O-03-04

Generation of nitrite in meat batter by remote infusion of atmospheric pressure plasma (#284)

Seonmin Lee[1], Kyung Jo[1], Yun-sang Choi[2], Heejoon Jeon[3], Samooel Jung[1]

[1] Chungnam National University, Animal&dairy science, Daejeon, South Korea; [2] Korean Food Research Institute, Research group of food processing, Jeonju, South Korea; [3] Lotte R&D Center, Meat Processing Division, Seoul, South Korea

Introduction

Plasmas are ionized gases including positive and negative ions, electrons, metastables, atoms, free radicals, and photons, which are generated by supplying energy such as thermal energy, energetic beam, and electric field to neutral gas. The role of atmospheric pressure plasma (APP) as a curing process in the meat industry has been reported based on the nitrite generation by reactions between reactive nitrogen species in plasma and water molecules.

Previous studies found the gradual increase of nitrite content in meat batter with the increase of APP treatment time. However, the temperature of the meat batter was also gradually increased because of heat absorption from plasma and plasma discharge source. Therefore, the optimum level of nitrite that could be generated in meat batter by direct treatment of APP was 42 mg kg^{-1} when the recommended temperature (lower than 13°C) of meat batter was considered. The regulations of ingoing nitrite for cured meat products are different depending on the country and categories of meat products. The allowed levels of ingoing nitrite for comminuted products in the European Union and the United State were 150 and 156 mg kg^{-1} (as sodium nitrite), respectively. South Korea limit residual nitrite less than 70 mg kg^{-1} in all cured meat products. The nitrite can develop cured color and flavor in cured meat products at a low level as much as 10 mg kg^{-1}, however, it is recommended to add nitrite as much as is allowed for obtaining microbial safety. Therefore, the way to increase nitrite level of meat batter up to allowed level by the treatment of APP with the allowed temperature of meat batter have been required.

Therefore, the remote treatment of APP was applied as a curing process for meat products in this study. The nitrite content and temperature of meat batter were tested with the remote APP treatment.

Methods

The plasma generated from cylindrical dielectric-barrier discharge was infused into a food mixer containing meat batter (Figure 1). The remote infusion of APP into meat batter were three times conducted on the same day with 1 h intervals, and this test was three times repeated in independent days. Meat batter samples were collected from three areas of the meat batter at 5-min intervals during plasma treatment over 30 min. The nitrite concentration of the meat batter was measured. The temperature of meat batter during mixing in a food mixer with or without the infusion of APP was measured at 5-min intervals for 20 min. The effect of plasma infusion and infusion time on the nitrite content and the meat batter temperature was analyzed using linear regression models with SAS software.

Results

The nitrite contents of meat batter with the infusion of plasma were nine times (3 operations x 3 trial). The regression analysis showed that the order of operations had a significant effect on the nitrite generation in meat batter ($P<0.05$) while a significant effect was not found in the trial. The first operations of three trials resulted in the low generation of nitrite compared with second and third operations (Figure 2).

After the exception of first operation data, no significant effect of operation order on the nitrite generation was found. The estimated coefficient of infusion time (min) for nitrite content (mM) in meat batter was 0.471 and adjusted R-square was 0.983 (Figure 2). The required time for the generation of 100 ppm nitrite in 3.2 kg of meat batter by remote infusion of plasma in our laboratory APP system was 14.78 min after pre-operation.

The temperature of meat batter was gradually increased regardless of plasma infusion with the increase of mixing time (Figure 3). The result of the regression analysis showed that the plasma infusion raised the temperature of meat batter further significantly. In this study, the target level of nitrite in meat batter was 100 mg kg^{-1}. The required infusion time of plasma was 14.78 min for 3.2 kg meat batter, and the meat batter temperature was 9.2°C after 15 min infusion of plasma. From the results, it was found that the remote infusion of plasma had a high and rapid rate for nitrite generation in meat batter compared with the direct treatment of plasma.

Conclusion

The remote infusion of APP into meat batter had a high and rapid rate for nitrite generation in meat batter compared with the direct treatment of plasma. In addition, the temperature rise in meat batter was small until the 100 mg kg^{-1} nitrite generation. Therefore, we conclude that the remote infusion of APP is more applicable system for curing of meat products in processed meat industry.

Notes

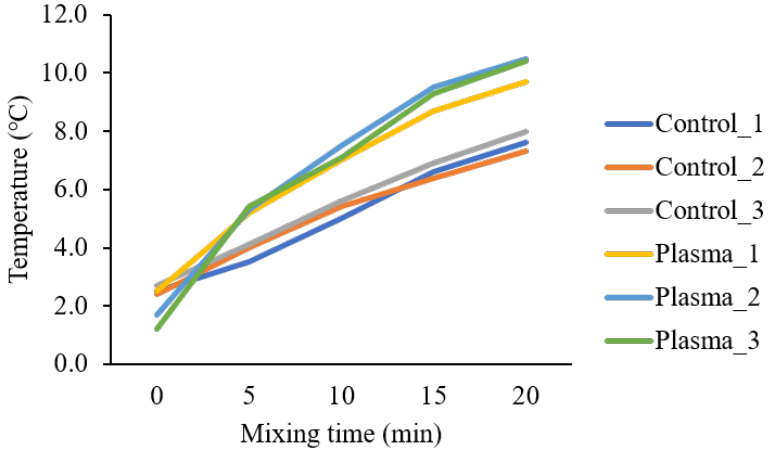

Fig 3. The changes of meat batter temperature with or without the remote infusion of APP t-value for plasma treatment; 5.27 ($p<0.05$), t-value for mixing time; 16.33 ($p<0.05$)

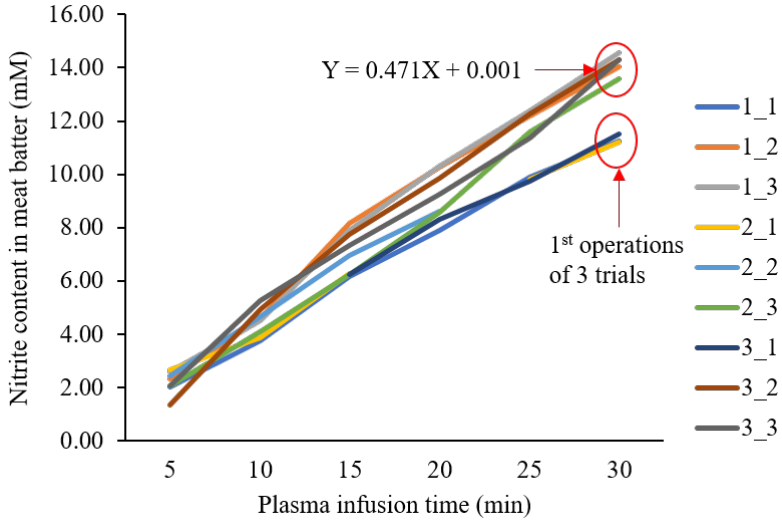

Fig 2. The nitrite content of meat batter with the remote infusion of APP (3 operation x 3 trials) t-value for operation order; 3.81 ($p<0.05$), t-value for infusion time without first operation data; 48.65 ($p<0.05$)

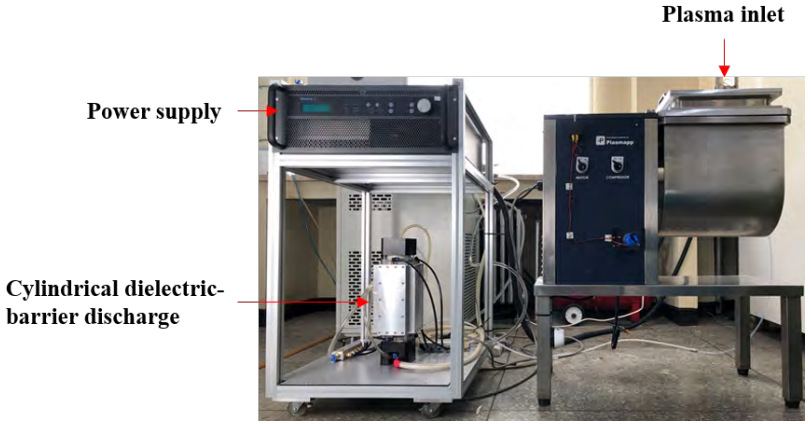

Fig 1. The system for remote infusion of APP into a food mixer containing meat batter

Notes