# Dehydroascorbic Acid in Frozen and Cooked Frozen Vegetables[1]

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Recently, attention has been directed toward the importance of analyzing raw and cooked vegetables for dehydroascorbic acid (*2, 4, 6*). Since it is possible that dehydroascorbic acid forms during preparation for freezing procedures and frozen-storage, it seemed of value to determine the dehydroascorbic acid content of vegetables in the fresh, scalded, and frozen-stored states. The frozen-stored vegetables were also analyzed after cooking to determine the net result of these procedures on the various forms of ascorbic acid.

Chard, spinach, peas, snap beans, and lima beans were used for these studies. Representative samples, unscalded and scalded, were frozen and stored at 0° F for 6 months. Twenty-five–gm aliquots of the frozen-stored vegetables were cooked in 50 ml of distilled water, cooled immediately, and the total sample blended. Reduced ascorbic acid was determined by the method of Loeffler and Ponting (*3*); dehydroascorbic acid, by the Bolin and Book modification (*1*) of the Roe and Oesterling method (*5*). Typical data are presented in Table 1.

A significant amount of dehydroascorbic acid was found in the fresh vegetables. This was markedly decreased by scalding, but increased again during frozen-storage. Cooking the frozen vegetable almost completely destroyed the dehydroascorbic acid present. In both the scalded and cooked, frozen vegetables, the dehydroascorbic acid content represented 12% or less of the total ascorbic acid, with the exceptions of unscalded spinach and chard, where the total ascorbic acid content was very low.

TABLE 1

ASCORBIC ACID CONTENT OF FROZEN AND COOKED FROZEN VEGETABLES

| Vegetable | Ascorbic acid* | Fresh | Scalded† | Frozen, stored 6 mos | | | |
|---|---|---|---|---|---|---|---|
| | | | | Unscalded | | Scalded | |
| | | | | Raw | Cooked‡ | Raw | Cooked‡ |
| | | | | mg/100 gm | | | |
| Chard | Reduced | 52.1 | 35.4 | 1.6 | 1.3 | 13.4 | 12.4 |
| | Dehydro | 7.7 | 1.6 | 19.0 | 1.1 | 10.6 | 1.6 |
| | Total | 59.8 | 37.0 | 20.6 | 2.4 | 24.0 | 14.0 |
| | Dehydro, % of total | 13 | 4 | 92 | 46 | 44 | 11 |
| Spinach | Reduced | 78.9 | 41.7 | 0.6 | 0.6 | 20.4 | 14.6 |
| | Dehydro | 3.8 | 1.7 | 9.2 | 0.6 | 6.8 | 1.4 |
| | Total | 82.7 | 43.4 | 9.8 | 1.2 | 27.2 | 16.0 |
| | Dehydro, % of total | 5 | 4 | 94 | 50 | 25 | 9 |
| Peas | Reduced | 25.3 | 20.5 | 9.1 | 9.2 | 17.6 | 15.0 |
| | Dehydro | 3.9 | 1.4 | 5.6 | 1.3 | 3.1 | 1.2 |
| | Total | 29.2 | 21.9 | 14.7 | 10.5 | 20.7 | 16.2 |
| | Dehydro, % of total | 13 | 6 | 38 | 12 | 15 | 7 |
| Snap beans | Reduced | 29.6 | 28.6 | 12.6 | 11.6 | 17.2 | 15.7 |
| | Dehydro | 4.7 | 0.8 | 12.7 | 1.5 | 6.5 | 1.7 |
| | Total | 34.3 | 29.4 | 25.3 | 13.1 | 23.7 | 17.4 |
| | Dehydro, % of total | 14 | 3 | 50 | 11 | 27 | 10 |
| Lima beans | Reduced | 27.9 | 17.9 | 20.3 | 16.9 | 17.0 | 12.8 |
| | Dehydro | 5.5 | 2.5 | 5.7 | 1.3 | 3.2 | 1.5 |
| | Total | 33.4 | 20.4 | 26.0 | 18.2 | 20.2 | 14.3 |
| | Dehydro, % of total | 16 | 12 | 22 | 7 | 16 | 10 |

* Ascorbic acid values calculated back to the fresh, raw basis.
† Chard, spinach, and lima beans scalded 2 min: peas, 1½ min: snap beans, 3 min.
‡ Chard and spinach cooked 5 min; peas, 10 min; snap beans and lima beans, 15 min.

The dehydroascorbic acid accounted for an appreciable part of the reduced ascorbic acid lost during frozen-storage in both scalded and unscalded vegetables. In the unscalded raw samples, the dehydroascorbic acid represented from 22 to 94% of the total ascorbic acid content, and in the scalded raw samples, 15 to 44%. However,

[1] Published as Scientific Paper No. 744, College of Agriculture and Agricultural Experiment Stations, Institute of Agricultural Sciences, State College of Washington.

since it is destroyed during cooking, analyzing for dehydroascorbic acid in these frozen-stored raw vegetables seems of questionable value.

Further studies are being made on the factors affecting the conversion of reduced to dehydroascorbic acid and the loss of total ascorbic acid during frozen-storage.

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## On the Infrared Spectra of Nucleic Acids and Certain of Their Components[1]


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The fact that nucleoproteins and nucleic acids are important constituents of tissue and take part in many cellular processes has been recognized for some time. Chemical methods for the identification of these substances and their components (nucleotides, nucleosides, purines, pyrimidines, and sugars) have been devised, but are characterized by their complexity.

Since all the nucleic acids are colorless, optical methods are limited to either (a) combination of the nucleic acid with an absorbing substance (*3*) by either adsorption or reaction or (b) investigation of the extravisible regions of the spectrum. Several careful studies of the ultraviolet absorption of nucleic acids (*1, 2, 4*) and their component purines and pyrimidines (*4, 5*) have been reported. Unfortunately, in the readily accessible region of the ultraviolet (210–400 mμ) the only components of nucleic acids which absorb are the purine and pyrimidine bases, and these do so over a relatively narrow spectral range. Thus, although the estimation of one particular purine or pyrimidine in the presence of others by ultraviolet spectrometry is possible if their spectra are sufficiently different (*6*), it is very difficult, if not impossible, when their spectra are similar, as in the cases of thymine, uracil, and adenine. It is, of course, not possible by this method to determine anything about the nature and amount of the other components of nucleic acid, namely, the sugars and phosphoric acid.

In this paper we report preliminary results on the determination of infrared absorption in the region 700–1,800 cm$^{-1}$ of yeast ribonucleic acid, thymus desoxyribonucleic acid, and some of their chemical constituents. The lack of solubility of these materials in other than aqueous solvents makes it necessary to determine the spectra in the solid phase. Three methods have been used: (a) films evaporated in high vacuum onto sodium chloride plates, (b) finely ground powder layers between sodium chloride plates (*7*), and (c) continuous films cast onto silver chloride plates. Fig. 1 summarizes the data, showing the positions of the principal absorption bands as lines (the height indicating the relative intensities) and the physical state in which the measurement was made.

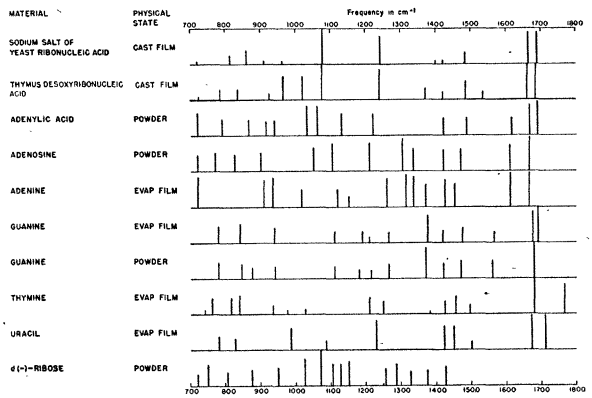


FIG. 1

Obviously, with such complicated molecules it is impossible to give definite assignments to all the absorption bands. It seems possible, however, to correlate several of the bands with particular atomic groupings, especially when many closely related compounds have been studied. It is certainly possible to differentiate one pure material from another by means of their infrared spectra. Thus, for example, by infrared spectroscopic methods it is possible to differentiate ribonucleic acid from desoxyribonucleic acid by means of their absorptions at frequencies lower than 1,100 cm$^{-1}$, thymine (6-methyl uracil) from uracil and adenine on the basis of their absorptions between 900 and 1,200 cm$^{-1}$, and, in fact, to detect thymine and uracil in mixtures. This suggests the possibility of differentiating between nucleic acids from different sources.

It is hoped that this approach can be extended to the study of nucleoproteins, nucleic acids, and their degradation products extracted from normal and neoplastic tissues. Complete details of the above spectra and other related compounds will be published elsewhere.

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[1] This work was supported in part by funds from the Office of Naval Research.