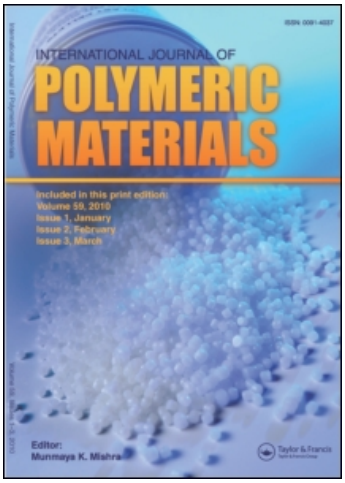

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Photoacoustical Spectroscopy Investigation of Cellular Polymers

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Optical non-transparent biological objects were investigated by photoacoustic spectroscopy method. The dynamics of structural changes both in the peel and in the pulp in the process of fruit maturing was studied. The change of intensity of absorption bands of fruits in the process of maturing as well as the appearance of new bands in the process of rotting provides monitoring both the terms of maturing and storage of such objects.

KEY WORDS Cellular polymers, spectroscopy, photoacoustics.

INTRODUCTION

One of the promising directions of the structural analysis is the photoacoustical-based investigation. The possibility of utilization of photoacoustical spectroscopy (PAS) to biological matter is provided in Reference 1. In the PAS technique the analyzed matter is placed in a specific tight cell provided with the window for light penetration. The sample is heated up on illumination due to light absorption resulting in the heat-up of the gas layer bordering the surface of the matter. This results in the gas expansion. The utilization of the modulated light results in a periodic cell expansion, i.e., pressure variation of the gas with the frequency of light modulation detected by the pick-up.

The advantages of PAS utilization for optically transparent biological matter are used for tracking the dynamics of structural changes in the peel and in the pulp in the process of maturing and storage of some fruits.

EXPERIMENTAL

Winter grades of Simirenko, Rosmarin, Shafran, Starcrimson and Golden Delicious apples as well as grapes of Taifi and Kishmish grades were used for investigation.

The absorption spectra of PA signals were measured using a single-beam PA spectrometer with automatic spectra recording.[2] The PA spectrum of the light source was initially recorded in the UV-band followed by the subsequent loading

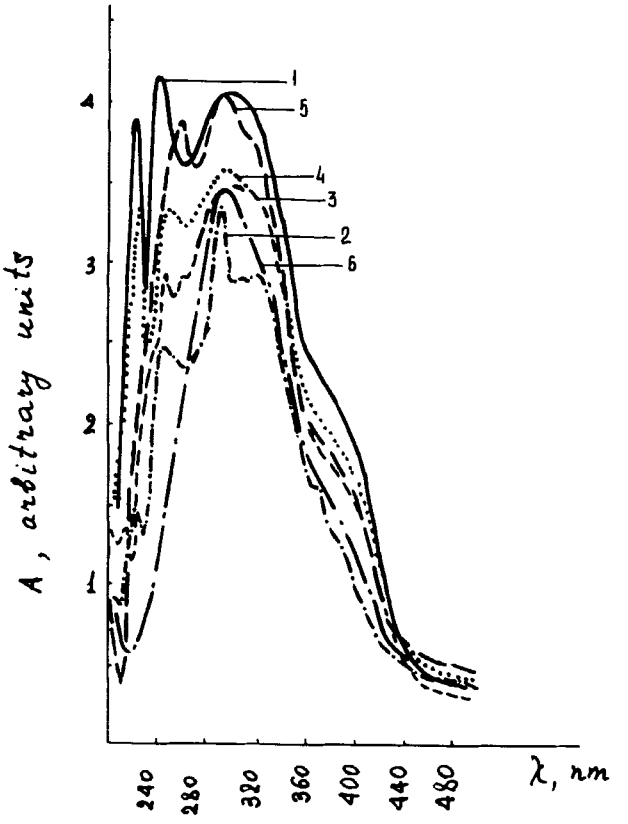

FIGURE PA signal vs wavelength diagram in the maturity period for apples (Simirenko grade, peel). 1. Beginning of June, 1989; 2. End of June, 1989; 3. Beginning of July, 1989; 4. Beginning of August, 1989; 5. Middle of August, 1989; 6. Beginning of October, 1989.

into the computer memory (the PA cell being filled with the coal). The spectrum of the investigated sample was recorded similarly. The normalization (the relation of the PA spectrum of the investigated sample to the reference PA irradiation spectrum) was used for PA absorption spectrum discrimination. For this purpose a 120 mg sample of the fruit pulp or the peel purified from the pulp with 8 × 8 mm dimensions was placed in the photoacoustical cell.

The spectrometer used provides the investigation of samples having the optical absorption coefficient 1–10 cm in the spectral range 200–300 nm. The frequency band of modulation was in the range 10–2000 Hz. The volume of the gas cell was 250 mm.

RESULTS AND DISCUSSION

According to Reference 1 at the modulation frequency 220 Hz the PAS appears only in the surface layer of fruits containing waxes while the above layer detects absorption mainly in UV-region of the spectrum due to protein molecules in this

layer. At lower frequencies (33 Hz) PAS is generated by the biological matter lying below the layer, e.g., carotinoids or chlorophyll-containing compounds of the apple peel itself. At low modulation frequency (24 Hz) the peel of unripe apples of winter grades was observed to exhibit absorption bands at 225 nm, 244 nm, 288 nm and 320 nm and at 208 nm, 220 nm, 242 nm and 328 nm for the pulp. On maturing (harvesting maturity) absorption bands at 244 nm and 320 nm for peel and at 242 nm and 320 nm for pulp disappear. The intensity of the PA absorption signal in the above regions for unripe fruits is decreased on maturing. PAS absorption bands at 210 nm, 230 nm and 295 nm for peel and at 225 nm, 235 nm, 250 nm and 290 nm for pulp are observed.

The intensity of the PAS absorption band at 225 nm and 285 nm is increased with the rot appearance. The PAS spectrum intensity of unspoiled fruits is twice as much as that for rotten fruits on comparison. The pulp of the rotten fruit exhibits an additional absorption band at 265 nm which seems to be associated with the presence of aromatic aminoacids of proteins (tritophan, thirosin, phenylamin and cystin) with the characteristic absorption in the above region.

Thus, monitoring the maturing terms and prediction of storage terms for fruits by early diagnostics of rotting processes is possible using the photoacoustical spectroscopy technique.

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