Effects of liquid smoke on red color formation and antimicrobial activity in the cured sausages

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Introduction: Liquid smoke is used extensively for imparting a smoked wood flavor to food products. It is also used in meat processing. For assessing the quality of meat products such as visual appearance, the red color, is a notable characteristic. Furthermore, the control of microbes in meat products is of critical importance. Lactic acid bacteria (LAB) are known to promote the deterioration of meat products. Thus, it is important to keep strict control on LAB growth during meat processing. The aim of this study was to investigate the effects of liquid smoke on red color formation and microbial growth, particularly of LAB, in cured sausages.

Materials and methods: Liquid Smoke EZ (Logos Co., Kyoto, Japan) was used in this study.

To investigate red color formation in cured sausages, model sausage was prepared by mixing minced pork, 2.0% salts, and 30 ppm sodium nitrite and then heating this mixture at 72°C for 30 min. The a* value of the sausage surface was evaluated using a colorimeter. The color-forming potential and residual nitrite content of the tested model sausage were assessed using previously described methods (Sakata et al. 1995).

To determine LAB growth, liquid smoke was filtered through a 0.2 μm pore size filter before use. LAB strains that were previously isolated from meat products were used for this evaluation. LAB strains were pre-cultured in GYP broth (Takeda et al. 2011), inoculated into GYP broth containing filtered liquid smoke, and then incubated at 30°C for 48 h. After incubation, the colony-forming units of LAB were estimated using GYP agar plates.

Phenolic compounds present in liquid smoke were analyzed using GC-MS. Liquid smoke was diluted with distilled water and was thoroughly mixed with n-hexane. The hexane layer was separated and collected for the GC-MS analysis, which was carried out using a GC system and a mass selective detector (Agilent Technologies, CA, USA). Samples were analyzed using an HP-5ms column (Agilent Technologies). Helium and toluene-d8 were used as carrier gas and internal standard, respectively.

Results: Liquid smoke elevated the a* value of surface in the model sausage in a concentration-dependent manner. Moreover, the color-forming potential was significantly higher for the 1.0% liquid smoke-treated sausages than for the control sausages ($p<0.05$), whereas the residual nitrite content was significantly lower ($p<0.05$) in the liquid smoke-treated sausages than in the control sausages.

The liquid smoke-treated sausages exhibited significantly suppressed colony formation of all evaluated LAB isolates when compared with the controls ($p<0.05$). We are now investigating the effects of liquid smoke on colony formation of viable microbes in the cured model sausage.

Furthermore, we analyzed the phenols present in liquid smoke since they are one of the main components of liquid smoke. It was found 4-ethyl-2-methoxy-phenol, 2,6-dimethoxy-phenol, and 3-methyl-catechol were the three most abundant phenolic compounds in liquid smoke.

Conclusion: Liquid smoke promotes the formation of red color and suppresses the growth of spoilage microbes, such as LAB, in cured sausages.