in the depression of DNA synthesis in *in vivo* studies of local radiation over a dose range of 94–1,500 rads and a dose rate range of 1·6–300 rads/min. The most pronounced effects of radiation occur during the first few minutes (3·75). Depression of DNA synthesis occurs at total dose (94 rads) equivalent to the D_{37} dose for cell survival for mammalian cells. The process of DNA synthesis is not radio-resistant when the three parameters, (*a*) total dose, (*b*) dose rate and (*c*) duration of radiation, are taken into consideration.

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Toxic Effects of Irradiated Foods

THE report by Holsten *et al.*[1] on the direct and indirect effects of radiation on plant cells has produced many comments in both popular and specialist scientific journals. These comments, however, were not brought about by the results reported, as similar data were published earlier (see work referred to in ref. 1). Instead, they arose owing to the statement "The work has other and obvious implications for the radiation sterilization of food . . .".

Cook and Berry[2], and also Goldblith[3], recently rejected the suggestions that the findings by Holsten *et al.* have such implications for the radiation preservation of food. Cook and Berry first imply that eventually radiation-produced toxic substances can be of no biological hazard to man as the doses which are responsible for any observable indirect effect by the growth medium are much higher than the doses which cause cell death when cells are directly irradiated.

Secondly, Cook and Berry and Goldblith also imply that the difference between a plant cell system and an animal is so great that any agent which affects the former cannot be operative in the latter system. They recommend that the wholesomeness of irradiated food should be evaluated only from results of birth-to-death investigations of animals.

So far, there is no evidence that any class of compounds which results in cytogenetic or cytotoxic changes (for example, mutation, cancer, chromosome aberrations) is only operative in one type of cell but not in another. On the contrary, it has been suggested that plant cells should be used to test chemicals for cytotoxic and cytogenetical effects[4].

Ingested toxic substances do not necessarily have to pass and be absorbed from the gastro-intestinal tracts in order to be hazardous; it is instructive to learn from Bailey and Dungal[5,6] that there may be a positive correlation between gastric carcinoma and ingestion of smoked food. Recent investigations have revealed that irradiated food can cause a slight, age-dependent lymphopenia in rats and also possibly an effect on the thymus[7,8], thus indicating that reactive, radiation-induced compounds can perhaps by-pass the detoxification process in animals.

It has repeatedly been stated that no other method for food preservation by additives (the 'additives' are formed *in situ* in the case of irradiation) has and is being scrutinized as thoroughly as that by radiation. However, there are good reasons for this, as (*a*) for irradiation the 'additives' are largely unknown and are likely to remain so for a long time; (*b*) the additives are not the same in any two different foods owing to the different radiation chemical reactions; (*c*) the amount of additives given in a feeding test cannot be increased beyond a certain value, limited by the ingested amount of food and the non-linear dose dependence of most radiation chemical yields at higher doses.

Most chemical food additives can be tested at concentrations 100 or 1,000 times greater than those technically necessary and thus an acceptable safety factor can be attained. There are two possible ways of avoiding the dilemma regarding the safety factor for irradiated food.

(1) Each food could be prepared exactly as it would be for human consumption and then tested on a large number of animals for a long time. If, for example, none of a test group is found to be affected in any harmful way by the treatment, this only tells that within a 90 per cent confidence limit 2·3 cases could have been caused by the treatment[9]. In a hypothetical test with 100,000 animals the true frequency will be $2{\cdot}3 \times 10^{-5}$ with the chosen confidence limit[9]. So far, not more than 1,000 animals have been investigated thoroughly after feeding with any single, tested and cleared, irradiated food[10]. This means that the true frequency of possibly deleterious effects could be as high as $2{\cdot}3 \times 10^{-3}$ at a 90 per cent confidence limit.

(2) More easily scored systems, such as cytotoxic investigations of plant cells and cell cultures *in vitro*, could be resorted to as a primary step towards the evaluation of the eventual wholesomeness of an irradiated material[4,11]. Foods passing these primary tests can then be investigated on 'large' numbers of animals—'large' as the available resources for each food might increase with the decrease in the number of foods likely to be thought worthwhile to test on animals. For example, genetical and teratogenic effects require the development of more elaborate methods accompanied by proper statistical treatment of data. (It is worth mentioning in this connexion that the thalidomide disaster might have been prevented if an easily performed investigation of possible cytotoxic effects in plant cells had been made[12] and if the validity of plant cells in such a test had been recognized.)

It must indeed be acknowledged that any compound causing cytogenetical or cytotoxic damage must be considered a potential hazard to any living cell or cell system—including man.

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