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Radiation in Treatment of Foods

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ABSTRACT

In the present world, it is not a difficult thing to preserve any kind of food item provided we follow the correct methods. The food stuffs are to be basically kept safe from the various microorganisms that thrive on the food materials. In this context is that the technique of radiation comes into the fore front. It even has a high margin of safety compared to other preservation methods since it keeps the food stuff afresh of all the vital contents like the minerals and vitamins. Radiation deploys the destruction and resistance to the growth of different kinds of microorganisms. The irradiated food stuffs are, therefore, stable with a long sterile shelf life without any refrigeration.

Keywords : Radiation, Preservation, Food stuffs, long sterile shelf life.

INTRODUCTION

Radiation is broadly defined as energy moving through space is invisible waves. Radiant energy has different wavelengths as well as degrees of power. Light, infrared, heat and microwaves are forms of radiant energy. So are the waves. Boiling and toasting use low-level radiant energy to cook food. The radiation of interest in food preservation is ionizing radiation, also known as irradiation. These shorter wavelengths are capable of damaging microorganisms such as those that contaminate food or cause food spoilage and deterioration. Irradiation employs radiant energies which affect food when their energy is absorbed. It requires special equipment to generate, control and focus this energy. Irradiation is relatively a new technology as applied to foods. Food irradiation is used primarily as a preservation method, but it also has potential as a more general unit operation to produce specific charges in food materials.

FOOD IRRADIATION

In 1983, the FDA approved irradiation as a means of controlling microorganisms on spices, and in 1985, the FDA widened the allowed uses of irradiation to additional foods such as straw basics, poultry, ground beef and pork.

EFFECTS OF RADIATION

i. Direct effects

A change in the color of texture of a food would be due to direct collusion of a gamma ray or high energy beta particle with a specific pigment or protein molecule such direct its unquestionably do occur, but their frequency of occurrences at a given radiation dose probably is not sufficient to explain the major portion of radiation effects in a given substrate.

ii. Indirect effects

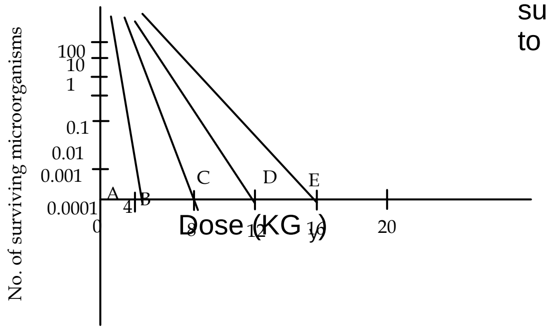
Just as radiations colliding with a cell or specific food molecule would produce ion pairs and free radials, much the same occurs when high energy radiations pass through water. In this case, water molecules are altered to yield highly reactive hydrogen and hydroxyl radicals. These radicals can react with each other, with dissolved oxygen in the water and with many other organic and inorganic molecules and ion that may be dissolved or suspended in the water.

In food irradiation preservations, the primary goal is to inactive undesirable microorganisms and enzymes while producing minimum changes in other food constituents. Microorganisms and enzymes can be inactivated by direct hits from radiations as well as by indirect effects. Other food constituents, largely in aqueous solutions, are largely affected by indirect effects from free radicals produced during radiolysis of water. Therefore, attempts to minimize changes in foods during irradiation have been focused on limiting indirect effects.

iii. Effects on microorganisms

The reactive ions are produced in the foods due to irradiation that destroys that micro-organism immediately by changing the structure of cell membranes and affecting metabolic enzyme activity. However, a more important effect is on the DNA and RNA molecules in cell nucleus, which are required for the growth and replication. The effects of irradiation only become apparent after a period of time when the DNA double helix fails to unwind and the micro-organism can not reproduce by cell division.

The rate of destruction of individual cells depends on the rate at which ions are produced and inter react with DNA, where as the reduction in cell number depends up on the total dose of radiation received. Some bacterial species contain more than one molecules of DNA and others are capable of repairing damaged DNA and in such cases we find that the rate of destruction is not linear with received dose (given growth).



Microbial destruction by irradiation

Curve A – Pseudomonas
Curve B – Salmonella
Curve C – *Bacillus cerous*
Curve D – *Deinococcus radiodurans*
Curve E – Typical virus

A simple guide is that, the simplest smaller organism; require the higher dose of irradiation to destroy it. Viruses are very resistant to irradiation and are unlikely to be affected by the dose ceils casein commercial processing. In general vegetative cells are less resistant to radiation than spores and insects and parasites require the lowest dose used commercially.
Yeast and moulds are readily destroyed and preventing their growth on fruits requires low dose. Spore forming species (e.g. *Clostridium botulinum*) and the ones able to repair damaged DNA rapidly (e.g. *Deinococcus radiodurans*) are more resistant.

Resistance of microorganisms
The most radiation- resistant microorganisms of consequences in food are *Clostridium botulinum*. Some viruses and microorganisms are yet more radiation resistant but are easily controlled by mild heating pious to irradiation. Many conditions in food can support growth and toxin formation by *Clostridium botulinum*. Among these are P^H 4.6 and below, aerobic conditions, extreme dryness of certain foods, refrigeration temperatures below 3^0C, and certain preservation chemicals. In foods, where these conditions do not exist, *Clostridium botulinum* must be assumed to be present and radiation dosage sufficient for its destruction is employed.
As is the case for neat preservation, and based on a similar assessment, radiation dosages required to destroy spores of *Clostridium botulinum* in various foods have been established. In the irradiation destruction curve shown below, D_m is the radiation dose giving a 90% reduction in population. In beef substrate (P^H above 4.6), the value of D_m , then there would be only one chance in a billion that a 1 kg can of such food would certain live spores. A 12 D_m dosage (12x0.4 M rad) is 4.8 M rad. Such a dosage provides a wide margin of safety.
For foods with P^H 4.6 and below, *Clostridium botulinum* is not a problem, but other spoilage organisms must be inactivated. The most resistant of these has been found to have a D_m of about 0.2 M rad. For sterilization with a substantial margin of safety, a 12 D_m dosage (equivalent to 2.4Mrad) also may be employed.

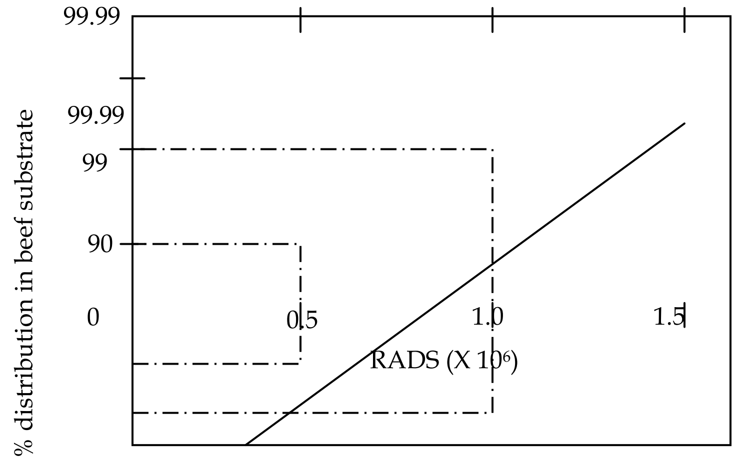


Fig. 2: The D_m Value for *Clostriodium botulinum*

Effect of irradiation on nutritional & sensory value
At commercial dose level, ionizing radiation has little or no effect on the digestibility of protein or the composition of essential amino acid. At higher dose levels, cleavage of the sulfhydryl group from sulfur amino acid in proteins causes changes in the aroma and taste of the foods. CHO are hydrolyzed and oxidized to simples compounds and, and depending on the dose received, may become de- polymerised & more susceptible to enzymatic hydrolysis. However there is no change in the degree of utilization of the carbohydrates value. The effect on lipids is reduced by irradiating food while frozen, but the foods that have high concentration of lipids are generally unsuitable for irradiation.

Food	Treatment (KG_y)	Thiamin	Loss% Riboflorin
Beef	4.7-7.1	60	4
Pork	4.5	15	22
Haddock	1.5	22	0
Wheat	2.0	12	13
Flour	0.3-0.5	0	0

Effect of irradiation on water-soluble vitamins

Food	Niacin	Pyridoxin	Pantothemic acid	Vit B12
Beef	14	10	-	-
Pork	22	2	-	-
Haddock	0	+15	+78	10
Wheat	9	-	-	-
Flour	11	-	-	-

Effect of irradiation on water-soluble vitamins

Dose range (KG_y)	Objectives	Examples & Applications
0.05-0.15	Extension of storage life by inhibition of sprouting.	Potatoes, onions, garlic, yarns
0.1-0.3	Destruction of parasites to prevent transmission to man through food.	Meat
0.1-0.5	Insect dis- infestation	Grains, beans, rice, flour, dried fruits, dates coffee, beans
0.075-1.1	Quarantine control against insect pests and plant diseases.	Mangoes, beans, fruit paro paws
0.5-1.5	Delay in maturation	Mushroom, fruit
1.0-5.0	Extension of storage life of ambient temperatures by reducing no. of bacteria, molds, yeasts.	Fruit, vegetables, starch
0.5-10	Extension of refrigerated storage life.	Meat, Poultry, fish
2.5-10	Increased digestibility, reduction in cooking time.	Soybeans, broad beans, lentils, dehydrated vegetables
3.0-13	Elimination of specific pathogens e.g. salmonellae which cause food poisoning.	Frozen meat animal feeds, poultry, eggs, coconut, spices
35-60	Sterilization of foods to allow long term storage without refrigeration.	Meat

Irradiation Doses used for Treating Foods

Thiamine retention comparison		
Meat	**Percent in irradiated sample**	**Percent in canned sample**
Beef	21	44
Chicken	22	66
Pork	12	57

Specific comparisons

Vitamin	Non-irradiated sample	Irradiated sample
Vitamin A (IU)	2200	2450
Vitamin E (mg)	3.3	2.15
Thiamin (mg)	0.58	0.48
Riboflavin (mg)	2.10	2.25
Niacin (mg)	58.0	55.5
Vitamin B_6 (mg)	1.22	1.35
Vitamin B_{12} (mg)	21	28
Pantothemic acid (mg)	13	17
Folacin (mg)	0.23	0.18

Vitamin content comparison of cooked chicken (1kg)

CONCLUSION

Irradiated foods are wholesome and nutritious. All known methods of food processing and even storing food at room temperature for a few hours after harvesting can lower the content of some nutrients, nutrient losses are either not measurable or, if they can be measured, are not significant. At the higher doses used to extend shelf-life or control harmful bacteria, nutritional losses are less than or about the same as cooking and freezing.

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