

Differences in Melanin Distribution in Different Regions of the Body

Measurement of Melanin in Skin

We measured the forehead, cheek, upper arm (inside), upper arm (outside), and forearm (outside) of a subject, using the Hadatomo™ Z photoacoustic microscope. The measurement area was 9 mm square and the scan step was 30 μm. A laser of 650 nm wavelength was used for measurement.

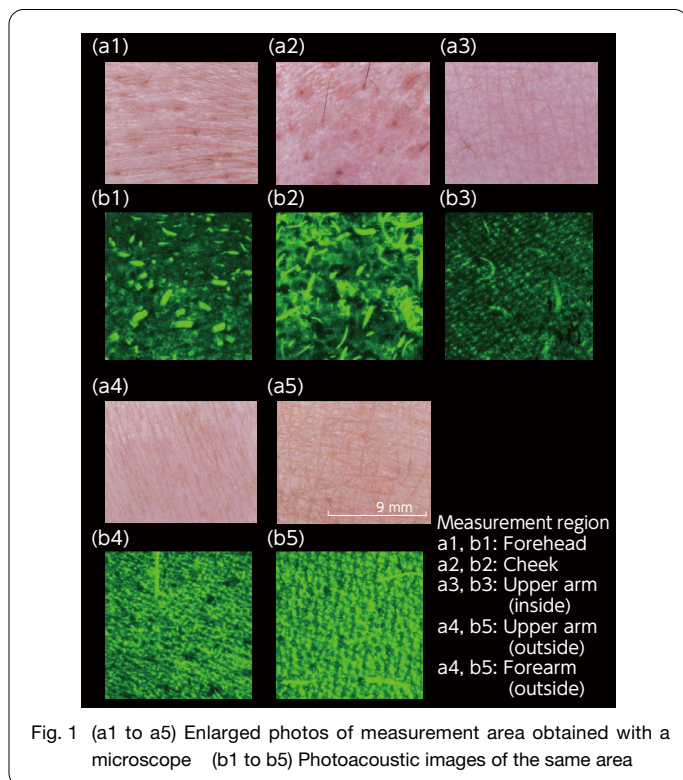


Fig. 1 (a1 to a5) Enlarged photos of measurement area obtained with a microscope (b1 to b5) Photoacoustic images of the same area

Fig. 1 shows enlarged images of the measurement area, obtained with a microscope, and photoacoustic images of the same area. On the forehead (a1, b1) and cheek (a2, b2) areas, hairs and distribution of melanin are observed, and in the cheek area, some spots are observed. This is also confirmed by higher brightness on the photoacoustic image. In contrast, on the inner upper arm (a3, b3), quite low brightness of melanin is observed, because this area is not exposed to the sun. On the outside upper arm (a4, b4), melanin is influenced by sun exposure, so that brighter photoacoustic signals are observed. Furthermore, on the outside forearm (a5, b5), influence of exposure is stronger, so that stronger signals representing melanin are observed.

Next, we measured the same areas with a simple melanin measurement instrument (Hi Skin by HiMirror) and compared the results with the photoacoustic images. The Hi Skin displays skin dullness as a number, by calculating scattering and absorption of light, using an LED. For the photoacoustic images, we calculated the standard deviation of signal intensity and the density

of signals having brightness of a standard level or higher for signals of up to 400 μm depth. Fig. 2 shows the results of each measurement.

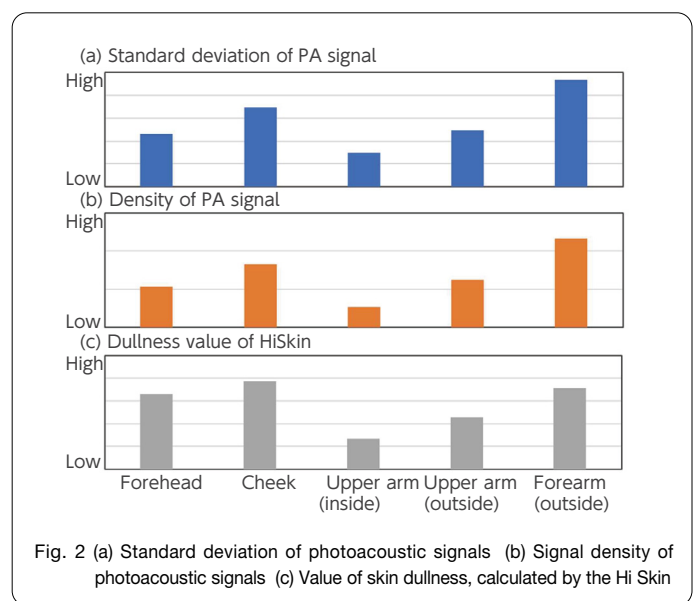


Fig. 2 (a) Standard deviation of photoacoustic signals (b) Signal density of photoacoustic signals (c) Value of skin dullness, calculated by the Hi Skin

All results show smaller measured values on the inside of upper arm, and larger values on the cheek and outside of upper arm. According to the values measured with the Hi Skin, the cheek shows a higher level of melanin than the outside of the forearm, while the results of analyzing the photoacoustic signal show a higher level on the outside of the forearm. Looking at the photoacoustic image shown in Fig. 1, melanin structures are observable in the pattern of the outside forearm (b5), and areas with less signal intensity and areas with high signal intensity are clearly separated, keeping the standard deviation value higher. In contrast, on the cheek (b2), though some signal intensity differences are observed, melanin distribution signals are distributed uniformly, leading to a lower standard deviation value compared to the outside of the forearm. When measuring with an optical measurement instrument such as the Hi Skin, increasing the spatial resolution is difficult, due to light scattering inside the organism, so photoacoustic images create possibilities for a new kind of analysis. The photoacoustic microscope Hadatomo™ Z can simultaneously obtain not only melanin images, but also images of blood vessels using ultrasound. It would thus be possible to analyze correlation between melanin values and blood vessel structure or the structure of the dermis.

