Micronutrients

(ii) Micronutrients

- The micronutrients generally do not have any significant energy value
- But they are essential components of the diet
- Of the micronutrients, concern generally involves minerals and vitamins. Irradiation does not alter the mineral content of a food. It could, however, alter the nutritional availability of minerals. Animal-feeding studies have not revealed a problem in this area. In fact, it has been observed that phosphorus in wheat is made more available by irradiation
- While the total number of vitamins is close to 20, their distribution varies from food to food
- Vitamins like thiamin and vitamin E are sensitive to irradiation in some foods. However, these vitamins are also sensitive to other processing methods
- Contribution of a few of these vitamins from different food groups to the human diet is illustrated, next

Percentage of Total Vitamin Contribution by Food Groups (Bolin, 1984)

Products	Ascorbic	Vitamin	Thiamin	Riboflavin	Niacin
Dairy Products	4.7	11.8	9.9	43.1	1.7
Eggs	0	6.8	2.5	5.9	0.1
Flour (cereal product)	0	0.4	33.6	14.2	22.7
Fruits	35.0	7.3	4.3	2.0	2.5
Meat, poultry, fish	1.1	22.9	29.4	24.6	46.0
Potatoes (including sweet)	20.9	5.7	6.7	1.9	7.6
Vegetables	38.3	36.4	8.0	5.6	6.8

• With the normal mix of different foods in human diet, the probability of vitamin deficiency due to irradiation of foods is low

Effect of Freezing, Heat Processing and Irradiation on Vitamin K Activity (mg/100g) of Some Foods^a

Food	Frozen	Heat	Irrad, 27.9 kGy	Irrad, 55.8 kGy
Asparagus	33	41	37	46
Broccoli	63	68	74	44
Cabbage	56	54	78	56
Spinach	93	125	227	198

^a Richardson et al., J. Nutr., <u>73</u>, 369, 1961

- Vitamin K activity is undamaged at a dose of ~60 kGy
- Vitamin E is the most sensitive of the fat-soluble vitamins to irradiation:

Vitamin E > Carotene > Vitamin A > Vitamin D > Vitamin K

Effect of Irradiation on Vitamin E in Poultry Meat¹

Meat	mg/100 g	% of Total
Chicken		
Control	0.43	100
5 kGy	0.21	49
Turkey		
Control	0.09	100
5 kGv	0.06	67

¹ Data taken from Sadat, T., M. vassenaix, Radiat. Phys. Chem., <u>36</u>, 661, 1990

 Poultry is not an important source of vitamin E since it contributes ≤ 10% of the total daily intake

Changes in Carotenoids on Irradiation In Different Varieties of Mangoes¹

Variety	Doco	Total Carotenoids Unirrad Irrad		
	kGv			
		(mg/100 g	of Fresh Fruit	
Alphonso	0.25	0.7	0.7	
Carabao	0.65	9.6	9.5	

¹ Singh (1990a)

Changes in Vitamin C on Irradiation in Different Varieties of Mangoes¹

	Dose	Vitamin ((mg/	Percent	
Variety	(kGy)	Unirrad	Irrad	Change
Okrong	0.2	15	15	0
	0.4	15	15	0
	0.5	15	17	+14
Peach	0.75	14	14	0
Rubi	0.75	40	37	-5
Sensation	0.75	56	67	+19

¹ Singh (1990a)

- The overall effect of irradiation is insignificant
- Most other varieties of mangoes show similar results, whereas some show very small losses of vitamin C

Effect of Irradiation and Storage on the Thiamin Content of Bread^a

Storage time months	Average thiamin content of bread (µq/100q bread)			
	Unirradiated Irradiated			
0	249	281		
6	226	209		
12	241	246		
18	194	225		
24	222	236		

^a Bread made from irradiated and unirradiated wheat. Data from Schonborn, W. and Ehrhardt, G. (1974) Technical Report IFIP-R 16, International Project in the Field of Food Irradiation, Federal Research Centre for Nutrition, Karlsruhe, F.R. Germany

- Low loss most likely due to low moisture level in wheat
- Wheat is an important source of thiamin in human diet

Effect of Gamma Irradiation (0.75 kGy) on Niacin, Thiamin and Riboflavin in Mangoes¹

Mango	VITAMIN (mg/100 g pulp)					
Variety	Riboflavin		Niacin		Thiamin	
	Unirrad	d_Irrad	Unirrad	d Irrad	Unirra	ad Irrad
Kent Peach Zill	0.06 0.06 0.09	0.05 0.05 0.08	0.042 0.09 1.65	0.038 0.07 1.78	0.06 0.05 0.09	0.05 0.03 0.09

¹ Singh (1990a)

 The losses are negligible in most varieties of mangoes

Effect of Post- Irradiation Cooking on Thiamin Content of Pork

Irradiation dose	Thiamin ^a (μg/g) pork		Thiamin loss ^b on cooking
(kGy)	Raw Cooked		%
0 0.57 3.76	8.89 8.20 5.50	7.88 7.26 4.75	11.29 11.48 13.59
5.52 7.25	5.50 4.46 3.77	3.86 3.20	13.59 13.54 14.99

^a Mean from data pooled (n=18) with respect to storage treatments ^b Percentage expressed as the average of 18 values of the form (Jenkins et al., J. Food Sci., <u>54</u>, 1, 1989

 The increase in thiamin loss on cooking as a function of dose is very small

Vitamin Losses Due to Radiation Pasteurization of Pork Chops and Chicken Breasts Impact on Human Diet (American)

Meat	Thiamin	Riboflavin	Niacin
Pork Chops	1.5%	0.1%	0.4%
Chicken	0.1%	0%	U%

Fox et al. Int. J. Radiat. Biol. 55(4), 689-703, 1989 (Radiation dose 1 kGy at 0°C)

 In light of the contribution of pork and chicken in the American diet to the overall intake of these vitamins, the loss of thiamin and niacin is not very significant

In Comparison

Effect of Conventional Canning on Nutrients in Vegetables¹

	V OG OTANION
Nutrient	% Loss
Vitamin C	26-90
Thiamin	16-83
Riboflavin	25-67
Niacin	0-75
Folacin	35-84
Pantothenic acid	30-85
Vitamin B ₆	0-91
Biotin	0-78
Vitamin A	0-84
	1

¹ From D. Lund (1987) in Nutritional Evaluation of Food Processing (Eds. Karmas and Harris) Avi Publishing

 Canning process appears to cause rather large losses of most of the vitamins

Effect of Blanching on Nutrients in Vegetables

Blanching method	Nutrient	% Loss
Water	Vitamin C Riboflavin	16-58 30-50
	Thiamin Niacin	16-34 32-37
Steam	Vitamin C Vitamin B ₆	16-26 21

¹ From D. Lund (1987), in Nutritional evaluation of food processing (Eds. Karmas and Harris) Avi Publishing.

- Since Vitamin C is very soluble in water, many fruits and vegetables can lose this vitamin merely on excessive washing. This extraction process becomes more efficient at the high blanching temperatures
- However, loss of vitamin C in frozen storage is lower for blanched vegetables

Loss of Vitamin C in Frozen Fruits



 There is better retention of Vitamin C at lower temperatures (in frozen foods) but its loss continues during storage

Conclusions

- Under most processing and storage conditions, losses of some micronutrients occur. The losses on irradiation are similar to those in other processes
- Vitamin E and thiamin are amongst the most sensitive vitamins to irradiation, as they are to other processes
- Depending upon the intake of processed foods (including irradiated foods) supplementation of some micronutrients from other sources may be required

Nutritional Loss Concerns (contd) Induction of Anti-Vitamin Activity

- An earlier study had suggested that irradiation may cause formation of antimetabolites to thiamin and pyridoxine in meats
- A study on the possible occurrence of antithiamin and antipyridoxine factors in irradiated chicken and beef was carried out at the Letterman Army Institute of Research in San Francisco (Skala et al., J. Food Protection, 1987)
- This bioavailability study produced no evidence of anti-vitamin factors in irradiated meats