Detection of Gamma-irradiated Red and Black Pepper Powders in a Model Meat Product by Photostimulated Luminescence

Mee-Hye Shin, Yohan Yoon¹, Arun Kumar Sharma², and Ju-Woon Lee^{1*}

School of Food Science, Eulji University, Seongnam 461-713, Korea

¹*Team for Radiation Food Science & Biotechnology, Advanced Radiation Technology Institute, Korea Atomic Energy Research Institute, Jeongseup 580-185, Korea*

²*Division of Food Technology, Bhabha Atomic Research Centre, Department of Atomic Energy, Trombay, Mumbai, Maharashtra 400 085, India*

Abstract

This study examined the photostimulated luminescence (PSL) detection method suggested by the Korean Food and Drug Administration to assess whether the method can be used to identify irradiated spices in restructured pork patties, which served as a model system for processed meat products. Red and black pepper powders were irradiated at 0, 5.0, 7.5, and 10 kGy, and pork patties were formulated with the spice at irradiated pepper concentrations of 0.1% and 0.5%. PSL was then used to estimate amounts of light derived from the spice itself and pork patties. The results of PSL analysis showed that red and black pepper powders were determined as positive and presumptive positive, respectively, when irradiated at more than 7.5 kGy. However, when used in pork patties, all samples were negative for irradiation. Thus, PSL may not be useful in detecting irradiated ingredients used in processed meat products.

Key words: irradiation, pepper, meat products, photostimulated luminescence

Introduction

Korea Food and Drug Administration (KFDA) significantly revised the Food Standard and Regulation related to indication and labeling enforcement for irradiated foods and ingredients, and the regulation has just started since January 1 in 2010 (KFDA, 2010). In this regulation, concentrations of irradiated ingredients used in foods should be indicated on the labels on foods as well as Radura symbol (symbol of irradiated foods) (KFDA 2010), which is more rigid than those of E.U. (2000) and Codex (2003).

In order to determine whether foods are irradiated, gaschromatic analysis and electron spin resonance spectroscopy are used for the foods containing fat, and the foods containing bone and cellulose, respectively (Codex, 2001). In addition, the photostimulated luminescence (PSL) and thermoluminescence (TL) methods have been used to

detect irradiated spices, depending on physicochemical characteristics of samples (Sanderson *et al.*, 1996). Between two methods, PSL method has widely used for prescreening because of rapid detection time and simple preparation procedure (Sanderson *et al.*, 1997), while TL method provides relatively confident results, but industry may be faced with difficulty of analysis for whole specimen due to complex sample preparation procedure and subjective result analysis (Chung *et al.*, 2000). In addition, both methods are not possible to determine source of irradiation and absorbed doses (Chung *et al.*, 2002). Especially, there are no reports that the methods can be used to detect irradiated ingredients added in processed meat products.

Therefore, this study examined PSL method to determine whether the methods can be used to detect irradiated red and black peppers added in restructured pork patties, which served as a model system for processed meat products.

Materials and Methods

Gamma irradiation and sample preparations

Red pepper powder, black pepper powder, ground pork and pork back fat were purchased from a domestic mar-

*Corresponding author: Ju-Woon Lee, Team for Radiation Food Science and Biotechnology, Advanced Radiation Technology Institute, Korea Atomic Energy Research Institute, Jeongseup 580-185, Korea. Tel: 82-63-570-3204, Fax: 82-63-570-3207, E-mail: sjwlee@kaeri.re.kr

ket in Jeongeup, South Korea. Red and black pepper powders were analyzed with PSL to investigate whether the ingredients were irradiated. Vacuum packaged spices in polystyrene bags were irradiated at 0.0, 5.0, 7.5, and 10.0 kGy at 10.0 kGy/h using a Co-60 irradiator (IR-79, MDS Nordion Co., Ltd, Canada) in Advanced Radiation Technology Institute of Korea Atomic Energy Research Institute, Jeongeup, Korea. Dosimetry was applied using 5-mm diameter alanine dosimeters (Bruker Instruments, Rheinstetten, Germany).

Round shape of pork patties (100 g) were prepared with a patty maker according to the method of Lee *et al.* (2005). Briefly, 7 kg of ground pork, 2 kg of ground pork back fat, 100 g of NaCl (1.0%; w/w), 10 g (0.1%; w/w) or 50 g (0.5%) of each spice sample, and ice water (890 g to 0.1% of spice samples or 850 g to 0.5% of spice samples) were mixed in a mixer (M15 mixer, Falsf Co., Spain). The meat batter was then used to prepare a patty (100g, 1 cm thickness), and the patties were cooked in a cooker (NU-VUES-3 cooker, Menominee, MI, USA) up to 70°C of internal temperature. Cooked patties were cooled down at room temperature (18°C), frozen at -70 °C, and lyophilized in a freezing dryer (Model FD-5505P, Ilshinlab Co., Seoul, Korea). Dried samples were powdered by a labmill (HMF-1050, Hanil Electric Co., Seoul, Korea), and powder was used at subsequent PSL analysis.

Photostimulated luminescence (PSL) analysis

PSL analysis was performed according to the procedure suggested in the Food Code (KFDA 2010). The PSL measurement was performed by a Pulsed PSL irradiated food screening system (SURRC; Scottish Universities Research and Reactor Center, UK); lower threshold/T1: 700 photon counts/60 s; upper threshold/T2: 5,000 counts. All dispensing and handling samples were carried out under subdued light. The PSL system used in this study

was composed of control devise, sample chamber, and detector head assembly. Control device produces fore infrared rays through fore infrared ray luminescence diode. Light energy from irradiated samples is numerated through detection of light energy after amplifying light energy in biakali cathode luminescence amplification tube.

Five g of sample in 50-mm diameter petri dish (Bibby Sterilin type 122) was placed in a sample chamber, and amount of light was measured for 60 sec. Conditions of analysis was as following; cycle time = 1 sec, the number of cycle = 60, dark count = 98.0 ± 0.3 , and light count = 104.0 ± 1.0 . In determination procedure, lower threshold value (T1) and upper threshold value (T2) was 700 count/60 sec and 5,000 count/60 sec, respectively. The samples had the photon counts below T1 were determined as negative, and the samples had the above T2 were determined as positive (IAEA 1991; EN1786 1996; EN1788 1996; KFDA, 2010).

Results and Discussion

Detection of irradiated pepper powders

The red pepper powders irradiated at more than 7.5 kGy were determined to be positive, and the samples experienced 5-kGy irradiation were presumptive positive, which had 700-5,000 counts/60 sec of PSL signal (Table 1). Black pepper showed presumptive positive results when it was irradiated at more than 7.5 kGy (Table 1). The results indicate that PSL method can be used to identify irradiated spices, but detecting the ingredients irradiated at low irradiation doses may be difficult. The PSL method determines the samples as negative with T1=700 photon counts and presumptive positive, which should be reanalyzed with other detection method such as TL (KFDA 2010).

Table 1. Photostimulated luminescence (PSL) values (Mean±S.D) of red pepper and white pepper gamma-irradiated at different doses

Irradiation dose (kGy)	PSL signal			
	Red pepper		Black pepper	
0.0	302±37	Negative	268±36	Negative
5.0	3976±69	Presumptive positive	593±41	Negative
7.5	5978±71	Positive	779±39	Presumptive positive
10.0	6402±86	Positive	827±46	Presumptive positive

Negative: < 700 counts/60 s.

Presumptive positive: 700 - 5,000 counts/60 s.

Positive: 5,000 counts/60 s.

Table 2. Photostimulated luminescence (PSL) values (Mean±SD) of pork patty formulated with irradiated red and black pepper gamma-irradiated at different doses

Irradiation dose (kGy)	Pepper concentration (%)	PSL signal			
		Red pepper		Black pepper	
0.0	0.0	322±29	Negative	322±29	Negative
	0.1	593±65	Negative	374±64	Negative
	0.5	423±43	Negative	273±76	Negative
5.0	0.1	281±48	Negative	330±72	Negative
	0.5	319±33	Negative	317±95	Negative
7.5	0.1	301±20	Negative	307±16	Negative
	0.5	355±86	Negative	293±76	Negative
10.0	0.1	387±56	Negative	393±52	Negative
	0.5	384±49	Negative	357±56	Negative

Detection of irradiated pepper powders used in pork patties

The pork patties added with red pepper powder had photon counts ranged from 281±48 photon counts (0.1% of 5 kGy-irradiated red pepper powder) to 593±65 photon counts (0.1% of non-irradiated red pepper powder), which are determined as unirradiated (Table 2). Similarly, the pork patties supplemented with black peppers determined as negative with photon counts ranged 273±76 (0.5% of non-irradiated black pepper powder) to 393±52 (0.1% of 10 kGy-irradiated black pepper powder) (Table 2). Especially, the samples treated with no pepper powders had 322±29 photon counts (Table 2). This result indicates that PSL methods may not be useful in detecting irradiated ingredients used in processed meat products. Delincee (2002) and Machioni *et al.* (2005) also suggested that identifying irradiated ingredients in processed foods should not be overstressed because the detection methods currently used are not feasible to identify foods containing irradiated ingredients. Taken together, the KFDA labeling regulation for irradiated foods may not be scientifically appropriate and feasible for the processed foods containing irradiated ingredients.

In conclusion, use of the PSL method which is recommended method by KFDA should be reconsidered to determine whether processed foods contain irradiated ingredients.

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