

## Effects of *kimchi* powder on quality characteristics of frankfurter sausages prepared with irradiated pork meat

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**Abstract**— in this study, the effects of *kimchi* powder on physicochemical properties of frankfurter sausages prepared with the irradiated pork meat were evaluated. The pork meat was irradiated at gamma-irradiation doses of 0, 5, and 10 kGy, and the irradiated pork meat was then used to make frankfurter sausages with containing *kimchi* powder (0.05%). The addition of *kimchi* powder on frankfurter sausage prepared with irradiated pork meat provides the similar physicochemical properties as compared no treatment and the improvement of sensorial properties of frankfurter sausages.

**Keywords**— *Kimchi* powder, frankfurter sausage, irradiated pork

### I. INTRODUCTION

Food irradiation technique is one of the effective methods for improving storage quality and stability of various foods. This method were approved by various international organizations (FAO, IAEA, and WHO) in 1990s. According to Byun [1], the nutritional and sensorial properties of foods during storage did not affected by irradiation. Thus, food irradiation technique is pragmatically used in several foods. Especially, for meat and meat product which contain high nutritional values, irradiation is recognized worthily. However, the irradiated meat has partial problems, such as the promotion of lipid oxidation and off-odor, due to the formation of free radical. Many studies are evaluated to solve these problems.

*Kimchi* is a traditional fermented food in South Korea, and is made of mainly leaf or root various vegetables. In addition, *kimchi* has unique flavours due to the addition of spices and fermentation. For these

reasons, the addition of *kimchi* enhances flavour of several foods [2], Cho [3] and Lee et al. [4] reported the positive effects of *kimchi* to meat products. However, no data is available on the effect of *kimchi* on the physicochemical properties of the irradiated meat.

Therefore, the aims of this study were to evaluate the effect of *kimchi* powder on the physicochemical and sensorial properties of frankfurter sausage prepared with gamma irradiated pork.

### II. MATERIALS AND METHODS

#### *Meat preparation and gamma irradiation*

Fresh pork hams and back fat were purchased in a local market. All subcutaneous, intramuscular fat and visible connective tissue were removed from the fresh pork muscles. Trimmed muscles were ground through an 8 mm plate, after which the ground tissue was placed in polyethylene bags. The meat was irradiated at 0, 5, and 10 kGy in a cobalt-60 irradiator (point source, AECL, IR-79, Nordion international, Ottawa, Ontario, Canada) with source strength of 100 kCi in Advanced Radiation Technology Institute of Korea Atomic Energy Research Institute (Jeongseup-si, Jeollabuk-do, South Korea). The dose rate was 70 kGy/min at 18±0.5 °C. Dosimetry was performed using 5mm diameter alanine dosimeters (Bruker Instruments, Rjeomstettem, Germany), and the free-radical signal was measured using a Bruker EMS 104 EPR Analyzer. The actual dose was within ±2% of the target dose.

#### *Preperation of Kimchi powder*

*Kimchi* powder was prepared as described by Lee et al. [4]. Commercial Baechu (Chinese cabbage) *kimchi* was purchased from a local market (Chongga *kimchi*, Daesang FNF, Seoul, Korea). The chemical composition of the *kimchi*, determined in triplicates according to the AOAC [5] method, was: 91.3 g/100 g moisture, 2.2 g/100 g protein, 0.5 g/100 g fat, 0.85 g/100 g ash, and 2.1 g/100 g dietary fiber. *Kimchi* was blended with a cutter (C4 VV, Sirman, Marsango, Italy) and then packed about 300 g of each bags and pressed flat for drying. The vacuum-packaged *kimchi* was immediately frozen at  $-20 \pm 1$  °C until used. Hot air drying was carried out in a hot air dryer (Enex-Co-600, Enex, Yongin, Korea) at  $60 \pm 1$  °C. The samples were dehydrated until they reached a constant weight (<15% final moisture) for 12 hr at the hot air dryer, and then finely ground to <0.5 mm (35 mesh) in size. The powders were stored in a deep freezer ( $-70$  °C) until further used.

#### *Manufacturing of frankfurter sausage*

Frankfurter sausage was manufactured with ground irradiated pork, pork back fat and additives (Table 1). Onion and garlic powder were purchased from local distributor and *kimchi* powder was prepared according to the above method. Three batches (each 3 kg) were prepared for each treatment. Irradiated ground pork meat was homogenized and ground for 1 min in a silent cutter (Nr-963009, Scharfen, Witten, Germany). 1.5% salt was added to the meat and mixed for 1 min, back fat was added after 3 min and the batters were homogenized for 6 min. A temperature probe (Kane-May, KM330, Harlow, Germany) was used to monitor the temperature of the emulsion, which was maintained below 10 °C during batter preparation. Batters were stuffed into collagen casings (#180, NIPPI Inc., Tokyo, Japan; approximate 16 mm diameter) using a stuffer (Stuffer IS-8, Sirman, Marsango, Italy), and samples were heating at 80 °C until 75 °C at core temperature for 30 min in smoke house and were smoking at 65 °C for 20 min. And then the sausage cooled with cold water for 10 min until 10 °C at core temperature. The produced samples were vacuum sealed in polyethylene bags and stored at 4 °C before analysis.

Table 1. Formulations of frankfurter sausages

Ingredients (%)	Control	<i>Kimchi</i> treatment
Irradiated pork meat	60	60
Pork backfat	20	20
Ice water	20	20
Total	100	100
NPS <sup>a</sup>	1.50	1.50
Phosphate <sup>b</sup>	0.30	0.30
Ascorbic acid	0.02	0.02
ISP <sup>c</sup>	0.50	0.50
MSG <sup>d</sup>	0.06	0.06
Onion powder	0.30	0.30
Garlic powder	0.30	0.30
<i>Kimchi</i> powder	-	0.50

<sup>a</sup>NPS: 99.4% NaCl containing 0.6 % sodium nitrite.

<sup>b</sup>Phosphate: sodium tripolyphosphate.

<sup>c</sup>ISP: Isolated soy protein.

<sup>d</sup>MSG: Monosodium L-glutamate.

#### *pH measurement*

The pH values of frankfurter sausages were measured in a homogenate prepared with 5 g of sample and distilled water (20 ml) using a pH meter (Model 340, Mettler-Toledo GmbH, Switzerland). All determinations were performed in triplicate.

#### *Instrumental colour evaluation*

The color of sample was determined using a colorimeter (Minolta Chroma meter CR-210, Minolta Co., Japan; illuminate C, calibrated with a white plate,  $L^* = +97.83$ ,  $a^* = -0.43$ ,  $b^* = +1.98$ ). Six measurements for each of five replicates were taken. Lightness (CIE  $L^*$ - value), redness (CIE  $a^*$ - value), and yellowness (CIE  $b^*$ - value) values were recorded.

#### *Cooking yields*

Cooking yields were determined by calculating the weight differences before and after cooking as follows: Cooking yields (%) = weight of sausage after cooking (g) / weight of sausage (g) before cooking × 100

#### *Texture profile analysis (TPA)*

The textural properties of sample were measured by a 0.25 Ø spherical probe attached to a texture analyzer (TA-XT2i, Stable Micro Systems Ltd., Surrey, UK).

The test conditions were as follows: stroke, 20 g; test speed, 2 mm/sec; distance, 10.0 mm. Data were collected and analyzed regarding the hardness (N), springiness, cohesiveness, gumminess (N), and chewiness (N) values.

#### Sensory evaluation

Experienced 12-member panel consisting of students and researchers of Meat Science Lab. at Konkuk University in Korea was used. Samples were taken out from vacuum packaged bags, cut into 5 mm slices and served to the panels when samples were at room temperature. Panellists were presented with randomly coded samples. Colour (1=extremely undesirable, 10=extremely desirable), flavour (1=extremely undesirable, 10=extremely desirable), and tenderness (1=extremely tough, 10=extremely tender), of samples were evaluated using a 10 point descriptive scale.

#### Statistical analysis

An analysis of variance was performed on all the variables measured using the general linear model (GLM) procedure of the SAS statistical package [6]. Duncan's multiple range test ( $P < 0.05$ ) was used to determine the differences between treatment means.

### III. RESULTS AND DISCUSSION

Table 2 shows the effects of *kimchi* powder on the pH, instrumental colour, and cooking yields of frankfurter sausage prepared with irradiated pork meat. As the increase of irradiation dose to pork meat, the pH value of frankfurter sausage shows trend to significantly increase ( $P < 0.05$ ). The *kimchi* treatment had a lower pH values than the control at same irradiation dose, however, there was no significant difference ( $P > 0.05$ ). The lightness of the frankfurter sausage significantly decreased due to increase irradiation dose ( $P < 0.05$ ), no significant differences in redness of frankfurter sausage were observed due to irradiated pork meat and *kimchi* powder ( $P > 0.05$ ). As the addition of *kimchi* powder, the yellowness of frankfurter sausage significantly increased ( $P < 0.05$ ). The cooking yields for the frankfurter sausage were significantly unaffected by the irradiation dose and the addition of *kimchi* powder ( $P > 0.05$ ). The effects of

*kimchi* powder on the textural properties of frankfurters sausage made with irradiated pork meat (Table 3). The hardness, gumminess, and chewiness of the frankfurter with *kimchi* powder was lower than the control (without *kimchi* powder), there were no significant differences ( $P > 0.05$ ). The sensorial properties of frankfurter sausage prepared using irradiated pork meat and *kimchi* powder are shown in Table 4. As the increase of irradiation dose to pork meat, the flavour of frankfurter sausage made with its decreased. However, the addition of *kimchi* powder inhibited the changes in flavour by gamma-irradiation due to its characteristics flavour. However, there were no significant differences for colour and tenderness of frankfurter sausage prepared with irradiated pork meat ( $P > 0.05$ ).

Table 2. Effects of *kimchi* powder on the pH, instrumental colour, and cooking yields of frankfurter sausage prepared with irradiated pork meat

Traits	ID <sup>a</sup> (kGy)	Control	<i>Kimchi</i> treatment
pH	0	6.31±0.03z	6.29±0.03z
	5	6.43±0.04y	6.42±0.02y
	10	6.59±0.02x	6.55±0.03x
CIE L*	0	78.14±1.52Xx	75.43±1.93Yx
	5	77.08±3.93Xy	72.02±2.69Yy
	10	73.15±1.65Xz	71.36±1.60Yz
CIE a*	0	7.85±1.19Y	9.00±0.63X
	5	7.73±1.36	8.52±0.39
	10	7.77±0.95	8.50±0.90
CIE b*	0	8.26±0.51Y	14.06±0.28X
	5	8.84±0.87Y	11.33±0.82X
	10	8.19±0.93Y	10.73±1.43X
Cooking yields (%)	0	88.95±1.62	89.22±1.35
	5	88.92±1.25	89.09±1.08
	10	87.77±1.03	88.57±1.83

<sup>a</sup> ID: irradiation dose.

All values are mean±S.D. ; (n = 6).

X,Y Means in the treatments with different letters are significantly different ( $P < 0.05$ ).

x-z Means in the treatments with different letters are significantly different ( $P < 0.05$ ).

Table 3. Effects of *kimchi* powder on the textural properties of frankfurter sausage prepared with irradiated pork meat

Traits	ID <sup>a</sup> (kGy)	Control	<i>Kimchi</i> treatment
Hardness (N)	0	4.88±0.28	4.42±0.26
	5	4.95±0.48	4.47±0.53
	10	5.35±0.33X	4.89±0.19Y
Springiness	0	0.96±0.05	0.97±0.03xy
	5	0.96±0.03	0.97±0.02x
	10	0.95±0.02	0.94±0.03y
Cohesiveness	0	0.54±0.03x	0.55±0.02x
	5	0.51±0.04xy	0.49±0.03y
	10	0.50±0.02y	0.52±0.03y
Gumminess (N)	0	2.55±0.20	2.54±0.32
	5	2.53±0.19X	2.21±0.34Y
	10	2.67±0.19	2.54±0.23
Chewiness (N)	0	2.55±0.20	2.55±0.24
	5	2.43±0.20	2.16±0.35
	10	2.54±0.16	2.39±0.21

<sup>a</sup> ID: irradiation dose.

All values are meat±S.D. ; (n = 12).

X,Y Means in the treatments with different letters are significantly different (P<0.05).

x-z Means in the treatments with different letters are significantly different (P<0.05).

Table 4. Effects of *kimchi* powder on the sensorial properties of frankfurter sausage prepared with irradiated pork meat

Traits	ID <sup>a</sup> (kGy)	Control	<i>Kimchi</i> treatment
Colour	0	9.78±0.36	9.83±0.25
	5	9.56±0.53	9.61±0.49
	10	9.56±0.53	9.44±0.73
Flavour	0	9.22±0.79x	9.28±0.75
	5	8.11±1.14y	8.94±0.73
	10	7.83±1.12Yy	9.06±0.30X
Tenderness	0	8.69±0.43	8.57±0.46
	5	8.44±0.73	8.44±0.73
	10	8.33±0.71	8.44±0.73

<sup>a</sup> ID: irradiation dose.

All values are meat±S.D. ; (n = 12).

X,Y Means in the treatments with different letters are significantly different (P<0.05).

x,y Means in the treatments with different letters are significantly different (P<0.05).

#### IV. CONCLUSIONS

The addition of *kimchi* powder did not cause significant changes in the physicochemical properties excluding lightness and redness. However, the results of this study show that addition of *kimchi* powder to frankfurters prepared with irradiated pork could improve its sensorial properties.

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