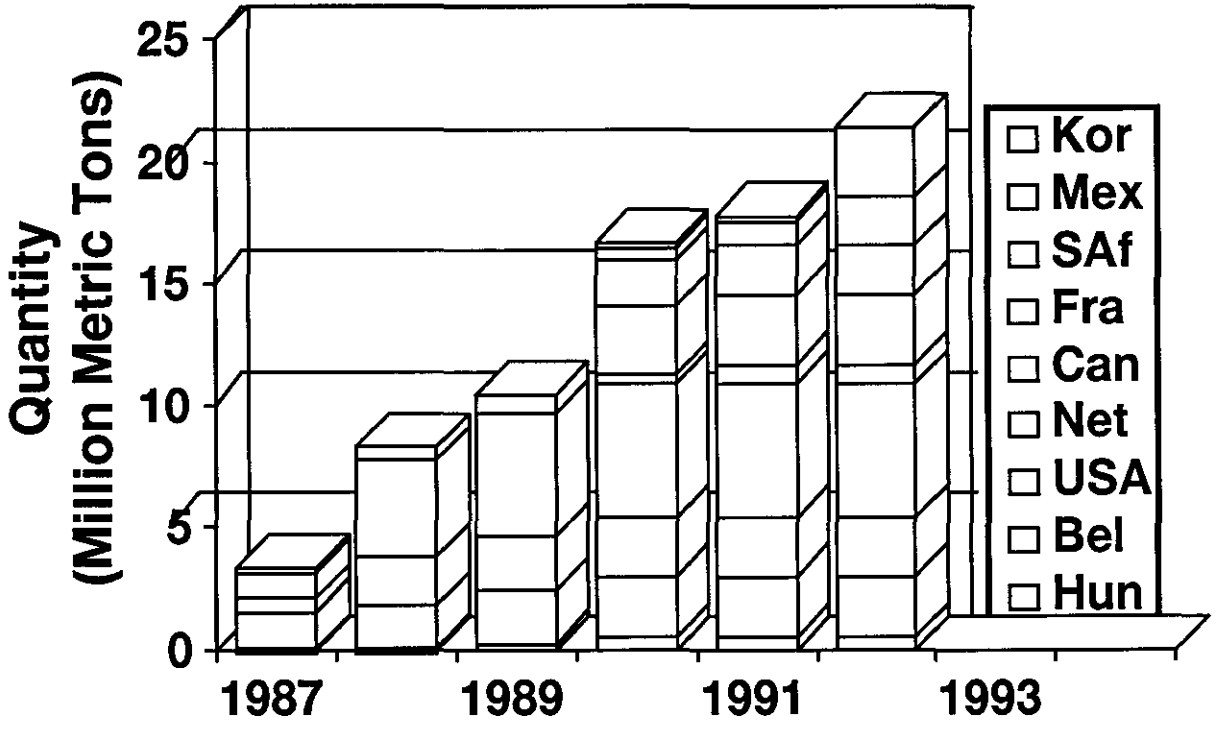
Spices, Herbs
and
Other Vegetable Seasonings

Spices, Herbs and Other Vegetable Seasonings

- Spices and herbs are used for flavouring foods like meat, fish, vegetable products, convenience foods and bakery products
- Spices are an important commodity in international trade
- Production mostly in tropical and sub-tropical countries with the exception of Hungary
- Low moisture commodities
- Contamination from spoilage organisms like bacteria (aerobic spore forming), moulds and yeasts (10^3-10^8 cfu/g)
- Chemical methods for decontamination, e.g. ethylene oxide and propylene oxide are effective decontaminants
  - However, toxicity of such chemicals is of concern
- Irradiation is very effective with most of the spices
  - Reduces pathogenic bacteria
  - Reduces populations of bacteria, moulds and yeasts
  - Kills contaminating insects

Commercial Irradiation of Spices and Vegetable Seasonings in Different Countries



- Since 1992, the number of countries irradiating spices and seasonings has grown enormously

Microorganisms

Comparison of the Effect of Ethylene Oxide and Irradiation on Total Bacteria in Selected Spices[a]

Spice	Untreated	Ethylene Oxide	Irrad Dose (kGy)	
	Organisms/g			
Black pepper	4.0×10^6	1.5×10^3	0	16
Paprika	9.9×10^6	0	0	10
Oregano	3.3×10^4	0	0	6
Allspice	1.7×10^6	42	0	10
Celery seed	3.7×10^5	8	0	10
Garlic	4.6×10^4	1.4×10^4	0	8

[a] From M. Vadji and R.R. Peireira, *J. Food Sci.* 38, 893 (1973)

Essential Oils

- The volatile essential oils are important for taste and flavour of spices
- In most spices there is negligible change of the essential oil content of spices, on irradiation

Effect of Fumigation and Irradiation on the Volatile Oil Content of Cinnamon and Fennel

	Volatile oil content (% v/w)		
	Untreated	Fumigated	10 kGy
Cinnamon	1.02 ± 0.03	0.88 ± 0.03	0.99 ± 0.04
Fennel	1.02 ± 0.02	1.07 ± 0.02	1.00 ± 0.005

- Fumigation with ethylene oxide at a concentration of 1500 g m^{-3} during eight hours at ambient temperature

Toofanian and Stegeman, Acta Alimentaria 17, 1988, p. 271

Effect of Irradiation on Essential Oils from Cardamom

Component	Percentage at dose (kGy)			
	0	5	10	15
α-Pinene	1.33	1.22	1.28	1.21
β-Pinene + Sabinene	3.56	2.70	2.86	2.71
1,8-Cineole (eucalyptol)	37.80	38.02	34.57	38.04
Linalool	2.34	2.03	2.01	2.09
Terpinenol-4	1.27	1.01	1.11	1.03
α-Terpineol	1.86	2.59	2.83	2.34
Terpinyl acetate	46.77	47.31	49.79	47.34

From S. Bachman, S.W. Witkowski, and A. Zegota (1978, IAEA-SM-221/70)

Colour

Curcumin (Turmeric)

Colour of Turmeric (Curcumin Content) During Storage at Ambient Temperature

Storage Period (months)	Treatment	Relative Curcumin Content
1	Control	2.82
	Irradiated (10 kGy)	2.73
6	Control	2.82
	Irradiated (10 kGy)	2.96
8	Control	2.82
	Irradiated (10 kGy)	3.04

Munasiri et al., J. Food Sci. (1987) 52, 823

Capsanthin (Chilli)

Extractable Colour (Capsanthin Content) in Chilli During Storage at Ambient Temperature

Storage Period (months)	Treatment	Absorbance at 460 nm	Reduction in Colour due to Irradiation (%)
2	Control	0.455	
	Irrad (10 kGy)	0.43	5.5
8	Control	0.320	
	Irrad (10 kGy)	0.305	4.7

Munasiri et al., (1987)

Sensory Attributes

Not an easy group of foods to do sensory analyses because

- Panel not always familiar with different spices (adaptation effect)
- Distinguishing odour of different spices made difficult because of the adaptation factor
- Personal likes and dislikes
- Flavour assessment dependent on the medium (dilute solution, dry powder, or in food items)

Flavour

Threshold Doses Required to Produce Detectable Changes in Flavour

Spice	Dose (kGy)
Caraway	12.5
Coriander	7.5
Cardamom	7.5
Marjoram	7.5-12.5
Black Pepper	12.5
Pimento	15.0

S. Bachman and J. Gieszczynska *In* "Aspects of the Introduction of Food Irradiation in Developing Countries". Int. Atomic Energy Agency, Vienna, 1973

Herbs

- Several herb teas have been studied for microbial contamination and D_{10} values

Chamomile flowers
Mint leaves
Linden flowers
Dog-rose hips
Sage leaves

} Generally used in foods as flavouring aids, in pharmaceuticals, and in cosmetic applications

Herbs (contd)

D_{10} Values (kGy) in Dry Plant Materials

Species or groups of microorganisms	Artifically contaminated			
	Chamomile flowers	Mint leaves	Linden flowers	Dog-Rose hips
Total count	1.43	1.14	1.37	1.27
Sporogenic bacteria	1.52	1.89	1.92	1.15
Germinating mould spores	1.35	1.30	0.79	0.63
Enterobacteria	0.88	0.40	1.16	0.76
E. coli	0.81	0.41	1.37	0.59
Sulfite-reducing Clostridia	0.50	1.00	0.96	1.26

Katusin-Razem et al., J. Food Sci. 53, 1120, 1988

- Considerable differences seen in D_{10} values for the same micro-organisms in different herbs

Herbs (contd)

Effect of Irradiation on the Chemical Composition of Ethereal Oil of Mint (mg per 100 g Dry Matter)

Component	Dose (kGy) 0	5	10
β-Pinene	5.7 ± 0.6	6.6 ± 0.3	6.4 ± 0.5
1,8-Cineole	19.3 ± 2.4	20.1 ± 1.8	20.3 ± 1.3
Menthone	61.1 ± 10.1	61.1 ± 13.1	65.0 ± 9.8
Isomenthone	9.6 ± 1.3	10.6 ± 2.5	9.9 ± 1.3
Menthyl acetate	15.2 ± 2.2	14.2 ± 1.1	16.0 ± 1.8
Neomenthol	12.3 ± 2.1	13.9 ± 3.0	14.5 ± 2.8
Neoisomenthol	10.3 ± 1.3	11.1 ± 2.4	12.8 ± 1.2
Menthol	164.0 ± 22.3	144.2 ± 12.3	166.1 ± 13.4
Piperitone	8.6 ± 0.4	8.2 ± 1.1	11.0 ± 0.8

Four replicates of same sample (four injections each) ± S.D.

Herbs (contd)

Effect of Irradiation on Carotenoids Expressed as β-Carotene, and Vitamin C in Dog-Rose Hips (mg/per 100g Dry Matter[a])

Dose (kGy)	Carontenoids	Vitamin C
0	3.62 ± 0.13	474 ± 24
5	3.49 ± 0.12	407 ± 21
10	3.58 ± 0.14	238 ± 10
15	3.60 ± 0.13	

[a] Seven replicates of same sample ± S.D
Katusin-Razem et al., J. Food Sci. 53, 1120, 1988

- No change in carotenoids
- Some loss of vitamin C (~ 46%) in dog-rose hips

Selected Examples of Clearances for Irradiation[1]

Country	Product	Purpose of Irradiation	Type of Clearance	Permitted Dose (kGy)	Date of Approval
Canada	Spices and Dried Seasonings	Decontamination	Unconditional	10	Oct. 1984
Hungary	Spices	Decontamination	Unconditional	6	Aug 1986
Indonesia	Spices	Disinfestation	For export only	10	Jan 1986
Thailand	Spices and Condiments	Insect disinfestation	Unconditional	10	Dec 1986
USA	Spices and Dried Seasonings	Decontamination and disinfestation	Unconditional	30	July 1983

[1] FAO/IAEA ISSN 1011-2588 (Majority of the Countries have given clearances for a dose of 10 kGy

Considerations for Successful Application in Food Irradiation

- Purpose: Decontamination, pathogen control, sprout inhibition, quarantine, shelf-life extension
- Benefits: Eliminate or cut down on use of chemicals (ETO, MB), retain freshness of the product, disease control, decrease wastage, market expansion
- Technical Advantage: Over other processes
- Economical Aspects: Cost of irradiation, savings by reduced spoilage and better consumer health
- Market Size: Large, medium, small (affects cost of irradiation, size and type of irradiator)

Considerations for Successful Application in Food Irradiation (contd)

- Quality: Retention, deleterious effect
- Industry: Interest necessary for commercial success
- Regulatory Aspects: Compliance to proper analyses, Clearance, and implementation of regulations
- Customer Need: If food is plentiful and safe, need for irradiation diminishes
- Requirements: Source, dosimetry (dose uniformity); good-quality food; packaging; pre- and post-irradiation storage; irradiation dose-range, temperature and atmosphere; package labelling; trained personnel

A Visit Through Successful Examples

- Some examples of successful applications
    - Strawberries
    - Mushrooms
    - Potatoes/onions
    - Apples
    - Papayas
    - Chicken
    - Wheat
    - Spices
- And some not so successful
    - Most dairy products

Conclusions

- In general, irradiation seems to be the best method of decontamination of herbs and spices
- Radiation dose for decontamination must be established for each spice
- Colour of some spices is slightly affected by high doses (15 kGy)
- Other chemical and flavour changes are minor or negligible
- Better methods for evaluation of the flavour of spices need to be devised