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The Influence of Molds and Some Storage Factors on the Ascorbic Acid Content of Orange and Pineapple Fruits

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ABSTRACT

The effects of some storage factors—storage temperature, length of storage period and rot development— on the ascorbic acid content of the fruits of orange (Citrus sinensis) *and pineapple* (Ananas comosus) *were investigated. There was a gradual decrease in the ascorbic acid of healthy orange and pineapple fruits as the storage temperature (10°–30°C for pineapple and 5°–30°C for orange), or period of storage, increased. At 0°C and 5°C, especially when the relative humidity was low, pineapple fruits dried up while orange fruits wrinkled at 0°C. Very low levels of ascorbic acid were recorded for both fruits at the two temperatures. More ascorbic acid was lost in infected orange and pineapple fruits than in the healthy fruits. However, no total loss of ascorbic acid was recorded under any variations of each of the storage factors during the present investigation.*

INTRODUCTION

There are high levels of ascorbic acid in Alphonso mango fruits stored for long periods at low temperatures prior to removal to room temperature (RT) for ripening, suggesting possible synthesis under such conditions (Thomas, 1975). Pantos & Markakis (1973) also recorded a decline in ascorbic acid content of artificially ripened tomato fruits during storage at temperatures between 55 and 70°F (13 and 21°C).

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The reports of Ghosh *et al.* (1965) and Srivastava & Tandon (1966, 1968) showed that the complete destruction of ascorbic acid in orange and guava fruits was a manifestation of the infections produced by rot pathogens. Adisa (1983) also recorded a gradual decrease, leading to a total loss, of ascorbic acid in infected pepper fruits.

Earlier observations, obtained from investigations on canned fruits and fruit juices, had suggested that extensive changes, especially in colour and flavour, run parallel to the progressive decrease in their ascorbic acid contents. It is, however, believed that the loss in ascorbic acid of canned juices depends more on storage temperature than on length of storage period. A report of the effects of different storage temperatures, length of period of storage and rot infections on the ascorbic acid content of the fruits of orange (*Citrus sinensis*) and pineapple (*Ananas comosus*) is presented in this paper.

MATERIALS AND METHODS

The ascorbic acid content of the treated pineapple and orange fruits was determined using standard methods (Anon, 1970). The ascorbic acid determination was carried out by the titrimetric method using standard dichlorophenol–indophenol (DCPIP) solution. The DCPIP solution was standardised each day with freshly prepared standard ascorbic acid solution. The effect of temperature on the content of ascorbic acid in the fruits was investigated by storing ripe, freshly harvested fruits in incubators set at 0, 5, 10, 15, 20, 25 and 30°C for 8 weeks. The determination of the ascorbic acid content at each temperature was done after 2 months of storage. The effect of length of storage period on the ascorbic acid content of the fruits was investigated by storing (separately) each of the fruits at 10 and 20°C for 8 weeks. The determination was done every 2 weeks during the storage period. All fruits were subjected to about 92%–95% relative humidity (water soaked cotton wool in polyethylene bags) to prevent their drying up.

The effects of rot infections on the ascorbic acid content of fruits were also investigated. Fresh, ripe orange fruits were inoculated with two drops of a spore suspension (5×10^4/ml) of *Aspergillus aculeatus* Iizuka (IMI 223289) and *Penicillium citrinum* Thom (IMI 223301). Two drops of a spore suspension (5×10^4/ml) of *Ceratocystis paradoxa* (Dade) C. Moreau (IMI 223309) and *Aspergillus flavus* Link ex. Fr.

(IMI 223288) were inoculated on fresh pineapple fruits. Each set of the rot pathogens had earlier been isolated from the fruits. *C. paradoxa* and *A. aculeatus* produced soft rots while *P. citrinum* and *A. flavus* produced dry rots. The control fruits were inoculated with distilled water. All inoculated fruits were incubated at 25°C for 14 days. The ascorbic acid content of the control and rot-infected fruits was determined every 24 h. Four replicates were made for each of the determinations of ascorbic acid and the results were expressed in milligrams per 100 g of fruit.

RESULTS AND DISCUSSION

There were considerable differences in the ascorbic acid contents of pineapple and orange fruits. The orange fruits had lower levels of ascorbic acid than pineapple fruits (Figs 1 and 2). The results of the investigations of the effect of storage temperature on ascorbic acid in

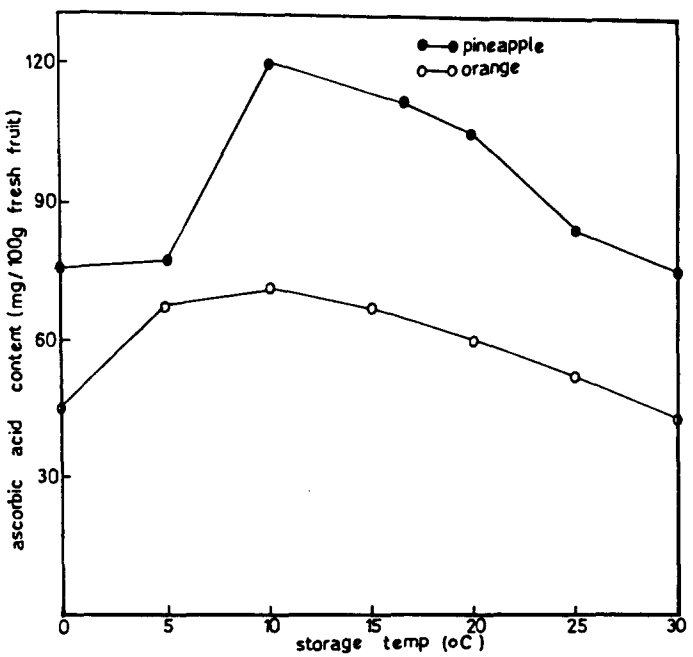

Fig. 1. Effect of storage temperature on the ascorbic acid content of orange and pineapple fruits after 8 weeks' storage. The results are expressed in milligrams per 100 g of healthy fruit and are means of four replicates for each treatment.

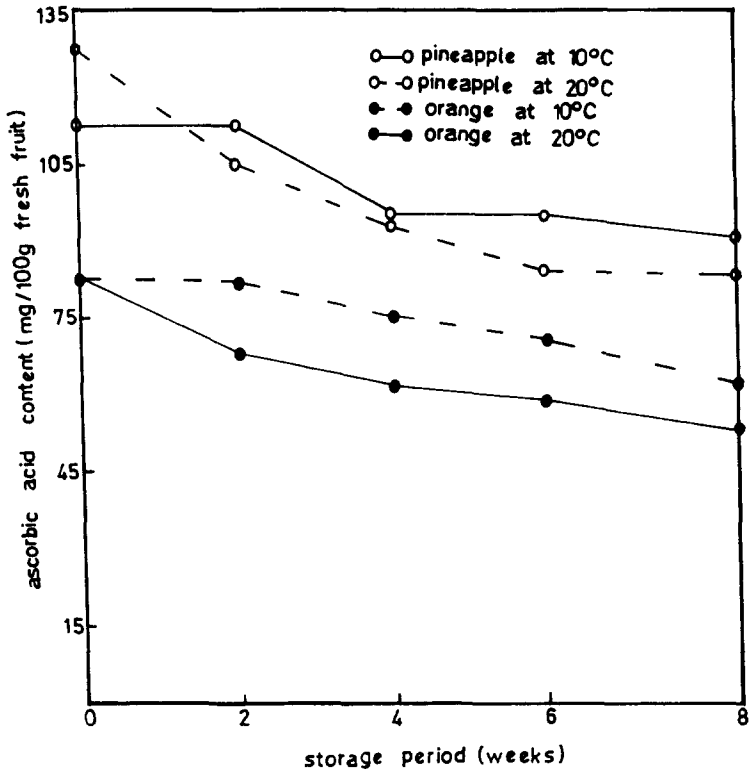

Fig. 2. Effect of storage period on the ascorbic acid content of orange and pineapple fruits after 8 weeks' incubation. The results are expressed in milligrams per 100 g of healthy fruit and are means of four replicates for each treatment.

orange and pineapple fruits showed that, with increase in temperature (10–30°C), the ascorbic acid content of both fruits decreased (Fig. 1) during the 8 weeks of storage. The ascorbic acid contents of both fruits stored at 0, 5, 25 and 30°C were drastically reduced. At 30°C, about 38·3% and 43·6% of ascorbic acid were lost in pineapple and orange fruits, respectively (Fig. 1). Agarwal & Ghosh (1979) observed that, during ripening, the amount of vitamin C in citrus fruits decreases. The loss of ascorbic acid in both fruits depends on the storage temperature rather than on length of storage period (Figs 1 and 2). During the present investigations, there were no significant differences in the losses of ascorbic acid in fruits stored for 8 weeks at 10°C and 15°C (for pineapple) and at 5°C and 10°C (for orange), whereas

about 40% losses of ascorbic acid were recorded in both fruits stored at 30°C for 8 weeks.

Storage temperature had a great effect on the content of ascorbic acid, causing a gradual decline from 10° to 30°C. Pantos & Markakis (1973) reported a similar decrease in the ascorbic acid of tomato fruits between 55° and 70°F (12·8° and 21·1°C). The two fruits used in the current studies showed evidence of drying at 0°C and 5°C with a subsequent reduction of ascorbic acid. The chilling effects might have left pitted surfaces on the fruits. Although Thomas (1975) suggested synthesis of ascorbic acid at low temperatures, Duckworth (1966) proposed bruising and mechanical damage as contributing factors to the loss of ascorbic acid via oxidation. The investigations of the effect of rot development on the content of ascorbic acid in orange and

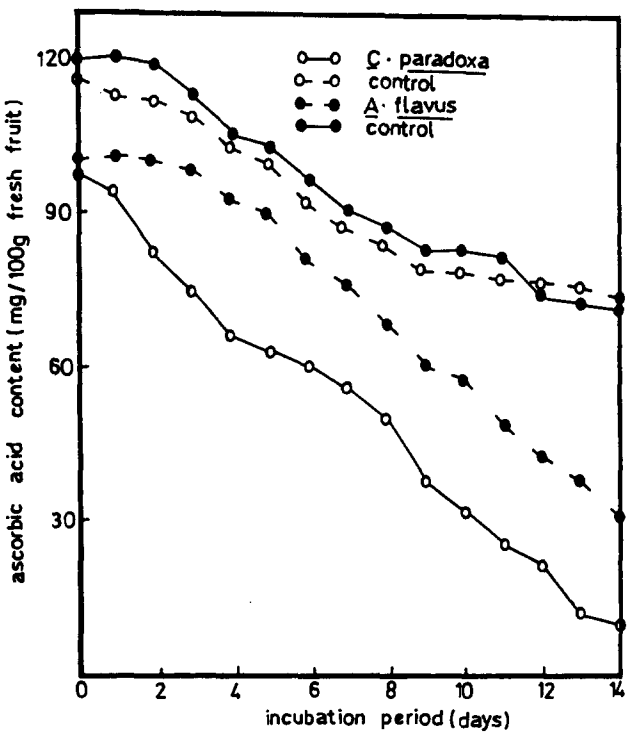

Fig. 3. The effects of rot infections caused by *Ceratocystis paradoxa* and *Aspergillus flavus* on the ascorbic acid content of fruits of *Ananas comosus*, after 14 days of incubation at 25°C. The results are expressed in milligrams per 100 g of fresh fruit and are means of four replicates in two experiments.

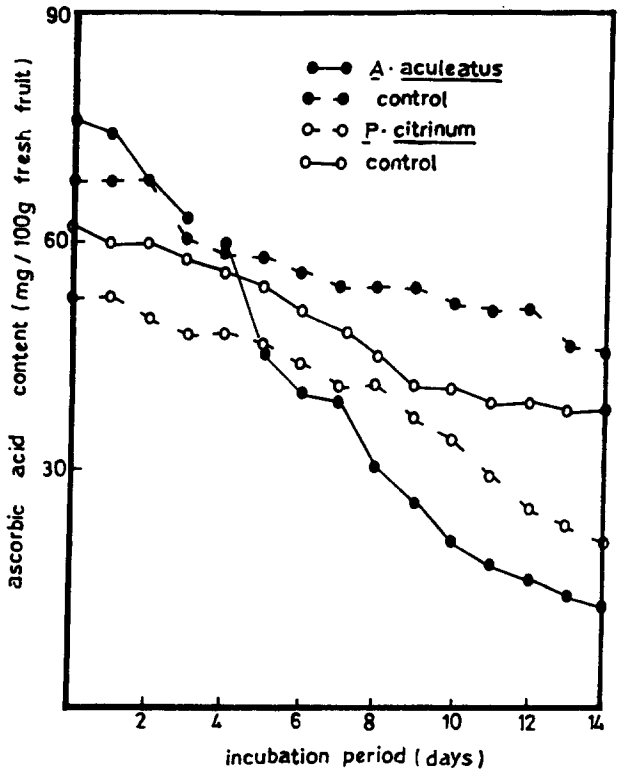

Fig. 4. The effects of rot infections caused by *Aspergillus aculeatus* and *Penicillium citrinum* on the ascorbic acid content of fruits of *Citrus sinensis*, after 14 days of incubation at 25°C. The results are expressed in milligrams per 100 g of fresh fruit and are means of four replicates in two experiments.

pineapple fruits (Figs 3 and 4) clearly show that there was a rapid decrease in the ascorbic acid content of the infected fruits as the incubation period increased.

The rate of loss of ascorbic acid was observed to be faster in infected fruits than in non-infected fruits. Srivastava & Tandon (1968) reported the complete loss of ascorbic acid in *B. theobromae* infected orange fruits. This differs from the findings from the present studies in which no complete loss of ascorbic acid occurred in either the infected orange or pineapple fruits. Although the loss in ascorbic acid content was greater in the soft rotted than in the dry rotted fruits, there was no complete loss of ascorbic acid, either in the infected pineapple or orange fruits. While about 88·7% loss of ascorbic acid was recorded in *C. paradoxa*

infected pineapple fruits (soft rot), 70·0% loss was recorded for *A. flavus* (dry rot) and only about 40·4% loss for the control fruits (Fig. 3). Under the same conditions, after 14 days of incubation at 25°C, the infections of *A. aculeatus* and *P. citrinum* gave 84·0% and 65·5% losses, respectively, in inoculated orange fruits (Fig. 4). A loss of 35·9% was also recorded for the control fruits.

The more rapid loss of ascorbic acid in infected orange and pineapple fruits than in the non-infected fruits clearly indicates that there is an alteration in the physiology of the fruits by the rot pathogens due to pathogenesis. The oxidation of ascorbic acid is accelerated by ascorbic acid oxidase (Srivastava & Tandon, 1968) which is reported to be of common occurrence in biological systems, or by some other degenerating oxidases produced during pathogenesis (Agarwal & Ghosh, 1979).

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REFERENCES

Adisa, V. A. (1983). Fruit rots of *Capiscum annuum* L. and *C. frutescens* in Nigeria. Part III. Effect of post-harvest infection by two Fusaria species on a few nutrients. *Die Nahrung*, **27**, 669–74.

Agarwal, G. P. & Ghosh, K. (1979). Post infection changes in ascorbic acid content in lemons, musambi and orange fruits induced by *Colletotrichum gloeosporioides*. *Indian Phytopath.*, **32**, 108–9.

Anon (1970). *Official methods of analysis* (11th edn). Association of Official Analytical Chemists, Washington, DC.

Duckworth, R. B. (1966). *Fruit and vegetables*. Pergamon Press, Oxford.

Ghosh, A. K., Tandon, R. N., Bhargava, S. N. & Srivastava, M. P. (1965). Vitamin C content of guava fruits after fungal infection. *Naturwissenschaften*, **52**, 478.

Pantos, C. E. & Markakis, P. (1973). Ascorbic acid content of artificially ripened tomatoes. *J. Fd. Sci.*, **33**, 550.

Srivastava, M. P. & Tandon, R. N. (1966). Influence of *Botryodiplodia* infection on two varieties of guava. *Experientia*, **28**, 789–90.

Srivastava, M. P. & Tandon, R. N. (1968). Changes in ascorbic acid content of Mosambi fruit induced by *Botryodiplodia theobromae*, *Can. J. Pl. Sci.*, **48**, 337–8.

Thomas, P. (1975). Effect of post-harvest temperature on quality, carotenoids and ascorbic acid content of Alphonso mangoes on ripening. *J. Fd. Sci.*, **40**, 704–6.