INACTIVATION OF LISTERIA MONOCYTOGENES INOCULATED ONTO SLICED CHICKEN BREAST AND HAM BY A PEN-TYPE ATMOSPHERIC PRESSURE PLASMA WITH DIFFERENT INPUT GAS COMPOSITION

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Abstract - **A pen-type atmospheric pressure plasma (APP) was developed and investigated the inactivation of *Listeria monocytogenes* inoculated on sliced chicken and ham. He, N_2, and their mixture with O_2 were introduced to produce plasma. The population of *L. monocytogenes* inoculated on sliced chicken and ham showed significant reduction from 1.37 to 4.73 and from 1.94 to 6.52 log cycles by different input gases. Among the gases, N_2+O_2 was the most effective. The pen-type APP reduced the number of aerobic bacteria to undetected level (<10^2 CFU/g) in both samples, except for the sliced ham with N_2 only, and the effect was maintained during 7 days. Results indicated that a pen-type APP is one of the potential APP systems to inactivate the contaminated *L. monocytogenes* in sliced chicken breast and ham and to prolong the shelf-life of the foods.**

Key words - **atmospheric pressure plasma, sliced chicken breast, sliced ham**

I. INTRODUCTION

In recent years, as consumers' interests in food safety increased, many studies have been performed to secure food processing from contamination of foodborne pathogens [1]. In order to develop the appropriate sterilization methods without any kinds of adverse changes, researchers have developed non-thermal treatments such as irradiation, high pressure, natural antimicrobials, active packaging, and so on [2].

Among the non-thermal treatments, recently, scientists' attention for atmospheric pressure plasma (APP) has been increased. Gas plasma, ionized gas with a net neutral charge, can be considered as the fourth state of matter. It is consisted of ions, electrons and uncharged particles [3,4]. These act as inactivation agents so that APP is capable of reducing microbial population [5]. APP has been used for surface modification, environmental, and biomedical applications [6,7]. And nowadays, it is considered as an emerging method for food safety in food processing [8].

Therefore, the objective of this study was to evaluate the efficiency of a pen-type APP, a new type APP device for food treatment, on the inactivation of *L. monocytogenes* inoculated on real food system including sliced chicken breast and ham.

II. MATERILAS AND METHODS

A. Sample preparation

Sliced chicken breast (Harim Co., Ltd., Iksan, Korea) and ham (CJ Co., Ltd., Jincheon, Korea) were purchased from a local market in Daejeon, Korea. Prior to inoculation test, sliced chicken breast and ham were vacuum-packaged and sterilized by irradiation (40 kGy) using a cobalt-6o gamma irradiator at the Advanced Radiation Technology Institute, Jeongup, Korea.

B. Microorganism and inoculation

L. monocytogenes (KCTC 3596) obtained from the Korean Collection for Type Culture (KCTC, Daejeon, Korea) was cultured at 37 □ for 18 h in tryptic soy broth (50 ml) (Difco Laboratories, Detriot, MI, USA). The strain was transferred to a 50 ml centrifuge tube and then centrifuged (2,090 x *g* for 10 min at 4 □) in a refrigerated centrifuge (UNION 32R, Hanil Science Industrial, Co., Ltd., Korea). The pellet was washed twice with sterile saline (0.85%) and then suspended

in saline to a final concentration of approximately 10^8 CFU/ml. The test culture suspension (10 μl) was inoculated on, sliced chicken breast and ham (15 x 15 x 1 mm). To facilitate the attachment of microorganisms to the samples, the samples were left for 1 h.

C. Treatment of a pen-type APP

The samples were treated by plasma produced at 2 kV peak to peak voltage. The sliced chicken breast and ham were treated for 2 min. He and N_2 (7 slpm, standard liter per minute) were used basically for generating plasma. In order to observe the effect of the gas mixture, O_2 (70 sccm, standard cubic centimeter per minute) was added to each gas treatment. For plasma treatment, inoculated samples were placed on the bottom conductor in direct contact with plasma. The distance between the powered electrode and the treatment surface was maintained at 4 cm.

D. Microbiological analysis

The samples for the microbial count were prepared in a series of decimal dilutions utilizing sterile saline. The media used for *L. monocytogenes* inoculation and total aerobic bacteria was tryptic soy agar (Difco Laboratories). Each diluent (100 μl) was spread in triplicate on the medium. The plates were incubated at 37 ℃ for 24 h and then calculated for the microbial count and expressed as log CFU/g.

E. Statistical analysis

Statistical analysis was performed by one-way Analysis of Variance (ANOVA), and significant differences between mean values were identified by the Student-Newman-Keul's multiple range test using SAS software with a confidence level at $P < 0.05$ (SAS, Release 9.2, SAS Institute Inc., Cary, NC). Mean values and standard error of the means (SEM) are reported.

III. RESULTS AND DISCUSSION

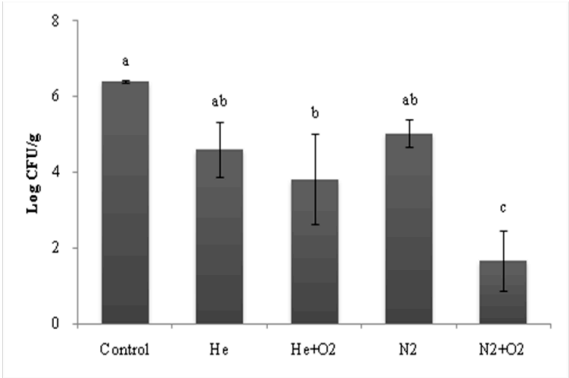

Figure 1. The effect of a pen-type atmospheric pressure plasma on inactivation of *Listeria monocytogenes* inoculated onto sliced chicken breast with different gas compositions.

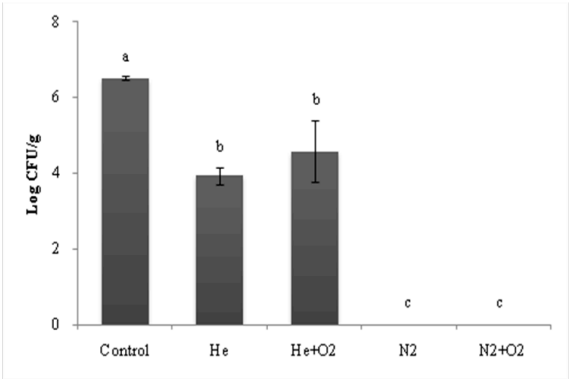

Figure 2. The effect of a pen-type atmospheric pressure plasma on inactivation of *Listeria monocytogenes* inoculated onto sliced ham with different gas compositions.

Figs. 1 and 2 implies microbial reduction of *L. monocytogenes* inoculated on sliced chicken breast and ham after 2 min treatment of the pen-type APP. Microbial population inoculated on sliced chicken breast and ham showed significant reductions ranged by 1.37 – 4.73 log cycles and 1.94 - 6.52 log cycles, respectively. Similarly, each gas combined with O_2 resulted in more effective inactivation in both samples. The gas combination of N_2+O_2 was the most effective. Result indicates that the addition of O_2 improved the efficiency in microbial reduction when compared with use of He or N_2 alone. The different responses to each sample were discovered as it found that the pen-type APP was slightly more effective in inactivating sliced ham than chicken breast. Different inactivation

efficiency with the same microorganism on different surfaces illustrated the importance of the surface characteristics of the substrate.

IV. CONCLUSION

A pen-type APP is one of the potential APP systems to inactivate the contaminated *L. monocytogenes* in sliced chicken breast and ham and to prolong the shelf-life of the foods. A further enhancement of APP system should be investigated to provide a suitable market-friendly non-thermal treatment method for food industry.

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