RADIATION PROCESSING OF FOOD[1]

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Despite the current interest in it, there is nothing basically new about radiation processing of food. Ever since 1905 when Roentgen discovered X-rays, it has been known that ionizing radiations kill bacteria. However, the radiation processing of foods began to be studied seriously about fifteen years ago because of the promise it held to preserve foods without the deteriorating effect of heat.

Original experiments in sterilizing foods made use of the Capacitron and the Van de Graaf machine. Both of them are generators of high velocity electrons, also called beta rays. Then advances in nuclear physics during and since World War II developed interest in the use of gamma rays in this application.

Radiation processing of foods is enticing because it destroys enzymes, viruses, bacteria, yeasts, molds, and insects; it is adaptable to continuous processing; it is accompanied by a nominal increase in temperature of the product being irradiated (hence the term "cold sterilization"); and low levels of treatment have an effect equivalent to pasteurization, due to surface sterilization.

In the radiation processing of foods, only beta and gamma rays may be used. Alpha rays and protons are ruled out because they have no penetration. Neutrons may not be used because they induce radio-activity in food exposed to them thus rendering them unfit for consumption.

Beta rays are obtained from machines like the Van de Graaf accelerator, the linear accelerator, the resonant transformer and the Capacitron. All of these machines embody the principles of an electron generator and electron accelerator emitting a beam of specified intensity.

The characteristics of a beta ray machine are that it can be turned on and off at will, the beam is directional, hence less shielding for the protection of workers is required. Beta rays exercise their effect in a matter of seconds. A food product processed by beta rays undergoes an increase of temperature of no more than 5° F. Their penetration is limited. In water they will penetrate about 1/4-inch per million electron volts, so that today, the maximum thickness of mass that can be treated for sterilization is two inches and that is obtained by irradiating from the bottom as well as the top.

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For the radiation processing of foods, gamma rays from spent fuel rods from reactors, radio-active Cobalt (with a half-life of 5.3 years), radio-active Cesium (with a half-life of 33 years and a lighter shielding requirement), and gamma energy piped from a power reactor, may be used.

In comparison with beta rays the operational characteristics of gamma rays differ in several respects. They cannot, for example be turned on and off. Moreover, they are emitted in all directions hence, are not directional and require much heavier and more elaborate shielding. They also require more time to exercise their effect, in other words minutes, rather than seconds. Like beta rays a food product processed by gamma rays undergoes an increase of temperature of no more than 5° F. On the other hand, they are

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much more penetrating so that they will penetrate 12 inches of water per million electron volts.

In general, the less complex the organism the less susceptible it is to destruction by radiation. The following scale will serve to illustrate this point. To inactivate enzymes a radiation dosage of 30 million reps is required. (The rep is a unit of dosage of radiation. It is an abbreviation for roentgen-equivalent-physical and represents an energy absorption of a little less than 100 ergs per gram of material of unit density.) For viruses the killing dosage is 3 to 5 million reps, for bacteria 1 to 3 million, for yeasts and molds 100,000 to 1 million, for insects 25,000 to 100,000 reps and for man a mere 600 reps.

Unfortunately the sterlizing dosages for enzymes and bacteria exercise undesirable side-effects on the color, flavor and texture, depending upon the particular food. This is the result of radiation effects on the constituent carbohydrates, proteins and fats. While these changes are minute in quantity, effecting only about 0.003% of the total material, yet they nevertheless effect sensory changes in many foods. The carbohydrates are least affected and are broken down into simple sugars. The proteins yield side-effect products such as poly-peptides, amino acids, ammonia and sulphur-containing compounds. From this it can be appreciated that serious problems need to be solved before "cold sterilization" can be realized.

There are more than fifty research organizations in the United States working on the problem of radiation processing of food. There is reason to feel therefore, that eventually, perhaps within the next decade, radiation sterilization will have a place in food processing.

Perhaps, as with freezing, blanching will have to precede radiation to inactivate enzymes and avoid the heavy radiation dosage they require. Other combinations of existent or yet to be developed processing stages, perhaps antibiotics along with radiation, may find ultimate application. However, there are some sign-posts in evidence that suggest that side-effects from irradiation may be minimized or circumvented. As one example, irradiation at low temperature reduces the formation of free radicals responsible for these undesirable effects. The addition of ascorbic acid or other free radical acceptors has a beneficial effect. The latest idea being researched, especially in the application of radiation processing to milk, involves the constant removal from the field of action of side-effect products.

Other problems must also be solved before radiation processing is applied commercially to foods. Engineering aspects remain to be developed. The economic facets are as yet unclear and questions of toxicity and nutritional effects on radiation processed foods need to be completed. It goes almost without saying that all parties interested in the development of radiation processing want to proceed in a thorough, responsible fashion to remove any question of hazard in connection with the consumption of irradiated foods. No commercial application will be made until the U. S. Food and Drug Administration approves of and passes on the safety of the device.

Thus far, short term and acute toxicity tests are assuring. The Surgeon General of the Armed Forces is now engaged in long term feeding tests including some involving human subjects at the Fitzsimmons General Hospital in Denver. They too, thus far, are reassuring. By about 1960 it is estimated that certain foods will have been cleared on wholesomeness and safety to the point where fairly large scale acceptance tests can be planned, making use of Armed Forces personnel.

Dove-tailing with this is the execution of plans which provide that within about a year from now, a pilot plant with a capacity for irradiating 3000 pounds of food per hour will be operating at Sharpe General Depot at Lathrop, California. It will be capable of producing relatively large quantities of foods for further research and testing, to develop information on commercial-scale equipment and to obtain cost data.

Attention now is being given to effects obtained by exposing foods to radiation dosages of less than 3 million reps. While these effects do not thoroughly sterilize the product, they do sterilize the surface of the product so that its edible life is extended generally with subsequent holding under refrigeration.

Here are some of the things that can be done. Potatoes and onions can be prevented from sprouting. The insect infestation in grain can be killed off. Trichonella in pork can be inactivated. The edible life of fish, notably halibut, cod and tuna can be extended. The refrigerated life of fresh meat can be extended about five-fold. Table-ready and processed meats, such as frankfurters, bologna, ham and bacon enjoy extended refrigerated edible life. Similar benefits can be imparted to fruits. Among those already satisfactorily tested are apricots, bananas, berries, melons, peaches, pears, plums and pineapples. The same is true for vegetables, some of which are, asparagus, carrots, celery, corn, green beans, peas, spinach and tomatoes.

What will be the impact of radiation processing on our supply of foods in the future? Radiation processed foods will probably encroach on canned, frozen,

refrigerated and fresh foods but will not necessarily displace any of them. When brought to the point of successful commercial application, this mode of processing food will probably permit the use of a wider range of packaging materials and simplify the fixturing and operation of retail food stores. The preparation and packaging of heretofore perishable products may be carried out on a centralized basis. The offering of foods in greater variety may be encouraged.

Radiation processing of food may indeed seem revolutionary in scope and effect but, as with frozen foods, it will be applied progressively over a significant period of time as problems are solved and render practicable, extended applications. It is assumed therefore, that its introduction will not cause serious dislocations and, since it will be evolutionary, conversions and adjustments called for can be effected in an orderly manner.

REPORT OF THE COMMITTEE ON RESEARCH NEEDS AND APPLICATION - 1957[1]

At the annual meeting of the Association on September 4, 1956, the Committee met and elected F C. Baselt as secretary. The objectives, policy and procedures were discussed and approved. These are as follows:

A. *Objectives*

To serve the man in the field; to serve as a clearhouse for new ideas; to cor-ordinate our activities with a similar committee of the American Public Health Association; to request questions and proposals from the membership; to determine how much demand there is to find specific information about a given problem; to find the best methods for informing the membership about the existence of this Committee.

B. *Policy*

To get down to the grass-roots level. This Committee will provide a time and place where local sanitarians can exchange ideas and discuss professional problems with the experts in research. In effect, it will provide a common meeting ground. There must be a spirit of fellowship, sincerity and willingness to help. The great experts must never talk down to a man, but must be ever mindful of an attitude of mutual assistance. This is important if the Committee is to attain its objectives. The Committee does not abstract articles or submit an annual research project.

C. *Procedures*

Solicit proposals for the best methods to serve the man in the field. How can we promote discussion of problems by research and field men? Where appropriate, proposals received by this Committee should be assigned to existing committees. Where necessary, action may be taken to assign a problem to a research agency.

The Committee felt that a question and answer page in the Journal would be a desirable method for contacting the membership, and the Executive Board of the Association approved this suggestion. Accordingly, an editorial entitled "Something New Has Been Added" appeared in this Journal in January, 1957. The editorial emphasized that the primary function of the Committee was to serve the man in the field. At the same time, suggestions were requested for a name for the Question and Answer page. Questions were to be addressed to: Department of Public Health, Indiana University Medical Center, Indianapolis, Indiana. Some names which have been submitted are: The Ouija Board, Saniquiz, The Query Box, The Brain Trust, Sanitary Nutcracker, Answering Your Saniquestions, Sanitary Information, and Ask and Be Answered.

To date, about a dozen questions have been sent to the Chairman. In each case, the question is referred to the appropriate expert on this Committee. In the event the information is not available within the Committee, the committee member suggests one or more names to the Chairman who then follows up with a letter to the new reference. This simple plan works well and should be continued.

With regard to reference made by this Committee to trade-marked products or classes of products, it was unanimously voted that the Committee would neither recommend, or disapprove of such items. Consequently, the sanitarian inquiring about a given product will have to decide for himself by a suitable test program.

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