REACTION PRODUCTS

model.

Comment

The imprecision and irreproducibility of results for *in vivo* rabbit eye tests is likely to preclude exact correlation with *in vitro* data; this difficulty must hamper the verification of any alternative to the Draize test. It is also inevitable that the desire to avoid using animals unnecessarily will, ironically, slow down the verification process. Predictably the development of alternative tests is proving far from simple. None of the approaches considered above has yet reached a stage where they can either be of widespread practical value or be totally dismissed.

[M.A. Gray]

IRRADIATED MANGOES

Most of the doubts about food irradiation have now been dispelled and all foods irradiated to a dose of 10 kGy (1 Mrad) have been declared fit for human consumption by a Joint FAO/International Atomic Energy Agency/WHO Expert Committee (BIBRA Bull. 1983, *22*, 260). Among many tests performed on a variety of foods in the last decade, animal studies carried out by the International Food Irradiation Project have shown the safety of irradiated subtropical fruits such as mango and papaya (Report R51, 1979). With an eye on the implications for preserving mangoes by irradiation, Niemand *et al.* (J. agric. Fd Chem. 1983, *31*, 1016) have recently attempted to clarify the behaviour of irradiated one-component sugar solutions in short-term mutagenicity tests since there have been various results indicating their mutagenicity or cytotoxicity.

Salmonella typhimurium strains TA1535, TA1537, TA1538, TA98 and TA100 were used in the Ames assay to test 1% (w/v) solutions of the major sugars present in subtropical fruits (glucose, fructose, sucrose and maltose) and of ribose. The solutions were subjected to various doses of γ-radiation at a rate of 16.64 kGy/hr at 25°C. Each solution was tested in the absence of oxygen (degassing achieved by use of an ultrasonic water bath) and under conditions of oxygen saturation (oxygen bubbled through solution during irradiation). All the solutions were mutagenic to strain TA100 only, except for the deoxygenated fructose solution which was not mutagenic in any strain. Ranking the oxygenated solutions in order of decreasing mutagenic effect gave ribose > fructose > maltose > sucrose > glucose. The mutagenicity of each deoxygenated solution was approximately 65-85% of the activity of the corresponding oxygenated solution. Addition of catalase (a peroxide-splitting enzyme) to the ribose solution immediately after irradiation did not affect the level of mutagenicity, indicating that the mutagenic effect was not due to the formation of peroxides.

Given that mutagenicity was oxygen-dependent, and that sugar-solution radiolysis products like glucosone and glyoxal are known to be produced in low yields in deoxygenated solutions, Niemand *et al.* (*loc. cit.*) decided to synthesize various radiolysis products and structurally-related compounds, and then test them individually for mutagenicity. [One assumes

that only TA100 was used for these further tests but, unfortunately, the authors identify this strain explicitly only for results with glyoxal and glucosone.] Of six dicarbonyls tested, D-*erythro*-hexo-2,3-diulose showed a high mutagenic response (but was unstable at room temperature) and D-*threo*-pentos-2-ulose (xylosone) and glucosone were also mutagenic. The glucosone response was not altered by testing with S-9 mix. Both of the deoxy sugars tested, 2-deoxyribose and 2-deoxyglucose, have been implicated as carbohydrate radiolysis products (Scherz, Nature New Biology 1968, *219*, 611), but they did not show any mutagenic activity in the present study. Methyl vinyl ketone and crotonaldehyde were tested as examples of α,β-unsaturated carbonyl compounds, and were found to be cytotoxic but not mutagenic. Various cytotoxic α,β-unsaturated carbonyls can be formed in irradiated sugar solutions (Schubert & Sanders, *ibid* 1971, *233*, 199). Finally, glyoxal (ethanedial) showed a dose-dependent increase in mutagenicity, a finding that agrees with previous data from Bjeldanes & Chew (Mutation Res. 1979, *67*, 367).

The study continued with an investigation of the effects of radiation on a subtropical fruit, the mango, and on an artificial model of the fruit. The model was an aqueous solution of the chemical components present in mango fruit, grouped into four classes: organic acids, phenol and lipids, cellulose and starch, and sugars and carotene. It was found to be non-mutagenic in TA100 both untreated and after irradiation. When glucosone was tested in the presence of the mango model at concentrations in excess of the amount that would be found (if formed) in the irradiated fruit, glucosone mutagenicity disappeared. By a process of elimination it was shown that omission of two chemical classes—organic acids and phenol and lipids—allowed the expression of 85% of glucosone's mutagenicity when tested on its own in aqueous solution. Omission of the organic acids had a greater effect than omission of phenol and lipids; the effect of omitting both was additive. Virtually no alteration of pH resulted from omission of the acids, so this was ruled out as an explanation. Examination of Kent mangoes showed that neither irradiated mango juice nor the supernatant prepared from the centrifuged homogenate of irradiated mango flesh exhibited any mutagenicity at either the commercial irradiation dose (0.75 kGy) or at an extreme dose (20 kGy). Glucosone tested for mutagenicity in TA100 in the presence of supernatant from unirradiated mango showed a reduction in activity of roughly 50-65%, compared with glucosone alone in aqueous solution.

The authors conclude that the mutagenic activity of irradiated sugar solutions can be ascribed to 1,2-diketo structures (e.g. those of xylosone, glucosone and glyoxal), although a possible role for α,β-unsaturated carbonyls cannot be totally excluded. It is not clear whether irradiated model mango and real fruit are both non-mutagenic because no mutagenic radiolytic products are formed, or because such products lose their mutagenic potency by reacting with other fruit constituents. However, the results indicate that even if mutagenic compounds are formed by fruit irradiation, they are inactive in the presence of fruit components. The authors emphasize that the yields of any mutagens formed by commercial doses of radiation would be 200-2000 times less than the concentrations used in this study, further demonstrating the safety of irradiated subtropical fruits like the mango.