EFFECT OF IRRADIATION ON SENSORY CHARACTERISTICS AND SHELF-LIFE EXTENSION OF *DAK-GALBI*

Yohan Yoon[a], Jin-Gyu Park[a], Jae-Nam Park[a], Beom-Seok Song[a], Jae-Hun Kim[a], Myung-Woo Byun[a], Cheon-Jei Kim[b], Ju-Woon Lee[a*]

[a] Team for Radiation Food Science and Biotechnology, Advanced Radiation Technology Institute, Korea Atomic Energy Research Institute, Jeongeup, Jeonbuk 580-185, South Korea
[b]Department of Food Science and Biotechnology of Animal Resources, Konkuk University, Seoul 143-701, South Korea
*Corresponding author (phone: +82-63-570-3204; fax: +82-63-570-3207; e-mail: sjwlee@kaeri.re.kr)

***Abstract*-The objective of this study was to evaluate the effect of gamma irradiation on shelf-life extension and sensory characteristics of *dak-galbi*. *Dak-galbi* sauce was exposed to 0, 5, 10, 15, 20, 25, and 30 kGy of gamma irradiation, and the sauce was mixed with diced chicken, followed by cooking. The cooked *dak-galbi* in vacuum bags were then stored at 35°C for 5 days. During storage, the samples were analyzed on day 0, 1, 2, 3, 4, and 5 for microbial analysis, and on day 0 for sensory evaluation. Higher ($p<0.05$) dose irradiation on sauce limited bacterial growth, and no adverse effects ($p\geq0.05$) of irradiation were observed in sensory characteristics. The results suggest that gamma irradiation on *dak-galbi* sauce may be useful in shelf-life extension with no compromising the sensory characteristics of *dak-galbi*.**

***Index Terms*-irradiation, *dak-galbi*, shelf-life extension.**

I. INTRODUCTION

Dak-galbi is the foods prepared by stir-frying diced chicken after marination in a *gochujang* (chili pepper paste) based sauce. *Dak-galbi* sauce contains soy sauce and various raw spices. Since *dak-galbi* sauce contains raw spices, and the spices may bring food spoilage bacteria in the sauce, non-thermal treatment to *dak-galbi* sauce may be useful in destroying food spoilage bacteria as well as pathogens, which may extend shelf-life of *dak-galbi* sauce.

Gamma irradiation has been used as a non-thermal treatment for food preservation in more than 50 countries, including Belgium, Canada, France, South Korea, India, United States, Netherlands, and others (Turgis *et al*., 2008). Many studies presented that irradiation improve shelf-life of fresh meat such as beef and pork (Lee *et al*., 2004; Whang, 2002; Waje *et al*., 2008). The studies by Jo *et al*. (2003) and Lee *et al*. (2001) showed that irradiation on *bulgogi* sauce improved storage stability of the sauce. Therefore, this study evaluated the effect of gamma irradiation on shelf-life extension and sensory characteristics of *dak-galbi*.

II. MATERIALS AND METHODS

A. Sample preparation and gamma irradiation

Dak-galbi sauce (water: 25%, soy sauce: 5%, garlic: 5%, pepper: 0.5%, corn syrup: 10%, red pepper paste: 55%, sugar: 5%, ginger: 4.5%) was obtained from a local *dak-galbi* restaurant in Jeongeup-si, Jeollabuk-do, South Korea. The sample (1 kg) was exposed to 0, 5, 10, 15, 20, 25, and 30 kGy of gamma irradiation. The *dak-galbi* sauce (200 g) and water (100 mL) were added to diced chicken (800 g), and the mixture was stir-fried on an electronic pan (NU-VUE-3 Cooker, Menominee, MI. USA) for 12 min, followed by cooling at room

temperature. The vacuum-packaged *dak-galbi* samples were stored under an accelerated condition (35°C) for 5 days.

B. Microbiological analysis

Dak-galbi samples were analyzed on day 0, 1, 2, 3, 4, and 5 for microbial analysis. The 10 g portions of *dak-galbi* samples were transferred into sterile bags (20×25 cm; Sunkyung Co., Seoul, South Korea) containing 90 mL of 0.1% peptone water, and they were pummeled by a stomacher (Model 400, Tekmar Co., Los Angeles, CA, USA) for 2 min. Homogenates were serially diluted with 0.1% peptone water, and the diluents (1 mL) were pour-plated using 20 mL of plate count agar (PCA; Difco, Becton Dickinson, Sparks, MD, USA) After the media became solid, plates were incubated at 37°C for 48 h.

C. Sensory evaluation

Sensory properties for *dak-galbi* samples were evaluated by 10 panels only on day 0 according to the method described by Civille and Szczesniak (1973). Color, appearance, flavor, taste, texture, off-odor, and overall acceptance of the samples were evaluated using a 7 point descriptive scale where 1 = extremely dislike or extremely weak to 7 = extremely like or extremely strong.

D. Statistical analysis

Samples were analyzed in triplicate for microbiological analysis and one sample per panel for sensory evaluation. All data were analyzed by the generalized linear model procedures of the SAS® version 9.2 (SAS Institute, Cary, NC, USA). Mean comparisons were performed by the Tukey's multiple comparison at alpha = 0.05.

III. RESULTS AND DISCUSSION

Before irradiation, initial bacterial populations of *dak-galbi* sauce was 6.2 log CFU/g, but the populations in the sauce declined to below detection limit (1 log CFU/g) after irradiation at 30 kGy (data not shown in tabular form). After *dak-galbi* was marinated with the sauce followed by cooking, total bacterial populations in the cooked *dak-galbi* marinated with non-irradiated sauce were 2.6 log CFU/g, but bacterial cell counts of the *dak-galbi* treated with irradiated sauce at more than 15 kGy were below detection limit (Table 1). The bacterial cell counts in the samples were then significantly ($p<0.05$) increased during storage, but bacterial populations in *dak-galbi* lowered ($p<0.05$) as irradiation dose used to *dak-galbi* sauce increased (Table 1). This result suggests that injured cells from irradiation may be rapidly recovered during storage.

In the results of sensory evaluation, no significant differences ($p\geq0.05$) in sensory characteristics among irradiation doses were observed. This result indicates that gamma irradiation on *dak-galbi* sauce did not influence sensory characteristics of cooked *dak-galbi* (Table 2).

IV. CONCLUSION

Application of gamma irradiation on *dak-galbi* sauce could extend shelf-life of *dak-galbi* without compromising the sensory characteristics.

ACKNOWLEDGEMENT

This research was financially supported by Nuclear Research and Development Program of the Korea Science and Engineering Foundation (KOSEF) by Ministry of Education, Science and Technology (MEST).

Table 1. Total bacterial populations (mean ± standard deviation; log CFU/g) in cooked *dak-galbi* after marination with gamma-irradiated sauces during accelerated storage for 5 days at 35°C

Irradiation doses (kGy)	Storage (days)					
	0	1	2	3	4	5
0	2.6 ± 0.4^{Ac}	5.3 ± 0.3^{Ab}	6.7 ± 0.4^{Aa}	-	-	-
5	2.1 ± 0.4^{Ac}	4.2 ± 0.4^{Bb}	6.4 ± 0.3^{Aa}	-	-	-
10	2.3 ± 0.2^{Ac}	4.7 ± 0.4^{Ab}	6.2 ± 0.3^{Aa}	-	-	-
15	$<1.0\pm0.0^{Bd}$	3.4 ± 0.3^{BCc}	5.3 ± 0.1^{Bb}	7.6 ± 0.4^{Aa}	-	-
20	$<1.0\pm0.0^{Bd}$	3.2 ± 0.3^{Cc}	4.4 ± 0.2^{BCb}	6.6 ± 0.2^{Ba}	-	-
25	$<1.0\pm0.0^{Be}$	2.8 ± 0.3^{Cd}	3.8 ± 0.2^{CDc}	5.5 ± 0.4^{Cb}	7.3 ± 0.2^{Aa}	-
30	$<1.0\pm0.0^{Be}$	$<1.0\pm0.0^{De}$	3.3 ± 0.1^{Dd}	3.9 ± 0.3^{Dc}	5.5 ± 0.3^{Bb}	6.3 ± 0.4^{Aa}

Bar indicates no determination of bacterial populations because of spoilage
$^{A-D}$: Means within a column with different superscripts are significantly different ($p<0.05$)
$^{a-e}$: Means within a row with different superscripts are significantly different ($p<0.05$)

Table 2. Sensory characteristics (mean ± standard deviation) of cooked *dak-galbi* after marination with gamma-irradiated sauces during accelerated storage on day 0

Irradiation doses (kGy)	Sensory characteristics					
	Appearance	Taste	Flavor	Texture	Off-flavor	Overall acceptability
0	6.3 ± 0.2^{A}	6.1 ± 0.3^{A}	6.2 ± 0.2^{A}	6.4 ± 0.1^{A}	1.1 ± 0.1^{A}	6.4 ± 0.3^{A}
5	6.5 ± 0.3^{A}	6.0 ± 0.3^{A}	6.2 ± 0.2^{A}	6.4 ± 0.1^{A}	1.1 ± 0.1^{A}	6.4 ± 0.3^{A}
10	6.5 ± 0.3^{A}	6.0 ± 0.3^{A}	6.3 ± 0.1^{A}	6.4 ± 0.1^{A}	1.1 ± 0.2^{A}	6.4 ± 0.3^{A}
15	6.2 ± 0.1^{A}	5.9 ± 0.4^{A}	6.3 ± 0.2^{A}	6.4 ± 0.2^{A}	1.1 ± 0.1^{A}	6.5 ± 0.3^{A}
20	6.3 ± 0.2^{A}	5.9 ± 0.4^{A}	6.2 ± 0.1^{A}	6.4 ± 0.1^{A}	1.1 ± 0.2^{A}	6.5 ± 0.4^{A}
25	6.3 ± 0.3^{A}	5.8 ± 0.2^{A}	6.2 ± 0.1^{A}	6.3 ± 0.1^{A}	1.2 ± 0.1^{A}	6.5 ± 0.4^{A}
30	6.2 ± 0.4^{A}	5.7 ± 0.3^{A}	6.2 ± 0.2^{A}	6.3 ± 0.2^{A}	1.1 ± 0.1^{A}	6.4 ± 0.3^{A}

^{A}: Means within a column with same superscripts are not significantly different ($p\geq0.05$)

REFERENCES

Civille, G. V., & Szczesniak, A. S. (1973) Guidelines to training a texture profile panel. *Journal of Texture Studies*, 6, 19-28.

Jo, C., Kim, D. H., Shin, M. G., Kang, I. J., & Byun, M. W. (2003) Irradiation effect on *bulgogi* sauce for making commercial Koran traditional meat product, *bulgogi*. *Radiation Physic and Chemistry*, 68, 851-856.

Lee, Y-C., Kim, S-H., & Oh, S-S. (2001) Effect of gamma irradiation on the quality of *bulgogi* sauce. *Korean Journal of Food Science and Technology*, 33, 327-332.

Lee, J-W., Kim, J-H., OH, S-H., Lee, Y-S., Kim, D-J., Oh, S-Y., & Byun, M-W. (2004) Radiation sensitivity of *Aspergillus flavus* in semi-dried beef jerky. *Food Science and Biotechnology*, 13, 613-615.

Turgis, M., Borsa, J., Millette, M., Salmieri, S., & Lacroix, M. (2008) Effect of selected plant essential oils and modified atmosphere packaging on the radiosensitivity of *Escherichia coli* O157:H7 and *Salmonella* Typhi in ground beef. *Journal of Food Protection*, 71, 516-521.

Waje, C., Kim, M-Y., Nam, K-C., Jo. C., Kim D-H., Lee, J-W., & Kwon, J-H. (2008) Effect of irradiation on the color, microbiological quality, and sensory attributes of frozen ground beef, pork, and chicken after 6 months at -6^{o}C. *Food Science and Biotechnology*, 17, 212-215.

Whang, K. (2002) Combination effect of modified atmosphere packaging and electron beam irradiation on the oxidative and microbiological stability of ground pork during storage. *Korean Journal for Food Science of Animal Resources*, 22, 322-329.