improving on appert

Increasing crop yields and animal
production requires a varied technology,
involving plant breeders,
soil scientists, entomologists, plant
pathologists, animal physiologists,
veterinarians and so on through a seemingly
endless list.
When food has been produced there are
problems in storage and processing.
Losses in storage alone are enormous.
But there is not one major field of
agriculture or food science where isotopes or
radiation cannot be used either to improve
production or, more often,
to carry out research,
treatment or processing hitherto impossible.
There has been steady progress in the
application of nuclear techniques in all fields
of food and agriculture —
in some consolidation and refinement,
in others the development of new ideas.

One such new idea is that of using radiation to extend the storage and/or market life of certain foods. This concept has been described as the only novel development since the invention of food canning by Nicholas Appert about 150 years ago. Food in cans is a boon to housewives (and bachelors) throughout the world; but many foods cannot be packed in cans — and, in any case, the processes involved in canning render the foods involved instantly distinguishable in most cases from the fresh, natural product. Food irradiation promises not to displace canning, but rather to supplement it as a means of reducing losses through spoilage and extending market areas.

Food products may be irradiated for a variety of purposes. One, which could become extremely important, is disinfestation of stored grain. Insects are a constant drain on the world's resources. During the 1950s it became apparent increasingly that ionizing radiation might be used to destroy insects in grain more effectively than chemical techniques, and with no harmful residues or changes in the product itself. Research workers showed that quite low doses of radiation were sufficient to kill adult insects, or to sterilize them, to prevent insect eggs present in grain from hatching, to prevent insect larvae from completing their life cycle. Some experts conceive it to be possible that insects of the varieties which do infest grain might develop resistance to radiation after being exposed to it for several generations; but since the treatment is one which will either kill the insect or render it sterile no new generation can in theory develop to transmit the genetic basis for resistance. With some chemical insecticides sub-lethal application results in increased resistance to the chemical, and types of insecticide are frequently changed in order to maintain control of the insects.

The use of radiation for grain disinfestation was first approved as a technique in the USSR in 1959. There, as in other countries which have since approved the technique, the radiation source used is Cobalt 60, and the dose is in the range of up to 75 kilorads (the greatest dose permitted, in Canada). Clearance of the use of radiation for this purpose is at present severely restricted; but there is a vast international trade in food grains. If irradiation is to become a widely used technique in exporting countries, importing countries must be willing to accept the treated grain and, more, do so on a basis which is consistent. Industry cannot tailor-make one shipment to the specific requirement of one country, and the next to a different requirement for a second country.

The scope of the art

Disinfestation is only one of a wide range of purposes for which food irradiation may be used. The power of ionizing radiation may also be directed against bacteria, yeasts, and moulds responsible for food spoilage, against sprouting in vegetables such as potatoes, and against bacteria and other pathogenic organisms which, while they do not themselves spoil food, are dangerous to human health. Additionally, varying doses of radiation may be used to attain varying end-points: use to destroy animal parasites in meat products, or micro-organisms capable of causing food poisoning or of spreading infectious disease is known as radicidation. The partial destruction of microbes — pasteurization by radiation — slows down spoilage and prolongs storage life for some time; the total destruction of bacteria, yeasts and moulds, combined sometimes with mild heat treatment to inactivate enzymes and with packaging to prevent re-infection with microbes, can stabilize a food product permanently. This last process, borrowing from the name of the inventor of food canning, is known as radappertization; it requires the use of radiation in large doses.

Relatively low doses of radiation may arrest or slow down natural processes of fruit ripening and vegetable sprouting, by altering the metabolic rate of the product. This was the first application of radiation

IRRADIATED FOOD PRODUCTS CLEARED FOR HUMAN CONSUMPTION IN DIFFERENT COUNTRIES

Country	Product	Purpose of irradiation	Radiation source	Dose (permis-sible range) (krad)	Date of approval
CANADA	potatoes	sprout inhibition	Cobalt 60	10 max. 15 max.	9 Nov. 1960 14 June 1963
	onions	sprout inhibition	Cobalt 60	15 max.	25 Mar. 1965
	wheat and wheat products	insect disinfestation	Cobalt 60	75 max.	28 Feb. 1969
DENMARK	potatoes	sprout inhibition	10 MeV Electrons	15 max.	27 Jan. 1970
HUNGARY	potatoes (experimental batches)	sprout inhibition	Cobalt 60	10	23 Dec. 1969
ISRAEL	potatoes	sprout inhibition	Cobalt 60	15 max.	5 July 1967
	onions	sprout inhibition	Cobalt 60	10 max.	25 July 1968
NETHERLANDS	asparagus (experimental batches)	pasteurisation	Cobalt 60	200 max.	7 May 1969
	cacaobeans (experimental batches)	disinfestation	Cobalt 60 4 MeV Electrons	70 max.	7 May 1969
	strawberries (experimental batches)	pasteurisation	Cobalt 60 4 MeV Electrons	250 max.	7 May 1969
	mushrooms	pasteurisation	Cobalt 60 4 MeV Electrons	250 max.	23 Oct. 1969
	potatoes	sprout inhibition	Cobalt 60 4 MeV Electrons	15 max.	23 Mar. 1970
	shrimps (experimental batches)	pasteurisation	Cobalt 60 4 MeV Electrons	50—100	13 Nov. 1970
	spices (experimental batches)	radicidation	Cobalt 60 4 MeV Electrons	800—1000	1970
	onions (experimental batches)	sprout inhibition	Cobalt 60 4 MeV Electrons	15 max.	5 Feb. 1971

Country	Product	Purpose of irradiation	Radiation source	Dose (permissible range) (krad)	Date of approval
SPAIN	potatoes	sprout inhibition	Cobalt 60	5—15	4 Nov. 1969
UNION OF SOVIET SOCIALIST REPUBLICS	potatoes	sprout inhibition	Cobalt 60	10	14 Mar. 1958
	grain	insect disinfestation	Cobalt 60	30	1959
	dried fruits	insect disinfestation	Cobalt 60	100	15 Feb. 1966
	dry food concentrates	insect disinfestation	Cobalt 60	70	6 June 1966
	fresh fruits and vegetables (experimental batches)	pasteurisation (extension of market life)	Cobalt 60	200—400	11 July 1964
	semi-prepared raw beef, pork and rabbit products, in plastic bags (experimental batches)	pasteurisation	Cobalt 60	600—800	11 July 1964
	poultry eviscerated, in plastic bags (experimental batches)	pasteurisation	Cobalt 60	600	4 July 1966
	culinary prepared meat products (fried meat, entrecôte), in plastic bags (experimental batches)	pasteurisation	Cobalt 60	800	1 Feb. 1967
	onions (experimental batches)	sprout inhibition	Cobalt 60	6	25 Feb. 1967
UNITED STATES	wheat and wheat products	insect disinfestation	Cobalt 60	20—50	21 Aug. 1963
			Caesium 137	20—50	2 Oct. 1964
			5 MeV Electrons	20—50	26 Feb. 1966
	white potatoes	sprout inhibition	Cobalt 60	5—10	30 June 1964
			Caesium 137	5—10	2 Oct. 1964
			Cobalt 60 and Caesium 137	5—15	1 Nov. 1965

processing of a food product to be approved by a national authority — again, in the USSR, in 1958, where potatoes treated in this way against sprouting were cleared for human consumption.

There are a number of technical problems in this work still to be solved. Sometimes the use of radiation on a particular product may cause changes in colour, flavour, odour or texture — not in themselves harmful, but possibly unsettling to the consumer! Also, radiation sources are not cheap, and radiation processing of food products may be economically viable only if undertaken on a large scale.

Is it safe?

In nearly every country there is legislation which forbids the sale for human consumption of any processed food unless it is demonstrably wholesome, safe for consumption and does not consist of inferior material. The processor of any food must therefore show that the products he manufactures meet the requirements of such laws. Irradiated food is not excepted from this condition; and, since the concept is comparatively new, irradiated food is being subjected to studies far more stringent than those made in relation to older, "conventional" means of food preservation.

This was the genesis of the "International Project in the Field of Food Irradiation," established formally on 1 January this year. Organizations in 19 countries are taking part in a study concerned mainly with the wholesomeness testing of food products treated by irradiation; $225 000 a year for up to five years has been budgeted for this work. The project has been launched jointly by the European Nuclear Energy Agency of the OECD (ENEA) and the IAEA together with FAO; the World Health Organization is taking part in an advisory capacity.

The main inspiration for this project was the magnitude of the research required to establish wholesomeness data derived from feeding studies using a variety of test animals. The research itself is being conducted under contract in specialized laboratories in member countries of the OECD, IAEA and FAO, co-ordinated by a small central body and under the direction of a project leader at the Federal German Institute for Food Preservation, at Karlsruhe. The simple establishment of this project, on such a scale, may be read as an affirmation of confidence in the potential value of food irradiation as a new technology. Hopefully, the results obtained will result in the development of similar standards for approval by the various national health authorities and thus encourage international trade in irradiated fresh and processed foods by the participating countries and possibly by others as well.

Prime beneficiaries, in the end, are likely to be developing countries — some of which already have food irradiation study programmes. A case in point may be demonstrated by the Indian experience so far. There, studies have been made of the irradiation of Bombay duck (*Harpodon nehereus*), shrimps (*Metapenaeus Sp.* and *P. Stylifera*) and pomfrets (*Stromateus cinereus*). The income from fisheries in India in 1966 — the latest date for which figures are readily available — was estimated at $80 million, with annual foreign exchange earnings of more than $17 million. Within this market freezing and canning processes have made great advances in recent years, but domestic trade has suffered from the difficulty of transporting fish products from the coast to markets inland. These studies, as reported to an IAEA conference some months ago, showed that radiation processing of fish products in that country, if approved, "can be expected to result in considerable savings... by centralization of filleting operations as well as reduced waste and distribution costs. Irradiated fish fillets with their increased shelf life would allow regular and less frequent deliveries to the retail shops and offer significant prospects, especially for transportation from coastal regions to consumer centres".

In the initial stages of the International Project, work is being concentrated mainly on the testing of irradiated potatoes, wheat and wheat products for wholesomeness, with a view to obtaining unconditional acceptance of these products. A temporary clearance for five years was recommended by a joint FAO/IAEA/WHO expert committee in 1969. Clearly, the work could take some time, but the potential benefits are immense.