

Spectrum and Time Transition of Biophotons Emitted from Suspension of Cucumber

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Abstract: We measured the spectrum and time transition of biophotons emitted from a suspension of prepared sample liquid of cucumber (*Cucumis sativus* ‘white spine type’) for an 18-hour period. We prepared the suspension of sample liquid by removing the skin of the cucumber fruit, processing the peeled fruit and then passing the obtained liquid through a paper filter. A set of glass low-pass filters was used for biophoton measurements. The biophoton spectrum was measured within the wavelength region of 280-650nm (ultraviolet to visual light). The biophoton spectrum was calculated using the differences of relative intensities to control samples. We found that it was broad and the strongest intensity peak was located at 520-540nm. Also ultraviolet emission (280-370nm) was detected although it was weak. Intensities of peaks at 480-540nm reached their maximum 4-5 hours after the start of measurements. The ultraviolet peak was detected for 10 hours after the start of measurements, but it could not be detected after that.

Keywords: cucumber, *Cucumis sativus* (‘white spine type’), biophoton, spectrum, visual light, ultraviolet, time transition, suspension

1. Introduction

One of us has been working with others in studies using pieces of cucumber fruits (*Cucumis sativus* ‘white spine type’) as bio-sensors for detection of effects by electromagnetic stimuli and non-contact healing¹⁻⁶. These effects have two detection methods; one of them is a biophoton method^{7,8} and the other is a cucumber gas (odor) method⁹⁻¹¹. The former has a merit that it is easy to study the time transition, while the latter has a merit that multiple-place measurements are easy to do. In the present study we focus on the spectrum of biophotons in order to improve the biophoton measurement method.

Intensity of biophotons, which are emitted from pieces of cucumber, reaches the maximum about 5 h after making samples, and then decreases gradually^{8,11}. However, measuring the spectrum of biophotons is not easy because their intensities are weak and sample variations are large. Therefore, in preliminary tests, instead of cucumber pieces we used a liquid sample

(cucumber suspension) which is more uniform and its photon intensity is greater. The suspension was made by grinding the whole cucumber fruit including the skin.

From the preliminary tests, we got the following results. (1) The cucumber suspension seemed to emit ultraviolet radiation although its intensity was weak. (2) Biophotons consisted of some components for which intensity decreased rapidly and had its maximum 5 to 8h after the start of measurements (**Fig. 1**). (3) The cucumber suspension, excluding the skin seemed to have few decreasing components. (4) The supernatant liquid obtained from centrifuged cucumber suspension did not emit photons.

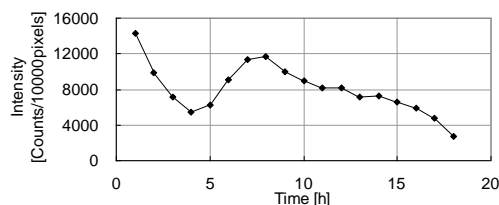


Fig. 1 Example of Photon Intensity of Cucumber Suspension Including Skin

Usually, our previous studies measured biophotons emitted from cross sections of round pieces of cucumber¹⁻³. Therefore, for comparison

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in the present study, we used a cucumber suspension prepared excluding the skin and measured the details of the spectrum and its time transition. Moreover, we aimed to examine ultraviolet emission.

2. Methods

Date and Place: The experiment was done at the Institute for Living Body Measurements of the International Research Institute (Chiba, Japan) from May 2010 to August 2010.

Making Samples: First, we peeled off the skin and the just-under-the-skin green parts of 2 cucumber fruits. Next, the peeled bodies were processed by first grating them into a container that was cooled with ice cubes. Then the grated cucumber was ground with a mill for 1min. Next, the cucumber liquid was filtrated through a paper filter (No. 101, Advantec) to get the liquid sample suspension. Five glass Petri dishes (diameter 32mm; depth 15mm) were used and each dish was filled with 4mL of the suspension.

Biophoton Measuring System: An image intensifier (I.I.) system was used (Model C2400-47, sensitivity 60mA/W at 400nm, wavelength 280-650nm, Hamamatsu Photonics). Biophotons were measured for a 1h interval, and in all, an 18-hour period was measured. The distance was 250mm between the camera lens and samples.

Biophoton Spectrum Measurements: Petri dishes were arranged on a sample stage as shown in Fig. 2. Glass low-pass filters (Sharp-cut filters, Hoya Candeo Optronics) were set 5mm above the experimental dishes (E1-E4) to ensure that oxygen in the air contacted the cucumber suspension^{13,14}.

Twelve kinds of filters (L-37, L-39, L-42, Y-44, Y-48, Y-50, Y-52, O-54, O-56, O-58, R-60, R-62) were grouped into 3 groups of 4 each, and each group was measured 8 times for a total of 24 data sets. Intensities of biophotons [counts/10000pixels] of the wavelength bands were calculated from the differences among the

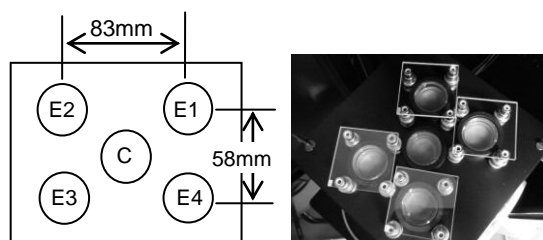


Fig. 2 Arrangement of Samples
E1-E4: Experiments. C: Control.

ratios to the intensity of control samples. Moreover, calibration data were obtained through blank tests without filters (suspension only)¹².

3. Results

Excluding outliers, we analyzed calibrated data of 21 data sets.

3-1. Cumulative Spectrum

Fig. 3 shows the measured spectrum of biophotons accumulated for 18h. The spectrum of the suspension was broad and its main component was green light. The strongest component had a wavelength 520-540nm and its ratio was $26.0 \pm 3.1\%$, the second strongest was 540-560nm ($18.3 \pm 2.5\%$), and the third was 500-520nm ($14.4 \pm 3.0\%$). There was no violet light, but a weak ultraviolet emission (280-370nm) was detected ($2.4 \pm 1.9\%$).

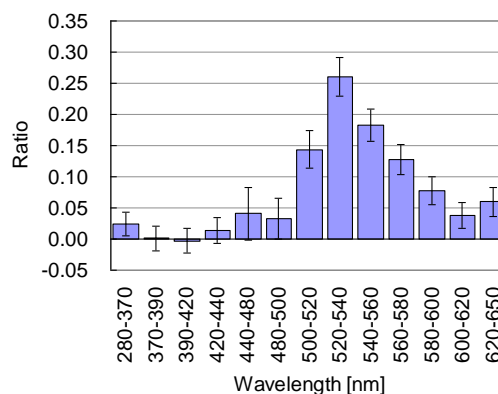


Fig. 3 Cumulative Spectrum for 18h (Ratio)
Error bars are SDs.

3-2. Time Transition

Fig. 4 shows the time transition of control samples. Time transitions of ratios of intensities of each wavelength band are shown in Fig. 5, and their intensities are shown in Fig. 6.

We considered that the reliability of the measured ratio of the intensity was inferior 15h after the start of measurements because the intensity was low. Therefore, here, we analyzed only data obtained in the first 14h.

Blue-green light (480-540nm) increased till 4-5h, and then decreased. At other wavelength bands, photon intensities reached the maximum within 3h or showed monotonic decreasing. The ratio of the intensity increased at 500-540nm. The ratio was stable at 540-580nm. At other wavelengths, the ratios decreased.

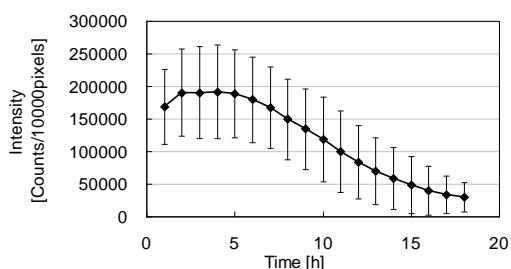
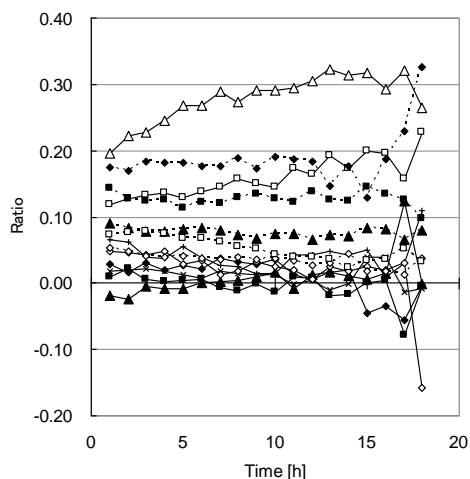
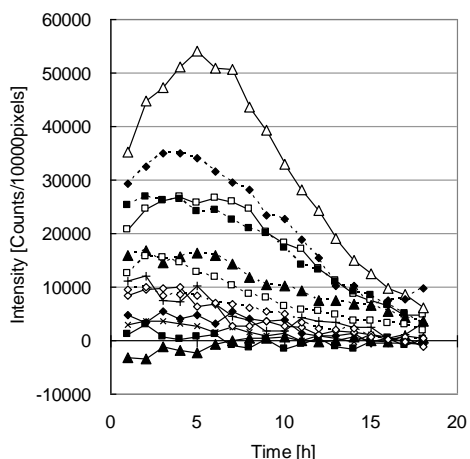


Fig. 4 Time Transition of Photon Intensity of Control Samples
Error bars are SDs.



◆ 280-370nm ■ 370-390nm ▲ 390-420nm
 × 420-440nm + 440-480nm ◇ 480-500nm
 □ 500-520nm △ 520-540nm ··· 540-560nm
 ··· 560-580nm ··· 580-600nm ··· 600-620nm
 ··· 620-650nm

Fig. 5 Time Transition of Ratio of Each Wavelength Band



◆ 280-370nm ■ 370-390nm ▲ 390-420nm
 × 420-440nm + 440-480nm ◇ 480-500nm
 □ 500-520nm △ 520-540nm ··· 540-560nm
 ··· 560-580nm ··· 580-600nm ··· 600-620nm
 ··· 620-650nm

Fig. 6 Time Transition of Photon Intensities

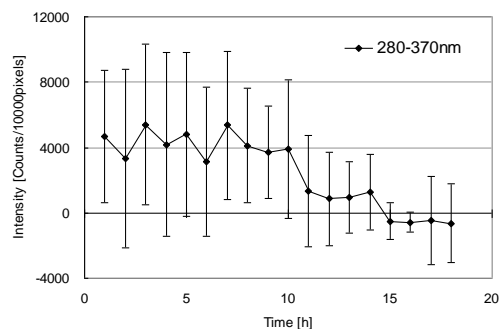


Fig. 7 Time Transition of Photon Intensity of Ultraviolet Emission (280-370nm)
Error bars are SDs

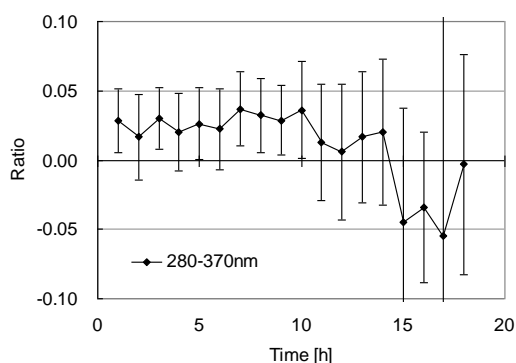


Fig. 8 Time Transition of Ratio of Intensity of Ultraviolet Emission
Error bars are SDs.

Ultraviolet emission (280-370nm) was detected till 10 hours, but it disappeared after that (Fig. 7). The ratio of the intensity was stable during the first 10 hours and its average was 2.8% (Fig. 8).

4. Discussion

4-1. Comparison with Sample Pieces and Liquid Sample Suspension

The photon intensity of the liquid sample suspension was 20 times larger than that of sample pieces. The photon emission from the suspension was influenced by sample conditions (e.g. harvest areas, weather) the same as the pieces were. However, the measured distribution of spectrum (Fig. 3) was considered as reliable because its deviation was small relatively.

The photon intensity of the control suspension often kept the maximum values for longer times than pieces. We considered one of the reasons for this was that the suspension consisted of various components which had different patterns of time transitions. The transition pattern at 520-540nm was relatively

similar to the pattern of the pieces. Further studies are needed to reveal relationship with bio-PK reaction¹¹⁾.

4-2. Emission of Ultraviolet Radiation

Emission of ultraviolet radiation, which had been expected through our preliminary tests, was examined in the present study. (Additionally, in an optional test using Filter U330 which allows only ultraviolet radiation to be passed, we detected ultraviolet radiation directly). However, we could not determine whether or not emission of ultraviolet radiation was related to detection of anomalous effects such as non-contact healing. Further studies are needed.

5. Conclusions

Cucumber liquid suspension (excluding skin) was measured and had a broad biophoton spectrum in which green light (520-540nm) was the strongest. Also ultraviolet radiation (280-370nm) was emitted although its intensity was weak.

Time transitions of photon intensities were different, depending on wavelength. The transition pattern of green light (520-540nm) was relatively similar to the pattern shown by cucumber pieces.

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