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Development of Inner Packaging Material for Maintaining the Freshness of Fruits and Vegetables

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ABSTRACT

The oak and pine charcoal were used to develop the inner packaging material for maintaining the freshness of vegetables and fruits, and to investigate the possibility in the application for inner packaging. The effects of the charcoal type, species, particle size, and grammage on the adsorption efficiency of ethylene gas were studied. White charcoal has superior ethylene gas adsorption performance to those of black charcoal. Pine charcoal was superior to oak charcoal in the ethylene gas adsorption. Higher gas adsorption was obtained by the higher grammage sheet. The difference in the adsorption efficiency was not significant between ONP and KOCC.

Keywords : *KOCC, ONP, white charcoal, black charcoal, pine, oak, particle size, grammage, ethylene gas adsorption*

1. Introduction

In the case of most vegetables and fruits, the emission of ethylene gas begins right after harvesting and continued during storage and transportation. The ethylene gas emitted from harvested vegetables and fruits cause the loss of commercial value and possible storage period significantly. The loss of commercial value is due to the over-ripening, discoloration, staining, and aging etc. Low temperature storage method and MA (modified atmosphere)storage method were developed and have been applied to maintain the freshness of vegetables and to improve the storage period by the control of emission and/or adsorption of ethylene gas (1-5). The porous activated carbon, activated silicate, potassium permanganate, natural zeolite, etc. were also used to remove ethylene gas directly (6). The charcoal was also tried to remove ethylene gas by the adsorption for the improvement of storage period of apple, but the long-term effect was not obtained (7).

Potassium permanganate was very effective to remove ethylene gas, but there were many problems to handle chemical and disposal of waste. Although the charcoal has high specific surface area of 200-300 m^2/g, the efficiency was not good enough.

Therefore, the crashed and screened fine charcoal powder was incorporated into pulp sheet (8-11). This

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study was carried out to investigate the possibility whether the charcoal sheet and/or pulp mold can be used to remove ethylene gas for the maintaining the freshness of vegetables and fruits.

2. Experimentals

Wastepaper such as ONP and KOCC were used instead of pulp to reduce the raw material cost. KOCC and ONP were disintegrated with laboratory disintegrator and pulper. The refining is not applied because the improvement in fiber bonding and strength properties were not so much significant in this case. The oak and pine charcoal were pulverized and fractionated into 60-80, 80-100, and 100-120 mesh fraction to investigate the effect of particle size on the adsorption of ethylene gas. Cationic PAM is used as a retention aid. The difference in adsorption efficiency of ethylene gas by white and black charcoal, and the effect of grammage were also investigated.

3. Results and Discussion

The KOCC sheet without the addition of charcoal adsorbedonly 3.4% of ethylene gas injected for 11 hrs, while the white charcoal KOCC sheet showed much higher ethylene gas adsorption efficiency (about 52-59% of ethylene gas injected) than KOCC sheet and black charcoal sheet (ca. 26-31%) as shown in Fig. 1. The reason why the ethylene gas adsorption of white charcoal is superior to black charcoal can be seen in Photo 1 and Photo 2. One can see the white charcoal particle gave larger specific area than black charcoal, although the performance was compared for same particle size fraction.

Smaller charcoal particles gave higher ethylene gas adsorption efficiency than larger charcoal particles in

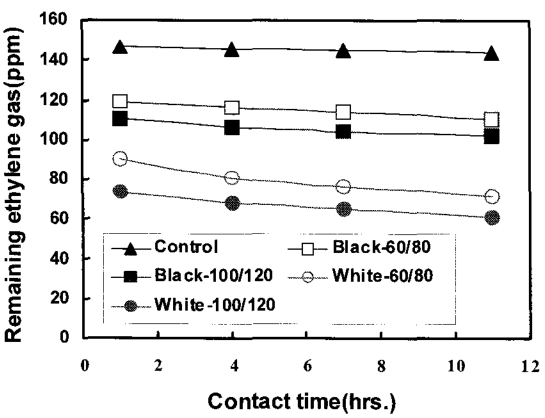

Fig. 1. Effects of oak charcoal type and particle size on the ethylene gas adsorption of KOCC charcoal sheet.

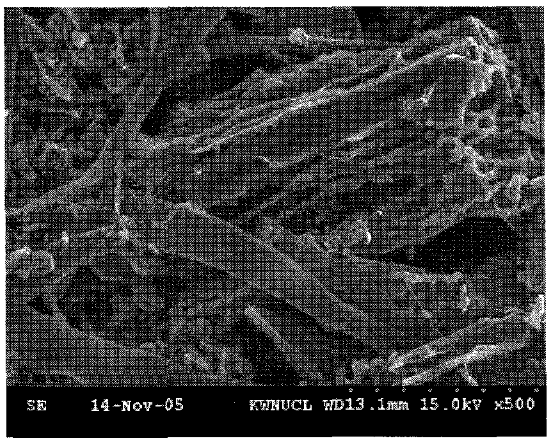

Photo 1. SEM of oak white charcoal KOCC sheet (100-120 mesh fraction, 500x).

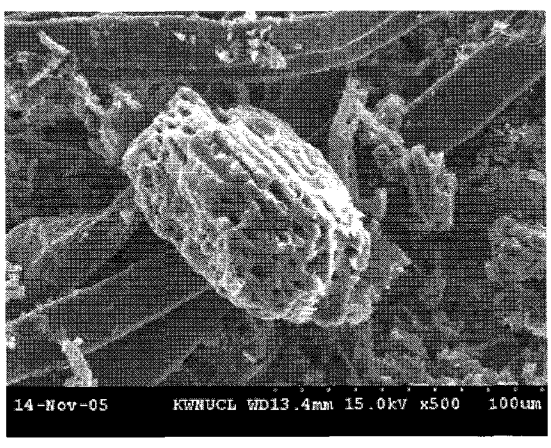

Photo 2. SEM of oak black charcoal KOCC sheet (100-120 mesh fraction, 500x).

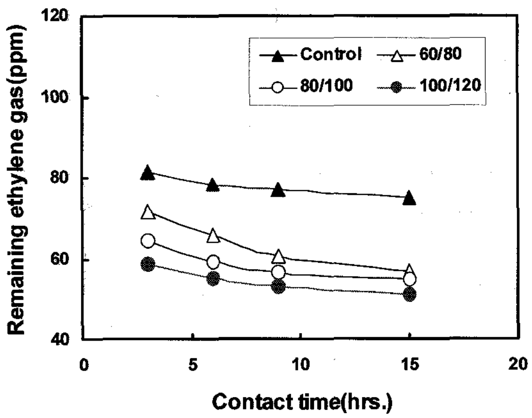

Fig. 2. Effectsof particle size of black oak charcoal on the ethylene gas adsorption of KOCC charcoal sheet.

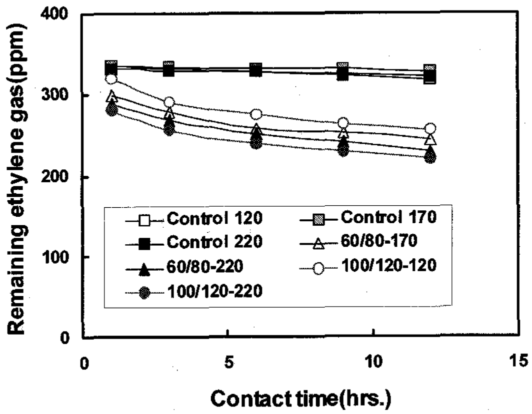

Fig. 3. Effectsof grammage and particle size on the ethylene gas adsorption of KOCC charcoal sheet.

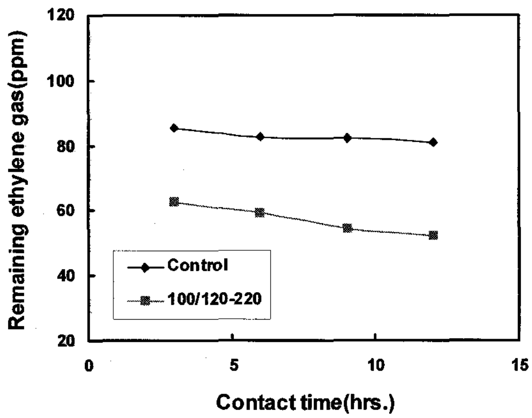

Fig. 4. Ethylene gas adsorption of ONP charcoal sheet.

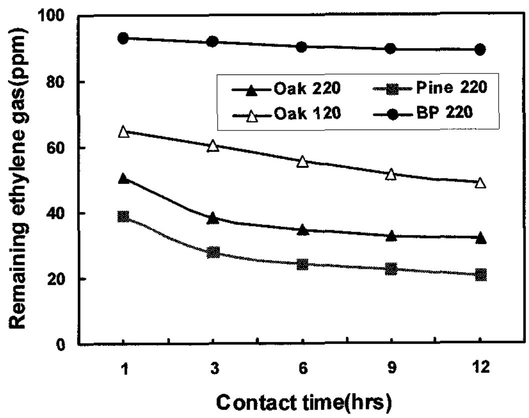

Fig. 5. Effects of specieson the ethylene gas adsorption.

both white and black charcoal (Figs. 1 and 2). This result means that the larger specific surface contributed significantly to the improvement in ethylene gas adsorption. However, there are some limitations to use smaller charcoal powder because the dewatering during papermaking (wire and wet press part) is very difficult, and more retention aid is required to get higher retention of charcoal particles. Therefore, it is required to find the optimum balance among the ethylene gas adsorption, energy consumption for water removal during papermaking and productivity.

The higher grammage of KOCC charcoal sheet gave better ethylene gas adsorption efficiency (Fig. 3). In the case of ONP sheet, the addition of oak black charcoal also improved the adsorption of ethylene gas significantly (Fig. 4).The oak and pine white charcoal were pulverized and collected the 120-140 mesh fraction to investigate the effect of particle size on the ethylene gas adsorption performance. The disintegrated KOCC was used to make the sheet. The pine white charcoal gave better ethylene gas adsorption performance than oak white charcoal (Fig. 5). The difference in gas adsorption might be due to the change of porous structure and surface properties

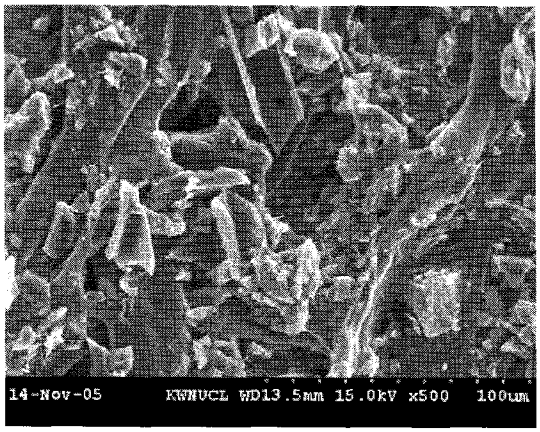

Photo 3. SEM of oak white charcoal KOCC sheet (120-140 mesh fraction, 500x).

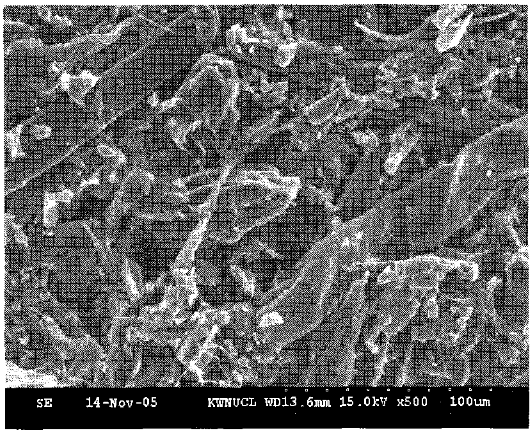

Photo 4. SEM of pine white charcoal KOCC sheet (120-140 mesh fraction, 500x).

originated from species.

4. Conclusion

The addition of charcoal powder improved the ethylene gas adsorption greatly whatever the charcoal type, species, and particle size. However white charcoal was superior to the black charcoal in the contribution for the improvement of ethylene gas adsorption. Smaller charcoal particle gave better ethylene gas adsorption performance, but there are some limitation caused by the productivity and higher energy consumption in water removal during papermaking. Pine charcoal gave higher ethylene gas adsorption performance than oak charcoal. This result might be caused by the different porous structure and surface properties originated from species.

Literature Cited

1. Oh, S.Y., Shin, S.S., Kim, C.C. and Lim, Y.J., Effect of packaging films and freshness keeping agents on fruit quality of 'yumyung' peaches during MA storage, J. Kor. Soc. Hort. Sci. 37:781-786(1996).
2. Park, Y.M. and Lee, S.K., Effects of an ethylene scrubber on storability and incidence of low-oxygen injury of 'Fiji' apples during CA storage and efficiency of several ethylene scrubbers, J. Kor. Soc. Hort. Sci. 33:44-47(1992).
3. Choi, Y.H., Ko, S.U., Kim, S.H., Kang, S.K. and Lee, C.H.,Influence of modified atmosphere packaging on fruit quality of 'tsunokaori'tangor during cold storage, Kor. J. Hort. Sci. Technol. 20:340-344 (2002).
4. Zhang, S., Chachin, K. and Iwata, T., Effects of polyethylene packaging and ethylene absorbent on storage of mature-green mume (*Prunus mume* Sieb. Et Zucc.) fruits at ambient temperature, J. Japan Soc. Hort. Sci. 60:183-190(1991).
5. Osajima, Y., Wada, K. and Ito, H., Effects of ethylene-acetaldeyde removing agent and seal-packaging with plastic films on the keeping quality of mume (*Prunus mume* Sieb. Et Zucc.) and kabosu (*Citrus sphaerocarpa* hort. Ex Tanaka) fruits, J. Japan Soc. Hort. Sci. 55:524-530(1987).
6. Osajima, Y., Sonoda, T., Yamamoto, F., Nakashima, M., Shomoda, M. and Matshumoto, K., Development of ethylene absorbent and its utilization, Nippon Nogeikagaku Kaishi 57:1127-1133(1983).
7. Park, Y.M. and Ha, H.T., Gas absorption of oak charcoal and modeling for practical application, Kor. J. Hort. Sci. Technol. 19:174-178(2001).
8. Seo, Y.B., Jeon, Y., Lee, H.H., Jung, T.Y., and Lee. J.S., Development of charcoal containing paper for packing grades(I), Journal of Korea TAPPI 35(2):46-51(2003).

9. Seo, Y.B., Jeon, Y., Lee, H.H., Jung, T.Y., and Lee. J.S., Development of charcoal containing paper for packing grades(II), Journal of Korea TAPPI 35(2): 52-57(2003).
10. Jeong, C.S., Park, S.M., Won, J.M. and Lee, S.J. J., Development of the functional packaging paper for ethylene gas absorption using charcoal, Kor. Hort. Sci. Technol. 21(2):153-156(2003).
11. Woo, C.J., Won, J.M., Jeong, C.S. and Lee, S.J., Manufacturing method of internal packaging material for maintaining the freshness of vegetables and fruits, Korean Patent 0456608(2004).