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Gamma-Irradiation Sensitivity of *Aspergillus flavus* Contaminated in Semi-Dried Beef Jerky

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Introduction

Beef jerky is one of the meat products with an increasing demand as it is very convenient to eat and highly nutritious. As a lei ports food, jerky can be stored at an ambient temperature due to the low water activity (aw). However, people want to purchase the high quality food with good flavor, texture and nutrition. Jerky is not preferred mainly due to its hardness[1,2]. Yang[3] managed to make semi-dried beef jerky containing about 10% higher moisture content (aw 0.85) and with improved textural property. However, the shelf-life was very poor. Without the addition of any humectants, the increase of moisture content induced the increase of aw, and the storage stability was consequently weakened by the growth of the fungi and other microorganisms[4]. Therefore, the present study was conducted to evaluate the effect of gamma irradiation on the microbial quality of the semi-dried jerky with a higher moisture content (higher aw) and improved textural property. The optimal absorption dose of a gamma ray was evaluated to inactivate the harmful fungus, *Aspergillus flavus*.

Materials and Methods

Fungus, *A. flavus* was obtained from Korean Culture Center of Microorganisms (KCCM 11453, Seoul, Korea). Tryptic soy broth (TSB, Difco Laboratories, Detroit, MI) and Potato dextrose agar (PDA, Difco Laboratories) were used as the media for the determination and growth of *A. flavus*. For the calculation of the D_{10} and 12D values of A. flavus inoculated onto PDA was incubated at 25℃ for 3 to 5 days. Spores were washed from the surface with a cold rinsing solution (0.1% of peptone containing 0.1% of Tween 80) and the number of spore mL-1 was determined with a counting chamber. The final concentration of spore suspension was approximately $10^6 \sim 10^7$ cells/mL. 0.1 mL of the spore suspension was put onto the sterilized samples and smeared for the good distribution of the spore suspension. Inoculated samples were individually packaged in sterilized polyethylene bags, sealed, and gamma-irradiated at the designated doses. Semi-dried beef jerky was prepared by the method of Yang[3]. Samples were cut to 10 × 10 cm size, vacuum-packaged and gamma-irradiated. The applied dose levels

were 0 (control), 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 kGy to obtain the D_{10} value, and 30 kGy for the sterilization. Water content, aw and pH of non-irradiated and irradiated samples were determined. The complete experiment was performed twice. Determination of D_{10} value and other analyses were conducted using 5 and 4 individually-packaged jerkies, respectively. Analysis of variance of the general linear procedures of SAS software (SAS Institute, 1988) was used to evaluate differences between all samples. Level of significance was set at $P < 0.05$.

Results and Discussion

Determination of Water content, aw, and pH

Water content, aw and pH of semi-dried beef jerky were about 40%, 0.86, and about 5.83, respectively (Table 1). Changes of the water content, aw and pH by high dose irradiation were not found. Water content of the commercial jerky was in the range of 20 to 40%[5] and Miller *et al.*[6] reported that adequate water content for satisfying the sensory property and the productivity of jerky was about 35 to 38%. Semi-dried beef jerky used in this study was an intermediate moisture meat product that has about 0.1 higher aw than those of the ordinary jerky.

Table 1. Water content, aw and pH of gamma-irradiated semi-dried beef jerky

Irradiation	Water content (%)	aw	pH
0 kGy	39.78±0.16[a]	0.86±0.03	5.85±0.04
30 kGy	40.02±0.21	0.86±0.02	5.81±0.03

[a] Mean±standard deviation

D_{10} value of A. flavus by gamma irradiation

D_{10} values of *A. flavus* by gamma irradiation in the three conditions are shown in Table 2. *A. flavus* was more sensitive in the broth (0.36 kGy) and suspension (0.36 kGy) than in the semi-dried jerky (0.47 kGy) as expected. Kume *et al.*[7] reported that the D_{10} value of *A. flavus* was 0.27 to 0.29 kGy in a wet condition and 0.54 to 0.60 kGy in a dry condition and the survival curves were exponential. The results are similar to our data (Fig. 1). 12D values of *A.flavus* are also shown in Table 2.

The irradiation dose needed to completely inactivate fungus was 5.64 kGy in semi-dried jerky. Fungi can grow in semi-dried jerky better than in the ordinary jerky due to a higher aw. Aziz and Youssef[8] could observe the growth of *A. flavus* in fresh and processed meat. The mould can be contaminated in meat products and produce mycotoxins. Therefore, more harmful organisms can be controlled by proper treatment. Ionizing radiation can effectively eliminate the harmful fungi without any deteriorative effect on the quality of the jerky. The results indicated that gamma irradiation can be used for ensuring the hygienic

Table 2. D_{10} and 12D values of *Aspergillus flavus* by gamma irradiation in broth, suspension and semi-dried beef jerky

Irradiation condition	D_{10}	12D	SD[a]
Broth	0.36	4.32	0.002
Suspension	0.36	4.32	0.001
Semi-dried beef jerky	0.47	5.64	0.001

[a] Standard deviation ($p<0.05$).

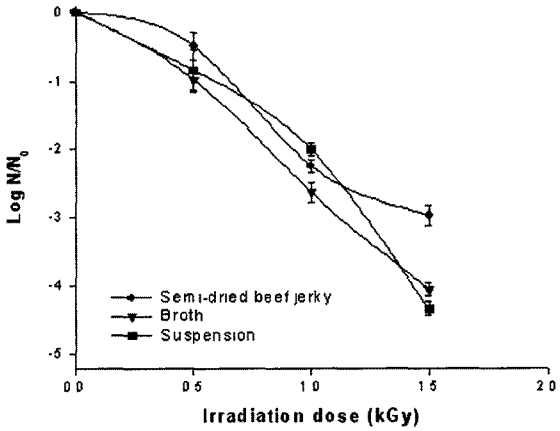

Fig. 1. Growth inhibition of *Aspergillus flavus* by gamma irradiation.

quality of semi-dried beef jerky with an improved sensory quality due to an increase of the moisture content.

Summary

This study was conducted to investigate the adequate irradiation dose to eliminate harmful fungi inoculated in beef jerky with a 10% higher moisture content and improved textural property. *Aspergillus flavus* (approximately 10^6 CFU/cm^2) was tested in broth, spore suspension, and inoculated jerky. D_{10} values of *A. flavus* were 0.36 kGy in the broth and suspension, and 0.47 kGy in the jerky. The results indicate that gamma irradiation can be effectively used to control the fungus growth in beef jerky with an improved quality and higher moisture content.

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