RADIATION DISINFESTATION OF GRAIN

At least half the total annual output of wheat, barley and maize in the world is produced in countries which have bulk storage and handling facilities for all or an appreciable part of their stocks. This proportion is increasing with economic development and the installation of more modern systems of grain handling. However, about one-third of this grain is infested and much of it has to be treated to prevent complete deterioration, especially in tropical or sub-tropical areas.

Since in many countries, even in highly developed ones, large volumes of grain are destroyed yearly by insects (the loss of wheat totals nearly 300 million dollars in the United States alone), effective methods of insect control are necessary not only to prevent loss of food but also to keep it clean and pure. In addition, there is a need for preventing the spread of insects in grain moving in international trade.

Recent work shows that ionizing radiation is a promising new tool for insect control and can supplement the existing chemical control measures. Not only does radiation offer a method for complete control of infestation, it may also ensure partial protection against re-infestation through reproductive sterilization. The increasing concern about hazards to health through residual toxicity in chemical methods of control is an additional reason for increasing interest in radiation disinfestation of grain.

A panel of 25 experts from Australia, Germany, France, India, Italy, Sweden, the United Kingdom and the United States as well as from the Food and Agriculture Organization, the World Health Organization and the European Nuclear Energy Agency was convened by the International Atomic Energy Agency in Vienna last May to consider ways of applying radiation to grain handling and insect control, and to make recommendations on the advisability and nature of any future action in this field. Among other subjects, the panel discussed the use of electron accelerators and gamma radiation for grain disinfestation as well as problems of radiation entomology and wholesomeness of irradiated grain.

Panel Discussions

The use of electron accelerators producing up to 30 kilowatts of radiation power and capable of processing over 300 tons per hour was discussed by M.G. Kelliher (United Kingdom), K.H. Morgenstern (USA) and E. Young (USA). They reported that three possible accelerator types should be considered for the grain disinfestation process. These are the linear accelerators, the medium energy high current accelerators, and the low energy high current accelerators.

D.E. Wiant (USA) summarized the work done at Michigan State University with electron accelerators both on grain insects and on wheat and wheat products.

The case for cobalt-60 sources for the treatment of grain was presented by another American scientist, L.E. Brownell. He pointed out that one of the advantages of gamma radiation is that it penetrates the grain completely and would therefore be very effective in treating the insect eggs. In warm climates the reproduction of insects is more rapid and treatment with toxic fumigants may be required several times per year. In such cases, a single treatment with gamma radiation followed by storage in insect-proof containers could be economical and satisfactory. If treated with gamma radiation and stored in insect-proof steel elevators, which should be ventilated for the control of temperature and humidity, large quantities of grain may be stored for indefinite periods of time in warm and tropical climates. Professor Brownell, however, pointed out that for a single treatment the use of gamma radiation would be more expensive than the use of chemical fumigants, but if more than two fumigations were required during storage of the grain, the irradiation process could be more economical.

K.K. Nair, of India, gave an account of some of the work being done at the Indian Atomic Energy Establishment at Trombay on the effects of gamma radiation on insect pests. He reported, for example, that in experiments with the Khapra beetle, a major pest of stored grain in India, it had been observed that the sterilizing dose for the male was more than 150 per cent higher than for the female. Data obtained from experiments with rice weevil indicated that total mortality resulted in two weeks after irradiation. As

A modern grain storage facility, with a total capacity of 45,000 tons, at Latakia, Syria. The IAEA panel considered that such facilities would be suitable for the installation of radiation equipment for the disinfestation of grain

regards sterility, even after two months no fresh emergence had been observed in any of the treated groups.

Two British scientists, F. Jefferson and F. Rogers, discussed the factors which influence the choice of method - the use of cobalt-60 sources or electron machines - in the radiation processing of grain. Mr. Jefferson also mentioned the analogy between the present development of radiation disinfestation of grain and that of the sterilization of sutures and other medical supplies by electron machines. The latter is now in use by commercial companies.

Another British scientist, P.B. Cornwell, pointed out that the contribution of entomological research to the application of ionizing radiations for disinfestation of grain was to provide the necessary data on which to base proposals for plant design and estimates of cost. Entomological research has the following important functions:

- to evaluate the minimum effective dose level for industrial application and to indicate the accuracy of such a figure;

- to indicate what possible factors encountered in practice are likely to reduce the efficacy of the evaluated dose;

- to indicate the outcome of deliberately or accidentally using a dose below the evaluated level;

- to provide information on the degree of tolerance required for dose uniformity during irradiation; and

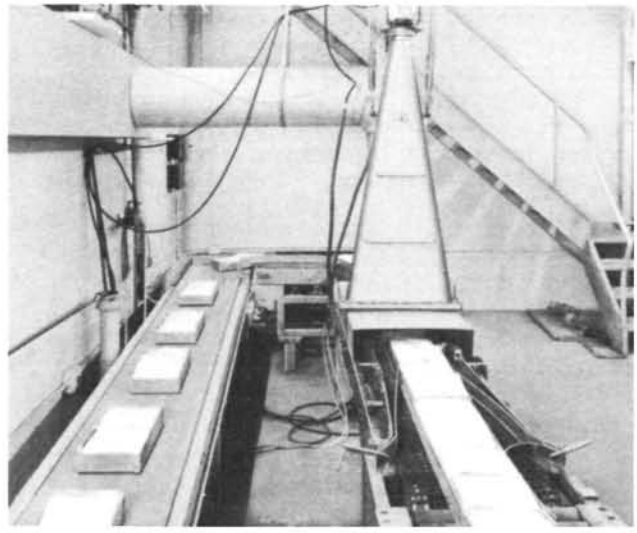
- to compare the merits of toxic chemicals and sterile sperm as insecticidal agents.

F.J. Ley, also of the United Kingdom, presented and discussed some information on the nutritive value and possible toxicity of irradiated food, with particular reference to grain. He said that data available from animal feeding studies on cereals, using rats, mice, dogs, poultry etc., suggested that there was no hazard from the consumption of cereals irradiated at the dose level required for grain disinfestation. Nor did this dose impair to any significant extent the nutritive value of cereals with respect to carbohydrate, protein and vitamins.

Conclusions and Recommendations

After reviewing the present state of knowledge regarding radiation disinfestation of grain, the experts unanimously agreed that pilot plant operations be initiated as soon as practicable in order to evaluate the use of irradiation plants under practical conditions in their entomological, engineering and economic aspects.

The experts pointed out that irradiation processing offered immediate promise for treatment of grain as a complement to existing methods. They noted that there would be some delay before a number of entomological problems would become apparent and recommended that research effort be directed towards



Electron accelerators are now in commercial use for the sterilization of medical supplies. Picture shows high voltage electron beam processing of packaged materials passing under the radiation source

solving certain fundamental problems related to the proposed pilot plant projects; such as rapid methods for differentiation between sterile insects and normal ones; study of the metabolism of irradiated immature stages of insects in relation to the heating of treated grain; research into possible induction of radiation resistance; irradiation susceptibility of insects which show resistance to conventional insecticides; and study of methods of sensitizing insects to irradiation damage.

It was also pointed out that the distribution of irradiated food for human consumption was controlled in most countries under present legislative procedures, and no country had yet approved radiation treatment of cereals. The experts recommended that countries in a position to submit evidence to their appropriate authorities regarding the wholesomeness of irradiated cereals should be encouraged to do so as soon as possible. Further research in this field, particularly with reference to the effect of low doses on vitamin content, should be also encouraged. It was also recommended that IAEA, FAO and WHO should jointly further the expert appraisal of evidence concerning the wholesomeness of irradiated food, with particular reference to grain.

Regarding the engineering aspects of irradiation pilot plant projects, the experts noted that the process could be automated and operated safely. Electron accelerators and cobalt sources could be used for all the throughput rates utilized in most conventional grain handling installations. The experts recommended that, for a pilot plant study, electrical machines with electron energy in the range of 2 - 4 MeV to achieve uniformity of dose deposition and simplicity of grain handling for the throughput rate of 100 - 200 tons of grain per hour be used. For the throughput rate of

20 - 40 tons per hour, they recommended cobalt-60 sources, with which it is possible to achieve a radiation efficiency of 50 - 70 per cent.

Discussing possible locations of pilot plants the panel thought that they should, if possible, be incorporated into existing or projected elevators for use by commerce or government. They should be situated in countries where there is a need for the treatment of a high proportion of grain passing through the elevators and where there are at least minimum facilities for entomologists and engineers who will be concerned with the evaluation of the pilot plants in operation. Tropical and sub-tropical areas, it was noted, seem especially suitable for such pilot plants.

A SURVEY OF ATOMIC PROSPECTS IN TEN COUNTRIES

During April, May and June this year, an IAEA mission visited nine countries in Africa and one in the Middle East to study their prospects, plans and activities for atomic energy applications and to assess their needs for assistance from the Agency. * This preliminary assistance mission, which was the ninth of its kind to be sent out by the Agency, went to three countries in East Africa, namely Kenya, Tanganyika and Uganda; to three countries in West Africa, namely Cameroun, Gabon and Togo; to three other African countries, namely the Congo (Léopoldville), Ethiopia and Madagascar; and to the Lebanon.

In all these countries, the Agency team held extensive discussions with the national authorities, collected information on their plans or activities in the atomic energy field as well as on subjects that may have a bearing on the prospects of atomic energy applications, gave them such advice on the spot as was needed, and assisted them in formulating requests for Agency assistance for implementing their atomic energy programmes. The mission's reports on its visits will not only help the Agency in dealing with such requests, but serve generally as reference sources regarding the conditions and prospects in these countries for the development of atomic energy for peaceful purposes.

Some of the information contained in these reports, which is likely to be of wide interest, is summarized in this article.

* *The mission was composed of five members of the Agency's staff (Mr. John C. Webb, of the Division of Technical Supplies, who led the mission; Dr. H.T. Daw, of the Division of Health, Safety and Waste Disposal; Mr. M.M. de Orival, of the Division of Reactors; Mr. O.E.S. Lloyd, of the Division of Economic and Technical Assistance; and Dr. A. Trofimenko, of the Division of Exchange and Training) and two outside experts (Dr. J.F. Goetz, of Tauernkraftwerke A.G., Salzburg, Austria; and Dr. B.D. Mayberry, Head, Department of Horticulture, Tuskegee Institute, Alabama, USA).*

THREE EAST AFRICAN COUNTRIES

Raw Materials

Prospecting for uranium and other nuclear raw materials in Kenya has been carried on intermittently since 1948. The work has included some aerial surveying and an extensive car-borne scintillometer survey, but no deposits of economic significance have been located, except for a deposit of pyrochlore, north of Mombasa, which might be regarded as a potential source of niobium.

Tanganyika has a well-staffed and well-equipped mining and geological service, the main activities of which are at present devoted to the continuation of geological mapping and exploration of any mineral indications found in field work. No significant uranium discoveries have yet been reported but the Agency mission felt that this should not be taken as implying that radioactive minerals and other nuclear materials do not exist in Tanganyika. The geology of the country suggests favourable conditions which would warrant detailed study at the appropriate time. The mission noted the existence of a large deposit of pyrochlore in Tanganyika and the research being done to develop a process to extract niobium from this source.

Uganda occupies an important place in nuclear raw materials production by virtue of its expanding production of beryl ore and the projected production of niobium from pyrochlore. Beryl production is expected to exceed 1000 tons this year. The exploitation of large deposits of leached carbonatite soils near Tororo is about to begin, with the primary objective of producing fertilizer from apatite. The pyrochlore tailings from apatite flotation will be treated for the recovery of niobium oxide, the expected annual production of which will be 80 tons of marketable concentrates. No uranium deposits have