IRRADIATION AS A POST-HARVEST TREATMENT FOR MANGOES

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Irradiation is used as a post-harvest treatment for a number of fruit types. Research in South Africa on the use of ionising radiation for the control of various problems associated with post-harvest storage of fruit was initiated more than ten years ago. During 1976 research was started at the Atomic Energy Board, as it was then called, on the effect of the process on the various fungal, insect and physiological problems that occurred. Since then, a large store of knowledge has been accumulated.

Fruits examined, range from the various sub-tropical varieties such as mangoes and bananas to citrus. Work in this field has not been limited to laboratory trials but marketing campaigns have been carried out, simulated transport experiments executed and more recently, actual consignments of products have been treated for sale.

More work has been performed on the use of radurisation to control the problems associated with the mango than for any other fruit. It has been shown that the process can delay ripening sufficiently for export by sea to become feasible, that the fungal pathogens can be controlled and that weevil emergence can be inhibited. However, it must be realised that there is no way that any treatment can improve the physical quality of a fruit, and radurisation is no exception to this rule.

Recently mangoes due for export were rejected by the authorities because of blackening. This problem was immediately ascribed to the irradiation treatment. A similar problem arose with a consignment of litchis destined for sale in England, but which was landed in France. In neither case was the blemishing directly due to the processing. It was reported several years ago that the use of TBZ and Iprodione together with irradiation caused unsightly marks on the peel. In the case of the litchis, it was reported by the S.A. Agricultural Union that the blemishing was caused by sulphur. Despite claims that irradiation causes damage to fruit, in none of the instances have these claims been substantiated. In all cases, damage said to have been caused by irradiation has been shown to have been due to other factors.

It has been shown in our experiments involving combination treatments that, for any fruit, the combination treatment must be correctly applied. There is no farmer who would expect to have a successful harvest if he were to, apply the wrong type of fertiliser. Similarly, the use of the wrong fungicides is to be shunned.

At Pelindaba, trials were carried out to examine the effect of different fungicides when applied in combination with irradiation. Success was attained using some of the more common systemic fungicides such as Benomyl and Iprodione, and it was suggested that these products be used. The use of untested fungicides is not recommended as the effect of irradiation in the presence of these products in unknown.

It is well known that irradiation alone is not sufficient to inhibit the development of all the pathogens resident on the mango. Use of other treatments in combination with irradiation can create a synergism in which the effect of the combination exceeds the sum of the effects of the treatments applied alone. In this category there are important treatments *viz.* heat and fungicides. The use of a hot fungicide dip (Benomyl and Iprodione) followed by irradiation was shown in our early experiments to reduce decay caused by fungi from approximately 70% to around 20% after a four week storage period (Brodrick and Thord-Gray, 1982). Using this treatment, no damage was caused to the fruit. Preliminary trials on other fungicides were carried out; none, when used in conjunction with irradiation, had the same beneficial effects as Benomyl and Iprodione. For this reason, trials on the fungicides were halted.

With passing time, however, new fungicides have come on the market, and some of the old ones have been improved. Before these products are used in combination with irradiation, both laboratory and larger scale trials

should be carried out. Fungicides which have not been tested should not be used as their use would probably lead to an unacceptable result.

The need for research is also immediately apparent when one considers the damage caused by insects. Weevil damage is most common in the late mango cultivars. At present, however, there is little understanding of the factors involved in weevil emergence, particularly those related to fruit maturity. Before treatment is applied, it must be known whether the weevil has emerged or not. It is of no use to irradiate the fruit after the weevil has emerged from the pip, as no treatment can reverse the damage that has been caused. Ongoing research into the weevil problem in the various cultivars is thus essential, and the results of this research should be incorporated into guidelines, which should be adhered to by the producer, distributer and the Irradiation Processing Plants, and which should specify how to sample a consignment to determine whether the process should be applied to control this pest.

It is essential to consider the aspect of quarantine. With the banning of ethylene bidromide for the disinfestation of citrus, in the United States, and the increasing pressure world-wide for a reduction in the use of chemical preservatives, the use of irradiation is becoming increasingly attractive. In a recent visit to Australia, it was pointed out that there is an embargo on South African sub-tropical fruit due to insect pests such as the False Codling Moth. Fruit fly in the mango can also be a problem for overseas importers wishing to sell South African fruit. High energy treatment results in disinfestation without chemical residues being left on the fruit.

Physiological aspects are also of great importance. In an attempt to develop a treatment that would allow export by sea, different irradiation and storage conditions were examined. One of the major obstacles at present in the sale of mangoes overseas is the price. This is due more to the cost of airfreight than the cost of the fruit itself. Reducing the cost of transport would bring down the retail price of mangoes in Europe, resulting in higher sales and thus greater profits for the producer. The only practical way of reducing transport costs is to move away from airfreight and to export by sea. The main problem is that the fruit has to last for up to four weeks from the time of picking. Use of irradiation in conjuction with low temperatures can give this sort of shelf-life due to the fact that the process inhibits and retards fruit maturation (Brodrick *et al*, 1983). However, there are a number of factors that have to be recognised. Firstly, the maturity of the fruit at picking is of critical importance. Irradiation is a process that effects fruit development. Work should thus be carried out to determine whether the normal, green stage is the best for picking of fruit destined for irradiation treatment. Secondly, irradiation does affect colour development, and it must be realised the green colour does not necessarily mean that the fruit is not ripe.

Physiological problems of the mango such as jelly pip must also be considered. It has been reported that this problem is related to a calcium shortage. However, this can only be rectified by supplying the element to the tree before the flower set. Since irradiation cannot improve this condition, good quality fruit is essential if shelf-life extension is desired.

These four aspects show the complexity of producing a top quality fruit. One often hears "The work has been done. Why keep repeating it?" As new cultivars are introduced, new fungicides brought on the market and new techniques investigated, research into the effects of these factors needs to be carried out. At the present time there is a dearth of knowledge in the entomological problems associated with sub-tropical fruit. With the increasing resistance world wide to the use of chemicals in the hygienisation of fruit, the use of high energy radiation is becoming more important. However, the effectiveness of the treatment can only be emphasised by ongoing research.

A set of guidelines could assist both the processor and the producer. The following table could be used as a skeleton around which such a set of guidelines could be produced.

Development of such a guideline (Table 1) should be carried out, not by academic institutions alone, but by a committee with members drawn from all facets of the mango industry. Such a document would be effective in improving fruit quality, and in this way fruit will reach overseas markets in good condition, resulting in a higher turnover and increased profits.

TABLE 1. Brief guidelines for the irradiation of mangoes

1. Fruit quality

Fruit to be treated by radurisation should be:

Free of physiological disorders such as jelly pip
Free of weevil in the flesh

2. State of picking

Cultivars should be picked according to the specifications recommended by the Department of Agriculture

3. Combination treatment

Fruit should be treated with a hot water dip (55^{0}C for 5 minutes) or a hot fungicid dip. Only recommended fungicides should be used.

After drying and cooling, fruit should be waxed with one of the recommended fruit waxes.

After drying of the wax, fruit should be irradiated to an average dose of 0.75 kGy within 24 hours of the heat treatment.

4. Post irradiation storage

Fruit should be stored at 10-11^{0}C.

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