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SHORT COMMUNICATIONS

Detection of Irradiated Frozen Meat and Poultry Using Carbon Monoxide Gas as a Probe

INTRODUCTION

Food irradiation has been acknowledged as a practical solution to pathogenic microbial contamination of meat and poultry products in many countries (IAEA, 1989). In the North American region, for example, the United States cleared the irradiation of poultry up to 3 kGy in May 1990 (*Federal Register*, 1990). Under these trends, reliable methods to detect irradiation are urgently required for control and acceptance of irradiation on an international basis (IAEA, 1989). Several methods for detection have been proposed for meat and poultry products (Meier et al., 1990; Nawar and Balboni, 1970; Oduko and Spyrou, 1990; Dodd et al., 1988), but so far electron spin resonance (ESR) spectroscopy seems well developed as a detection method for bone-, shell-, and seed-containing samples (Dodd et al., 1988). Gas–liquid chromatography appears to be promising for detecting irradiated lipid-containing foods such as meat and poultry, frozen and unfrozen, through analysis of radiolytic products of fatty acids (Nawar and Balboni, 1970).

We found that carbon monoxide, one of the major radiolytic gases arising from irradiated foodstuffs (Pratt and Kneeland, 1972; Simic et al., 1979), was retained in irradiated frozen products. In this paper, we propose a novel method to detect radiolytic CO formed within the irradiated *deboned* frozen products.

MATERIALS AND METHODS

Samples. Deboned fresh chicken, pork, and beef were purchased at a local market in Sakai and stored in a freezer at ca. −20 °C before analysis.

Irradiation. Each frozen sample (ca. 50 g) was placed in a polyethylene bag and irradiated at several doses at −20 °C with ^{60}Co γ rays (10 kGy/h). The temperature of −20 °C was achieved using a NaCl–ice mixture as refrigerant. The irradiated samples were stored again under the same condition as described above. The polyethylene bags were not sealed, so that the headspace gases could go out freely during the storage period. Nonirradiated control samples were also stored under the same condition.

Gas Sampling and Analysis. Five grams of the sample and 10 mL of water were put in a glass screw vial (30 mL) with a hole cap and rubber packing and then quickly heated for 15 s in a microwave oven. Quick heating was necessary to avoid additional gas production caused by microorganisms surviving in the sample or from other unknown origins during the heating period. Water was required for uniform heating of the sample.

One milliliter of the headspace gas was taken out using a gastight syringe through the packing and analyzed with a gas chromatograph (HP5890A) equipped with a methanizer (Gasukuro MT-221) and a flame ionization detector on a 2.3-m column of molecular sieve 13X. Carbon monoxide was identified by a GC–MS (JEOL JMS-DX302) and measured by comparing its gas chromatographic area with that of the authentic sample of a known concentration.

RESULTS AND DISCUSSION

We observed that the amounts of CO within five nonirradiated samples were small; the average yields were 0.012 ± 0.002 μL/g for chicken, 0.033 ± 0.012 μL/g for beef, and 0.008 ± 0.002 μL/g for pork, the error being 1

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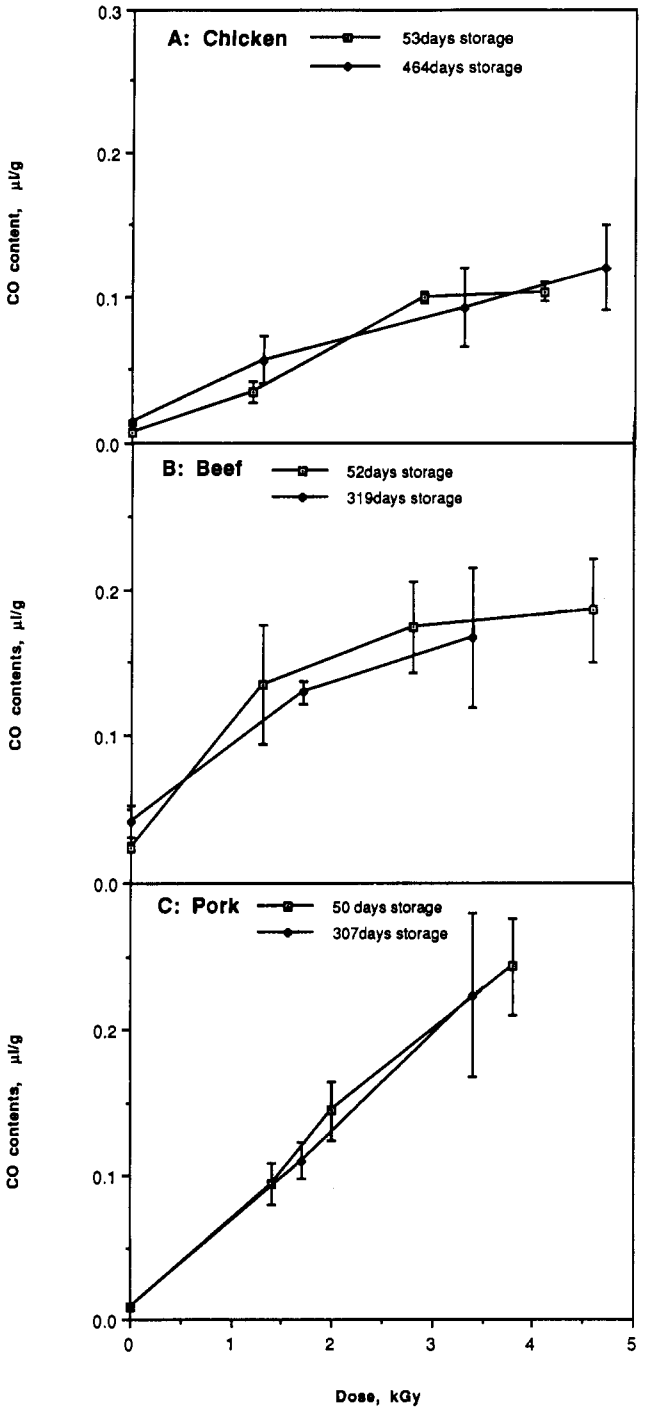

Figure 1. CO contents within irradiated frozen chicken (A), beef (B), and pork (C) after ca. 50 days and ca. 1 year of storage as a function of doses. The amounts of CO are expressed in terms of the volume of CO at 25 °C and 1 atm liberated from 1 g of frozen sample. Error bars depict 1 standard deviation calculated from three measurements. CO contents within nonirradiated samples after each storage period are indicated at 0 kGy in each graph.

standard deviation. As shown in Figure 1, the yields of CO (average of three measurements) increase with increasing irradiation doses. The change of the CO levels between the two storage periods (ca. 50 days and ca. 1 year) was unexpectedly small. After 1 year of storage, the CO level of each item was at least 4 times higher than that of the corresponding nonirradiated item at the smallest dose employed here (ca. 1.3 kGy, one-third of the dose allowed by U.S. regulation). Figure 1 clearly shows that the level of CO could be used as a probe for irradiation detection.

From these results, the validity of this method for the identification of irradiated frozen meat and poultry is demonstrated by the small background from the nonirradiated samples, the long detectable period (ca. 1 year), and the accessibility to gas chromatography. Our method is at least comparable to the ESR method with respect to sensitivity and the detectable period but has a distinct advantage over it in that it can be used for boneless products and therefore has more general applicability.

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