Radiation Physics and Chemistry 111 (2015) 57–61

Contents lists available at ScienceDirect

Radiation Physics and Chemistry

journal homepage: www.elsevier.com/locate/radphyschem

# Microbial analysis and survey test of gamma-irradiated freeze-dried fruits for patient's food

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## HIGHLIGHTS

- Dried fruits can be sterilized with a dose of 12 kGy.
- Sensory survey of the hospitalized cancer patients ($N=102$).
- Sensory quality of dried fruits is acceptable to cancer patients.

## ARTICLE INFO

*Article history:*
Received 17 February 2014
Received in revised form
10 February 2015
Accepted 13 February 2015
Available online 14 February 2015

*Keywords:*
Freeze-dried fruit
Patient food
Sterilization
Gamma irradiation
Sensory survey

## ABSTRACT

This study examined the microbiological and organoleptic qualities of gamma-irradiated freeze-dried apples, pears, strawberries, pineapples, and grapes, and evaluated the organoleptic acceptability of the sterilized freeze-dried fruits for hospitalized patients. The freeze-dried fruits were gamma-irradiated at 0, 1, 2, 3, 4, 5, 10, 12, and 15 kGy, and their quality was evaluated. Microorganisms were not detected in apples after 1 kGy, in strawberries and pears after 4 kGy, in pineapples after 5 kGy, and in grapes after 12 kGy of gamma irradiation. The overall acceptance score, of the irradiated freeze-dried fruits on a 7-point scale at the sterilization doses was 5.5, 4.2, 4.0, 4.1, and 5.1 points for apples, strawberries, pears, pineapples, and grapes, respectively. The sensory survey of the hospitalized cancer patients ($N=102$) resulted in scores of 3.8, 3.7, 3.9, 3.9, and 3.7 on a 5-point scale for the gamma-irradiated freeze-dried apples, strawberries, pears, pineapples, and grapes, respectively. The results suggest that freeze-dried fruits can be sterilized with a dose of 5 kGy, except for grapes, which require a dose of 12 kGy, and that the organoleptic quality of the fruits is acceptable to immuno-compromised patients. However, to clarify the microbiological quality and safety of freeze-dried fruits should be verified by plating for both aerobic and anaerobic microorganisms.



## 1. Introduction

Immuno-compromised patients, such as those who have HIV or AIDS, who are pregnant, or who are undergoing chemotherapy or radiation therapy for cancer, can sometimes be prone to more serious infections and/or complications than healthy people (Todd et al., 1999). Pietranera Adeil et al. (2003) stated that these concerns make their food intake very restricted and that avoiding all food products that could be a source of microorganisms limits variations in the food offered, thus hampering the quality of life for those patients.

It is known that edible fruit is important to improve out health and well-being. Apples, pears, strawberries, pineapple and grapes are largely consumed perishable fruits with high economic value and healthy nutrients. The protection provide against degenerative diseases by fruits has been attributed to the fact that they provide an optimal mix of phytochemicals and other bioactive compounds

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http://dx.doi.org/10.1016/j.radphyschem.2015.02.011

such as phenolic compounds (Da Silva-Pinto et al., 2008; Gabas et al., 2007). Also, they are a rich source of antioxidants such as anthocyanins, which benefit human health and also have protective properties against disease such as cancer, heart disease, vision problems and aging (Beattie et al., 2005; Ayala-Zavala et al., 2004; Gorinstein et al., 2001; Sweeney et al., 2002).

Although fresh fruits have many benefits on the protection of various diseases, there are some problems associated with microbial contamination during the storage time. Therefore, to increase the microbial safety and storage period, freeze-drying method is widely used in the industry. Freeze drying, as relatively process of drying in vacuum at very low temperatures, ensures the preservation of all thermo labile compounds in the initial fresh material, and final low content of moisture provides microbiological stability and preservation of products (Ghio et al., 2000). In recent, Wojdylo et al. (2009) reported that freeze-dried strawberries showed a no significant changes of phenolic contents compared with fresh strawberries. Moreover, Wu et al., (2010) also found that freeze-drying increased the total levels of phenolic compounds, and they attributed this to higher sample porosity and extraction efficiency of phenolic compounds from plant tissue. Thus, freeze drying is one of the best method to ensure the microbial safety and physiological properties without the changes of phenolic compounds.

Even though freeze drying fruit assured the microbial safety, consumption of dried fruits by immune-compromised patients is not until recommended; because food-borne infections can be a fatal life threatening factor (Butterweck, 1995; Hanekom et al., 2010). Microbial control is an important aspect to be considered in the development of pathogen-free foods for immuno-compromised patients (IAEA, 2009). To broaden the availability of dried fruit products to immune-compromised patients who are recommended to ingest sterilized foods, inactivation of all microorganisms in foods is needed. Retort heating is generally applied to sterilize foods for immuno-compromised patients in hospitals. However, heat treatment is not suitable to sterilize some fresh food products, such as fruits, vegetables, and dried foods.

Irradiation technology may be an effective sterilization method to extend the shelf life of various foods, without compromising their nutritional properties (Farkas, 2006). Several researchers have shown that ionizing irradiation is a suitable method to control food-borne pathogens in fresh fruits, in apple juice, in diced celery, and in instant cup noodle for immuno-compromised patients (Bidawid et al., 2000; Bijl et al., 2011; Prakash et al., 2000; Lee et al., 2012).

Sterilization by irradiation is needed to inactivate all microorganisms in dried fruits. The objective of this study was to examine the microbiological and organoleptic qualities of gamma-irradiated freeze-dried apples, pears, strawberries, pineapples, and grapes, and to evaluate the organoleptic acceptability of the sterilized freeze-dried fruits for hospitalized cancer patients.

## 2. Materials and methods

### 2.1. Sample preparation

Commercial freeze-dried fruits (apples, strawberries, pears, pineapples, and grapes) were purchased from a local market, in June 2012. All samples were placed in a sterilized package (AL-LDPE, aluminum-laminated low-density polyethylene, Sunkyung Co., Ltd., Seoul, Korea) on a clean bench at room temperature.

### 2.2. Irradiation treatment

The samples were gamma-irradiated at 1, 2, 3, 4, 5, 10, 12, and 15 kGy with a dose rate of 10 kGy/h at room temperature (about 15–20 °C), at the Korea Atomic Energy Research Institute (Jeongeup, ROK). The source strength was approximately 320 kBq, and

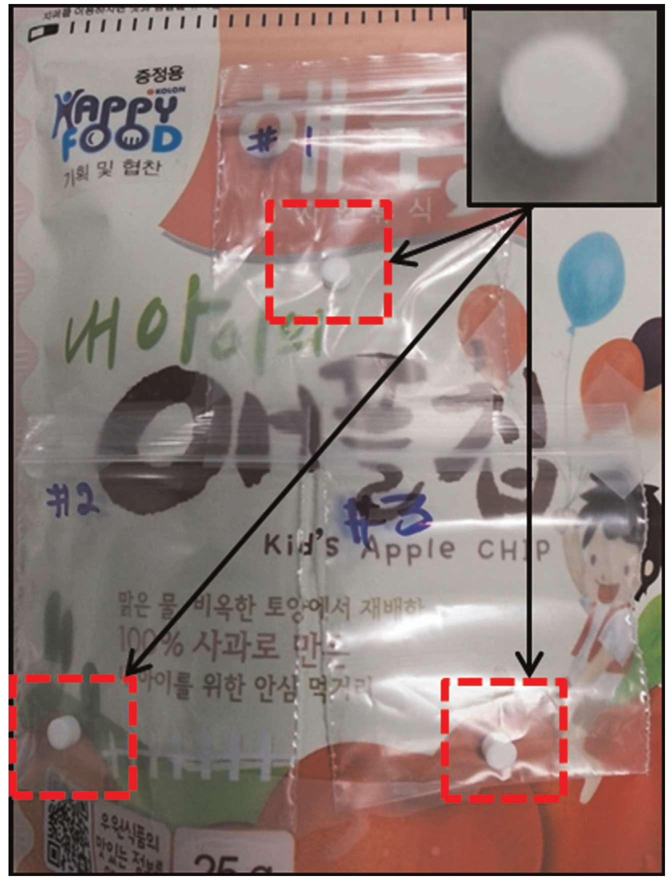


**Fig. 1.** Alanine-EPR dosimetry process for freeze-dried fruit.

**Table 1**
Characteristics of study participants.

| Variable | | | Number (%) |
|---|---|---|---|
| Demographic characteristics | Sex | | |
| | | Male | 65 (63.7) |
| | | Female | 37 (36.3) |
| | | Total | 102 (100) |
| | Age | | |
| | | ≤ 49 years | 19 (18.6) |
| | | 50–59 years | 32 (31.4) |
| | | 60–69 years | 34 (33.3) |
| | | ≥ 70 years | 17 (16.7) |
| | | Total | 102 (100) |
| | Education level | | |
| | | ≤ Middle school | 35 (34.3) |
| | | High school | 46 (45.1) |
| | | ≤ College | 21 (20.6) |
| | | Total | 102 (100) |
| Clinical features | Type of patients | | |
| | | In-patients | 27 (26.5) |
| | | Out-patients | 75 (73.5) |
| | | Total | 102 (100) |
| | Type of cancer | | |
| | | Gastrointestinal | 47 (46.1) |
| | | Lung | 25 (24.5) |
| | | Other (Breast, cervix, thyroid, renal etc.) | 29 (28.4) |
| | | Total | 102 (100) |