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On the influence of bath oils with different solvent characteristics and different amounts of a non-ionic tenside on the hydration and barrier function of the stratum corneum

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Synopsis

The research results presented here show the dehydration effect of water baths and oil baths with a high content of a non-ionogenic tenside. Baths of this composition lead to an increase in transepidermal water loss in the sense of slight barrier damage. With oil baths containing a small amount of the non-ionogenic tenside and with even more in spreading oil baths, an increase in the hydration of the stratum corneum and a decrease in transepidermal water loss in an occlusive effect can be proven by contrast. Practical significance of the results of these investigations is gained, especially for patients with atopic eczema. For these patients, the tenside content in a bath oil should be kept low or, better, spreading baths without tensides should be used.

INTRODUCTION AND AIM OF THE STUDY

Most of the publications on the effect of bath oils in consideration of their tenside content and the character of the oil investigate their influence on skin surface lipids (1–3). Gloor *et al.* could prove a dependence of the skin surface lipids on the tenside content and the amount of emollients in bath oils (4–6). The lower the amount of tenside in the oil baths and the higher the amount of emollients are, the more skin surface lipids were present.

Although the barrier function and the water content of the stratum corneum can be considered to be functions that are dependent on various lipid parameters, the capacity of bath oils with differing tenside content and oil character (dispersion oil, spreading oil) to influence them has not yet been investigated. With the present study, two questions are to be evaluated critically. First: is it possible to achieve an exsiccating effect or to influence the barrier function of the skin negatively by varying the amount of a non-ionogenic tenside in bath oil solutions? Second: Has the character of an oil bath either as a spreading bath or a dispersion oil bath an influence on the aforementioned parameters?

MATERIAL AND METHODS

TEST SUBJECTS AND TREATMENT

In this study 15 volunteer test persons were included. They had no pathologic results on the skin sites that were investigated (volar forearm). The measurements were carried out in partly air-conditioned rooms (22°C, 45% relative air humidity). The time for acclimatization was 30 minutes.

The age distribution of the nine men and six women included in the study was 20.6 (18–37) years for women and 27.2 (16–35) years for men.

The wash solutions used had the following composition:

A:	Almond oil	30.0
	Paraffinum per liqu.	70.0
B:	Tween 20[1]	18.0
	Almond oil	64.0
	Aqua purif.	18.0
C:	Tween 20	47.0
	Almond oil	41.0
	Aqua purif.	12.0

Bath oil A was a spreading oil bath, and bath oils B and C were dispersion-type oil baths with differing amounts of tenside. The dilution was 0.2 ml per 500 ml (corresponding to 40 ml per 100 l of a bath) with luke-warm tap water (35°C) for each formulation. Before the start of each test, the forearms, which were not treated previously, were subdivided in two areas separated from each other by strips of adhesive tape. The test sites were rotated from test person to test person and thereby randomized. An initial value was measured (0-value) to which all further measurements were related.

Washing procedure. The washings were performed according to the test procedures of Bettinger *et al.* (7): The individuals sites were washed for three minutes with a roll of foam material that was moved back and forth 30 times per minute. After one and two minutes, respectively, the roll was soaked in the bath oil solutions again. No pressure was applied to the skin other than that of the roll's own weight. The forearms were lying horizontally on the padding during the washing procedure.

The washing solution was left to incubate on the skin for 15 minutes. Subsequently the first measurement was performed after residues of solution A (spreading bath) were swabbed off with a non-fraying tissue (Kleenex, Kimberley Clark, USA). After the first measurement, we rinsed off the bath oil residues carefully without spilling the solutions from one test site to another. Afterwards the second washing was performed with tap water only, at 35°C, on all four test sites, each with an individual, fresh roll of foam material. Further measurements were performed 30, 60, 90, and 120 minutes after the first washing.

[1] Polyoxyethylene sorbitanmonolaurate DAB 9, non-ionic tenside, Merck, Schuchardt, Hohenbrunn, Germany.

METHOD OF MEASUREMENT

The horny layer hydration was determined by capacitance measurement using a Corneometer CM 820 (Courage & Khazaka, Cologne, Germany). The depth of measurement ranged from 60 μm to 100 μm. The method is critically discussed by Blichmann and Serup (8) as well as by Hashimoto-Kumasaka *et al.* (9), especially in comparison with other methods that register stratum corneum hydration. The measurements were carried out according to the guidelines published by Berardesca (10). The barrier function was detected with the help of transepidermal water loss using a Tewameter TM 210 (Courage & Khazaka, Cologne, Germany). The principle of the measurement method and the guidelines for use are described in detail and discussed by Pinnagoda *et al.* (11).

STATISTICAL EVALUATION

The measurements were related to the initial value (T0) before the first washing. Because the distribution was not normal, we carried out a distribution-free Wilcoxon signed-rank test for dependent samples. Average, standard deviation, median, and box (first and fourth quartile or 25% and 75% percentile, respectively) are given in Tables I and II. The significance level for differences was set to $p < 0.05$; high significance was assumed for $p < 0.01$.

RESULTS

The results are presented in Table I and II, and the statistical evaluation of the differences between the measured values in the individual groups are shown in Table III and IV. Figures 1 and 2 illustrate the results.

TRANSEPIDERMAL WATER LOSS

The spreading bath and the oil bath with the low tenside content produce an occlusive effect. By contrast, the oil bath with the high tenside content and the water bath lead to increased transepidermal water loss and therefore to barrier damage. The difference between the spreading bath and the oil bath with the low tenside content is small. The water bath does not differ definitively from the bath with the high tenside content.

STATE OF HYDRATATION OF THE STRATUM CORNEUM

A dehydration effect in the form of a decrease in the capacitance values can be found for water alone and for the bath solution with the high tenside content, without any significant difference between these two baths. The best hydration is seen in the group with the spreading bath, with highly significant differences to the water bath, to the oil bath with high tenside content, and to the oil bath with low tenside content. The bath solution with the low tenside content showed a highly significant increase in the moisture content of the stratum corneum relative to high tenside concentration and the application of water alone, although it was less pronounced than with the spreading bath. The solution with the high tenside content differs from water alone, only at the

Table I
TEWL Values (SD) in g/m^2 × h [averages, standard deviations, median values, and boxes (25% and 75% percentile)]

15 min	M	SD	Median	Box
Spreading bath	-0.92	1.01	-0.5	-1.7/0.2
Tween 20: 18%	-0.44	1.07	-0.5	-0.8/0.0
Tween 20: 47%	0.29	0.93	0.2	-0.6/1.0
Water	0.34	1.80	0.6	0.0/1.2
30 min	**M**	**SD**	**Median**	**Box**
Spreading bath	-0.63	1.19	-0.6	-1.3/0.0
Tween 20: 18%	-0.55	1.04	-0.6	-1.0/0.2
Tween 20: 47%	0.11	1.14	0.0	-0.4/0.5
Water	0.53	1.37	0.5	0.1/1.5
60 min	**M**	**SD**	**Median**	**Box**
Spreading bath	-0.91	1.17	-0.7	-1.7/-0.2
Tween 20: 18%	-0.07	1.33	-0.6	-1.4/0.0
Tween 20: 47%	0.12	0.86	0.0	-0.7/0.7
Water	0.61	1.64	0.5	0.1/1.5
90 min	**M**	**SD**	**Median**	**Box**
Spreading bath	-1.15	0.93	-1.0	-2.0/-0.2
Tween 20: 18%	-0.79	0.79	-0.6	-1.1/-0.5
Tween 20: 47%	-0.15	1.21	0.0	-0.4/0.8
Water	0.31	1.19	0.5	0.1/1.2
120 min	**M**	**SD**	**Median**	**Box**
Spreading bath	-1.28	1.16	-1.1	-1.7/-0.5
Tween 20: 18%	-0.80	1.20	-0.6	-1.3/0.0
Tween 20: 47%	-0.30	1.60	0.0	-1.0/0.6
Water	0.09	1.29	0.3	-1.0/1.1

end of measurement period at a weakly significant level, so that no definite difference between these groups can be assumed.

DISCUSSION

The present study was performed with the aim of elucidating the influence of different bath oils with two distinct dissolution characteristics (spreading and dispersion bath oil) and different amounts of a non-ionic tenside on the state of hydration of the stratum corneum and transepidermal water loss, and therefore on barrier function and occlusivity. Two questions were in focus: First, the question of the possible dehydrating and barrier-damaging effect of the non-ionic tenside. Second, the influence of the character of the bath oil (spreading vs dispersion oil bath) on these parameters.

The dessicating effect of tensides is established, since the basic work of Blank and Shappirio (12). Gabard *et al.* (2) as well as Müller *et al.* (3) could demonstrate a decrease

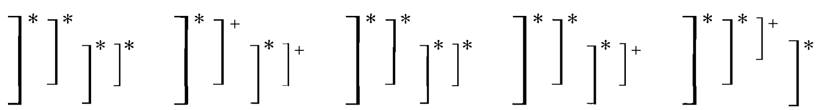
Table II
Capacitance Values (corneometry) in Arbitrary Units [averages, standard deviations, median values, and boxes (25% and 75% percentile)]

15 min	M	SD	Median	Box
Spreading bath	1.99	9.96	1.5	-6.4/10.9
Tween 20: 18%	2.10	4.89	1.1	-1.5/5.9
Tween 20: 47%	-3.20	4.51	-2.0	-5.9/0.0
Water	-4.54	5.71	-5.7	-8.9/-1.3
30 min	**M**	**SD**	**Median**	**Box**
Spreading bath	12.74	3.88	12.9	10.0/15.4
Tween 20: 18%	0.41	5.08	1.8	-2.6/29.0
Tween 20: 47%	-3.72	3.67	-3.5	-7.2/-1.3
Water	-4.94	4.27	-5.2	-9.0/-2.1
60 min	**M**	**SD**	**Median**	**Box**
Spreading bath	10.47	4.81	10.0	6.7/13.7
Tween 20: 18%	0.90	5.47	1.4	-4.02/2.7
Tween 20: 47%	-4.60	2.57	-3.8	-7.0/-2.4
Water	-5.97	5.35	-4.5	-10.4/-1.2
90 min	**M**	**SD**	**Median**	**Box**
Spreading bath	8.22	5.62	9.2	3.1/11.0
Tween 20: 18%	0.12	6.58	1.8	-3.0/5.1
Tween 20: 47%	-4.13	3.31	-2.5	-6.5/-1.9
Water	-4.65	4.47	-4.8	-7.4/-1.9
120 min	**M**	**SD**	**Median**	**Box**
Spreading bath	7.16	6.47	6.6	2.9/10.0
Tween 20: 18%	0.93	7.68	2.4	-2.0/6.3
Tween 20: 47%	-1.65	4.48	-0.6	-9.1/1.8
Water	-4.70	4.46	-3.9	-9.4/0.0

in transepidermal water loss, and therefore in occlusivity, from a spreading oil bath. Gloor *et al.* could prove an interdependence between the stratum corneum lipids and tenside content and the amount of emollient in bath oils (4–6). Here, a lower tenside content leads to a higher lipid amount after application of a bath oil with emollients.

Table III
Differences Between TEWL Values

	15 min	30 min	60 min	90 min	120 min
Spreading bath					
Tween 20: 18%					
Tween 20: 47%					
Water					



Wilcoxon signed-rank test (* = $p < 0.01$, + = $p < 0.05$).

Table IV
Differences Between Capacitance Values (Corneometer)

	15 min	30 min	60 min	90 min	120 min
Spreading bath	]*	*] *] *]	*] *] *]	*] *] *]	]*]*]*
Tween 20: 18%	]*]*	*] *]	*] *]	*] *]	]*
Tween 20: 47%					]+
Water					]+

Wilcoxon signed-rank test (* = p < 0 .01, + = p < 0.05).

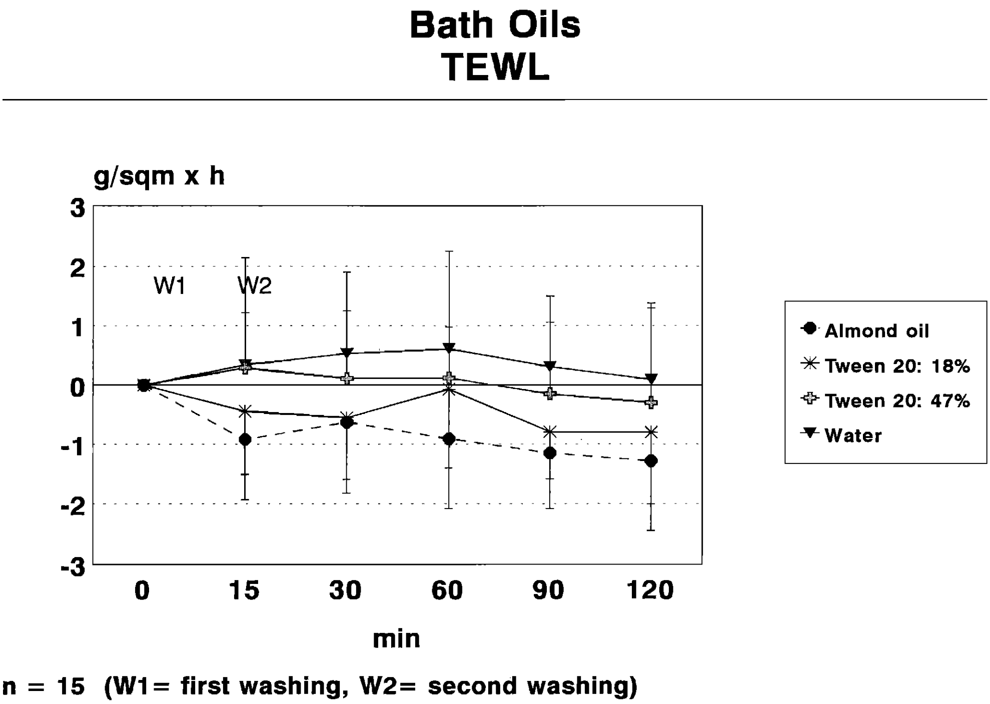


Figure 1. Transepidermal water loss measurement with the Tewameter during the two hours following washing.

The data compiled in this work allow the interpretation of an exsiccating effect of water baths and oil baths with a high content of a mild non-ionogenic tenside. Furthermore, baths of this composition lead to an increase in transepidermal water loss in terms of a slight barrier damage. Tenside solutions are not occlusive as oil solutions are. Treatment with solutions containing a high amount of Tween 20 leads to a "dry" sensory feel on the skin surface. In this context, water and the higher tenside content solution showed the least lubricity and the spreading oil the best lubricity. Thus the barrier damage may be partly due to a lack of lubricity during the washing procedure and an abrasion of the barrier lipids.

Oil baths with a low share of the non-ionogenic tenside and, even more, spreading oil baths produce an increase in the hydration of the stratum corneum and a decrease in

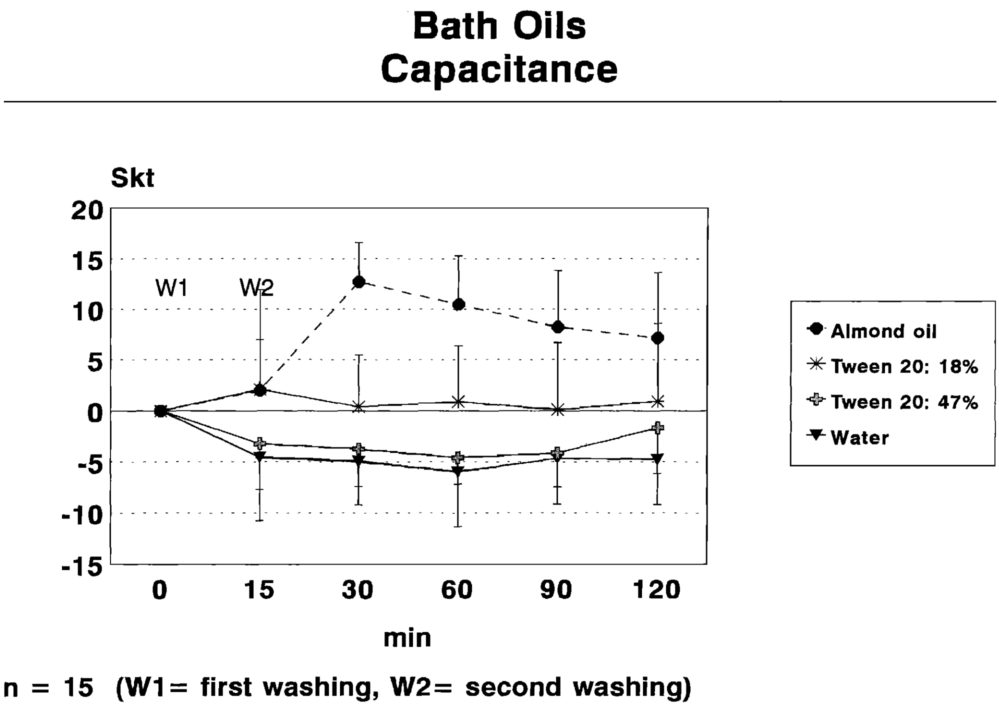


Figure 2. Capacitance measurement with the Corneometer during the two hours following washing.

transepidermal water loss in terms of an occlusive effect. This occlusive effect of spreading oil may partly explain the increase in stratum corneum hydration.

The results of this investigation gain a practical significance in patients with atopic eczema. For these patients, the tenside content in a bath oil should be kept as low as possible or, even better, spreading baths without tensides should be used.

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