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PRELIMINARY STUDIES ON THE PRESERVATION OF FALSA (GREWIA ASIATICA)

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Abstract. Some effects of gamma radiation and packing in polyethylene bags were studied on 'falsa'. Fruit packed in polyethylene bags containing $KMnO_4$ developed proper colour and remained in good condition for 5 days (at 25°C) while the condition of conrol fruit deteriorated after 2 days. There was an increase in sugars, while ascorbic acd and acidity decreased during ripening. *Alternaria* sp. and *Helminthosporium* sp. seemedi to cause fruit decay.

'Falsa' being a tropical fruit, is mainly grown in the Indo-Pak subcontinent. Of the two known species of this ruit s i.e. wild (tall) and cultivated (dwarf) the latter is grown in Pakistan and is relished fresh due to its excellent sugar–acid combination. This fruit can be grown on a land considered very poor for raising other crops and, therefore, a farmer gets comparatively good return from its cultivation.

In Pakistan falsa syrup, squash and juice are in great demand during summer as a cold drink since they are most refreshing and delicious. This fruit is highly perishable and gets spoiled within one day after picking. In order to keep this fruit wholesome during transit and storage before processing, it is necessary to study the extension of its shelf life. Since gamma radiation and controlled atmosphere storage have been found to be successful in the extension of shelf life of various fruits and vegetables, [1–8] these treatments were applied to this fruit.

Materials and Methods

'Falsa' at different stages of ripening, i.e. green, turning (fruit showing change of colour from green to pink) and pink was procured from Experimental Fruit Garden of the West Pakistan Agricultural University, Lyallpur. Irradiation of the fruit at turning stage was carried out in gamma beam-150 (Co^{60} source of 950 curie) at 0, 15, 30 and 45 Krads. Irradiated (30 Krad) and control fruit was stored at 25 ± 2°C in wooden boxes lined with polyethylene bags as: (i) without polyethylene package (open); (ii) packed in polyethylene bags only; and (iii) packed in polyethylene bags containing $KMnO_4$ crystals.

Unirradiated 'falsa' was also stored in cold storage at 5°C. Duplicate samples of the fruit were analysed biochemically for ascorbic acid, sugars, acidity and total soluble solids (T.S.S.) at different stages of ripening, immediately after irradiation and after subsequent storage periods. Vitamin C was assayed photometrically by dinitrophenylhydrazine method of Roe and Oesterling.[9] Total sugars, glucose, fructose and sucrose were determined spectrophotometrically using potassium ferricyanide as an oxidizing agent.[10] Acidity and total soluble solids were determined by the method of Horwitz.[11] The T.S.S.–acid ratio in the irradiated and control 'falsa' were calculated using refractometer readings and acidity values. Changes in the ripening trend were recorded by visual observations.

For microbiological studies, turning and ripe 'falsa' after surface sterilization with calcium hypochlorite (0.1%), were suspended in the malt-extract broth maintained at pH 3.0 (which was the pH of the fruit extract). After incubating the broth at 30°C for 2 days, serial decimal dilutions were made and 1 ml was pipetted out in petri plates using pour plate technique with malt-extract agar and Czapek agar having pH 5.0 and 7.0.

Results and Discussion

Visual Observations. Ripening trend during storage at different temperatures and various packaging conditions was similar in both irradiated (0–45 Krad) and control 'falsa'. Radiation in combination with various packing treatments also did not extend the shelf life of this fruit at 25°C. Irradiated and control fruit held open at room temperature (25°C) were spoiled on the second day of the storage. The fruit packed in polyethylene bags in presence or absence of $KMnO_4$ at 25°C, however, remained wholesome for 5 days. Fruit of these treatments were free from microbial attack. The development of colour was relatively better in polyethylene bags containing $KMnO_4$. The reason for this proper development in colour, however, cannot be explained. Fully mature and ripe fruit packed in polyethylene bags and stored in cold room (5°C) remained wholesome for 10 days as compared to the fruit held at room temperature (25°C).

Biochemical Analysis. Results of biochemical analyses of fresh fruit picked from the bush at different stages of ripening are given in Table 1. There was considerable increase in T.S.S. and T.S.S.–acidity ratio and comparatively less decrease in total acidity. Vitamin C decreased from 18.00 mg to 10.75 mg/100g from fully developed green stage to fully ripe pink stage. As regards sugars, there was marked increase in reducing, nonreducing and total sugars as the ripening progressed.

Effect of irradiation (30 Krad) on 'falsa' at turning stage and subsequent storage on different chemical constituents is given in Table 2. It is clear from the data that irradiation did not affect directly or indirectly (during suqubseent storage) various physicochemical

TABLE 1. ANALYSIS OF FRESH FRUIT PICKED FROM THE BUSH AT DIFFERENT STAGES OF RIPENING.

Stage of ripening	Acidity (%)	T.S.S.–acidity ratio	T.S.S. (%)	Vitamin C (mg/100 g)	Glucose (%)	Fructose (%)	Total reducing sugars (%)	Sucrose (%)	Total sugars (%)
Green	2·98	2·79	8·5	18·00	0·17	2·73	2·90	0·15	3·06
Turning	2·54	4·53	11·5	17·50	0·29	3·77	4·06	3·58	7·83
Pink	2·45	6·32	15·5	10·75	0·32	3·93	4·25	3·81	8·26

TABLE 2. EFFECT OF IRRADIATION ON DIFFERENT CHEMICAL CONSTITUENTS OF 'FALSA' DURING STORAGE AND RIPENING AT 25°C.

Storage time (days)	Treatment	Acidity (%)	T.S.S. (%)	T.S.S.–acidity ratio	Vitamin C (mg/100 g)	Glucose (%)	Fructose (%)	Total reducing sugars (%)	Sucrose (%)	Total sugars (%)
0	Control	2·76	11·5	4·16	16·00	0·47	3·59	4·06	3·58	7·83
	Irradiated (30 Krad)	2·76	12·0	4·35	15·75	0·50	3·75	4·25	3·95	8·41
3	Control	2·45	21·0	8·57	8·00	0·50	3·85	4·35	4·96	9·57
	Irradiated (30 Krad)	2·45	20·8	8·49	8·00	0·49	4·00	4·49	4·85	9·57

parameters. But ripening during storage had marked effect and the changes were similar to those observed in case of fruit ripening on the bush. Results pertaining to other radiation levels included in the experiment, i.e. 15 and 45 Krad, were not significantly different from those of 30 Krad treatment. Similar effect of low level irradiation on such biochemical parameters have been reported by various workers on different fruits.[3,5,6,8,12]

Vitamin C was at the highest level in green fruits and it gradually decreased during ripening and senescence. While studying the maturation changes in mangoes, Agnihotri *et al.*[13] postulated that vit C appeared to be synthesized in green chloroplast of the fruit from carbohydrate precursors like D-galactose and was at its peak in the young fruit. Soule and Harding,[14] and Chaudhry and Farooqi[15] also reached the same conclusion.

The decrease in acidity and increase in T.S.S. and T.S.S.–acidr atio during ripening of 'falsa' agrees with the findings of Agnihotri *et al.*[13] Krishnamurthy *et al.*[16] and Wahhab and Khan[17] who studied maturation changes in some other fruits. These workers found that increase in T.S.S. during ripening was due to conversion of starch to sugars and that such changes were also responsible for the ripening of fruits. Decrease in acidity during ripening of 'falsa' may be due to the conversion of organic acids to other metabolites such as alcohols, esters etc. The increase of T.S.S.–acid ratio during ripening may be attributed to the decrease in acidity and increase in T.S.S. As discussed earlier, the increase in sugar contents during ripening of 'falsa' in storage may be due to conversion of starchy material to reducing and nonreducing sugars. Baile[18] also reported that the starchy material of fruits broke up into sugars during ripening. The results of present investigations are thus in line with the findings of these workers.

Microbiological Observations. Microbiological studies were carried out using 4 g each of turning and ripe 'falsa' in 4 ml of malt-extract broth. After incubation of the plates using malt-extract agar and Czapek agar at 30°C, different colonies of microorganisms were subcultured and identified. It was found that the total number of organisms per g of fruit in turning and ripe 'falsa' was about 10^8 and 10^{11} respectively, indicating an increase in microorganisms by 3 log cycles in the ripe fruit. As the ripening of fruit proceeded from turning to ripe stage, the incidence of yeasts increased. The presence of more yeasts in ripe 'falsa' than in the unripe ones may be due to the formation of sugars in the ripe fruit.

TABLE 3. INCIDENCE OF FUNGI IN TURNING AND RIPE 'FALSA'

Fungi*	Stage of ripening	
	Turning	Ripe
Aspergillus niger	4×10^2	4×10^2
Penicillium sp.	5×10^2	5×10^2
Fusarium sp.	1×10^2	1×10^2
Alternaria sp.	2×10^2	1.5×10^5
Helminthosporium sp.	2×10^2	8×10^4

*No. of fungi/g fruit.

The incidence of various fungi in the turning and ripe fruit is given in Table 3. It is seen that in the ripe fruit, *Alternaria* sp. and *Helminthosporium* sp. are predominant and, therefore, it is believed that they may be associated with the spoilage of 'falsa'. Presence of *Aspergillus niger* and *Penicillium* sp. in both turning and ripe fruit indicate that these fungi are mainly soil and aerial contaminants. Malt-extract agar and Czapek agar at pH 5.0 and 7.0 were used to determine whether there was any difference in the number and kind of microorganisms using different media with different acidity. It was found that there was no significant difference in all the treatments used.

Conclusion

Radiation did not extend the shelf life of 'falsa'. However, fruit packed in polyethylene bags remained

in good condition for 5 days at room temperature as compared to the control which decayed after 2 days. Storage at 5°C extended the shelf life of fruit for 10 days. Of the many microorganisms, *Alternaria* sp. and *Helminthosporium* sp. may be associated with the spoilage of 'falsa'.

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References

1. E.C. Maxie, C.F. Johnson, H.L. Rae and N.F. Sommer, Proc. Am. Soc. Hort. Sci., **89,** 91 (1966).
2. R.A. Dennison and E.M. Ahmed, Proc. Intern. Symp. Food Irrad. (Germany), 619 (1966).
3. W.A. Farooqi, M. Ali and A. Muhammed, Food Irrad. Saclay, **8,** 37 (1967).
4. E.G. Hall, Food Preserv. Quart., **28,** 2 (1968).
5. M. Ali, W.A. Farooqi and A. Muhammed, Food Irrad. Saclay, **2,** 1 (1968).
6. M. Ali, A. Sattar and A. Muhammed, Sci. Ind., **6,** 381 (1969).
7. Anonymous, Proc. Nat. Controlled Atmosphere Res. Conf. (Michigan State University, January 27–28, 1969).
8. A. Sattar, M. Ali and A. Muhammed, Food. Irrad. Saclay, **10,** 22 (1970).
9. J.H. Roe and M.J. Oesterling, J. Biol. Chem., **152,** 511 (1944).
10. S.V. Ting, Agr. Food Chem., **3,** 263 (1956).
11. W. Horwitz, Assoc. Offic. Anal. Chemists, Official Methods of Analysis (Bengamin Franklin Station, Washington D.C. 1970), 7th editon.
12. E.C. Maxie and N.F. Sommer, Preservation of Fruits and Vegetables by Radiation, Proc. FAO and IAEA., August 1966, Vienna (1968).
13. S.G. Agnihotri, K.L. Kapur and J.C. Srivastava, Punjab Hort. J., **3,** 286 (1963).
14. M.J. Soule Jr. and P.L. Harding, Proc. Florida Mango Forum, **16,** 13 (1956).
15. T.M. Chaudhry and M.A.R. Farooqi, West Pakistan J. Agr. Res., **7,** 78 (1969).
16. G.V. Krishnamurthy, N.L. Jail and B.S. Bhatia, Food Sci. (Mysore), **9,** 277 (1961).
17. A. Wahhab and A.J. Khan, Pakistan J. Sci., **6,** 124 (1954).
18. J.B. Baile, Advan. Food Res., **10,** 293 (1960).