

# STUDY ON IRRADIATION STERILIZATION OF SPICES

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## Abstract

The total bacterial counts of commercially available the five spices powder and chilli were respectively found to be  $10^5/g$  and  $10^7/g$ , whereas the total fungal counts of both the five spices powder and chilli were about  $10^4/g$ .

The sterilization efficacy of spices irradiated by electron beam was studied on this paper. The effects of irradiation on the colours of spices were assessed by spectrophotometric analyzing aqueous extracts of spices. The content of water-insoluble volatile oils was determined in control and irradiated samples of spices by measuring the u.v.absorption. The effect of different packaging materials was discussed on total viable bacterial population in unirradiated and irradiated the five spices powder during storage at ambient temperature.

KEYWORDS: Irradiation, Electron beam, Sterilization, Chill, The five spices powder<sup>4)</sup>

## 1 INTRODUCTION

The contamination of spices may occur during harvesting, handling, transportation and storage<sup>[1,2]</sup>. Spices with a high bio-burden can not meet hygienical standard. Utilizing of heavily contaminated spices in food process is equal to bringing a contamination source for food. Thus it will accelerate the putrefaction of manufactured food products, reduce food shelf-life, and even impair consumers' health.

Normal heat treatment is not suitable way for spices sterilization because of its effect on flavouring function of spices whose flavourous compositions are heat sensitive substances. Fumigation with ethylene oxide was previously used to sterilization spices in many countries<sup>[3]</sup>. However, fumigation method has several disadvantages such as toxic residues are left and organoleptic properties of spices are changed<sup>[4]</sup>. Therefore it is necessary to seek for alternative methods for decontamination.

In this paper the sterilization efficacy of spices irradiated by electron beam was studied. The effects of

irradiation on the colours and volatile oils content of spices were determined. Moreover, storage test of spices was studied.

## 2 MATERIALS & METHODS

### 2.1 Materials

Chilli and the five spices powder purchased in the market by Hangzhou Flour Mill were serviced as our experimental materials.

### 2.2 Samples Prepare and Irradiation

Homogeneous spices were randomly sampled. Take distinct weights of samples for different tests. After sealed in polyethylene bags, quantitative samples were irradiated with electron beam produced by an electronic accelerator in our institute. When irradiated samples were on a moving plate where doses are even.

### 3.Determination Method and Instruments

#### (1) Microbiology

The total bacterial and fungous counts and bacillus coli. for samples were examined by testing methods of food hygiene in China.

#### (2) Colours

The absorption of aqueous extract of both chilli ( $\lambda_{max}=195nm$ ) and the five spices powder ( $\lambda_{max}=198nm$ ) were assessed by means of a UV -3000 spectrophotometer, consulting the testing method in a reference<sup>[6]</sup>.

#### (3) Volatile oils

Volatile oils were isolated by the steam distillation method, consulting a reference [6]. Spectral absorbances were measured for chilli ( $\lambda_{max}=195nm$ ) and the five spices powder ( $\lambda_{max}=198nm, 296nm$ ) with a UV -3000 spectrophotometer.

#### (4) Storage

Samples of the five spices powder were packed in (A) paper with plastic coating inside (B) complex film: BOPP/PVDC/LDPE. Samples were stored at ambient temperature both before and after irradiation. Microbes in unirradiated and irradiated samples of the five spices powder were analyzed as a function of storage time for two kinds of packaging materials.

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1) Microbiology Institute of Zhejiang Province, Hangzhou

2) Hangzhou Flour Mill of Zhejiang Province, Hangzhou

3) Testing Technology Institute of Zhejiang Province, Hangzhou

4) Mixed powder of prickly ash, star aniseed, cinnamon, clove and fennel

### 3 RESULTS & DISCUSSION

#### 3.1 Irradiation Sterilization efficacy

Spices were treated by electron beam at six different absorbed doses up to 10 kGy. There are three parallel samples at each dose. Total bacterial counts of spices were tested on 3rd, 7th, 22nd day stored at ambient temperature following irradiation. Three unirradiated samples were serviced as controls. Results showed total bacterial counts of spices drop on an index law with increase of doses. At doses of 3.6 kGy, the total bacterial counts for chilli with original bacterial population  $10^7/g$  were respectively decreased to  $10^4/g$  and less than  $10^2/g$ . As for the five spices powder, initial bacterial counts  $10^5/g$  were reduced to lower than  $10^3/g$  at a dose of 3 kGy and became too few to examine after subjected to 6 kGy irradiation. The regression equations expressing a relation between surviving bacterial counts and absorbed doses for two kinds of spices were obtained by statistics treatment of experimental data.

$$\text{LgN} = 7.2950 - 0.9218D \quad (r = -0.9971) \text{ for chilli}$$

$$\text{LgN} = 5.4237 - 0.8463D \quad (r = -0.9855) \text{ for the five spices powder}$$

Where: N — surviving bacterial counts.

D — absorbed doses ( $0 \leq D \leq 10 \text{ kGy}$ )

R — correlate coefficient.

In view of critical value of correlate coefficient at significant level ( $\alpha=0.01$ ), above-mentioned two equations are linear correlate at high significant difference level.

Dose dependence of total fungous counts for chilli and the five spices powder was given in Tab1. The total fungous counts shown in Tab.1 are mean values tested on 4th, 22nd day stored at ambient temperature after irradiation.

Also, dose dependence of MPN (most probable number) of bacillus coli. for chilli was repeatedly determined for three times. The results show MPN of bacillus coli. was 11000/100g before irradiation and dropped to less than 30/100g at a dose of 3 kGy. As to the five spices powder, bacillus coli. could not be found up in unirradiated samples.

#### 3.2 Effects of irradiation on colours of spices

Absorptions in aqueous extract of spices were assessed by spectrophotometry during storage period at ambient

temperature after irradiation. Absorptivities can be obtained from actual concentrations of samples by Lambert-Beer formula<sup>[6]</sup>

The effects of irradiation on the u.v. absorptions of both chilli and the five spices powder were shown in Tab.2. Obviously, irradiation enlarges the u.v. absorptions in aqueous extract of spices, The more the doses, the more the absorptivities. Besides, the data tested during storage period of 2 months after irradiation revealed absorptivities of asmples irradiated at different doses were close to ones of controls. Whether or not irradiated, absorptivities of spices decrease during storage. The more the doses, the more the decrement of absorptivities. It was shown that the effects of irradiation on the colours of spices were not steady. Darkening phenomenon of spices due to irradiation was temporary, so to speak.

#### 3.3 Effects of irradiation on the content of volatile oils in spices

Volatile oils of both chilli and the five spices powder irradiated at a dose of 10 kGy were isolated by the steam distillation method. Absorptivities of above obtained volatile oils could be determined by spectrophotometry. The results of irradiated (10 kGy) and unirradiated samples were compared in Tab.3. The data given in Tab.3 were mean values of tested results. Statistical analyses showed there were no significant differences between irradiated and unirradiated samples.

#### 3.4 Storage

Irradiated (4.5kGy) and unirradiated samples of the five spices powder were stored at ambient temperature. The total bacterial counts of stored samples were determined during storage period of 1, 30, 74, 105 days. Experimental data in Tab.4 were mean values of tested results.

Tab.4 revealed irradiated (4.5kGy) samples were completely sterilized and there was no any occurrence of microbes growing during storage period of 105 days. Also, it could not tell any difference from one sort of package material to another one.

Statistical analyses showed the total bacterial counts of unirradiated samples have no any significant change during storage period of 105 days for two kinds of package materials.

#### 4 REFERENCES

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Tab.1 Dose dependence of total fungous counts of irradiated spices

Dose (kGy)	Fungi (1/g)	
	Chilli	The five spices powder
0	13800	9300
0.83	6600	3500
1.24	20	200
1.66	10	40
3.11	0	0

Tab.2 The effect of irradiation on the u.v.absorption in aqueous extract of spices

Dose (kGy)		0	3	6	8	10	
Absorptivity(a)	Chilli ( $\lambda_{max}=195nm$ )	Storage period of 1 month	3.98	4.56	4.27	-	5.14
		Storage period of 2 months	3.41	3.64	3.65	-	3.66
	The five spices Powder ( $\lambda_{max}=198nm$ )	Storage period of 1 month	4.53	4.93	5.00	5.06	-
		Storage period of 2 months	3.88	3.99	3.92	3.73	-

Tab.3 The effects of irradiation on the content of volatile oils in spices

Spice	$\lambda_{max}(nm)$	Absorptivity (a)	
		Unirradiated	Irradiated (10kGy)
Chilli	195	1.950	1.924
The five spices powder	198	1.002	1.012
	296	0.364	0.290

Tab.4 Total bacterial counts of unirradiated and irradiated the five spices powder during storage at ambient temperature

Dose (kGy)		0				4.5			
Storage period (day)		1	30	74	105	1	30	74	105
Total bacterial Counts	Paper	$5.6 \times 10^5$	$5.3 \times 10^5$	$5.7 \times 10^5$	$6.3 \times 10^5$	<10			
	BOPP/PVDC/LDPE	$4.7 \times 10^5$	$7.5 \times 10^5$	$4.6 \times 10^5$	$6.3 \times 10^5$	<10			