CONTRIBUTION TO THE PENETRATION OF RADIONUCLIDES ACROSS THE SKIN. AGE DEPENDENCE OF PROMETHIUM THROUGH RAT SKIN IN VITRO

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Introduction

Regarding the actual composition of radionuclides absorbed on the surface of the skin tissue two practical damages must be considered: absorbed energy of beta radiation in soft tissue, and the extent of penetrated amounts of radionuclides caused internal contamination.

Uptake of radionuclides by skin is fully different in case of intact skin, that it is in case of damaged skin, being from tens to hundred times higher in case of skin scarified, burned or wounded [1].

The penetration of radionuclide depends on age of the skin.
In this paper:

- the time dependence of permeation of $^{147}Pm^{3+}$ from aqueous solution through animal skin model was studied,
- the age dependence of promethium through the skin was proved,
- the optimum biological model of human skin was selected, and
- the relative importance of the main diffusion pathways for $^{147}Pm^{3+}$ the diffusion across the intact skin and the diffusion through the hair channels was assessed.

Experimental

The Pm^{3+} cation was used in the experiments. The radionuclide ($^{147}Pm^{3+}$) was used with its homologe nitrate carrier $Nd(NO_3)_3.6H_2O$. The experimental arrangement consisted of Franz-type [2] vertical penetration cells (active area 0.8 cm^2) completed with fresh skin from the abdominal region from 3- to 12-day-old rats (3DR to 12DR) of the Wistar strain (Breedeing farm Dobrá Voda, Slovakia). The 3DR to 6DR skins are still hairless and the 7DR to 12DR are hairy.

Ions that had permeated throuhg the skin from the donor solution (0.3 ml) to the receptor solution (7.3 ml, phosphate buffered saline, 1:9; pH 7.4) were determined in aliquots (0.3 ml) sampled at 1,3,5,7,9 and 24 h after starting the experiment. The permeation cells were kept at 32 °C during the experiment. The concentration of the carrier in the donor solution was 10^{-1} % (w/v).

The activity applied in the experiment for one Franz-type cell was 790 kBq in 0.3 ml of donor solution. The radioactivity of permeated $^{147}Pm^{3+}$ was measured by liquid scintillation spectrometer (LSC TriCarb 2500 TR, Packard Instrument Co., Meriden, USA) in 5 ml of toluene scintillation coctail (SLS-31, Spolana, Neratovice, Czech Republic). The permeated fractions and fluxes were calculated by the PC program PERMEA[3].

Results and discussion

In Fig.1. is compared the permeation of promethium across skin of different age. The age of skin markedly influences the penetration of substances into an organism. The values of permeated fractions decrease from 3DR to 7DR and further increase till 12DR. This proces can be explained with:

- with accelerated thickness of the skin before maturation of the skin
- rising of surface density of folicules, which contribute to the transfolicular penetration.

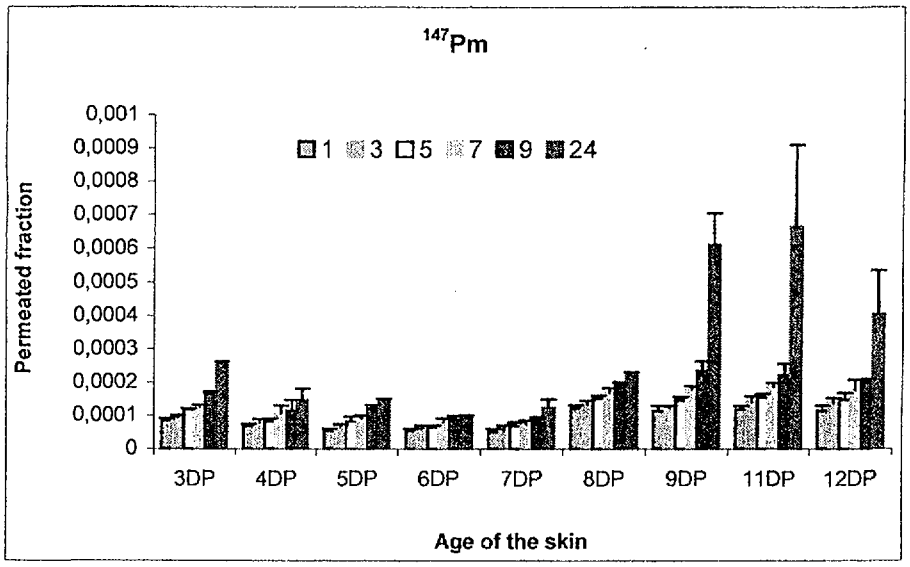

Fig. 1. Age profiles of permeated fraction of ^{147}Pm across the intact skin from 3DR to 12DR at donor carrier concentration 0.1 %.

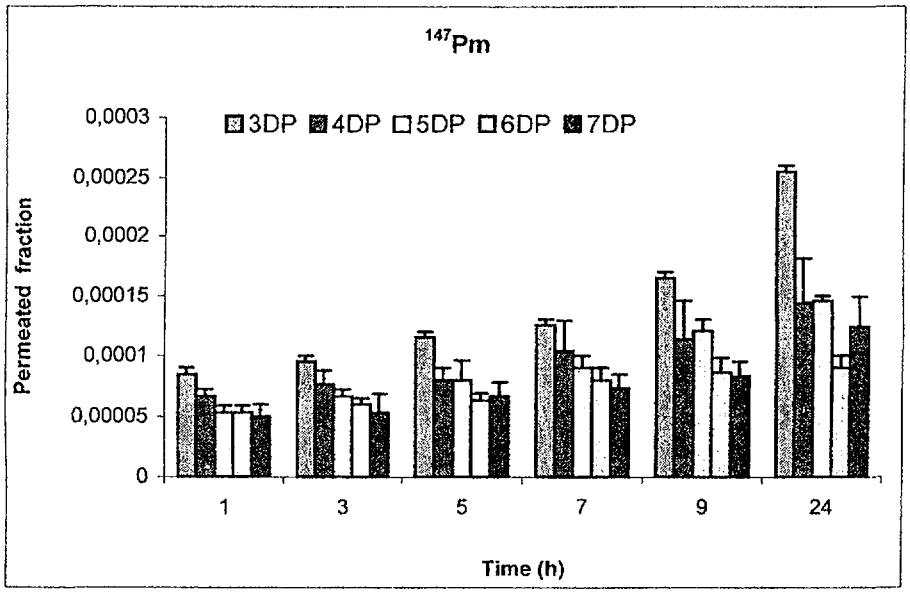

Fig. 2. Time profiles of permeated fraction of ^{147}Pm across the intact skin from 3DR to 7DR at donor carrirer concentration 0.1 %.

The increasing density of hairs at the oldest rat skins prevent the access of donor solution to the surface of the skin and is directly proportional to the density of follicules.

The results in Fig. 2 and 3 document the discussed facts.

In the Fig. 2 are given the permeated fractions of 3DR to 7DR skin. The permeated fraction through the 3DR skin is caused by low thickness of the skin, yet not quite proper for experimental use as animal model from mechanical point of view. The skin of 4DR and 5DR is more thick and resistant as documented by decreasing speed of permeation.

5DR represents the optimal animal model of human skin as certified in our work as well as by other authors[4-6].

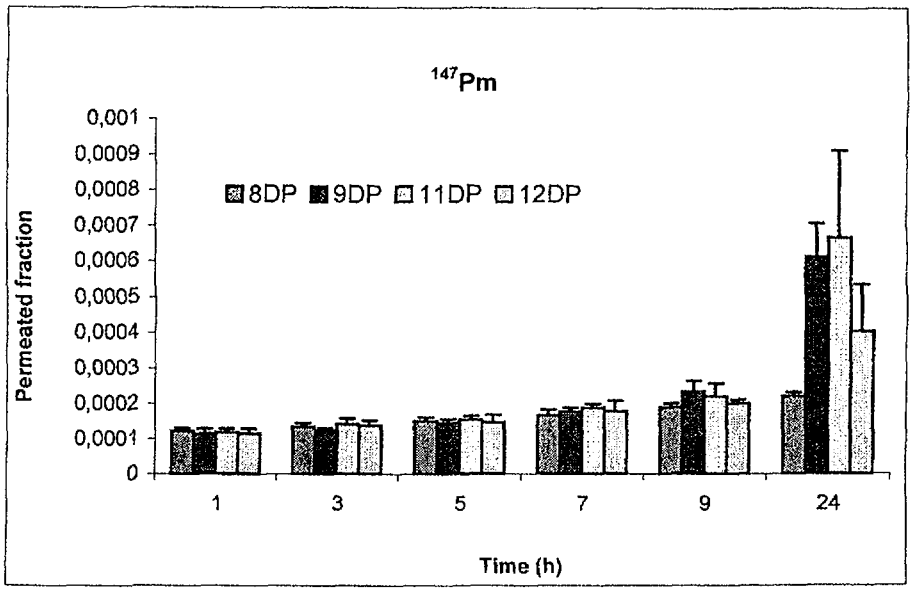

Fig. 3. Time profiles of permeated fraction of ^{147}Pm across the intact skin of 8DR to 12DR at donor carrirer concentration 0.1 %.

In Fig. 3 are given the permeated fractions through 8DR to 12DR. The higher permetion comparing to case of 5DR was caused with higher density of follicules. It was applied the tranepidermaly passage of ions of donor solution. In the case of 12DR the more grown hairs prevent the direct contact of the skin with donor solution and consequently the value of permeated fraction is lower. This transfolicular permeation contribute to transepidermal permeation as is with 5DR.

Conclusion

Concluding it can be said, that:

- it was proved, that the 5DR represents the optimum animal model to the human skin,
- in the case of 8DR to 11DR the dominant route of $^{147}Pm^{3+}$ penetration is along the follicles,
- the permeation resistance of the skin depends on the thickness and mechanical properties of the skin.

Comparing amounts of penetrated ions of promethium through the skin withouth hairs (3DR to 6DR) and through the skin with hairs, it was showed that the additional diffusion along hair´s follicles pronaunced with animal skin can be important also in case of human skin where hair density is many times lower than in used animal models.

Acknowwledgements

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