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SPECTRA OF TWO-PHOTON-EXCITED LUMINESCENCE IN GENETICALLY MODIFIED SOY FLOUR

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ABSTRACT

The method of diagnostics of food products on the example of soy flour powders is presented. The method is based on optical registration of two-photon-excited luminescence spectra under laser (578.2 nm) excitation. The spectra obtained allow us to establish differences in the composition and structure of compounds. The developed method can be used to analyze the quality of a large class of bioactive structures that luminescence under the action of visible-range laser radiation.

KEYWORDS: laser, spectrum, two-photon-excited luminescence, soy flour, cuvette, excited radiation.

INTRODUCTION

The problem of quality of food products can not be solved without modern methods of diagnostics. The deterioration of the ecological situation, the entry into the food market of a large number of foreign products, sometimes of poor quality, put forward new requirements for methods of Express control of food products.[1] At this time, most control methods are very expensive, do not have versatility and take a long time. However, for practice it is necessary to use universal and inexpensive methods of Express analysis.[2]

In a commonly used technique for detecting secondary radiation spectra (photoluminescence, Raman scattering, two-photon excited luminescence) in a condensed medium, laser radiation is focused inside the medium. At a sufficiently high intensity of laser radiation, this leads to a change in the initial characteristics of the substance: photodestruction, local heating of the medium, as well as photoinduced phase transformations. In this paper we propose a new original method of excitation of secondary radiation in powders. This technique[3,4] in the mode of Express control allows to study the effect of laser radiation on biological objects, makes it possible to establish the types of fatty acids, vegetable oils, amino acids that are part of the analyzed samples, the types and concentration of biologically active inclusions of toxic components in food.

MATERIALS AND METHODS

A schematic diagram of the experiment in "reflection" geometry is shown in.[3] The set-up incorporates a copper-vapor laser, which generates visible radiation, with wavelengths λ=510.6 and 578.2 nm. The lasing is performed in the form of short pulses (20 ns) with a repetition rate of 10^4 Hz. The average power of pulses was 1 W.

Radiation from the laser was focused by a lens on an investigated sample. A sample in the form of a crystalline powder was placed in a cell with plane-parallel quartz windows. The secondary radiation was focused by a lenses onto the entrance slit of an MDR-2 monochromator. After passing through the monochromator, the radiation was detected by an FEU-130 photomultiplier that operated in the photon counting mode. The intensity meter converted the average rate of normalized pulses into voltage. The output of the meter was connected to a computer. The computer collected digital information on the spectrum of secondary radiation and controlled the stepping motor, which turned discretely the diffraction grating of the MDR-2 monochromator.

The recording system with a gating allowed one to detect signals of the secondary radiation with a high sensitivity (down to 10^{-15} W).

The following substances were investigated: soy flour micropowders (the average sizes of particles of powder ~ 60 micron. The experiments were conducted at T=300 K temperature.

RESULTS AND DISCUSSION

Analysis of the spectra of two-photon excited luminescence (TPEL) soy flour consisted of two series of measurements. The first series of measurements was carried out with the so – called control sample-unmodified soy flour, by careful grinding of Mature genetically unmodified beans. In the second series, samples of TG-soy obtained as a result of the use of special technological methods of genetic modification were studied. The identification of the substance under study was determined by comparing the registered spectrum with the reference one, and in this case a number of special features were used that stand out in the TPEL spectrum. The role of these properties were applied as follows: 1) wavelength, corresponding to the position of the peak intensity in the spectrum of TPEL; 2) type of lines in the spectrum of TPEL; 3) the half-width of the main contour in the spectrum of TPEL; 4) the position of intensive lines in the spectrum of TPEL.

Figure 1 shows the TPEL spectra of unmodified soy flour obtained at T=300 K by different intensities of exciting radiation. All spectra are registered under the same technical conditions of spectra recording, which excludes the occurrence of differences caused by the technique. As can be seen from the figure, we observed at low intensity of laser radiation (curve 1), the TPEL spectrum has a maximum in the region of 360 nm. With an increase in the intensity of the exciting radiation, the intensity of the TPEL spectrum increases sharply. The TPEL spectrum (curve 2) consists of several mutually overlapping bands located in the range of 280-510 nm. In the ultraviolet region (near 300 nm) is detected "step" maximum. This maximum refers to the manifestation of chromophore groups of nucleic bases that are part of DNA and RNA. In the area of 360 nm there is a pronounced maximum. In this region of the spectrum is usually found fluorescence band of proteins, mainly associated with the manifestation of heteroaromatic amino acids – tryptophan. In addition, the contribution to this maximum can also make the corresponding chromophore group of nucleic bases that are part of the DNA and RNA of soy flour. With a further increase in the intensity of the exciting radiation (curve 3), a rather narrow peak with a maximum of 360 nm is formed in the spectrum. In,[1] the spectra of conventional resonance fluorescence of soy flour were studied, with which these spectra are consistent in shape and position.

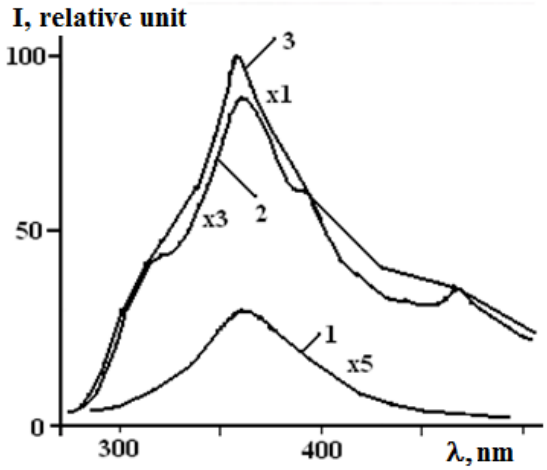

Fig. 1: TPEL spectra of unmodified soy flour obtained at T=300 K and different intensities of exciting radiation (λ=578.2 nm): the curve (1) corresponds to the intensity of I_0=10; (2) - I_0=15; (3) - I_0=20 (where I_0 values are given in units of 10^7 W/cm^2).

Figure 2 illustrates the type of TPEL spectra of genetically modified soy flour obtained at T=300 K at different intensities of exciting radiation. As shown in Fig.2, we observed at low intensity of exciting radiation (curve 1), the TPEL spectrum has a maximum in the region of 360 nm, similar to the TPEL spectrum of unmodified soy flour. When the intensity of the exciting radiation increases, the intensity of the TPEL spectrum increases sharply. The maximum of the spectrum does not change (curve 2). With a further increase in the intensity of the exciting radiation (curve 3), two narrow peaks with maxima of 360 nm and 390 nm are formed in the spectrum. In contrast to the unmodified soybean sample, there is no" step" maximum in the ultraviolet region (300 nm).

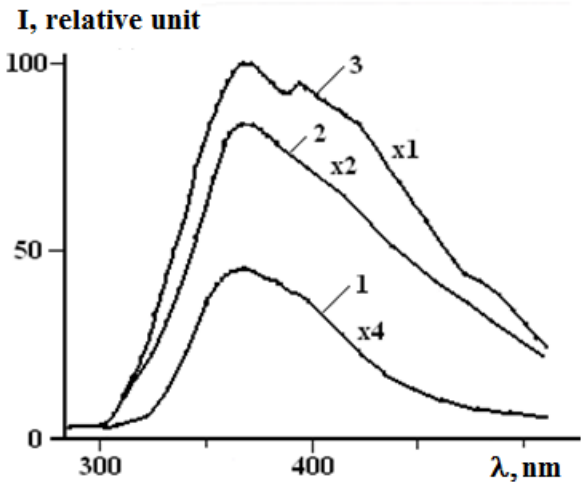

Fig. 2: TPEL spectra of genetically modified soy flour obtained at T=300 K at different intensities of exciting radiation (λ=578.2 nm): the curve (1) corresponds to the intensity of I_0=10; (2) - I_0=15; (3) - I_0=20 (where I_0 values are given in units of 10^7 W/cm^2).

At high intensities of exciting radiation, the intensity of TPEL in all the studied samples is quadratic. The reason for this may be the process of transition from spontaneous to forced luminescence. However, the absence of a significant narrowing of the spectrum indicates that in our experiments only threshold effects for the forced TPEL are realized.

CONCLUSIONS

Thus, in this study it is shown that when excited by pulsed laser radiation, the spectrum of TPEL of soy flour is observed, the band of which is located in the region of 280-510 nm. As a result of comparison of the obtained TPEL spectra for a number of soy flour samples, including genetically modified samples, it was found that the transition from unmodified in TG products forms of TPEL spectra and their maxima are modified. This effect occurs due to the fact that the implementation of genetic modification occurs perturbation of the original structure of the material at the molecular level. In particular, such disturbances are carried out as a result of the process of modification of the molecular structure of DNA.

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