COLD STORAGE VERSUS ROOM TEMPERATURES ON KEEPING QUALITIES OF FRUITS

IT has become generally recognized that cold storage temperatures of 0° C. tend to retard the ripening and thus prolong the period of edibility of most fruits as contrasted with room temperatures of 18° to 24° C. (Powell,[1] Magness,[2] Overholser,[3] Carrick,[4] and others.)

The fact, however, does not appear to be so widely recognized that the better the intrinsic keeping quality, at room temperatures, of the species of fruit stored the greater the *proportional relative* delay in senescence brought about by cold temperatures.

METHOD OF PROCEDURE

Data obtained with a number of varieties of several species of fruits have been utilized to indicate the average keeping period as affected by storage at 0° and at 18° to 24° C. The fruits were handled and observations made as previously described in other publications (Overholser, 1922; (with L. P. Latimer), 1924).

With the fruits stored, an optimum period and a maximum period was determined. The *optimum storage period* referred to the average number of days the fruit could be stored and upon removal possess good quality and marketability. The *maximum storage period* referred to the time beyond which it was unsafe to keep the fruit in storage, although it was still in fair to good condition, because of likelihood of loss of quality, softening of texture, susceptibility to rot organisms, tendency to wilting and rapidity of breakdown subsequently.

Three pickings of the varieties of each kind of fruit were stored, the first being made soon after the beginning of the commercial harvest period, the second about the middle, and the third picking shortly before the close of the commercial harvest period for the variety.

EXPERIMENTAL DATA

Data showing the relative effectiveness of 0° C. and 18° to 24° C. in delaying the senescence of varieties of pears, plums, peaches and apricots, are presented in Table 1. The intrinsic keeping qualities of the species of fruits studied are generally considered by growers and shippers to be about in the order named, with the pears as a rule possessing the longest period, and the apricots the least period of marketability.

[1] *U. S. D. A. Bur. Plt. Indus. Bul.* 40 pp. 9–26. 1903.
[2] *Jour. Agr. Research* 19: pp. 473–500. 1920.
[3] *Calif. Agr. Exp. Sta. Bul.* 344. pp. 426–463. 1922.
[4] *Cornell Memoir* 81, pp. 1–54. 1924.

TABLE I

THE RELATIVE EFFECTIVENESS OF TEMPERATURES OF 0° AND 18° TO 24° C. IN DELAYING SENESCENCE OF SEVERAL KINDS OF FRUIT

Kind of Fruit	Number of varieties stored	Number of years observed	Temperature of storage Centigrade	Optimum storage period (days)	Maximum storage period (days)
Pears	52	6	0°	106	147
Pears	52	6	18° to 24°	12	16
Plums	21	3	0°	47	65
Plums	21	3	18° to 24°	7	9
Peaches ...	49	2	0°	37	50
Peaches ...	49	2	18° to 24°	6	8
Apricots ...	29	3	0°	23	32
Apricots ...	29	3	18° to 24°	5	6

DISCUSSION

It should be pointed out that the actual number of days before senescence varied greatly, depending upon the variety, even within a species, and varied somewhat for a given variety depending upon the maturity when harvested, the region where grown, the season and other factors. Of course, some varieties of a given kind would keep much longer and others much shorter periods of time than the averages given. Nevertheless it is believed that the data indicated the average difference in keeping qualities of the several kinds of fruits.

It should also be pointed out that certain varieties within a given species kept relatively long at 18° to 24° C. and comparatively short periods of time at 0° C. Furthermore, with other varieties of the same species the reverse was true. The deductions, therefore, apply only to the average response of the varieties of a given species as contrasted with the fruit of another species.

DEDUCTIONS

The pears, which had the longest period before the approach of senescence, kept about nine times longer at 0° C. than at 18° to 24° C. The plums, which possessed on the average the next longest period before senescence, kept about seven times longer at 0° C. than at 18° to 24° C. In a similar manner peaches kept six times and apricots only five times longer at 0° than at 18° to 24° C.

The data show that the effectiveness in retarding senescence of cold storage temperatures (0° C.) as contrasted with temperatures of 18° to 24° C. varied, depending upon the inherent keeping qualities of the species.

The longer the fruit could be retained at room temperatures the greater proportionally was senescence delayed by cold storage temperatures, and a comparatively few additional days in the keeping period at the higher temperatures indicated a rather marked additional keeping period at 0° C.

Fruit of a species which at room temperatures kept on the average only one or two times longer than fruit of another species tended to keep at cold storage temperatures as much as four or five times longer than that of the second species when both were subjected to the low temperatures.

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RELATION OF THE ADJUSTMENT OF SOIL REACTION TO BLACK ROOT-ROT OF TOBACCO

A SOIL made less acid by the use of lime is favorable to the development of black root-rot of tobacco, caused by the fungus *Thielavia basicola* Zopf. Anderson, Osmun and Doran[1] found that black root-rot caused practically no loss in a soil more acid than pH 5.6 and that it caused severe loss in a soil less acid than pH 5.9. In soil having a reaction too nearly neutral, loss caused by black root-rot may continue to increase for at least four years after the application of lime. A quick method of increasing soil acidity is needed so that tobacco may be grown profitably on such soil. The results of experiments in 1926 on the relation of acidifying chemicals to the hydrogen ion concentration of the soil and to the control of black root-rot are here summarized.

Acids were applied to soil of known pH value infested with *Thielavia basicola,* and in such soil tobacco was grown. Results were measured in terms of effect on pH value of soil, growth of plants and infection of roots.

Equivalent quantities of nitric acid and of sulphuric acid had practically the same effect on the pH value of the soil, lowering it in proportion to the quantity of acid used. When soil was acidified by the addition of a little dry soil which had previously absorbed concentrated sulphuric acid or nitric acid, the pH value of the soil was lowered about as much as when equivalent amounts of these acids in water were applied directly to it.

All acids used lowered the pH value of soil when first applied. But it soon reverted toward or to the original pH value in the case of the organic acids used—citric, lactic, malic, tartaric and acetic.

Orthophosphoric acid had much less effect in lowering the pH value of soil than did equivalent amounts of nitric acid or sulphuric acid. When the only object was to increase soil acidity, nitric acid or sulphuric acid used alone was as efficient or more efficient than when either of these acids was applied together with orthophosphoric acid to the soil.

Field experiments were conducted in a soil of the Gloucester Series, with a pH value of 5.9, severely infested with *Thielavia basicola.* During the growing season, the pH value of this soil was lowered 0.10 by 200 lbs. inoculated sulphur per acre, 0.15 to 0.20 by 400 lbs. inoculated sulphur per acre, and 0.15 to 0.25 by a combination of 1,800 lbs. sulphuric acid and 400 lbs. orthophosphoric acid per acre. The quantity of acid necessary to apply to a soil to produce a definite increase in soil acidity depends on the buffering of the soil and can not be exactly predicted for any other type of soil than that on which it has been determined experimentally. In this field the pH value of the soil was lowered enough by the acid treatments to be unfavorable to infection of roots by Thielavia. The yield of tobacco in treated plots, as compared with yield in plots not treated, was increased 28 per cent. by 200 lbs. sulphur, 34 per cent. by 400 lbs. sulphur and 58 per cent. by 1,800 lbs. sulphuric acid together with 440 lbs. orthophosphoric acid per acre.

In pot experiments, the increases in soil acidity resulting from the application of nitric acid and of sulphuric acid were equally efficient in preventing severe black root-rot. The only organic acid used which protected tobacco against infection was acetic. Plants were free from black root-rot or showed only a trace in soil infested with Thielavia to which acetic acid was applied. Acetic acid has no lasting effect on soil reaction and its effect is probably to partially sterilize the soil.

The application of orthophosphoric acid to soil infested with Thielavia resulted in root infection more severe than that on check plants. Orthophosphoric acid is seemingly as favorable to infection by Thielavia as is lime. In the presence of abundant orthophosphoric acid, black root-rot may be severe in relatively acid soils. The use of orthophosphoric acid together with sulphuric acid or with nitric acid usually resulted in more black root-rot than when sulphuric or nitric acid was used alone. But in spite of the severe root infection which it induced, orthophosphoric acid resulted in a great increase in the growth of plants.

The acids were all more toxic to tobacco plants in

[1] Anderson, P. J., A. Vincent Osmun, and W. L. Doran, "Soil Reaction and Black Root-rot of Tobacco," *Mass. Agr. Expt. Sta. Bul.* 229, 1926.