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INVESTIGATIVE REPORT

Effect of Rice Starch as a Bath Additive on the Barrier Function of Healthy but SLS-damaged Skin and Skin of Atopic Patients

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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.***

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The addition of starch to bath water is recommended by some dermatologists for the treatment of atopic dermatitis (AD) or skin diseases associated with pruritus. However, there is hardly any documentation for its efficacy in the literature (1). The aim of this study was to investigate the possible effects of rice starch on skin barrier function. The study was conducted on artificially damaged skin of healthy volunteers using sodium lauryl sulphate (SLS) to provoke irritant contact dermatitis (ICD) (2, 3). We also included patients with AD who suffer from damaged barrier function characterized by dry, rough skin (4–6).

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 biennes) 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.

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®, HDP Medical, 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.

Effect of starch powder (10 g/l bath water) on atopic skin. Eight male and five female patients with AD, aged between 19 and 38 (25 ± 6) years, agreed with the experimental set up, which included the interruption of any topical treatment 14 days prior to the start of the study. Both eczematous lesions ($n = 5$) and clinically "normal" skin ($n = 13$) were evaluated on the arms.

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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.

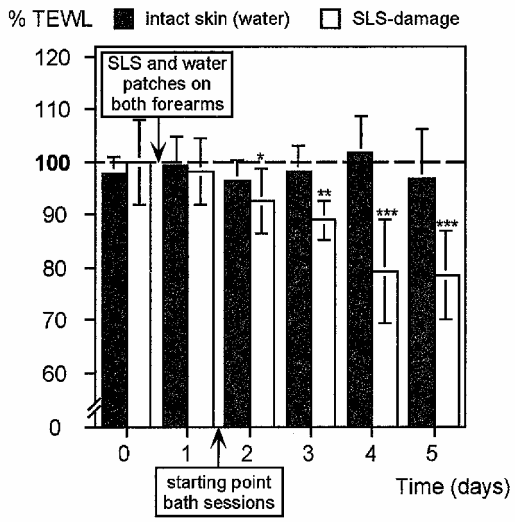

Fig. 1. Mean transepidermal water loss (TEWL) values ± SD ($n = 12$) of sodium lauryl sulphate (SLS)-damaged and intact skin of healthy persons, expressed as a percentage of the test spots on the control forearm (bath water without starch) arbitrarily set to 100% (dashed line). A final concentration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

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 ($p > 0.05$).

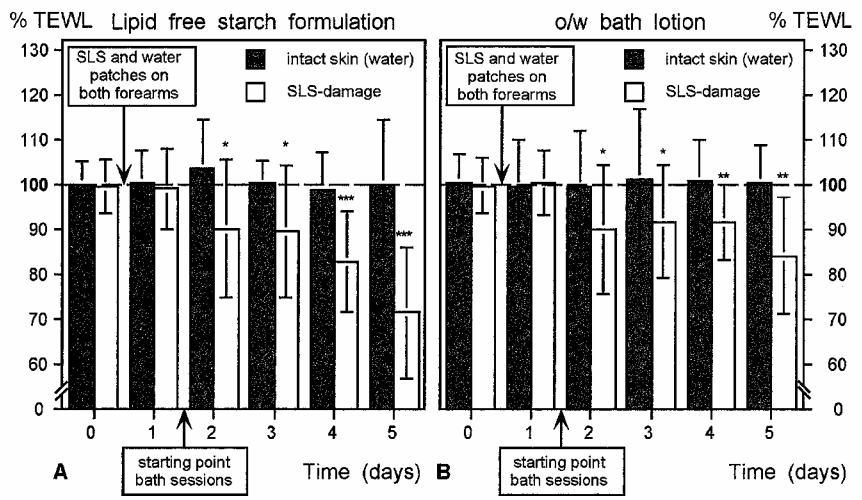

Fig. 2. Transepidermal water loss (TEWL) values of sodium lauryl sulphate (SLS)-damaged and intact skin of healthy persons after exposure to the starch-containing preparations (A. Lipid-free formulation; B. O/w bath lotion) added to bath water. A final concentration of 1 g/l starch was used in both formulations. 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 $***p < 0.001$.

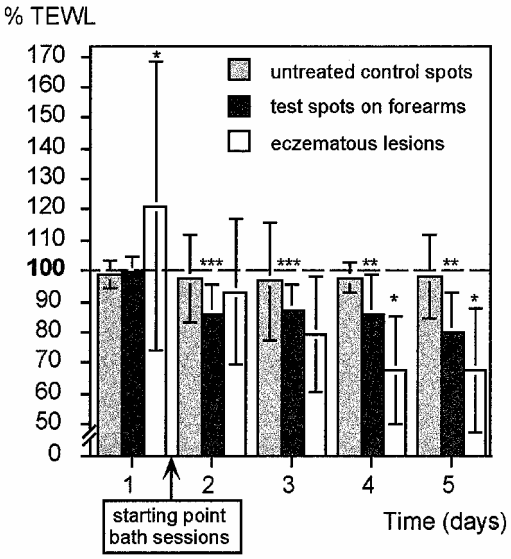

Fig. 3. Effect of starch powder dispersed in bath water on the TEWL values of atopic skin. A final concentration of 10 g/l starch was used. Mean values ± SD ($n = 13$; eczematous lesions, $n = 5$) are given expressed as a percentage of the appropriate test spots on the control arm (bathed in plain water) arbitrarily set at 100% (dashed line). Wilcoxon signed-rank test was $*p < 0.05$, $**p < 0.01$ and $***p < 0.001$.

DISCUSSION

The present study demonstrates a beneficial effect on damaged skin barrier from using rice starch in bath water. Since it has been shown that long-lasting exposure to water can aggravate the subclinical inflammatory reaction in irritated skin (9, 10), we used a short bath period of 15 min. However, this is still longer than is usually practised in routine dermatology (11). In detergent-irritated skin of healthy persons, similar improvements were observed when the final concentration of starch powder was 10 g or 1 g per litre bath water. The concentration of rice starch incorporated was not therefore an essential factor, nor was the formulation of the starch-containing preparation. Although one would expect better effects from the o/w bath lotion that combined starch with evening primrose oil, which is known as an efficient skin emollient (12), no statistical differences could be detected. In AD skin, barrier function improvement was observed with starch powder baths containing 10 g/l starch.

It is hypothesized that the healing effect of starch is due to the fact that small molecules can penetrate the upper layers of the fissured skin and form a homogenous layer. The presence of starch molecules in the upper layers of the stratum corneum has been shown by iodide colouration after tape-stripping. A blue colouration was seen only in the first two strippings, indicating no further penetration of the starch molecules. Strips taken from unaffected skin did not reveal any positive reaction. This is in line with our observation that starch powder baths did not change the TEWL of intact skin.

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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