples. Hence, the sonic treated seedlings can increase PAs secretion during they exposure to green music or 20 kHz ultrasound.

The synthesis of spermidine Spd in Chinese cabbage has already been reported [11]. In this context, the results presented here appear to support the notion that sonic exposures, particularly green music exposure enhances Spd syntheses in Chinese cabbage. For this reason, possible further studies should also focus on some enzyme activity in Chinese cabbage, which affects Spd synthesis.

The results depicted in Figs. 1 and 2 also showed that PAs concentration in the seedlings of both vegetables examined was higher than the PAs level measured in mature plants. These results seem to further indicate that higher concentration of PAs takes place in rapidly growing tissues of seedlings. It should also be noted that different vegetables had different responses to the same sonic treatment. Specifically, for Chinese cabbage, the PAs content after exposure to green music was the highest for both seedlings and mature plant. But in the case of cucumber the exposure to 20 kHz ultrasound resulted in the highest PAs level.

3.2. O_2 uptake in three treatments

The influence of the acoustic energy exposure on the oxygen uptake in the treated vegetables is presented in Figs. 3 and 4.

Fig. 3 shows that O_2 uptake in Chinese cabbage treated with green music was the highest among the three exposures described. In this case, the O_2 uptake of 15-d seedlings and 70-d mature plant were significantly higher than that of control (15-d seedling: $F = 19.08$, df $= 2, 21$, $p < 0.01$; 70-d mature plant: $F = 83.76$, df $= 2, 21$, $p < 0.01$). This result appears to indicate that Chinese cabbage was more sensitive to green music treatment.

As shown in Fig. 4 cucumber exhibited different behavior: for 15-d seedlings the O_2 uptake was the

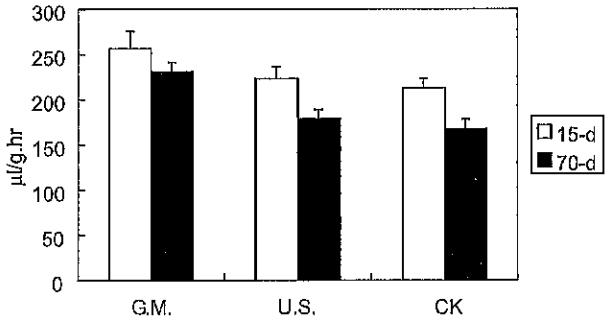

Fig. 3. Oxygen uptake (l/g h) in Chinese cabbage as a result of different acoustic treatments. Error bars represent the standard deviations of the means of oxygen uptake.

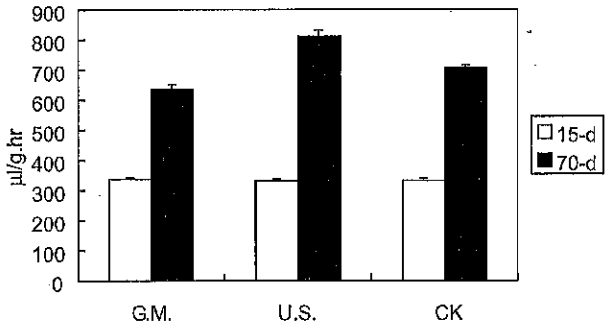

Fig. 4. Oxygen uptake (l/g h) in cucumber as a result of different acoustic treatments. Error bars represent the standard deviations of the means of oxygen uptake.

highest after the green music exposure, whereas 20 kHz ultrasound exposure resulted in the lowest O_2 uptake. On the other hand the results for all three exposure schemes have not shown any statistical significance ($F = 2.18$, df $= 2, 21$, $P > 0.05$). It is interesting to note that for 70-d mature plant the results was opposite: the highest level of oxygen uptake was observed for 20 kHz ultrasound exposure, then control and lastly green music. The O_2 uptake for U.S. exposure has shown statistically significant difference in comparison with that determined for sham and green music ($F = 283.69$, df $= 2, 27$, $p < 0.01$) exposure. The results presented above seem to indicate that cucumber growth at its later stage (70-d) could be influenced by 20 kHz ultrasound exposure, however, they do not offer any explanation why the younger, 15 d seedlings failed to respond to the same exposure.

Overall, the results of this work appear to indicate that Chinese cabbage growth is relatively sensitive to G.M. as the level of PAs and oxygen uptake increased following the G.M. exposure. Unfortunately, the data collected failed to provide more specific information about the relationship between PAs and O_2 uptake. The results of the cucumber exposure showed that this vegetable is more sensitive to 20 kHz U.S. exposure. Based on the outcome of this study it would appear that different vegetables produce different responses to different acoustic exposures.

The amount of the Vitamin C content was also investigated and is briefly summarized in Section 3.3.

3.3. Vitamin C content

The analysis of variance showed no statistically significant difference in vitamin C content as a result of different acoustic exposures examined in this work for both vegetables. For Chinese cabbage (15-d seedling and 70-d mature plant) the highest level of vitamin C was measured after the exposure to green music, then 20 kHz sound and lastly, sham or control. A slightly different behavior was determined for cucumber plants. Here, the highest level of vitamin C was observed following green music exposure, then control and lastly 20 kHz acoustic wave.

These results tell us the content of vitamin C is not easily affected by sound wave energy. This is because in comparison with PAs and O_2 uptake, vitamin C is relatively inactive in plants. Thus, if acoustic energy can promote the growth of some plants (here: Chinese cabbage and cucumber), the more active molecules such as PAs will first be affected. A more quantitative study of the relationship between the sound exposed, sonic-active molecules (like PAs) and other molecules, which are relevant to the crop yield is being prepared.

Acknowledgements

This research was supported by KOSEF (South Korea Science and Engineering Found). Grateful thanks are extended to Mrs. Hyung-Joo Yoon and all other researchers of the Department of Sericulture and Entomology who freely offered technical help and inspiration. Grateful thanks are also due to Dr. Zachary Huang of Michigan State University who has assisted in a comprehensive revision of the manuscript. Last, but not least thanks are extended to anonymous reviewers for their invaluable comments and encouragement.

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