Influence of Storage Conditions on Pulsed Photostimulated Luminescence of Irradiated Korean Sesame and Perilla Seeds by Whole Sample Measurement Method

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Introduction

Increase in the international trade of irradiated foods has created a demand for detection methods that will provide regulatory agencies with the tools to ensure compliance with labeling regulations. As a part of the regulation for food irradiation, government organizations should be able to detect whether a particular food has been irradiated. A number of detection methods have been proposed for the identification of irradiated foods in the research papers published. Previously, the utilization possibility of a pulsed photostimulated luminescence (PPSL) for irradiated foodstuffs was investigated and positively suggested as a new technique. However, the difficulty in the application of the PPSL to irradiated foodstuffs is change of the PPSL signal by influence of conditions and periods stored. Perilla and sesame seeds and their oil has been used in various foods as a spices in Korea and a large amount of these are imported from China and Sudan because domestic production has been decreased due to the change of agricultural environment, such as high expenditure in production within a country and importation liberty for agricultural products of low price from out a country. Pathogenic microorganisms and pests on account of improper handing in importation stage and after harvest can contaminate or invade the perilla and sesame seeds. Although, these are not commercially irradiated at present, if irradiation is used to make them safe for the pathogenic microorganisms and pests, PPSL technique will be used to monitor the irradiation process. Additionally, as the technique of PPSL is simple, quick and applicable to a wide range of foodstuffs with no other preparation, the utilization of PPSL in detection of irradiated food is positively expect. On identification of the perilla and sesame seeds irradiated, several papers were published but there is no results for change of accumulated PPSL signals under various storage conditions during long-term. The main objective of this study was to investigate capability of utilization of whole sample measurement method, observe effects of storage conditions and periods in the accumulated PPSL signals and eventually, apply to detection of irradiated perilla and sesame seeds.

Materials and Methods

Materials and irradiation

Korean perilla and sesame seeds were purchased from a local market in Korea. Samples were packed in polyethylene bags, split into two portions (room and darkroom conditions). Irradiation operations were carried out in irradiator (AECL, Canada) equipped with a Co-60 source at the Korea Atomic Energy Research Institute and irradiated to final absorption doses of 1, 5, and 10 kGy. Then, a dose rate was 10 kGy/h. To measure the exact final absorbed dose of gamma irradiation, the dose rates for cobalt-60 sources were determined using a ceric-cerous dosimeter. After irradiation, the samples of room condition were stored in laboratory condition, which existed sunlight and a fluorescent light, and the samples of darkroom condition were stored in a chamber oven (K.M.C-1203P3, Vision Scientific Co., LTD, Seoul, Korea) to block exposure by a light at room temperature during 12 months.

Measurement of Pulsed Photostimulated Luminescence (PPSL)

Measurement of accumulated PPSL signals was done using PPSL system purchased from SURRC. The PPSL system is composed of a control unit, sample chamber, and detector head assembly. The control unit contains a stimulation source, which is comprised of an array of infrared light (880 - 940 nm) emitting diodes, which are pulsed symmetrically on and off for equal periods. PPSL signal is detected by a bialkali cathode photomultiplier tube operating in the photon counting mode and recorded automatically in personal computer connected with the PPSL system. Optical filtering is used to define both the stimulation and detection wavebands. The Korean sesame and perilla seeds themselves (5 g) were introduced in 50 mm diameter disposable petri dishes (Bibby Sterilin types 122, Glasgow, UK). The samples were measured in the sample chamber for 120 s. The radiation-induced photon counts (PPSL signals) emitting per second from the samples were automatically accumulated in personal computer and presented the photon counts accumulated up to 60 s and 120 s.

Results and Discussions

Results show changes of accumulated PPSL signal according to storage conditions and periods of unirradiated and irradiated sesame and perilla seeds at 1, 5, and 10 kGy. The results of the effect of gamma irradiation on the sesame and perilla seeds themselves show that the number of radiation-induced PPSL signals significantly increased with irradiation dose up to 5 kGy. On the other hand, a slight decrease of the accumulated PPSL signals at a dose of 10 kGy compared to irradiation dose of up to 5 kGy was observed. Detection of irradiation by the PPSL system is base on higher radiation-induced PPSL signal than that of unirradiated sample. Therefore, although the signal of 5 to 10 kGy

was non-linear, discrimination whether the sample were irradiated or not was possible because of the higher signal of irradiated sample than that of unirradiated sample. On sample treated at 10 kGy than at 5 kGy, cause showing the slightly low PPSL signal was guessed due to radiation damage. There were no significant differences in accumulated PPSL signals in unirradiated sesame and perilla seed samples. Threshold level, which can distinguished unirradiated sample from irradiated sample was below 1,261±157 photon counts regardless of sample species tested, and storage conditions and periods during 12 months. Based on the above results, since irradiated samples showed higher accumulated PPSL signal than the unirradiated samples under all conditions, detection of irradiation that was discriminated each other from unirradiated and irradiated samples, was possible by PPSL measurement of sesame and perilla seeds themselves. Difference of accumulated PPSL signals in between the sesame and perilla seeds was not significantly observed. If the PPSL response of irradiated materials is significantly greater than that of unirradiated materials and the fading of the PPSL response is low over storage of long-term, then PPSL measurement may be suitable to determine whether foodstuffs have been irradiated. Therefore, decay rates of accumulated PPSL signal of unirradiated and irradiated sesame and perilla seeds were monitored during 12 months under various storage conditions. It can be seen that accumulated PPSL signal of irradiated sesame and perilla seeds were strongly influenced by the storage conditions. The accumulated PPSL signals after 12 months of sesame seeds irradiated at 1, 5, and 10 kGy resulted in the signal intensity falling to approximately 32.5, 60.2, and 52.8%, respectively, in darkroom condition and 99.9, 99.2, and 99.2 %, respectively, in room condition of the initial values (0 day). This tendency according to storage conditions also similarly observed in perilla seeds expect for decay rate (about 1.3 %) at 1 kGy in darkroom condition. Decay rate of the accumulated PPSL signals for sesame and perilla seeds displayed a decrease with increasing storage periods and in room condition, showed higher reduction. The decay rates of sesame and perilla seeds exhibited higher decrease in 5 and 10 kGy than in 1 kGy. Although, the accumulated PPSL signals of all sesame and perilla seeds decreased with increasing storage times, irradiated samples showed higher photon counts than those of unirradiated samples in room and darkroom conditions, in both conditions, detection of irradiation was still possible after 12 months. These results indicate that whole sample measurement method can be used as a method for detecting the irradiation treatment for irradiated sample stored during long-term. The accumulated PPSL signal of all the irradiated sesame and perilla seed samplesmeasured for 120 s were higher than those measured for 60 s. In the all samples, the photon counts were higher than those of the unirradiated ones regardless of measurement times of 60 and 120 s.

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