Use of Nuclear Energy to Preserve Man's Food

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Hunger and malnutrition are not only caused by scarcity and high world market prices, as has happened during the last few years. Even in times of low international prices and increasing surpluses, as in the 1960's, large groups of the world population are unable to obtain sufficient food. The situation of the world market is a very crude indicator of the relation between need and availability. Conditions on national and regional markets are often quite different to those on the world market. Moreover, the markets show only the demand of the well-to-do.

People with low incomes suffer hunger and malnutrition even when the market supply is fairly large and the prices are relatively low. Just as other commodities, food is not distributed on the basis of need but on the basis of purchasing power.

Roughly two thirds of the world's population live in countries that are so poor that they depend for food chiefly on the fairly low production that takes place within their own borders. Therefore it is highly important for these low income countries that the level of domestic agricultural productivity is raised, that the food losses are decreased and that income distribution is more equal. And there is little time left, realizing that when nothing happens the number of people with less food than the minimal required will in the year 2010 be four times higher than in 1960, and will reach a total of about 1.8 billion. In case the income differences in the world should decrease, the number of people having less food than the minimum required will still double in the next 30 years.

Again, a structural improvement can only be obtained when the food production in the poor countries is stimulated, when food losses are prevented and when the economic position of the small farmer is improved and stabilized. For that, a price policy and large buffer stocks of food are prerequisites, the latter in order to bridge the differences in demand and offer.

Increasing food production through improvement of productivity of the major food staples — cereals, food legumes and starchy foods — and through intensification, either by planting the same crop more frequently or by introducing additional enterprises to develop a mixed cropping or a crop/livestock system, requires time, maybe more time than we have.

If hunger is to be prevented and health is to be improved on short notice much more emphasis than up to now should be placed on effective storage and distribution of food. The quantitative and qualitative food losses are namely estimated to be between 20 and 40% in developing countries, rising even to 60—70% with certain products under certain conditions (humid tropics). These losses occur during handling, storage, milling and other processing methods, distribution and ultimate use.

The great advantage of this approach is that the technologies are available, and it is thus not necessary to develop new technologies to have more food available tomorrow. Application of these technologies is effective immediately. The only thing necessary is to evaluate existing technologies and if necessary transform or adapt them to the needs of the respective regions. Thereby one should now especially take into account the energy requirements of handling, storage, processing and distribution, with the aim of making the most efficient use of energy and/or high-energy requiring raw materials.

Food irradiation is one of these existing technologies. It is a physical method that can be used to preserve food from microbial and insect damage and infection, as well as from physiological deterioration. In other words, this method can extend the storage life of food considerably without noticeable change of the properties of the food commodity.

The impact of food irradiation can be very great especially because of its contribution to the hygienization of food. Irradiation eliminates pathogens like Salmonella and other enterobacteria and replaces potential dangerous chemicals like ethylene oxide, methylbromide, maleic hydrazide. Furthermore, irradiation is a very low energy process compared with heating, freezing etc., and saves energy by reducing the frequency of food-transports.

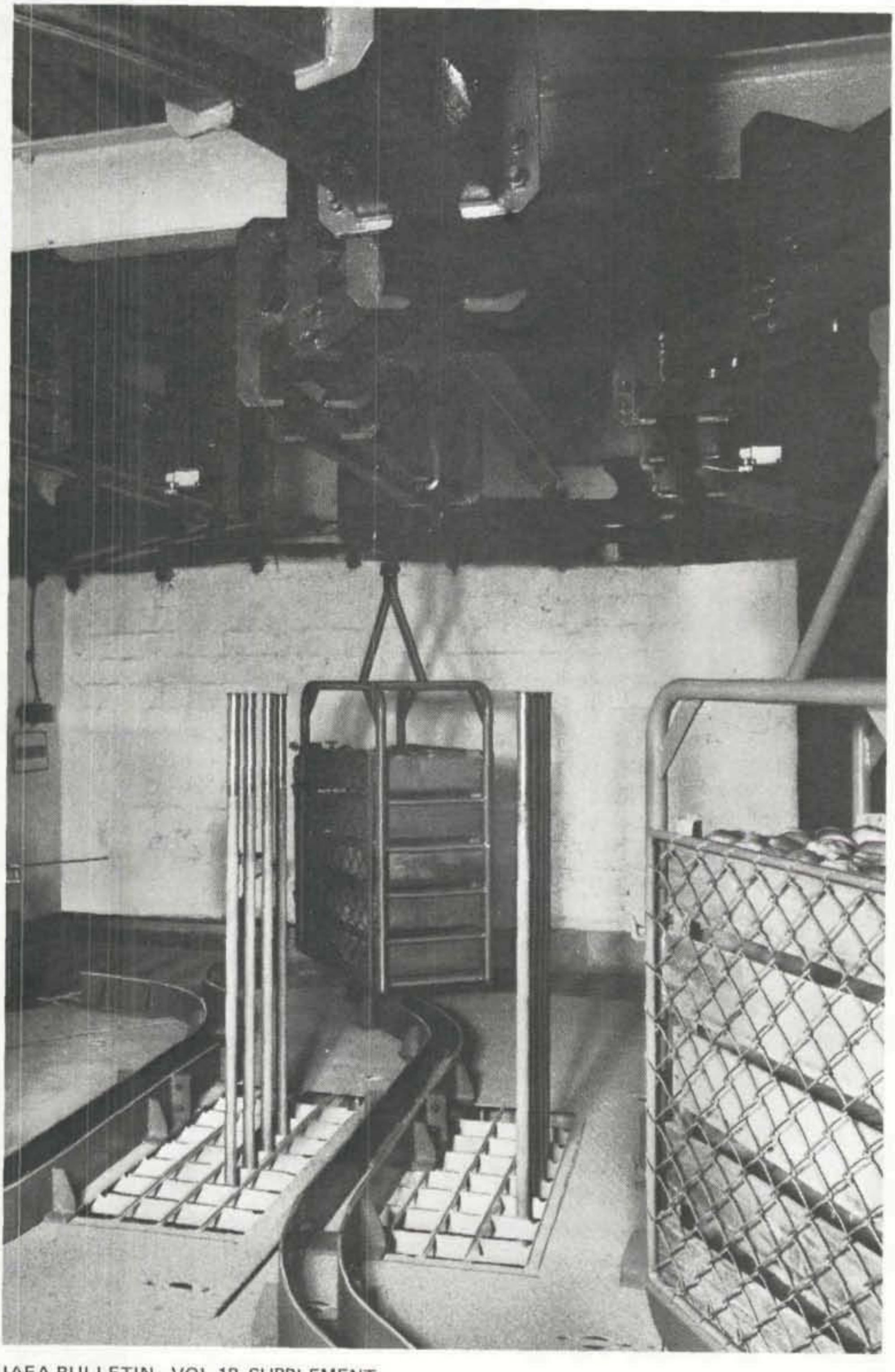
To save on energy is becoming very important. Over the past two decades, with our cheap energy and low-cost food economy, there was little impetus to push ahead with low energy processing such as food irradiation. This is now rapidly changing. Let us look at the figures. The energy requirement for radiation pasteurization is 0.76 kWh/ton, for radiation sterilization 6.3 kWh/ton. Freezing requires 90 kWh/ton, heat pasteurization 230 kWh/ton, heat sterilization 300 kWh/ton and drying 700 kWh/ton. Using the irradiation process, energy savings of 70–97% are possible. In addition, food irradiation does not require expensive packaging.

There is a growing concern about the ethylene oxide residuals. This has already led to proposed maximum concentrations (USA) or to a complete stop (the Netherlands). This has prompted many firms to turn to radiation processing (drugs, plastic disposable items, food like spices, chocolate powder, etc.). Besides the absence of toxic residues, there are the advantages of room temperature processing, of continuous processing, of reduced microbiological control costs, of high reliability, of flexibility in packaging, of price stability.

To repeat: the irradiation process increases the shelf life without noticeable changes in the characteristics of the food, it leaves no chemical residues, it eliminates pathogens like Salmonellae, it is an easy process and very reliable, it is a low energy process and it turns out to be, after long and intensive testing, a completely safe process.

These were the reasons why the Dutch Government (Agriculture and Public Health) and industry took a great interest in this method. In 1968 the Dutch pilot plant for food irradiation became operative as the result of a joint effort of Government and industry. In the first five years the pilot plant disseminated much information and obtained a number of clearances, both unconditional and provisional. Unconditionally cleared were mushrooms, food packaging materials, frozen meals and potatoes. Limited batches of cocoa beans, strawberries, asparagus, shrimps, spices, poultry and onions were cleared in the same period.

A food irradiation facility showing the irradiation of potatoes to inhibit sprouting during storage. Photo: Central Food Research Institute, Budapest.



From 1973 to 1976 the pilot plant was operated as an irradiation facility, and consequently the governmental funds were drastically reduced. An evaluation of this period showed:

- that the demand for irradiation on contractual basis increased to such an extent that already in 1975 the strength of the Co^{60}-source had to be raised from 85 kCi to 180 kCi;
- that, due to the mentioned increased industrial interest, the total income covers presently nearly 75% of the exploitation costs of the facility.

All of you who are familiar with pilot plant operations know that is an extreme high percentage.

During this period, 1973–1976, the public health authorities in the Netherlands showed an increasing interest in the method and cleared:

- Unconditional: milk blanks, onions and poultry;
- limited batches of batter mix, prepacked cut endive, prepacked peeled potatoes, shrimps and fish fillets.

Feasibility

The pilot plant activities have stimulated very much the practical application of the method. Because of the limited time I shall mention only a few examples.

In the Netherlands onions are stored for a period of 9 months. An effective sprout-inhibitor is therefore required, especially for the 100 000 tons of onions distributed and exported during the period March to June. Treatment with the chemical maleic hydrazide in the field does not guarantee the sprout inhibition during that period. Moreover, this chemical is not harmless. A three year practical evaluation has resulted in a design of a flowsheet for one of the largest onion exporters. This commercial irradiation plant is designed to irradiate 20 000 tons in four weeks, the processing costs are about 5 cents per kg. The export company has decided to build the plant provided that the export of irradiated onions to West-European countries will be made possible by the respective health authorities. The provisional approval of the joint FAO/IAEA/WHO expert committee, two weeks ago, will certainly promote the construction of this commercial plant.

Also a technological and economic evaluation of potato irradiation was made. As you know, irradiation is a very effective non-chemical method of sprout inhibition, and is preferred by the Dutch health authorities over the use of chemicals. Commercial irradiation of 20 000 tons during a period of 8–10 weeks immediately after harvest costs 0.5–1 cents per kg, the difference due to storage either in bulk or in boxes. Commercial application awaits the solution of the after cooking discoloration problem. The costs are not inhibitive.

The shelf life of peeled potatoes depends on excessive use of sulphite. The requirement for this suspected additive can be reduced four times – from 2 to 0.5% – by irradiation with 50 krad, resulting in a reduction of bacterial count and in a stabilization of the colour. An evaluation of commercial application is being made.

There is a growing consumer preference for fresh broilers (chickens). Shelf life extension is a prerequisite for satisfying this preference. Irradiation with 100–300 krad increases the shelf life 2–4 times without changes in the quality of the product. Besides, and this is very important, irradiation is the only possibility to protect consumers against Salmonellae, all other measures taken to eliminate Salmonellae from poultry have failed.

The results from a restricted market trial with the aid of a nation-wide wholesale organization indicated a full appreciation with regard to the improved hygiene and to the required shelf life extension. Next year the irradiation of poultry will be scaled up.

Shelf life of marine products is very short. Shrimps spoil quicker than fish because the protein and free amino-acid content is higher, and the meat structure is less compact. Because of this, large scale introduction of fresh fillets of cod and plaice into supermarkets and centralized distribution systems appears impossible without an adequate improvement of their shelf life. During the past 3 years a technological and economic evaluation of irradiated fish fillets and shrimps has been carried out. One hundred krad doubles to triples the shelf life of fish fillets and shrimps at 3–4°C. The costs are about 12 cents per kg at a throughput of 300 tons/month, operating the source eight hours per day and 20 days per month.

One should furthermore consider that the marketability of Dutch peeled shrimps depends completely on the use of benzoic acid. Besides being a suspected chemical preservative, the taste of shrimps containing benzoic acid at concentrations above 0.4% is disagreeable because of the sweet, bitter and astringent properties of the substance. One hundred krad reduces the required benzoic acid dose from 1–0.4%. We expect full commercialization of fish fillets and shrimps as soon as these products are unconditionally authorized. The Dutch public health authorities have already authorized the marketing of limited batches.

Finally I would like to mention that marketing trials with prepacked cut vegetables like endive and onions, with soup vegetables and with mangoes will be soon carried out.

The development of irradiation processing in the Netherlands has been considerably facilitated by a sound approach from both industry and public health authorities. It has been given a fair chance and unrealistic emotional feelings and attitudes were suppressed knowing that it would never be in the interest of the consumer to be deprived of a sensible alternative, an alternative which has the potential to improve the hygiene and the nutritional quality of food and which can contribute considerably to prevent the existing great food losses.

Future possibilities

As I stated in my introduction, if hunger is to be prevented and health is to be improved on short notice much more emphasis should be placed on an effective storage and distribution of food, so that the enormous food losses can be reduced.

These food losses are greatest in humid tropical countries where for instance insect pressure is very high. Can food irradiation be helpful here? I think definitely yes.

I will give you two examples:

– the Indonesian government outlined in 1969 a food strategy programme which is implemented with a rice-bufferstock operation in order to stabilize prices and to ensure the income of rice farmers. For that, the Indonesian logistic agency has built in Jakarta alone 196 warehouses, each with a capacity of at least 35 000 tons of rice. Furthermore this agency started to build warehouses all over the country with a total of 1.12 million ton capacity.

The present storage losses, in spite of fumigation treatments, are great, some 20% and more. This means a 5 dollarcent loss for each kg of rice. Irradiation with a low dose of 50 krad sterilizes fully the insects. So if one could package the rice which is imported, in packages of 2–5 kg upon arrival in the harbour, than irradiate and than store the packages in cartons or crates, losses could be totally prevented. The irradiation sterilizes the insects and the packaging material prevents re-infestation.

– In the Philippines they have built in Manila 3 ha of refrigerated warehouses with the aims of stabilizing prices, improving food quality and hygiene, and improving and stabilizing farmers' income.

Export of many food commodities would be facilitated if the shelf life could be increased, if the Salmonellae and insects could be eliminated and if sprouting could be completely suppressed. The irradiation process, together with refrigerating facilities in the food terminal, would reduce the food losses considerably, especially with respect to fish, fruits and onions.

I could easily extend these examples with many others. But it suffices to say that nobody has ever challenged the large potential of the irradiation process for reducing food losses, especially in the developing countries. On the contrary, the unfavourable climatic conditions and the limited energy resources in the poor countries do urge for a widespread application now. The implementation of the expert panel recommendations will also open the way for international distribution. And if the Netherlands and other developed countries do find it profitable, both from an economic and a health point of view, to apply this process, how much more could this technology be profitable for the developing world with its ever-growing food shortages.

I find it both from a socio-economic and a humanitarian point of view not only justified but necessary to apply this new technology as soon as possible.

My country is willing to contribute to that goal and has offered the facilities and know-how of the pilot plant for food irradiation at Wageningen to foster through development and training the practical application of this process in order to enhance world food supplies, and to improve the hygienic quality of foods.