Rice starch added to bath water was studied for its possible beneficial effects on impaired barrier function as evaluated by transepidermal water loss measurements. The forearm skin of healthy volunteers was irritated by sodium lauryl sulphate. Exposure to rice-starch-containing bath water – twice daily for 15 min – led to a 20% improvement on the healing capacity of damaged skin. The beneficial effect was also observed for a rice-starch-containing lipid-free bath formulation, and an oil-in-water bath lotion enriched with evening primrose oil. Skin barrier function in patients with atopic dermatitis also improved after the addition of starch powder to bath water. Rice starch in powder or formulated in a bath product can therefore be recommended as a skin repair bathing additive for barrier damaged skin, particularly in the case of atopic dermatitis patients. Key words: starch-containing suspensions; bath products; TEWL measurements.

Volunteers and experimental design

Effect of starch powder (10 g/l bath water) on SLS-damaged skin of healthy persons. Twelve healthy white female volunteers aged between 40 and 47 (44 ± 4) years were selected for the study. Their skin type was normal to dry as judged by a dermatologist. Two weeks before the start of the study, and during the test period, the volunteers were not allowed to use cosmetics such as soaps, body lotions or cleansers on both arms. For personal hygiene, only water could be used and they were asked not to make any distinction between left and right arms during washing. After receiving approval from the Ethics Commission of the Academic Hospital of the Vrije Universiteit Brussel and signed informed consent from the participants, skin irritation was induced by SLS patches on the ventral surface of the forearms. A volume of 160 μl of 1.6% (w/v) SLS (Sigma, St. Louis, MO, USA: 99% purity) was absorbed into a filter paper (20 mm, pore size 200 μm, Sartorius, Göttingen, Germany), applied under occlusive dressing (Dermalock®, HDPMedical, Waasmunster, Belgium) and fixed with a self-adhesive Fixomull® stretch (Beiersdorf, Hamburg, Germany). ‘Blank’ patches with 160 μl water were also applied on both forearms and served as the undamaged control test area. After 24 h exposure, the dressings were removed and the arms rinsed in pure water and gently tapped dry. Transepidermal water loss (TEWL) measurements were carried out 48 h later in order to eliminate the effect of occlusion on the skin.

Effect of starch-containing preparations (1 g/l bath water) on SLS-damaged skin of healthy persons. The same test procedures as described above were carried out. Twelve healthy white female volunteers aged between 20 and 33 (25 ± 4) years were exposed to a lipid-free starch formulation. Another group of 13 female volunteers (24 ± 3; age range 21–31 years) were exposed to the o/w bath lotion.

Materials and methods

Starch preparations

Rice starch was obtained from Remy (Wijgmaal, Belgium) and is derived from Oryza sativa (Gramineae) as 100% pure. Rice starch is readily suspended in water. Two starch-containing (40%) bath lotions were prepared. The first was a lipid-free formulation with high concentrations of glycerin (15%) and dimethicone (5%). The second preparation was supplemented with 5% evening primrose oil (Oenothera biennis) as an oil-in-water (o/w) bath lotion. The preparations did not contain perfume and had a pH of 5.8. The bath volume was 3 l of water in which either starch powder (30 g) or one of the two preparations (7.5 g) was suspended. Final starch concentrations were therefore 10 g/l or 1 g/l, respectively. The water was then heated to 37°C to obtain a comfortable bath temperature. As control, we used 3 l of water also warmed to 37°C. Arm baths were given twice daily for 15 min.
Efficacy measurements

Assessment of TEWL was made using a Tewameter TM210® (Courage & Khazaka electronic GmbH, Köln, Germany). TEWL was measured under standardized conditions in a climate-controlled room (7, 8). Measurements were done before the first bath session and on subsequent days, each time 12 h after the previous bath session.

Statistical analysis

Non-parametric Friedman tests were used for comparison of mean values as a function of time. Wilcoxon signed-rank tests were used to analyse the TEWL measurements. A $p$-value <0.05 was considered statistically significant.

RESULTS

Effect on SLS-damaged skin of healthy persons

Starch powder (10 g/l bath water). TEWL values measured on both arms prior to the study were similar. SLS exposure of the skin led to red and scaly lesions characterized by an approximately fivefold increased TEWL. To allow statistical comparison, TEWL values at the control test spots of the forearm — bathed in plain water only — were set to 100%. After daily exposure of forearm skin to bath water with starch powder, a significant improvement of up to 20% in TEWL was seen on the SLS-irritated test spot (Fig. 1). It was also observed that non-SLS-treated skin did not show changes of TEWL during treatment with rice starch powder.

Starch-containing bath additives (1 g/l bath water). As can be seen in Fig. 2, neither the lipid-free starch-containing bath additive nor the o/w bath lotion had any effect on intact skin. However, when the forearm skin was damaged with SLS and immersed in the starch-containing bath water, there was a significant positive effect of more than 15% on healing capacity. The effects were comparable for both types of starch preparation.

Effects on skin of atopic patients of starch powder bath (10 g/l bath water)

Fig. 3 shows a significant improvement in the barrier function of clinically normal looking skin from day 2 and of eczematous lesions from day 4 in atopic patients. Untreated control spots on the upper arms were not exposed to bath water and TEWL values remained unchanged throughout the study ($p > 0.05$).

![Fig. 1. Mean transepidermal water loss (TEWL) values ±SD (n = 12) of sodium lauryl sulphate (SLS)-damaged and intact skin of healthy persons, expressed as a percentage of the test spots on the control forearm (bath water without starch) arbitrarily set to 100% (dashed line). A final concentration of 10 g/l starch was used. Wilcoxon signed-rank test was *$p < 0.05$, **$p < 0.01$ or ***$p < 0.001$.

![Fig. 2. Transepidermal water loss (TEWL) values of sodium lauryl sulphate (SLS)-damaged and intact skin of healthy persons after exposure to the starch-containing preparations (A. Lipid-free formulation; B. O/w bath lotion) added to bath water. A final concentration of 1 g/l starch was used in both formulations. Mean values ±SD; n = 12 (A); n = 13 (B) are given expressed as a percentage of the test spots on the control forearm (bath water without starch) set at 100% (dashed line). Wilcoxon signed-rank test was *$p < 0.05$, **$p < 0.01$ and ***$p < 0.001$.

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Thus, rice starch powder, which is a simple and inexpensive compound, can improve the barrier function of damaged skin. The use of rice starch as a bath additive is only one example of a suitable application method for treating disturbed barrier function. Whether other dermato-cosmetic preparations containing starch have the same positive effects should therefore be investigated.

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