Spectral Reflectance of the Skin of Rats, Rabbits and Hairless Mice in the Regions 243–700 mμ and 0.707–2.660 μ

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THE DIFFUSE spectral reflectance of living human skin was measured for the visible (1–4), the ultraviolet (3, 4), and the near infrared ranges (5) of the spectrum. Recently, reflectance measurements made in this laboratory, with an improved technique and increased accuracy (6–8), have yielded additional data in the ultraviolet and the near infrared range (3, 9).

Reflectance data are of importance for the study not only of the structure and components of the skin (10, 11) but also of the effects of radiation and other agents which affect the skin (12, 13).

Corresponding reflectance data for the skin of common laboratory animals are rather scarce. Ascolese *et al.* (14) have presented curves on the rabbit, guinea pig and mouse for the range 400–700 mμ; Dimitroff *et al.* (15) have extended the range to 1000 mμ. Helmke (16) has used a limited reflectance measuring method on the living skin of the pig to correlate the visually measured decrease of reflectance in selected spectral bands (around 530 and 660 mμ) with the degree and the time course of radiation-produced erythema and pigmentation.

Reflectance data will furnish the information necessary for judging burn experiments on the basis of absorbed energy rather than of incident energy. The knowledge of the spectral reflectance of animal skin and its comparison with the human skin is important for such investigations.

This report extends the spectral range of earlier measurements on animal skin (15) and presents additional data on the hairless mouse. The spectral range covered in these measurements corresponds to the range of recent measurements on the human skin (3, 9). A corresponding study on the skin of Chester White pigs, used frequently in burn experiments, is under way and will be reported later.

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METHODS AND MATERIALS

Care and Preparation of Animals. Five Sprague-Dawley albino rats, average weight 225.2 gm; six hairless mice, average weight 19.9 gm; and five New Zealand white rabbits, 15–18 months old, average weight 4260 gm were used in the study. All animals were maintained on Purina Laboratory Chow and water, ad libitum.

The skin area selected for reflectance measurements on the rabbit and rat was the outer aspect of the right thigh; on the hairless mouse it was the posterior dorsal portion of the animal. The selected areas were prepared for spectral reflectance measurements as follows: rabbit and rat, clipped and depilated with Imra depilatory cream; the mouse, void of hair, needed no preparation. The measurements on the rats were made immediately after preparation, whereas on the rabbits they were made 48 hours after depilation because the depilating agent gave rise to some erythema after 24 hours (15).

All animals were anesthetized with Sodium Nembutal (Abbott), dosage as follows: rabbit, 25 mg/kg, intravenously; rat, 50 mg/kg, intraperitoneally; hairless mouse, 62.5 mg/kg, intraperitoneally.

Reflectance Measurements. *1. 243–700 mμ range.* As in the experiments on human skin (3), the Beckman Model DR recording spectrophotometer, equipped with a comparison type integrating sphere (8), was the instrument used for this spectral range. A $MgCO_3$ block which had previously been standardized against a 2-mm layer of MgO on a front surface mirror was used as the working standard (8). The measured reflectance values were converted to reflectances relative to the reflectance of MgO (i.e. r_{skin}/r_{MgO}) and are so reported.

2. 0.707–2.660 μ range. The instrument used for this spectral range was the NML spectrophotometer assembled at the Naval Material Laboratory (5) and modified with a comparison type integrating sphere designed and built at this laboratory (7). The same instrument was used previously for the measurements on human skin over the same wavelength range (9).

A vitrolite sample which had been standardized against MgO was used as a working standard. Two recordings were made, one with the beam incident on the vitrolite and the other with the beam incident on the skin. The measured reflectance values were converted to reflectances relative to the reflectance of MgO (i.e. r_{skin}/r_{MgO}) and are so reported.

RESULTS

1. 243–700 mμ Range. In figure 1, *curve 1* shows the mean spectral reflectance of six hairless mice, *curve 2* of five New Zealand white

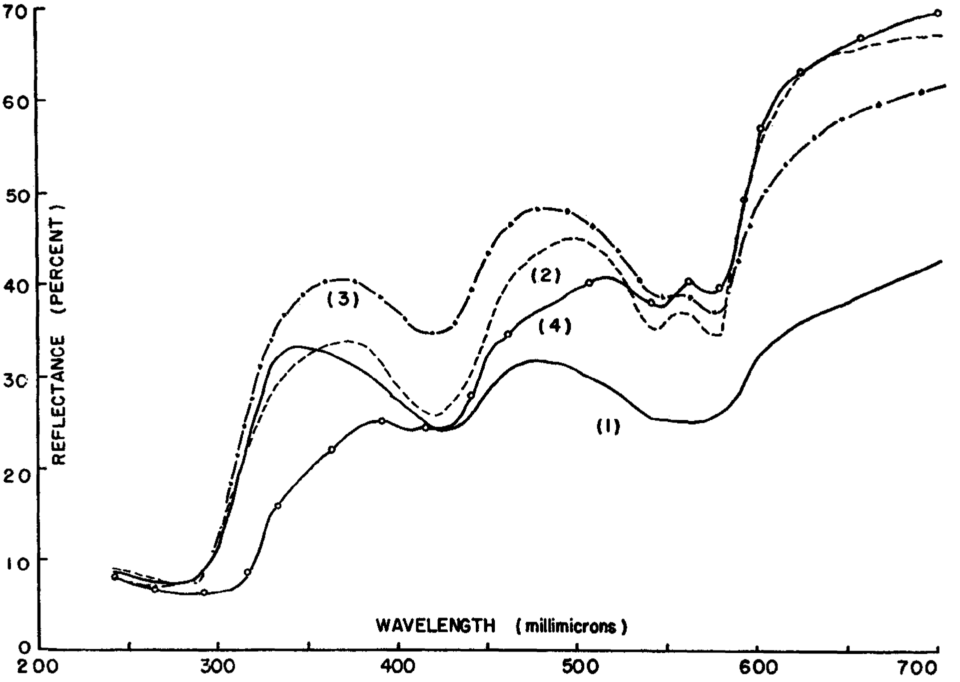

FIG. 1. Spectral reflectance values of the skin of hairless mice (*1*), rabbits (*2*) and rats (*3*) (mean values); and of human skin (*4*) (a fair-complexioned individual).

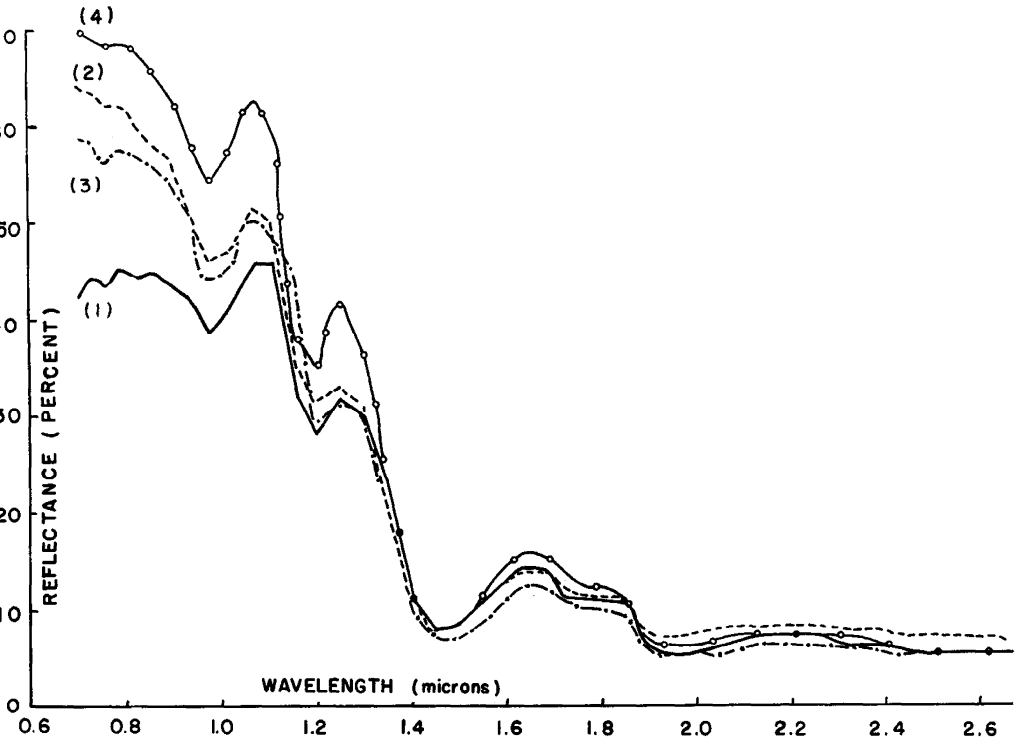

FIG. 2. Spectral reflectance values of the skin of hairless mice (*1*), rabbits (*2*) and rats (*3*) (mean values); and of human skin (*4*) (a fair-complexioned individual).

rabbits and *curve 3* of five Sprague-Dawley rats. *Curve 4*, showing the spectral reflectance of fair-complexioned human skin, obtained earlier (3) was added for comparison.

2. 0.707–2.660 μ Range. In figure 2, *curve 1*, the mean spectral reflectance of the six hairless mice is given. *Curves 2* and *3* show the reflectance of the five rabbits and five rats, respectively, and *curve 4*, added for comparison, shows the reflectance of fair-complexioned human skin as reported earlier (9).

DISCUSSION AND CONCLUSIONS

In the wavelength region 243–700 mμ, the shapes of the reflectance curves of the animals studied are quite similar to that of a lightly pigmented human, as can be seen in figure 1. Below 300 mμ there appears to be little or no difference in spectral reflectance measurements on either the animals studied or on humans as previously reported (3). As a percentage comparison, values obtained on the rat, rabbit and hairless mouse range from 7.2–8.7%, whereas values obtained on the human skin were from 6 to 8% and show little variation among individuals. In the wavelength range 300–425 mμ, the values obtained for the hairless mice and rabbits do not differ appreciably, whereas values obtained on the rat are slightly higher. Above 425 mμ the values obtained for the hairless mouse are considerably lower than the reflectance values of the rat or rabbit. As previously reported (15), the mean skin thickness of the rabbit and rat is 1.8 and 1.0 mm, respectively. Measurements of the thickness of the hairless mouse are of the order of 0.6 mm. Because of this difference in skin thickness of the mice in comparison with the rats and rabbits, it can be assumed that reflectance values obtained on the hairless mice do not represent the reflectance of the skin only but also of deeper tissues.

The prominent absorption bands of hemoglobin and water are quite evident for the rabbit and rat and comparable to those of the human. The oxyhemoglobin bands appear clearly in the rabbit and rat but are not resolved in the hairless mouse. This again can be ascribed to the contribution of deeper tissues to the measured reflectance of the hairless mouse. This would mean that the spectrophotometric reflectance measurement is not well suited to study skin effects on the hairless mouse. On the other hand, it may be possible that on this thin-skinned animal the nondistinctive method may be helpful in the observation of changes in deeper tissue areas.

For the wavelength region, 0.7–1.2 μ, the shapes of the reflectance curves of the hairless mouse, rabbit and rat are quite similar to that of the fair-complexioned human as can be seen in figure 2. However, the values obtained for the hairless mouse are considerably lower than those of the rat, rabbit or human. This difference may again be attributed to the difference in skin thickness of the mouse as compared with the rat and rabbit. Above 1.2 μ there appears to be very little difference in skin reflectance values obtained on the animals studied or the human, as previously reported (9). The values of 5–8% obtained at the long wavelength limit may be due to Fresnel reflection at the skin surface.

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